Advances in Nutritional Surveillance:

The Cornell Nutritional Surveillance Program 1981 - 1987

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Cornell Food and Nutrition Policy Program (CFNPP)
Division of Nutritional Sciences
Cornell University
Ithaca, New York

August 1989

The Cornell Food and Nutrition Policy Program (CFNPP) was created in 1988 within the Division of Nutritional Sciences, Cornell University to undertake research, training, and technical assistance in food and nutrition policy with emphasis on developing countries. The Nutritional Surveillance Program (CNSP), which was formed in 1980 with support from the Office of Nutrition of the Agency for International Development, is part of the CFNPP.

CFNPP is funded by several donors including the Nutrition Office and the Africa Bureau of the Agency for International Development, UNICEF, the Pew Memorial Trust, the Rockefeller Foundation, the Government of Indonesia, and the World Bank.

CFNPP is served by an advisory committee of faculty from the Division of Nutritional Sciences, the departments of Agricultural Economics, Rural Sociology and Government, and the Program of International Agriculture. Several faculty members and graduate students collaborate with CFNPP on specific projects. The CFNPP professional staff includes nutritionists, economists, and anthropologists.

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FOREWORD

Much has been learned about how to effectively design and implement nutritional surveillance since 1980 where the Division of Nutritional Sciences, Cornell University and the Office of Nutrition, Agency for International Development entered into a cooperative agreement to develop the theory, methodology and practice of nutritional surveillance. Under the able leadership of Jean-Pierre Habicht, principal investigator, and John Mason, Director of the Cornell Nutritional Surveillance Program (CNSP), a vast amount of research, training, technical assistance, and information dissimination was undertaken. This report summarizes and synthesizes the major findings and accomplishments and draws out lessons for the design and implementation of future nutritional surveillance activities.

During 1988, the mandate of CNSP was broadened to include food and nutrition policy analysis and the name of the program was changed to the Cornell Food and Nutrition Policy Program (CFNPP). Research, training, and technical assistance in nutritional surveillance continue to be an important component of CFNPP and lessons learned from CNSP activities are used to establish priorities for future work.

The major share of the work needed to prepare this report was contributed by Katherine Tucker, who spent many hours reading, summarizing, synthesizing, and interpreting a very large written output by CNSP staff and collaborators. David Pelletier also made a major contribution to this report, particularly with reference to the synthesis and the identification of lessons from the work. Each of the other four co-authors contributed specific sections of the report and assisted in overall interpretation of selected findings.

On behalf of Cornell University and collaborating institutions, it is a pleasure to express my most sincere appreciation to the office of Nutrition of the Agency for International Development for the initiative taken in 1980 and for the support received since then, and to the many other agencies that have provided support including the Africa Bureau, the Bureau for Policy and Program Coordination, the Bureau for Food for Peace, and the Indonesian Mission of the Agency for International Development; the headquarters, East Africa Regional office, and several country missions of UNICEF; the World Health Organization, the World Food Program, and the Indonesian government.

I believe the world is a better place because of the initiative taken in 1980 and the subsequent support. However, the job is merely begun. Persistent hunger and malnutrition continues to require our attention including better information to support the design and implementation of cost-effective action.

June, 1989
Ithaca, New York

Per Pinstrup-Andersen
Director of CFNPP

EXECUTIVE SUMMARY

The concept of nutritional surveillance was first introduced at the 1974 World Food Conference, and two years later a joint U.N. expert committee set up guidelines for defining, designing, and operating surveillance systems. In 1980, the Cornell Nutritional Surveillance Program (CNSP) was established through a Cooperative Agreement with USAID in order to further develop the theory, methodology, and practice of nutritional surveillance. This report describes the activities and accomplishments of CNSP from 1980 through 1987 and identifies some of the major areas for future work.

A pivotal accomplishment of CNSP staff was the review and synthesis of the experiences of various countries with "nutritional surveillance" activities. The results were published in 1984 in a widely circulated volume (B1).[1] The experiences reported in this volume confirmed the suspicions of the 1976 U.N. expert committee that countries differ considerably in information requirements, potential sources of data, and ability to convert data into usable information. Indeed, needs vary not only by country, but also by government department, administrative level (national, regional, district, etc.), and over time.

The synthesis volume provided a useful organizational framework for the many possible forms of surveillance and laid out general principles to follow in designing surveillance systems appropriate to local needs and conditions. Broad types of surveillance include policy and planning, program management and evaluation, and timely warning. A fourth type, problem identification, has since been added.

Through its methodological development and in-country activities, CNSP has provided concrete examples for each of the four types of surveillance and identified some of the factors likely to constrain success in each area. For certain surveillance activities, it is now possible to provide specific guidelines to developing countries.

CNSP's in-country experiences also reinforced the fact that the four types of surveillance are distinct in purpose and in requirements for data collection/processing, institutional structures, and links to decision-making. This diversity in types of nutritional surveillance, combined with differences in information

1 *The number in parentheses refers to the CNSP December 1987 List of Publications (Appendix 1).*

requirements, data availability and analytic ability within and among countries, posed difficulties in maintaining a coherent picture of "nutritional surveillance" as originally defined. In some of CNSP's country activities, particular information needs and other special local conditions sometimes made it difficult to assist decision-making *in that country at that particular time* and, simultaneously, to put in place a structured and on-going system that was easily replicated in other countries. The conclusion that emerges from these experiences is that developing countries may often need more than "nutritional surveillance *systems*" as traditionally conceived. Rather, they require the *capability* (in terms of training, institutional structures, resources, etc.) to undertake a variety of *surveillance activities* appropriate to their varied and changing information requirements and local conditions.

These considerations obviously have important implications for efforts to develop nutritional surveillance. Specifically, the task cannot be seen as merely solving technical bottlenecks in the process of "installing" a tightly integrated surveillance "system," a process that would lend itself more readily to the usual forms of technical assistance. Instead, the goal should be to critically evaluate the strengths and weaknesses of the various surveillance activities presently in practice, to develop alternative approaches where necessary, to improve our ability to recognize which approaches are appropriate in a given setting, and to transfer to developing countries the ability to do these things.

A number of lessons resulted from the first eight years of work by CNSP. These are summarized in the last section of this report.

INTRODUCTION

Nutritional surveillance or "to watch over nutrition, in order to make decisions which will lead to improvements in nutrition in populations" is a concept that is rapidly gaining recognition throughout the world (B1). General awareness has grown about the extent of malnutrition and its effect on the performance, health and survival of individuals that make up populations. Important questions are: what groups are malnourished; how many people are involved; where are they located; why are they malnourished; and how can limited resources be best used to alleviate the problem?

The term "nutritional surveillance" gained acceptance at the 1974 World Food conference, and was modeled on the concept of epidemiological disease surveillance. In 1975, UNICEF, WHO, and FAO held a joint expert committee meeting on the topic, which resulted in the report, "Methodology of Nutritional Surveillance" (WHO, 1976). The objectives defined in the WHO report include:

> . . . to describe the nutritional status of the population with particular reference to defined subgroups who are identified as being at risk...; to provide information that will contribute to the analysis of causes and associated factors..; to promote decision by governments concerning priorities and the disposal of resources to meet the needs of both normal development and emergencies; to enable predictions to be made on the basis of current trends in order to indicate the probable evolution of nutritional problems...; to monitor nutritional programmes and to evaluate their effectiveness (WHO, 1976:12).

The focus of a nutritional surveillance system is to monitor nutritional status and related indicators to provide information that will assist in decision-making for policy formulation and for the best allocation of scarce resources to nutritionally related problems.

The WHO report also outlined major considerations in the development of a surveillance system, including the "initial assessment" of the situation, potential indicators and data sources, and basic planning and design. It concludes with a recommendation that international agencies jointly respond to cooperate with countries in the setting up of (nutritional surveillance) systems...in organizing seminars for orientation on their objectives and methodology...aimed at senior staff of national agencies responsible for planning and development...and stimulating and assisting research projects to improve nutritional surveillance methodology.

Largely as a response to this report, several countries began to include items

related to nutritional surveillance in their development planning. In 1980, five years after the joint expert committee meeting, the U.N. (ACC/SCN)[2] Working Group on Nutritional Surveillance and the U.S. National Academy of Science Task Force on Nutritional Surveillance each met to discuss progress in the development and use of the concept.

It quickly became clear that expertise was needed to assist in the planning and development of the field of nutritional surveillance, and a Cooperative Agreement addressing this issue was signed in November 1980 between Cornell University and the United States Agency for International Development (USAID). The agreement's overall purpose was to establish a resource center specializing in nutritional surveillance, in developing theoretical and operational concepts for the design, development, management and evaluation of surveillance systems, in developing approaches which will encourage and support development of country initiatives, and in identifying the most effective and efficient use of financial, technical and institutional resources for nutritional surveillance. Cornell was expected to participate in in-depth cooperative efforts with developing countries to develop nutritional surveillance systems; to provide training in surveillance methodology; and to conduct operational research on system development and applied research in key areas such as: approaches to population sampling, identification and testing of indicators; development of simplified techniques for data collection; and research and development concerning the use of small-scale computers for field processing and tabulation of data (USAID, 1980).

The first major activity of the Cornell Nutritional Surveillance Program (CNSP) was a state-of-the-art review of nutritional surveillance work, using information compiled by the ACC/SCN working group and the NAS task force after their 1980 meetings, along with additional data gained from country visits and country contacts (CNSP, 1981). This review was published by WHO in 1984 (B1) and included detailed methodological procedures and concepts for nutritional surveillance. It served as a basic guide for future program activities.

In addition to the USAID Office of Nutrition funding for basic program activities (and for a Maternal and Child Nutrition Amendment in 1982), additional funds were obtained at various times and for specific activities from the USAID Africa Bureau, the USAID Bureau for Food for Peace and Voluntary Assistance, the USAID Indonesian Mission, the USAID Bureau for Policy and Program Coordination, UNICEF/New York, the UNICEF East Africa Re-

2 *Administrative Coordinating Committee, Subcommittee on Nutrition*

gional Office, UNICEF country offices in the region, WHO, FAO/Rome, and the World Food Programmes (CNSP, 1984; CNSP, 1986).

This report summarizes the major concepts developed and progress made by CNSP. It also includes information on the various country programs that CNSP initiated during the period 1980–87. The discussion is divided into three major sections: 1) scope and general principles; 2) methodological developments; and 3) country programs.

1. THE SCOPE AND GENERAL PRINCIPLES OF NUTRITIONAL SURVEILLANCE

In developing a conceptual model for nutritional surveillance, CNSP emphasizes the importance of making information available in a timely manner to those who need it for decision making. CNSP defines three major thrusts within the basic concept of nutritional surveillance based on different types of decision-making needs. These are: 1) national level planning; 2) program management and evaluation; and 3) timely warning and intervention.

A national nutritional surveillance system may focus on one or all of these areas depending on specific needs. The first stage in the development of a system is the "INITIAL ASSESSMENT" (Figure 1). Key decision makers/users of information are identified, as well as the primary decisions to be made, thus indicating the types of surveillance required. Preliminary answers to the questions of who, where, what type, and how many are malnourished are gathered from existing data, which are usually available from routine reporting within government agencies or existing surveys.[3] Remaining information needs, and potential resources are identified and institutional commitments, responsibilities, and linkages are defined. Based on the initial assessment a workplan is developed with a specific design for the country's nutritional surveillance program. It includes the definition of specific objectives, priorities, the needs of identified users of information, the suitability of existing data sources, arrangements for necessary data collection and analysis, linkage with decision-making, and an assessment of the feasibility and costs of the plan.

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3 *By "malnutrition" we refer to Protein-Energy Malnutrition (PEM). Typical outcome measures used in nutritional surveillance include the prevalence of malnutrition among preschool children (those less than 80% of weight-for-age as compared with standards), prevalence of low birth weights and estimates of infant or child mortality rates (J3).*

Purposes of step[a]	Actions to be taken
A. Identification of users, decisions to be taken, and hence purposes and types of surveillance required	**Draw up lists of:** - policies and programs currently or potentially impinging on (a) those most affected by nutritional problems and (b) the causes of these problems - ministries, departments, and institutions responsible for potentially relevant actions (planning, implementation, evaluation) **Hence define:** - existing policies and programs relevant to nutrition - institutions that are possible users of nutritional surveillance information - decisions to be taken now or in the future that require information, and existing information basis - information needed by relevant institutions for planning, initiation of programs, monitoring and evaluation
B. Identification of problems	**Decide on:** - type of malnutrition and whether chronic or acute - groups affected, in geographical and socioeconomic terms - causes of malnutrition in these groups
C. Specification of information needed and baseline statement	**Draw up summary statement of what is currently known about nutritional problems:** - use actual figures, presented as tables, maps, graphs, etc. - hence identify gaps in information needed for decision-making Identify sources of data from those already used in initial assessment, plus e.g., - data routinely available, if at present not used, from administrative sources - possibility of including nutrition variables in household surveys Assess the suitability of the data for surveillance purposes—variables, level of aggregation, linkage with other data, regularly, timing, reliability, etc.
D. Institutional arrangements	**Decide on:** - organizational and analysis unit, including staffing - linkages to decision-making - means of supporting field operations, including need to hire staff for data collection and supervision

[a]These steps are iterative, not sequential

Figure 1. Steps in Initial Assessment for Designing Nutritional Surveillance Systems.
Source: Table 2.2, B1

Although malnutrition is a complex phenomenon rooted in poverty, it is also important to have some idea of what may be causing malnutrition as a result of the initial assessment. Figure 2 (B1:19) outlines the major relationships, showing the links between food and income through nutrient intake and infection. Clearly, action may be needed in several sectors because policies or programs focused on agriculture, income distribution, employment, health and nutrition are likely to affect nutritional status. In addition, each of these sectors may yield useful data. While the definition of true cause-effect relationships requires a complex scientific research design, usually beyond the scope of a nutritional surveillance system, a general assessment of likely causes is often possible with existing data and knowledge of local conditions. Further, the assessment may suggest areas for further investigation through research or surveillance.

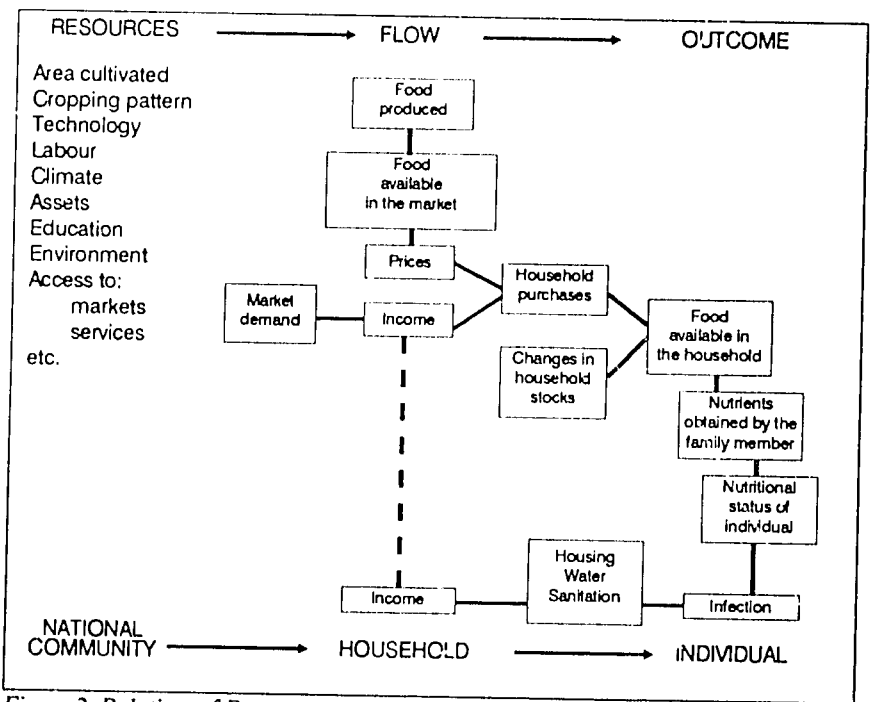

Figure 2. Relation of Resource and Flow Variables To Nutritional Outcome.
Source: Figure 1.1, B1

The first two types of nutritional surveillance (Policy/Planning and Program Management/Evaluation) form a continuum from problem identification to evaluation of the effectiveness of intervention strategies. Some of the discrete steps are recognized as distinct subtypes of surveillance including: 1) identifying

the size and nature of the problem and mobilizing political will to take action; 2) indicating the distribution of the problem (geographically and socioeconomically) and some of its national-level causes (this usually leads to formulating *broad* directions for intervention programs); 3) more detailed project-level planning for area-based projects, taking into account local variations in the ecology of malnutrition and the suitability of various strategies for that area (*ex ante* assessment); this also provides baseline information for later project evaluation; 4) development of an in-built monitoring system for program management to ensure that program "inputs" are delivered as expected; and 5) in-built evaluation of gross outcome, or more detailed evaluation to determine if the major outcome indicators are moving in the expected direction. This continuum is described mainly for organizational purposes but, in fact, the initiation of surveillance activities might begin at any step depending upon local needs.

NATIONAL-LEVEL PLANNING

One form of nutritional surveillance is intended to assist national planning for health and development. The major questions to be addressed are outlined in Figure 3 (B1:62). These involve the definition of the malnutrition problem, its correlates and trends, an assessment of the relevance of existing policies and programs, and the design and targeting of specific intervention strategies.

Answering these questions requires large-scale and recurrent data collection on nutritional outcomes and on relevant associated factors. Data sources identified during the initial assessment will often include community weighing programs, school entry height measurements, government health and vital registration statistics, census data, and information from agricultural reporting systems. The usefulness of the data will depend on coverage, validity, and reliability and on whether it can be combined with nutritional data at appropriate levels of analysis to define associations. In some cases, restructuring and improvement of existing ongoing data collection mechanisms may be adequate, but usually some form of additional data collection is necessary. This may take the form of new sample surveys (including both nutritional outcomes and associated factors) or, in some cases, nutrition modules may be added to existing socioeconomic/demographic surveys.

For targeting, the simple method of cross-tabulation by "FUNCTIONAL CLASS," (Joy and Payne, 1975, cited in B1) is commonly used to examine the distribution of the nutritional situation. Prevalence of malnutrition may be dissaggregated by geographic or administrative area, ecological zone, or by expected correlates, such as occupation, quality of housing, water supply, sanitation, literacy rates, and accessibility to or use of services. With similar

Question	Output	Planning Implication
1.(a) Are there certain areas/people with appreciably worse nutritional conditions than others, and what are their characteristics?	Initial assessment; one-time disaggregated data by region and socio-economic status	Targeting of interventions; assessment of causes and hence of relevance of existing policies and programs; preliminary assessment of size of problems, hence of initial resource implications
(b) Which Characteristics are most closely associated with the outcome?[a]		
2.(a) Is the overall health, nutrition, and socio-economic situation deteriorating or improving?	Aggregated data, over time	General view of situation; if general improvement, need to look at rate and at specific groups; if general deterioration, need for concern for overall position, as well as for groups
(b) Is the trend the same for all groups, or are there some groups showing a different trend?	Disaggregated data, over time	Targeting. Reassessment of problems; identification of intervention measures: resource allocations and procuring additional resources
(c) How are deteriorating or lagging groups defined?	Disaggregated data, over time with classifications	
(d) What characteristics are associated with differences in trend?[a]	Disaggregated data, over time, with classifications	More specific identification of causes of change, hence interventions and policy changes needed
3.(a) Is a specific short-term problem indicated (e.g., food shortage, epidemic)?	Only one (or a few) outcome indicator(s) sharply deteriorating	Specific interventions needed
(b) Are there fluctuations that indicate recurrent short-term deterioration?	Disaggregated data, over time	Preventive measures
(c) Are there trends that indicate probable crisis in the future?	Disaggregated data, over time	Preventive measures

[a]Dependent variable is, for question 1, outcome; for question 2, change in outcome.

Figure 3. Questions Nutritional Surveillance Information Should Answer to Aid Health and Development Planning Decisions. Source Table 3.1,B1

measures at different points in time, a rough assessment of trends may be obtained (Figure 4). Even when nutritional outcome measures are not available, or cannot be disaggregated by a geographic area, etc., a simple mapping of environmental and socioeconomic factors commonly associated with malnutrition may be sufficient to produce a general idea of the nutritional/socioeconomic situation which will allow identification of priority areas and groups.

It is worth noting, however, that functional classification and/or socioeconomic mapping exercises usually only pinpoint problems that require further

	A. Agro-ecological zones									Mean, Population weighted
	1	2	3	4	5	6	7	8	10/11	
% Population	13	15	19	7	15	5	11	9	6	
% < 90% Ht/Age										
1977	21	21	30	25	35	28	44	40	20	29.6
1979	25	27	27	21	26	31	20	19	40	25.7
% < 80% Wt/Ht										
1977	4	6	3	3	3	8	6	3	9	4.5
1979	2	2	4	4	2	0	3	3	6	2.9
Changes Ht/Age % < 90%	+4	+6	-3	-4	-9	+3	-24	-21	+20	-2.5
Changes Wt/Ht % < 80%	-2	-4	+1	+1	-1	-8	-3	0	-3	-1.7

	B. Provinces						Mean
	Central	Coast	Eastern	Nyanza	Rift Valley	Western	
% < 80% Wt/Age 1977	39	24	41	24	34	27	33
% < 80% Wt/Age 1979	23	29	29	27	27	21	26
Chgs Wt/Age % < 80%	-16	+5	-12	+3	-7	-6	-7

Figure 4. Example of Functional Classification Based Upon Changes in Nutritional Status in Kenya, 1977-79[a]

[a]Abbreviatons: Ht/Age = Height-for-age, Wt/Ht = Weight-for-height, Wt/Age = Weight-for-age; %<90% etc. refer to less than 90% of Harvard Standard. Calculations based on the figures given in references 14 and 15 of the source.

Source: Table 4.4, B1

investigation. When, for example, a change in agricultural practices is associated with declining nutritional status, more information would be required to determine the underlying causes and to define program and policy options. This information might sometimes be obtained through more detailed multiple variable analysis, through more focused formal or informal surveys, and/or by reference to existing knowledge of local conditions.

As pointed out by Mason et al., (B1) nutritional surveillance, and the policy and program actions that it often suggests share much in common with wider development goals based on meeting basic needs of the population. As such, the success or failure of nutritional surveillance depends upon the commitments of governments and collaborating donors to meet basic needs through redirection of resources. To some degree, nutritional surveillance for national planning purposes involves the sensitization of policy makers to the wider causes of malnutrition and to the range of measures necessary for its eradication. Functional classification and socioeconomic mapping are useful for this purpose and, together with the more detailed information suggested above, can assist in the design of specific programs for addressing various aspects of the problem.

Since 1980, CNSP assisted in conducting planning exercises in a number of countries. These include Costa Rica (D4), Indonesia (Surbakti, 1983), Philippines (R12), Sri Lanka (D3), Fiji (D8), Kenya (J22; D11), Botswana (R23), Lesotho (D12), and Malawi (CSR, 1986). These analyses require the availability of national data that can be linked to nutritional status and disaggregated by geographic area and/or socioeconomic groups. However, equally pressing is the need for technical/analytical expertise and mechanisms to link the final results to decision-making. By the very nature of the development planning processes in these individual countries, the link to decision-making is often not very close, but can be strengthened by maximizing the interaction between the data analysts and decision-makers throughout the analysis and dissemination phase.

The same basic principles used at the national level have also been applied at lower levels for project planning and evaluation purposes. In these cases, known as EX ANTE assessments, the design and implementation of an area-based project is preceded by a sample survey and/or collection of more detailed ethnographic data. These can then be used to indicate which groups are at greatest risk for malnutrition, some possible causal factors, and the most appropriate types of intervention strategies for various groups. The same data can later be used for evaluation purposes, because they provide a baseline for comparison with subsequent information generated from within the program or through a repeated sample survey. CNSP supported EX ANTE assessments in the Philippines (W8), Haiti (J13), Guyana (D6), and Malawi (NSS, 1987).

Despite the potential for this type of surveillance to improve the project planning process, there are a number of factors that mitigate against its widespread use. One of these is the difficulty of incorporating such an exercise into the project cycle, because of the tight implementation time tables associated with most projects (and the possible loss of funds if deadlines are not met). Another problem is a lack of technical expertise to undertake the survey and to rapidly analyze the results. As noted above, such expertise is often lacking at the national level and may be non-existent at regional or district levels. Finally, a major problem is that local input into the planning process is too often precluded by the traditional top-down approaches to planning prevalent in developing (and developed) countries.

PROGRAM MANAGEMENT AND EVALUATION

The second major type of surveillance is designed to assist program managers, administrators, and funders in the operation and evaluation of on-going programs. This includes consideration of process issues, (is the program operating as planned and is it reaching those targeted?); and outcome, (is there an improvement in terms of the specified objectives?). Outcome, in turn, may be examined at two levels: GROSS OUTCOME (is there a change?) and NET IMPACT (is the change due to the program?). The level of the evaluation will depend on the needs of the planners and funders of the program (Figure 5).

All programs require some level of "ADEQUACY evaluation." Program managers need to know if the program is being delivered as planned. For this reason some routine monitoring should be designed into the program. If the targeted groups are not being reached, or if the intervention is less than planned, the program is not likely to meet its objectives.

Targeting should begin at the planning stage of any program by defining the needy and their proportion of the targeted group. Adequacy evaluation should examine program data to determine the proportion of targeted and needy individuals who are actually receiving the program benefits. The use of two-by-two tables then allows summary measures of program performance, including: FOCUSING (proportion of total recipients who are needy); COVERAGE (the proportion of total needy who are targeted/recipients); LEAKAGE (proportion of total recipients not targeted); and DELIVERY (proportion of total targeted who are recipients). These measures can give important information to program managers to allow improvement of program efficiency (Figure 6).

In addition to targeting, questions of routine program operation, such as delivery of supplies and organizational procedures must be addressed. It is important that those implementing the program are involved in the evaluation (preferably from the planning stages) so that cooperation and understanding is maximized.

Step	Information required
A. What is evaluation for? (desk)	(1) For whom intended (who are the principals)? For what decisions? (2) What objectives of the program are to be evaluated? = Required cooperative venture between evaluators and principals → consensus regarding explicit objectives and resolution of contradictions. (3) What are the program procedures and activities supposed to be? = Original plan + changes → consensus regarding explicit procedures and activities. (4) Plan the evaluation.
B. Is the program design likely to meet program objectives? (desk)	(1) Objectives: What impacts are sought? In whom? May vary with impact sought → define "adequate outcome." (2) Activities: Will designed activities attain objectives in those who receive them? (3) Targeting: Will planned targeting attain objectives in population? (4) Procedures: Will designed procedures result in activities and targeting plannned? (5) Estimate effects and cost/effect: Are they adequate and reasonable? (6) Reiterate steps 1-5 until consensus reached. (7) If answer to any question 2-5 is "No," do not proceed further.
C. Is the program implementation likely to meet the objectives? (field)	(1) Is the implementation of delivery as designed? (2) Is implementation of targeting as designed? (3) Do deviations in procedures affect activities? (4) Are deviations in activities likely to pevent attainment of outcome objectives? (5) If answer to 4 is "Yes," do not proceed to evaluation of those outcomes. (6) What are constraints on implementation? Can they be remedied? (7) If answer to 6 is "No," this answers all other questions.
D. What is gross outcome? (field: quantitative measurements)	(1) Outcome in whom? Needy Targeted Recipients Total population (2) Adequacy of attained outcome (needs standard). (3) If inadequate, would nutritional situation be likely to be significantly worse without the programme? (negative confounding) (4) Upper limit of cost-effectiveness – if too high and no negative confounding likely, stop programme.
E. What is net impact?	(1) Gross difference in double-blind randomized trial = impact. (2) Gross difference outcome + attempted discarding of confounding = approximate net impact. (3) Cost-effectivenss = true net impact per unit cost. • Differentiate between effect on variable in individual and adequacy of effect in individual • In whom? – cost-effectiveness improves with increase in individual's need (responsiveness) and prevalence of need among those covered, but decreases with success.
F. Data presentation and distribution	(1) To whom? Already prepared - principals (manager and funder) should have been involved in draft of report. (2) What type of presentation? Frequent iterative presentations improve the usefulness of the report by better addressing the needs of the recipient, both as to what is addressed and how it is done. (3) Feedback to other than principals? • Do it in collaboration with principals (respect ethics of confidentiality and censorship). • Busy people need short summaries of decision options + results + recommendations. Careful people need everything relevant - fill these two needs separately.

Figure 5. Steps in Program Evaluation.
Source: Table 5.1, B1

*A

		Needy (e.g. malnourished)?	
		YES	NO
Targeted	YES	a_1	b_1
	NO	c_1	d_1

Base-line data

Planned focusing: Proportion of total targeted who are needy $= \frac{a_1}{a_1 + b_1}$

Planned coverage: Proportion of total needy who are targeted $= \frac{a_1}{a_1 + c_1}$

**B

		Targeted?	
		YES	NO
Recipient?	YES	a_2	b_2
	NO	c_2	d_2

– Program data

Survey data (directly)

Leakage

Proportion of total recipients who were targeted $= \frac{a_2}{a_2 + b_2}$

Proportion of total recipients not targeted $= \frac{b_2}{a_2 + b_2}$

Delivery

Proportion of total targeted not recipients $= \frac{c_2}{a_2 + c_2}$

Proportion of total targeted who are recipients $= \frac{a_2}{a_2 + c_2}$

**C

		Needy?	
		YES	NO
Recipient?	YES	a_3	b_3
	NO	c_3	d_3

– Program data

Survey data (directly)

Actual focusing: Proportion of total recipients who are needy $= \frac{a_3}{a_3 + b_3}$

Actual coverage: Proportion of total needy who are recipients $= \frac{a_3}{a_3 + c_3}$

*A: Planning (pre-program).
**B and C: Evaluation during program. (When delivery is exactly as targeted, recipients = targeted, and table C is exactly like table A).

Figure 6. Construction of 2X2 Tables Quantifying Target Groups, "Needy," and Program Recipients.
Source: Figure 1.1, C6

Planners and funders of the program will need this information, plus an idea of the gross outcome in order to decide whether to continue the program. The outcome measures selected should reflect the objectives of the program and must be RESPONSIVE to the intervention, i.e., there must be some dose-response relationship (C6; C7). For most nutrition and health programs (and some economic development programs) anthropometry has been selected as an appropriate outcome measure (see the section on methodology/indicators for more detail).

Assessing gross outcome requires a comparison of the result with baseline data or with a non-participating control group. Because it is often politically and ethically not feasible to withhold the program from needy individuals, data on new entrants (time-in program method) is often used (C7). Although a positive difference cannot be demonstrated to be due to the program, it is often sufficient to justify continuance of a program that is running adequately. When the evaluation of gross outcome reveals no difference, however, several questions must be asked beginning with adequacy evaluation results – including adequacy of targeting and delivery, the ability of the outcome indicator to respond to the intervention, the validity and reliability of indicator measurements, adequacy of sample size and the possibility of negative confounding (the program may actually be mitigating other negative effects)(C6).

National-level planners will need reliable information before decisions can be made to expand programs to other areas. For major investments, they will need to know, with some certainty, whether the program has a net positive effect and what is its cost-effectiveness versus other potential intervention strategies. The only way to be sure that true net impact is being measured is to conduct a double-blind randomized trial, which is very expensive, and in most cases, not feasible. Approximate net impact may be examined with a quasi-experimental design, where potential confounding variables are measured and accounted for statistically. Cost-effectiveness can then be approximated as the net impact per unit cost. Major sources of confounding (selection, maturation, history, instrumentation, regression to the mean and experimental mortality) are listed, with examples, in Figure 7 (C6).

Many of these problems can be avoided with careful evaluation and design. Several quasi-experimental design types are listed in Figure 8. The strongest is the "non-equivalent" control group design with before-after, with, and with-out program groupings. Because this design is often ethically and politically difficult, staggered implementation of the program is often used instead. Participant indicators are measured at entry and at several points during program implementation when they can be compared with new groups. Over time, consistent trends can give more assurance of causality. One problem with this design is the

Cause of Confounding	Example
1. Selection When the assignment of subjects to treatment and comparison groups is not random, the groups may differ systematically in some characteristic(s) associated with the outcome variable. Selection bias is therefore likely to be present. Self-selection is a common source of this type of bias.	Mothers who choose to participate in a program to reduce the incidence of low birthweight may tend to be more educated, richer, and more motivated than those who do not. These factors influence the outcome and compete with the program as an explanation for an observed reduction in the incidence of low birthweight.
2. Maturation Human subjects mature over time, and this process may cause changes in the outcome variable irrespective of program effects.	The nutritional status of 6- to 24-month-old children is often worse than that of older preschoolers. If the average age of participants in a nutrition program increases from, say, 18 to 36 months, observed improvement may be due to maturation.
3. History When a program is in effect, many other events may intervene and influence the outcome variable. When these historical events have different impacts on the treatment and comparison groups, they confound the program effects.	A supplementary feeding program is introduced in one of two otherwise equivalent areas. If food prices rise at different rates in the two areas, observed differences in nutritional status may not be solely because of the feeding program.
4. Instrumentation A threat may arise from changes in the way measurements are made or in what is measured or from measurement errors due, for example, to instrument decay.	The height for age of preschool children is often compared across age groups. Because length is usually measured for infants from birth to two years old and height is used for children older than two, comparisons between the two groups may be biased.
5. Regression artifact If subjects are chosen on the basis of exhibiting an extreme value on some variable (e.g., wasting), there may be improvement over time without any intervention. This tendency is called regression toward the mean. The solution is either to observe the effect on the whole population or to make comparisons within the selected extreme group (e.g., the malnourished).	In a nutrition program instituted for the malnourished, improvement may be shown in that some of the participants are no longer malnourished at the end of the program; but part of this improvement may not be due to the program because some subjects might have improved for other reasons.
6. Experimental mortality Some subjects may drop out of a program during the course of its implementation. If these subjects have different characteristics than those who remain, any before/after effect shown may be confounded by differences in the populations at the beginning and end of the program.	A food-for-work program may not lead to an improvement in the nutritional status of a community, even if it has in fact been effective. This could happen if enough of the participants who improve leave the community in search of jobs elsewhere. The observed change here underestimates the impact of the program.

Figure 7. Major Causes of Confounding (Threats to Internal Validity).
Source: Table 1.2, C6

Design	Referred to as	Analysis	Delivers
1. XO*	One-shot case study	None	Adequacy
2. OXO	One-group pre-test/post-test	Compare before/after	Adequacy
3. Group 1 XO Group 2 O	Static group comparison	Compare groups	Adequacy
4. X (Varies) O	Correlational	(a) Compare sub-groups (b) Correlate treatment levels with outcome, controlling for those confounding variables measured that are not themselves highly correlated with treatment	Adequacy, some inference on net income
5. Group 1 OXO Group 2 OO	Non-equivalent control group design	Compare groups with statistical control for confounding	More plausible inferences on net outcome
6. OOO X OOO	Interrupted time series	Before/after; time-series	

*X = treatment. For items 1-3, O = observation of outcome; for items 4-6, O = observation of both outcome and confounding variables

Figure 8. Conventional Evaluation Designs.
Source: Table 1.3, C6

possibility that individuals or communities who participate earlier in the program may do so for particular reasons (such as accessibility or education) which may bias the result (C7;C11).

Once outcome is assessed, effectiveness and cost-effectiveness can be examined. These are discussed by Habicht et al. (1979), (C6), and are hypothetically illustrated in Figure 9A which shows that, below a certain level of expenditure, a program can be expected to have no effect. Failure to see a response may, in some cases, be because of inadequate inputs per program recipient. The effect per 1,000 population is shown to rise at an increasing rate to a certain point, and then to continue to increase at a decreasing rate. Knowledge of this type of relationship is important in dealing with tradeoffs between monetary inputs per recipient and overall coverage.

Figure 9B illustrates a hypothetical curve related to cost-effectiveness, where increasing monetary inputs per targeted recipient pay off in terms of cases prevented per $1,000 to a certain point and then decline. This type of analysis is rarely used in program evaluation, but an accumulation of this type of information could greatly assist in improving the level of success in program outcome in relation to the investment of scarce resources (C6).

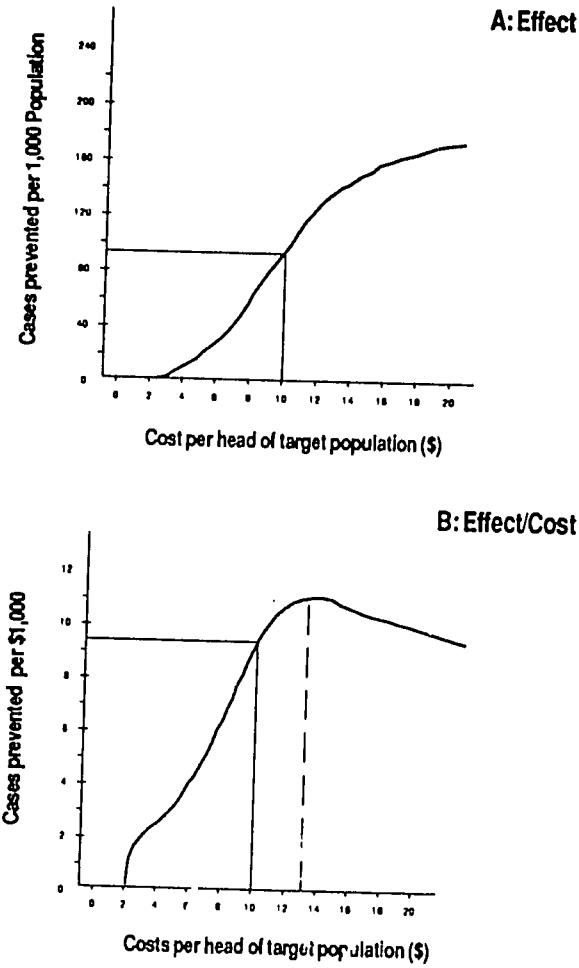

Figure 9. Effect/Cost Curves (scale only for illustration).
Source: Figure 1.2, C6

Cornell has been involved in the development of theory and methodology for the evaluation of health and nutrition programs in general (B1; C6; C7; J11; J23), on food-aid (C11; R4), on child feeding programs (R19, W11), and on water and sanitation programs (M5) and has actively participated in an evaluation of growth monitoring in Lesotho (R20; R21). Some of these projects will be discussed more fully in the sections on methodology (particularly indicators) and country development (Lesotho).

TIMELY WARNING AND INTERVENTION

A specialized type of nutritional surveillance is required when periodic food shortages cause malnutrition. This is particularly important in countries where food availability varies with the agricultural cycle and drought or other natural disasters may occasionally threaten food security. The mechanism developed to cope with these crises is called a "timely warning and intervention program." Its development and use is appropriate when there is a risk of acute food or income shortages and when resources exist to prevent or relieve the shortage, but information is constraining. In this situation, indicators must be developed that will predict subsequent food shortages. Once these markers are identified they are monitored. When the indicators approach a threshold level, a preplanned strategy can be implemented to avert the crisis. Consideration must also be given to time lags caused by normal data flow, time needed to mobilize the planned intervention strategy, and time for the strategy to have an effect. Figure 10 illustrates this time sequencing (B1). The need for very careful planning if the intervention strategy is to be successful is obvious.

The use of "staged" indicators and responses is an economical way to operate such a system. Certain "early" indicators, such as low rainfall, act as warning signs to begin preparations for a possible mobilization. "Concurrent" indicators, such as poor harvests, provide a signal to immediately initiate intervention strategies. "Late" indicators, usually changes in nutritional status, measure the success of the earlier interventions or, in the case of a failure, signal the need for emergency relief (B1).

Relevant indicators may include rainfall data, crop conditions, livestock status, food prices, employment data, indicators of food consumption, and direct nutritional status measurements. The specific ecological and socioeconomic characteristics of the population will determine which types of interventions are most appropriate. Potential intervention strategies which are useful at various stages and conditions include provision of agricultural inputs, price stabilization for certain staple foods, public works programs (for targeted income generation), and, when necessary, food distribution. Figure 11 gives some examples of ways in which indicators can be appropriately linked to intervention strategies (B1).

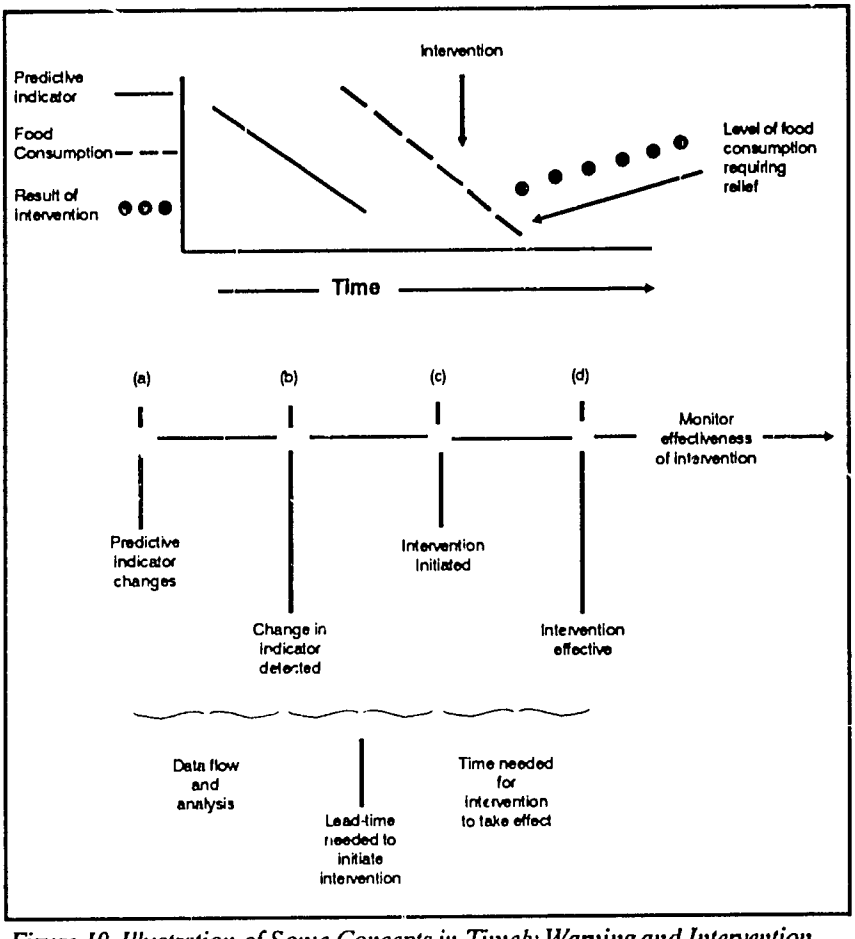

Figure 10. Illustration of Some Concepts in Timely Warning and Intervention.
Source: Figure 6.1, B1

Examples of indicators used to initiate each intervention		Examples of interventions to be initiated
Early indicators	**Concurrent indicators**	
Rainfall deficit during vulnerable period in crop cycle	Failure of crop to germinate	Seed (or credit) for replanting
Failed crop or other income failure	Decreased purchase of food	Public works employment program
Decreased food intake	Increased malnutrition	Food distribution

Figure 11. Examples of Interventions Linked to Indicators.
Source: Table 6.1, B1

Many of the indicators that could be useful are already collected by regular reporting mechanisms – such as data generated by agricultural extension workers or meteorological stations. The accuracy of these types of data sources must, however, be checked. When additional data collection is needed, a SENTINEL SAMPLE of those households or individuals most at risk can considerably reduce the burden of data collection and analysis (B1).

Examples of interventions linked to indicators

CNSP has worked with several countries on the development of timely warning and intervention programs, including Botswana (M7; J25; R5; R6) and Indonesia (M6; J16; R15). These experiences will be described in more detail in the section on country developments.

2. METHODOLOGICAL DEVELOPMENT

In this section, brief summaries of CNSP's major activities and the results of methodological and operational research are presented within the categories of information systems, sampling, indicator development, data analysis, and training.

DEVELOPMENT AND STRENGTHENING OF INFORMATION SYSTEMS

As described above, the first step in designing information systems is to decide which decisions need to be made and what information is required to make these decisions. The next step, is to identify valid and relevant data sources.

As mentioned earlier, data for nutritional surveillance work may sometimes be obtained from existing government documentation, from routine reporting sources (health, agriculture, vital statistics), or from surveys (census, sample surveys). During an initial assessment, existing data must be examined for their usefulness in relation to needs, for coverage, and for an indication of their validity and reliability. In some cases, disaggregation to the most useful level (such as the village) may be impossible, or data may be inconsistent because they were collected by several bodies, which used different boundaries, timing, etc. In some cases, a careful analysis of the situation can assist in making changes to improve the quality and usefulness of data from existing reporting mechanisms. Some examples follow. More detail is provided in the section on country developments.

In an assessment by CNSP of ongoing data collection in health clinics in Botswana several problems were detected including incomplete and inconsistent reporting and faulty measurement techniques. Observers suggested simplifying the reporting system in logbooks at the health center in order to increase compliance and standardization and adding some variables that could be used to monitor data coverage. Further training requirements for Family Welfare Educators to improve data quality included: weighing techniques, use of growth charts, use of the new logbook, and reporting procedures (R6; R7).

In the Philippines, an examination of "Operation Timbang" (OPT), the country's preschool weighing program, revealed an overall coverage of about 30 percent, with a large variation among municipalities. There was a high non-compliance rate and a problem with late reporting. Coverage rates were estimated,

and reliability obviously increased with coverage. Prevalences seemed, overall, to be over-estimated compared with sample survey results. It was concluded that while OPT served its purpose as a screening device, it was not useful for nutritional surveillance in its present form.

Other on-going data collected in the Philippines include the measurement of height and weight at school entry. Use of this information (particularly height for age) at the village and child level was found to be useful for targeting when associated with other factors in simple tabulation (functional classification) (R12).

Often, additional data collection is necessary, either in the form of sample surveys or as a nutrition module attached to an existing survey system. In Kenya, a national sample survey program exists with a permanent field operation. CNSP assisted the Kenyan government (financially, and with training and survey design) in creating a nutrition module that could be linked with the existing data. The enumerators, already skilled in survey data collection, needed only a few days of specialized training, particularly on anthropometric measurement. Data from other parts of the surveys included information on agriculture, demography, social indicators, household budget and consumption, market prices and employment. Three of these modules were completed and allow analysis of the nutritional situation in Kenya by functional classification and over time (J22; W17). CNSP has been collaborating with Kenyan authorities regarding their fourth national survey, as well as with the Indonesian government to set up a similar system (R17).

For specialized purposes, such as timely warning and intervention, a simpler routine data collection mechanism can be organized using a SENTINEL sample, and including only the most at risk households. This type of data collection is currently used in Indonesia where indicators, such as the absence of rice in the diet for one week, or the consumption of wild tubers, are used to signal the possibility of a crisis requiring further investigation and possibly, intervention (R15).

SAMPLING ISSUES AND APPROACHES IN SURVEILLANCE

For most nutritional surveillance uses, knowledge about the representativeness of the data is very important. This is true for establishing prevalences and also for making associations with other indicators. This is not to say, however, that surveillance must always use estimates that are representative of the general population. Rather, the sampled population should be related to particular information needs. Thus, if the target group is the poorest, then the sample should be representative of them, not the entire population. Similarly, if the

objective is to increase the use of health clinics by the poor through outreach methods, it may be sufficient to document the changing composition of the population attending clinics without reference to the general population

When existing routine data collection mechanisms are used, they are often designed to totally enumerate a population (such as Operation Timbang in the Philippines). Their *actual* coverage, however, greatly affects the composition of the actual population included in the data and, therefore, needs to be examined. It may be, for example, that those farthest from the health center do not use it and, thus, are not weighed. This would bias the sample and underestimate prevalence if distance from the health center was associated with increased cases of malnutrition. On the other hand, in the Philippines, decreasing coverage was associated with increasing bias, apparently overestimating the prevalence of underweight children, which indicates a selection bias towards malnourished children (W3).

For analysis of this type of data, sub-samples should generally be randomly selected from within the overall data set. Certain types of bias can sometimes be partially corrected with appropriate weighting techniques. For the Philippine school survey, Clark and Mason (M3) describe a staged sampling method where schools are selected after stratification. Students were randomly selected within schools, and weighting factors were applied to adjust for the varying proportions sampled within districts.

The use of carefully designed sample surveys has several advantages over existing on-going data collection systems including improved representativeness, data that are more reliable because of better training and supervision of enumerators, and the ability to link nutrition variables with several other factors. However, these data are costly to assemble and cannot replace existing data collection systems because they do not provide screening and follow-up for individuals needed by programs, nor do they allow for highly disaggregated analysis.

When sample surveys are conducted, they can be designed so that data can be taken from a relatively small sub-set. A simple random sample is based on the assumption that the sample is randomly selected from a complete list of households or individuals. Even if such a list exists, the logistics of locating and interviewing households scattered widely throughout a country would be formidable. Instead, samples for large surveys are usually selected in stages. Depending on the specific uses of the data to be collected, sampling designs can become quite complex. For the purposes of national nutritional surveillance systems, a methodology to obtain a representative sample of preschool children is described by Edmonston, et al. in the CNSP sampling manual (W30). The first stage involves selecting clusters, such as villages, and then choosing a set number

of households randomly from within each cluster.

Before constructing a sample design and calculating sample sizes it is necessary to decide which specific parameters and contrasts will be estimated based on the results. In various surveillance applications, these may typically include a) estimating prevalences; b) detecting differences in prevalences among two or more groups, or over time; and c) detecting differences in mean levels of various indicators among groups or over time. The mechanics of calculating sample sizes under various sampling strategies and for different surveillance purposes are provided in (W30).

INDICATOR DEVELOPMENT

In order to monitor nutritional status and/or other outcomes, valid and reliable measures are needed. Furthermore, to determine prevalences, valid cut-off points that are associated with functional outcome and that can accurately classify individuals into high risk groups are critically important for screening and targeting purposes.

Criteria for Selection and Use of Indicators

A significant amount of CNSP staff time has been devoted to the statistical and practical assessment of indicators of nutritional well-being. Indicators of current nutritional status or status in the past few years include anthropometric measures, such as height-for-age (H/A), weight-for-age (W/A), weight-for-height (W/H) and arm circumference. Birth weight predicts later infant health and survival and is sometimes useful as an indirect indicator of maternal nutritional status. Environmental factors, such as housing and water supply, and socioeconomic variables, such as real incomes and prices, are poverty measures that reflect the underlying causes of malnutrition. In addition, in Botswana and Indonesia, attention was directed to pinpointing indicators that predict impending changes in nutritional status: abnormal rainfall and crop production, grazing conditions and livestock health, and village and family food stocks (J25, R15).

The interpretation of nutritional indicators is complicated when some common measures provide inconsistent estimates of the degree and distribution of malnutrition. Tabor, et al., (W7), demonstrated that poverty indicators frequently used in Indonesia inconsistently rank rural districts. They suggest alternative approaches that involve the use of surveys of food stocks and energy intake. Pelletier, et al. (W21) found H/A and W/H measures were negatively correlated in a study of Philippine school children. Although they suggest that measurement errors and/or uncontrolled biological factors, might cause these anomalies, the issue remains largely unresolved. Haaga (J21) demonstrated in simulation experiments that minor errors in measurement can produce a serious

downward bias (i.e., toward zero or negativity) in correlation coefficients calculated between H/A and W/H measures. The biological causes and chronology of stunting and wasting (respectively, low H/A and W/H) are currently under study at Cornell.

Choices among alternative indicators depend upon the objectives and time horizon of policy makers (W13). Relative costs, precision, and timeliness are likely to be the three principal considerations. Recurrent surveys of food intake and anthropometry provide detailed but expensive data on changes in nutritional status over time. These surveys yield little information of value for decision making without careful and time-consuming analysis. Single surveys provide only a static picture, and, as a result, are of little value for predictive purposes when impending food crises may require immediate intervention. In contrast, predictive indicators rely largely on the straightforward analysis of routinely collected data, but may fail to identify specific target groups within areas prone to drought and crop failure.

Efforts have been made to develop survey strategies that rapidly produce reasonable results for project design purposes (J12). Further work in this area could focus on the use of quick survey techniques ("rapid rural appraisals") in timely warning systems. A promising model is provided by the sequenced analysis of simple quantitative and qualitative data collected in the Indonesian TWHS districts. CNSP made a significant effort to develop manuals to aid in the analysis of indicator data (see W6, and W3, for example). The various CNSP country studies make it clear, however, that methodologies must be adapted to specific environment and resource availability settings.

To date, CNSP indicator studies focused primarily on identifying the magnitude and sources of malnutrition. However, as experience is gained in the development of timely warning systems, ways to improve the sensitivity and specificity of targeting indicators and practical mechanisms for targeting should also be investigated. In the Indonesian TWHS for example, intervention strategies include public works projects and various means to increase rice supplies, each with a different implication for leakage and overall efficiency of public intervention. Some of the principles involved in the development of these methodologies are described below.

Figure 12 illustrates and defines a number of concepts useful in describing the performance of an indicator and various cut-off points for the indicator. In referring to Figure 12, it is important to recognize that "nutritional status" is an internal state that is measured with one or more *indicators* of nutritional status (e.g., anthropometry). Although frequently used interchangeably, the terms nutritional status and indicators of nutritional status are distinct. (Habicht, et al., 1979). It should also be noted that these principles can be applied to any

		"True" disease	
		Ill	Healthy
Diagnosed disease	Ill	a	b
	Healthy	c	d

Interrelationships:

$$V^{+} = \frac{1}{(1 + RK)} \text{ where } R = \frac{(1 - Sp)}{Se} \text{ and } K = \frac{(1 - P)}{P}$$

$$P = \frac{(p + Sp - 1)}{(Se + Sp - 1)}$$

$$p = SeP + (1 - Sp)(1 - P)$$

Definitions:

$$Se = \text{Sensitivity} = \frac{a}{(a + c)}$$

$$Sp = \text{Specificity} = \frac{d}{(b + d)}$$

$$V^{+} = \text{Positive predictive value} = \frac{a}{(a + b)}$$

$$V^{-} = \text{Negative predictive value} = \frac{d}{(c + d)}$$

$$P = \text{Prevalence of "true" disease} = \frac{(a + c)}{(a + b + c + d)}$$

$$p = \text{Prevalence of diagnosed disease} = \frac{(a + b)}{(a + b + c + d)}$$

Figure 12. Relationships Among Sensitivity, Specificity, Predictive Value, and Prevalence
Source: Table 1, Habicht 1980

category of indicators that are intended to screen, target, or measure changes in a population (i.e., anthropometric, clinical, socioeconomic, agricultural, etc.).

As shown in Figure 12, *sensitivity* refers to the proportion of truly malnourished individuals who are correctly diagnosed by the indicator. Clearly, sensitivity decreases as the number of false negatives (C) increase. *Specificity* refers to the proportion of truly healthy individuals pinpointed by the indicator, and its precision decreases as the number of false positives (b) increases. It also declines as sensitivity increases and vice versa. *Positive predictive value* refers to the proportion of those diagnosed as malnourished by the indicator who are in fact suffering from malnutrition. As with specificity, the accuracy of this indicator decreases as the number of false positives (b) increases. It's absolute value also falls as the absolute prevalence of the disease decreases. Although these concepts are probably too complex to be used in day-to-day surveillance systems, they can act as tools to aid in choosing the most suitable indicators and cut-off points during the *development* of surveillance systems.

In trying to identify the "best" indicator and cut-off point a number of considerations are relevant, starting with the intended use of the indicator. Two major purposes are distinguished here, individual screening and estimating the prevalence of malnutrition in a population. Analysis of the relatively simple relationships shown in Figure 12 leads to several generalizations with regard to screening and prevalence estimation (J1).

Choosing the most useful indicator and cut-off points for screening purposes involves trade-offs among the number of false positives, false negatives, and the cost per beneficiary. False positives (seen under low specificity) contribute to higher costs per beneficiary and, if the treatment has undesirable side-effects, may actually harm unintended recipients or society at large. False negatives (seen under low sensitivity) represent truly needy individuals who are not reached by the program and, because of the inverse relationship between sensitivity and specificity, are usually associated with high specificity and a low cost per beneficiary. Seen from a policy, or even a political economy perspective, a program that strives to meet the needs of all truly needy individuals can succeed only with very high sensitivities (few false negatives). This usually implies that specificity (many false positives) will be low and, consequently, costs will be high per beneficiary. Conversely, a program that seeks to exclude as many non-needy individuals as possible requires a very high specificity (few false positives) and very low sensitivity (many false negatives). Thereby, costs per beneficiary are minimized. Although the final decisions are dependent on the political orientation of the particular country, surveillance can help maximize the benefit to a population for a given level of cost by employing indicators and cut-off points that possess intrinsically high levels of both sensitivity and specificity. This,

however, must be balanced against the need to use only those indicators that are relatively inexpensive, technically feasible, and appropriate to the level of training and supervision required for their use.

In the case of prevalence estimation, Figure 12 shows that the true prevalence of malnutrition is reflected by an indicator when the number of false positives is equal to the number of false negatives. If the distribution of values for sensitivity and specificity at different cut-off points using specific indicator is known beforehand, the cut-off point corresponding to this "break-even" point can be adopted to produce an accurate prevalence estimate. It should be noted, however, that as the true prevalence in the population decreases, the break-even, cut-off point also declines (C3). As an alternative in those cases when the sensitivity and specificity distributions are unknown, prevalence can be estimated by comparing the distribution of indicator values in the malnourished population with the distribution found in a healthy population (J5).

Child Anthropometric Indicators

Because of the importance of anthropometric measures in the assessment of nutritional status of children, a vast literature has accumulated on the appropriate uses of various measures for different surveillance or public health purposes. This section summarizes some of the key findings from these works and indicates in which areas CNSP has contributed. The use of demographic and socioeconomic indicators is discussed in later sections. It should be noted that, because of the difficulties in collecting detailed dietary data, measurement of food consumption is generally limited to simple indicators designed for specialized purposes (e.g., timely warning), for research purposes, for use in national income and expenditure surveys, and occasionally, as part of project evaluations.

For ongoing surveillance purposes, the most commonly used indicators in preschool and school-age children are weight-for-age, height-for-age, and weight-for-height. Weight-for-age is a composite measure that does not distinguish between chronic and acute malnutrition. Height-for-age measures stunting resulting from past or long-term chronic malnutrition, and weight-for-height measures acute or current malnutrition (wasting). Because of the difficulty of accurately measuring length or height in young children, arm circumference is often used as an alternative indicator of wasting. As with weight-for-height, arm circumference, is for practical purposes, independent of the child's age (and height) (D2). For surveillance uses, the weight and height indicators are usually compared to the National Center for Health Statistics standards for U.S. children. Some countries have constructed local standards based on the more privileged segments of their population. However, because of the similarity between these privileged standards and the U.S. standards (and

the differences in both compared to poor segments in developing countries), the use of the U.S. standards have been recommended to facilitate international comparisons (Habicht et al., 1976 and M4).

Because growth, and thus changes in height and weight, result from a complex set of factors strongly correlated with socioeconomic status and mediated by food consumption and infection/health status, anthropometric measures may be useful not only in evaluating the gross outcome of nutrition projects, but for primary health care and agricultural and rural development project purposes as well (B1; J11; M2; C5).

Many routine monitoring and screening systems (such as the Philippines Operation Timbang and many growth monitoring programs) use weight-for-age as a quick summary measure of malnutrition. When height measurements are also taken, much more specific information is available. The decision as to which indicators to use depends on information needs and on the feasibility of accurate data collection. For long-term development effects, height-for-age is a useful indicator. Habicht, et al. (M4) suggest that height is more RESPONSIVE to changes in socioeconomic status than is weight. Martorell, et al. (C3) show that response to supplementary feeding in Guatemala is greatest for height/length, while there is only a moderate effect on weight.

Height-for-age of school entrants is now used by several nutritional surveillance programs (Costa Rica, the Philippines, Indonesia) as a measure of the socioeconomic level of a community. As such, it is probably a good source of information to employ when targeting general development programs where no large changes in the community have occurred over the past five years. It is also considered a reasonable measure to adopt when targeting health and nutrition programs for preschoolers. The validity of this assumption remains to be tested, however.

For sudden, short-term or acute changes in nutritional status, weight-for-height is likely to be the most useful measure. It is also related to immunological status (D10). While *changes* in weight-for-age may indicate problems, particularly for an individual in relation to a growth monitoring chart, a single measurement of weight-for-age is difficult to interpret in terms of current nutritional status. Many low weight-for-age children (especially over three years of age) are stunted and have adequate weight-for-height.

Logistical considerations and additional training are needed to ensure accurate measurements, which represent constraints in using height/length measurements. These must be balanced against the additional usefulness of the information.

Measurement error for height and weight is an important factor in assessing the reliability of data. An evaluation of Botswana's nutritional monitoring

system, for example, found that inaccuracies in weighing equipment and recording procedures led to large errors in prevalence estimates (R6, R7). An investigation into measurement error in the Kenyan nutrition modules (W22, W23) compared original survey data to a resurvey of the same households with supervisor assistance. Mean differences between the first and second measurement, and the standard deviations of these differences were examined. The data did not reveal an overall bias in physical measurements, although certain enumerators did show large deviations, suggesting the need for further training (W22). The use of standardization tests before and during the survey can assist in the identification of enumerators with poor measurement techniques.

Although inaccuracies in measuring and recording weight and height are obvious sources of error in surveillance data, some of CNSP's work showed that error in age estimation can also have profound effects. In the Kenyan data referred to above, ages and/or birth dates from the original and the resurvey were compared for congruency. Only 40 percent of the children were reported to have been born on the same day in both rounds, and only 60 percent were within the same month. There was strong evidence that age reporting improved with education of the mother (W22). Clearly, sizeable age errors will have large effects on indicators of weight- or height-for-age which could lead to a serious misclassification. Prevalence estimates could be affected by random error and systematic error in age estimation, while estimates of means for nutritional indicators would only be affected by systematic error in age reporting.

Bairagi and colleagues (J2; J26; W12) examined the issue of measurement error in detail. They noted (W12) that a population with higher anthropometric values is more susceptible to random age error; that for a given amount of bias or random error, the error in the estimate will be greater for younger children than for older children; and that only improvement in accuracy of measurement (and not an increase in sample size) can reduce the effects of bias and random error in anthropometry and age measurements. Using data from Bangladesh (reported versus recorded birth dates), both random error in age reporting and age heaping at whole years, with preference for certain years, was observed. The age of young children (0-4 years) was systematically overstated while that of 4-6 year-olds was understated. The standard deviation of age misstatement increased with age. The effect of random error is to inflate the estimated prevalence of malnutrition. The bias, in this case, tends to increase the prevalence estimate for children under four and to decrease it for older children (J2). A similar study in another area in Bangladesh showed that age was also more frequently overstated for well-nourished than for malnourished children.

Because of the correlation between correct age reporting and mothers' education, and the tendency of random error in age reporting to inflate observed

prevalence of malnutrition, one would expect that age error may artificially inflate the relationship between mothers' education and nutritional status. In the Bangladesh data, this was true -- mothers' education was significantly related to weight-for-age, height-for-age, weight-for-height, and arm circumference when reported ages were used, but only with arm circumference when actual ages were used (J26).

Although there is likely to be a fairly constant random error across populations, bias in age reporting is likely to vary by culture (W12; J2). Careful training of enumerators and cross-checking of information may help in reducing age bias, which is clearly a serious threat to data quality.

Household Behavioral and Maternal Factors

The availability of child anthropometric data in developing countries, and the long history of their use in nutritional assessment work, have made it possible for CNSP to use them for nutritional surveillance in a number of countries. However, early in CNSP's development, it was recognized that these data alone fail to capture information on some factors widely believed to be relevant to protein-energy malnutrition in developing countries. As part of an amendment to the USAID Cooperative Agreement supporting CNSP, the implications for surveillance of several of these areas were investigated; specifically, the causes and consequences of low birthweight and the influence of child feeding patterns and intra-family food distribution (IFFD) on nutritional status.

The Causes and Consequences of Low Birthweight. Low birthweight can be caused by a variety of environmental, behavioral, and maternal factors acting individually or in combination. It is also a primary predictor of subsequent growth and development, health status, and survival of the child. As such, it has the potential to be an excellent indicator of changes in living conditions in developing countries and is an important factor to consider when interpreting post-natal indicators (i.e., mortality, morbidity, growth, and development). It is not surprising, therefore, that WHO has recommended the collection of birthweight data as part of a larger information system to monitor progress in reaching good health for all by the year 2000 (WHO, 1981).

Although low birthweight may be useful for monitoring global changes in living conditions, CNSP's work focused on its utility *within* developing countries. In particular, the heterogeneity of low birthweight, as well as its causes, make it very non-specific and limited as a marker of changes in specific causes (see below). This is analogous to the situation with measures of postnatal growth of children. These reflect the net effect of a variety of factors acting in combination, (which is of interest in its own right), but cannot by themselves be used to infer changes in any one. In order to have information on the success or failure of

specific intervention strategies, (especially when implemented through different sectors of government or through different programs), this heterogeneity must be taken into account.

One of the common uses for birthweight data is for screening, because they are consistently highly correlated with infant mortality and other functional outcomes. There is a significant increase in risk for infant mortality when birthweight is below 2.5 kilograms and. thus, this is usually taken as the cut-off point in defining low birthweight. Data from the Malaysian Family Life Survey were used to examine this relationship (J9), and it was found that each increase of 100 grams in birthweight up to 2.0 kilograms was associated with a reduction in mortality of 25.9 deaths per thousand, between 2.0 and 2.5 kilograms, the reduction was 15.0 deaths per thousand; and between 2.5 and 3.5 kilograms, it was 3.1 deaths per thousand. Above 3.5, risk of infant mortality began to increase slightly with increasing birthweight (J9).

With such a strong relationship to functional outcome, it is logical to expect that efforts to reduce low birthweight should have large effects on infant mortality and morbidity. However, the causes of low birthweight are complex and vary among populations. Because the mortality risk associated with one cause of low birthweight may be quite different from that due to other causes, the selection of strategies and evaluation of their effects must be based upon a better understanding of the relationships among low birthweight, mortality, and the various causes.

There are two major types of low birthweight babies. First are those who are small because of prematurity. These babies have low survival rates, but tend to progress adequately if they survive the first few weeks. On the other hand, those who are full term but small (due to intrauterine growth retardation - IUGR) are more likely to survive at first, but are at greater risk of sustained poor growth and infant or child mortality caused by infectious diseases. Maternal factors that affect birthweight are many, including: age, obstetric background, height, nutritional history, pre-pregnancy weight, dietary intake during pregnancy, infection, organic pathology, smoking, alcohol or drug use, education and household income. Factors that affect the length of gestation include fetal and placental disorders and maternal infections (R1). At present, it is uncertain whether prematurity is related to maternal malnutrition during pregnancy. In order to improve the usefulness of birthweight as an indicator in screening, monitoring primary health care or comparing levels of socioeconomic status, we need to understand the relative importance of factors among populations, and their relationship to death, morbidity or impaired performance (R1).

In developing countries, most low birthweight babies are small for gestational age, indicating intrauterine growth retardation. One issue of interest is the

proportion caused by maternal malnutrition, as opposed to non-nutritional factors. This would help predict the degree to which intervention strategies directed at improving maternal nutritional status might reduce the incidence of low birthweights. In the Malaysian data, factors significantly related to lower birthweight included female sex, first born, periurban residence (compared with rural), and Indian ethnicity (compared with Malay). A preceding birth interval of less than fifteen months, which was found to interact with income, was used as a proxy for maternal nutritional depletion. This was interpreted to mean that the negative effect on birthweight is mitigated by increasing income. Late menarche (after 18 years) was used as a proxy for maternal height or past nutritional status, and was shown to be significantly related to very low birthweight.

Although indirect measures were used, these data provided evidence for an effect of maternal nutritional status on birthweight. This, in turn, suggests that improvements in maternal nutritional status brought about by intervention strategies, such as food supplementation, should help raise birthweights (J9). However, the independent effect of low maternal height on low birthweight cannot be prevented after the fact. It will take at least one generation to see any improvements within populations. Data from Guatemala also demonstrated that maternal nutrition is an important factor, and that supplementation can be used to reduce the incidence of low birthweight, when it exists in relatively high proportions of the population (C1).

In industrialized countries, on the other hand, where the incidence of low birthweight and infant mortality are relatively small, most are caused by prematurity. The appropriate intervention in this case would be to prevent prematurity and to attempt to increase survival rates of premature infants. For countries in between these two extremes, more information is needed to design strategies that specifically work to prevent causes of low birthweight and poor infant performance, health and survival rates (W27).

Additionally, to increase the cost-effectiveness of intervention programs aimed at reducing the incidence of low birthweight and infant mortality, there is a need to identify those women who can be helped. This again requires specific knowledge about causes and their relationships to functional outcome. Preventable death rates will not remain constant but will depend on the relative prevalence of underlying causes of low birthweight, which have different implications for survival. Furthermore, the effects of various causes are likely to differ in their relationship to prenatal, neonatal, early infant, and late infant mortality rates.

Small for gestational age (SGA) infants can be further distinguished according to the deficit responsible for their small size (W27). This will help to predict

subsequent growth (R1). Specifically, infants who are proportionally growth retarded (i.e., stunted but not wasted) have a better prognosis for survival, but their subsequent growth will not allow them to catch up to normal size infants following birth.

Disproportionally retarded infants (i.e., wasted with or without stunting) have a higher mortality risk, but the survivors do grow enough to catch-up to normal infants. Because the first category is probably caused by maternal malnutrition early in pregnancy, while the second category stems from nutritional inadequacies, in late pregnancy as well, it is clear that the *timing* of nutritional problems (and interventions) has an important bearing on the prognosis for subsequent survival and growth. It also means that some (presently unknown) proportion of child malnutrition may not be improved by intervention strategies introduced during the postnatal period.

It is important to recognize that in spite of the complex problems described above we do not expect that surveillance systems should be capable of distinguishing pre-term from SGA infants and proportionally versus disproportionally retarded infants. It would clearly be beyond the capacity of most developing countries to collect the necessary data on an on-going basis. However, it may be possible to characterize the composition of the "low birthweight" population at intervals of several years to determine possible changes over time. This could indicate when it is time to change emphasis within the mix of intervention strategies. At the very least, knowledge about these complexities should greatly assist in the interpretation of any surveillance data that is based only on low birthweight as a whole.

Child Feeding Practices. As reflected in much of CNSP's work, on-going nutritional surveillance systems are dependent on the use of anthropometric indicators of nutritional status. Because many of these indicators lack specificity (viz., the *reasons* for change in child anthropometry over time), a surveillance system that attempts to answer the "why" questions must include other types of data collection. From a policy perspective, answering the "why" question is essential for taking effective action. A large and important area concerns child feeding practices and their determinants.

A comprehensive review of the knowledge in this area (W16) identified five categories of information that might be relevant in different situations (Figure 13). These are: a) types and amounts of weaning foods used; b) timing of the introduction of complementary foods; c) reduction in the prevalence and duration of breast feeding and replacement by bottle feeding; d) hygienic practices affecting microbiological safety of weaning foods; and e) quality of child care. It was proposed that a limited amount of information in each of these areas could be collected through administrative sources and casual observations,

Changes of Concern	Examples of Possible Causal Factors	Examples of Possible Indicators*		Examples of Possible Interventions
		Early	Late**	
1. Types of amounts of weaning foods used (energy and nutrient density, amounts fed to children, frequency of feedings)	1. Changes in the relative price of staples leading to loss of nutrient quality	Prices of staples	HHS of weaning foods used	—Price manipulation —Subsidized oil to achieve satisfactory energy density
	2. Acculturation leading to undesirable substitution of ingredients in weaning food	Sales; anecdotal reports from the field	HHS of infant diets	Education
	3. Food shortage	Fall in food production	HHS of feeding habits	Food intervention
2. Timing of complementary feeding	1. Later introduction; storage of weaning foods	Anecdotal reports from the field	HHS of feeding habits	Education, or food intervention (if food shortage)
	2. Earlier introduction acculturation	Annecdotal reports from the field	HHS of feeding habits	Education
3. Reduction in extent of breastfeeding and adoption of bottle feeding.	Acculturation, social change	Sales of bottles, infant formula	HHS of feeding habits	Promotion of breastfeeding, legislation
4. Method of preparation which result in high infective properties in weaning foods	1. Changes in mothers' time allocation (seasonal employment) leading to dangerous methods of preparation, deterioration in the quality of the water supply, etc.	Anecdotal report, data on water quality	HHS of weaning food preparation, storage and feeding, environmental sanitation	Education, day care, low cost and easy to prepare weaning foods, improvement of water supply
	2. Lack of fuel for cooking	Prices, availability	HHS of fuel needs and use, environmental sanitation	Subsidized fuels, low cost and easy to prepare weaning foods
5. Quality of child care	Social change leading to increased demands on mothers' time (employment, breakdown of traditional social structure, migration to cities)	Anecdotal reports, demographic statistics, labor statistics	HHS of type of caretaker and of caretaker competence	Education, child care, legislation

*HHS = Household survey; **Later indicators include measures of health and nutritional status in children.

Figure 13. Surveillance Information Needs in Relation to Child Feeding Practices.
Source: Table 15, W16

while more detailed characterization would require occasional household surveys. The latter could also document the extent to which any of these are related to nutritional status of children in the particular country situation.

This approach was followed using data from a number of countries, including Malaysia (J10), Indonesia (D15), Honduras (J17), Panama (D14), and Columbia (D13). Among the important findings from these country studies were that the positive or negative effects of a given child feeding practice can be dependent on other characteristics. For instance, in Bogota the provision of extra supplements was especially beneficial to children with frequent diarrhea; in Honduras the negative effects of not breast feeding were found to be greater when toilets were absent, but unrelated to the presence or absence of piped water; in Panama it was found that the determinants of food allocation to children varied according to the sex of the child; in Java it was found that the quality of child care varied according to the age of the child, because of the tradition that lactating women need not participate in the strenuous manual labor normally expected of them. Analyses such as these can highlight practices that are especially harmful or beneficial in a given situation, and, thereby, point the way to the most promising areas for intervention.

Demographic Indicators

Infant and child mortality are important indicators of development, and "Child Survival" is a major priority for many development efforts. However, in many developing countries, adequate data are lacking, particularly in a form that can be disaggregated in relation to causal factors. Edmonston, et al. (M9) discuss the inclusion of indirect-mortality estimation in health and nutrition surveys. The required data are relatively easy to collect. They include age of mother, number of children ever born, number surviving, duration of marriage/union, and children born during a specified referenced period and their survivorship. These data can be converted into life table probabilities of dying between birth and age x using standard multipliers. The calculations, however, are not simple, and an experienced statistician/demographer is needed to compute and interpret the data. The combination of this with data collected during health and nutrition surveys (income, occupation, education, location, facilities, and so on) allows for the study of mortality differentials (M9). Edmonston prepared an example of a questionnaire module to gather data for mortality estimation (W31). In another working paper (W15), he describes a procedure for estimating the necessary sample size based on variance of the death rate, considering variance due to sampling error, random error and heterogeneity of risk in the population. To date, however, there have been no attempts by CNSP to integrate mortality indicators into on-going surveillance systems.

Data Processing and Analysis

Major constraints identified by newly formed surveillance programs are the availability of necessary facilities, systems, and expertise to process and analyze data in a timely manner. CNSP intensively addressed this issue in its training courses and in the in-country development of systems.

Methods useful for nutritional surveillance are discussed in three CNSP working papers (W6; W28; W32). Data entry procedures and computer use is reviewed by Test (W32). Because of the large potential for error in data entry, a data base manager, such as dBase III with verification options to identify data points outside of specified ranges, is suggested. Common data entry problems are column shifts or duplicate entry of lines. The use of histograms can assist in detecting unusual clustering of data, such as age heaping. Further techniques for identifying data errors include the examination of two variables with a known relationship using scatterplots or cross-tabs. Also, consistency checks for variables measuring related information can be helpful (W32).

For the conversion of raw data on heights and weights to indicators of percent of standard and standardized Z-scores, a microcomputer program is available from the Center for Disease Control (CDC), Atlanta.

For ongoing monitoring and targeting purposes, data analysis for nutritional surveillance generally centers around tabulation for functional classification. Common cross-tabulations include malnutrition (yes/no) by geographic location, categories of occupation, landholding size, distance to health center, water source, sanitation facilities, and so on. Mason (W28) notes that comparisons of factors categorized as with/without at the household level (such as with/without toilet) can be converted to percentage of households without toilet for analysis at the community level. For statistical comparisons, means of variables tend to be used, but prevalences are also presented for interpretation. As a rough rule of thumb, Mason (W28) suggests that a one percent difference in the mean of a measure of nutritional status approximately corresponds to 5 to 15 percentage points in prevalence, depending on the indicator.

More advanced methods of data analysis are described by Tabatabai (W6), including correlation analysis, analysis of variance, regression analysis, co-variance analysis, logit analysis, discriminate analysis, principal components analysis, and cluster analysis. These analyses are not usually used in basic surveillance systems for targeting or program monitoring for adequacy. They are required, however, for outcome evaluation and for detailed analysis of survey data for use in policy and planning.

Training

One of the major mandates of CNSP is to serve as a resource center and to promote nutritional surveillance in developing countries through training activities and workshops. To meet this need, a "short course" (average six weeks) was designed to train government officials from agriculture, health, planning and statistics offices, and others involved in nutrition planning. The course covers the principles and practice of nutritional surveillance, including national planning and policy analysis, program monitoring and evaluation, the use of indicators for timely warning, linkages with intervention strategies, and practical data analysis and interpretation (Figure 14). Lectures cover relevant areas in nutritional measurement, epidemiological principles, economics, and demography. Case studies and small group projects are employed to reinforce the use and understanding of these principles. The course, in various forms, has been held seven times. The first three were conducted at Cornell University, with very heterogeneous groups. Courseleaders felt that country-specific needs could be better met with focused regional courses. Four of these have been held in Kenya, Chile, Malawi, and Mauritius, respectively. In all, 134 participants from more than thirty countries have received this training. Further, a special data management and analysis course using microcomputers was held for fourteen participants from seven countries in the Eastern and Southern Africa regions, Funding and microcomputers for the course were donated by the IBM Corporation.

Nutrition surveillance:	Initial assessment; NS in health and development planning; NS in agricultural development and project evaluation; NS for early warning of hunger crisis.
Review of nutrition principles:	Anthropometry; nutrition interventions; maternal and child health; micronutrient deficiencies and other selected topics.
Policy analysis:	Household economics and food consumption; food policy issues; cost-effectiveness and cost-benefit analysis; food aid and emergency feeding.
Data analysis and interpretation:	Methods of data collection and processing; descriptive statistics; sampling and non-sampling error; inference from sample statistics; cross-tabulation; confounding of variables; multiway tables; trend analysis; correlation/regression.
Case studies and group projects:	Planning and carrying out analyses of example data sets; discussions of NS systems in different countries of the world.

Figure 14. Synopsis of CNSP Short Course.
Source: USAID, 1985

The courses have been very successful, and demand for them is high. Participation in past courses has led to several requests for more collaboration with Cornell in developing surveillance activities. Funding for participant fees was provided by fellowships from several development agencies, including UNICEF, USAID, PAHO, the UNU, and Catholic Relief Services.

In addition to these training courses, regional workshops were organized to provide exchange of information and to advance the state-of-the-art of nutritional surveillance. These were held in Colombia (1981), Kenya (1982), and Thailand (1983) (CNSP, 1982; CNSP, 1983; CNSP, 1984; CNSP, 1986; USAID, 1985). Major concerns discussed at the workshop in Bangkok, Thailand included the need for more effective analysis and presentation of existing data; a greater understanding of the importance and meaning of malnutrition at the policy making level; improved training, information networking and coordinated research at the regional level; and better intersectoral linkages, motivation and awareness of the importance of nutritional problems at the local level. Participants were concerned that a top-down design would overlook the data requirements of local users, and generate resistance to evaluation activities. Thus, effective data analysis and presentation of information were considered important training requisites (R13). Special needs were also identified for African surveillance activities (R3).

Several professionals from developing countries have independently visited Cornell for individual training in nutritional surveillance for periods of weeks to months and returned to work in nutritional surveillance projects (Costa Rica, the Philippines, and Kenya). Others (Mexico, Sri Lanka, Indonesia, and the Philippines) became involved in CNSP as graduate students while receiving training in international nutrition, rural sociology or agricultural economics, along with many students from developed countries. At least fourteen M.S. and Ph.D. theses were completed that were partially funded by CNSP and involved research related to nutritional surveillance. Many more graduate students of international nutrition and other development areas have received information on nutritional surveillance through seminars and a graduate course conducted by CNSP staff.

Finally, a set of manuals is being completed for use by those setting up surveillance surveys. The first, "Overview, Planning and Organization," is complete and available from CNSP. The second, "Training," (of field workers and supervisors) is currently in draft form. The third, "Sampling," is available as a working paper (W27), and components of the fourth, "Data analysis," can be found in analytical methods (W6) and data analysis and preparation (W32).

3. COUNTRY DEVELOPMENTS

The Cornell Nutritional Surveillance Program worked with several countries in developing national nutritional surveillance systems or advising on aspects of nutritional surveillance. Special efforts were made in Indonesia, the Philippines, Costa Rica, Kenya, Botswana, Malawi and Lesotho, but many more countries received training and short-term assistance from CNSP. Using similar methods, with a different focus, CNSP also contributed to the development of a nutritional surveillance system for New York State. Progress in various countries where CNSP provided major assistance is summarized below.

INDONESIA

Indonesia was one of the first countries to include the concept of nutritional surveillance in its development plan, listing it as a priority in 1976 (R14). Actual work with Cornell to develop a system commenced in 1979 based on three main requirements: 1) the need for a low-cost system to provide information that would lead directly to successful intervention strategies; 2) focus on one nutritional problem from which the system could be expanded; and 3) the Ministry of Health would initiate the system, but the eventual program would be multisectoral (J16). An initial assessment of existing data sources and potential strategies was conducted and, at a workshop in 1980, a consensus was reached to commence with a focus on the problem of periodic food crises. The first system was set up in Lombok and was later expanded to other areas.

Earlier efforts to reduce the effects of food crises resulted in the creation of BULOG, a government system designed to ensure an ample supply of staple foods. Under this program, staples were stored and released as needed to maintain prices within a specified level (R14). However, food crises continued to occur because of income failures occasioned by drought and loss of agricultural employemnt. Although BULOG maintained a reasonable supply, in certain situations many people could not afford to purchase needed food (J16).

To address this problem, a "timely warning and intervention information system" (TWIIS) was developed using indicators that predicted the likelihood of food crises and that triggered the initiation of intervention strategies. Funding for the development of the nutritional surveillance program was provided by USAID under a contract between Cornell and the Indonesian Ministry of Health (1980-1984, (R15)). The Kabupaten (similar to a county) was selected

as the smallest unit with the administrative ability to initiate useful interventions. The first step in designing a local system in Central Lombok was to investigate existing data sources to clarify the situational aspects accompanying food crises that had occurred in the past five years. These, along with information on seasonal agricultural and employment calendars, were used to identify factors associated with large income drops among the poor and to develop staged indicators with cut-off points, which signaled the need for action (J16; D7).

Selected indicators (and responses) included: 1) Early Indicator: percent area planted (seeds provided for secondary crops, public works projects planned for later in the year); 2) Concurrent Indicator: percent area of rice destroyed/harvested, (public works projects implemented); 3) Late Indicator food consumption monitored with simple reporting system using sentinel sample of poorest families. Cut-off points included households not consuming rice for one week or those consuming wild tubers or turi leaves; interventions included initiation of public works projects, sale of rice at subsidized prices, rice lending – (to be paid back in part when possible) and free distribution of rice in severe cases (J16; R14).

In 1982, a nutritional surveillance steering committee (NSSC) was created within the Indonesian Nutrition Directorate. It proposed that local universities become involved in operational research to assist the TWIIS. In 1983 in Lombok, the University of Mataram began to provide "operational research," training, and indicator development and linked the kabupaten program with the Regency (Provincial) committee. In developing these linkages, the Bogor Agricultural Institute also participated, with Cornell support. Observation showed that processes were operating as planned, that targeting of rice lending was most successful at reaching the poor, that public works were moderately successful, and that subsidized rice sales were least successful. The inclusion of the poorest families in the sentinel sample appeared to signal food crises too often, thus, a redefinition of the sample was recommended. Overall, the TWIIS was found to be self-sustaining and the system is currently being expanded to several other priority locations in Indonesia (R15).

The TWIIS appeared to be useful in averting food crises. However, it could not solve the poverty-related problem of chronic malnutrition. In 1984, Cornell was once again asked to assist in the development of a more generalized nutritional surveillance system. A child weighing program existed (UPGK), but only measured weights were collected, which did not permit assessment of local prevalences. For program planning decisions, more information was needed about types of malnutrition, its extent and geographic location, its determinants, and its effects. Researchers suggested that an integrated system of data reporting was urgently needed to manage primary health care activities and that repeated

cross-sectional surveys were required to define the problem and assess changes (R14).

Two existing surveys, the SUPAS (including information on socio-economic status, household characteristics, health and mortality) and the SUSENAS (including food consumption data) provided important information. If these could be combined with some anthropometric data, using representative sampling within ecological zones, adequate information would be available for nutritional surveillance (R14). CNSP suggested the addition of a nutrition module every two years to allow links to be forged between different aspects of the SUSENAS survey which are measured annually in separate rotating modules (R17).

CNSP also recommended that the National Nutritional Surveillance Steering Committee, set up to coordinate the TWIIS, expand its functions to monitor the program and to act as a coordination point for the synthesis and evaluation of existing data sources, while supporting the establishment of the TWIIS in new areas (R14; R17).

School surveys of height at entry were also used in Indonesia, but uneven school attendance made interpretation difficult, and it was unclear whether generalizations could be extended to the preschool population. Currently, CNSP is evaluating these and the UPGK weighing data.

THE PHILIPPINES

In the Philippines, nutritional surveillance activities have been coordinated by the National Nutrition Council since 1980. Major sources of data are preschool weighing (Operation Timbang), school measures of heights and weights, census data, data from the Ministries of Human Settlements and Agriculture, and survey data from the Food and Nutrition Research Institute (FNRI), (W1; R2).

Operation Timbang is intended to completely enumerate preschoolers' weight-for-age. Data are used for individual screening and follow-up and to define priority areas for targeting of food aid and nutrition programs. Collection is mainly carried out by staff of the Ministry of Health clinics, but sometimes by village health or nutrition workers. An assessment of the actual coverage of the program, however, showed that it included only about 30 percent of all children because of inadequate resources, non-compliance and problems with timely reporting. A comparison with a sample survey revealed that Operation Timbang (OPT) data tend to overestimate the prevalence of malnutrition (W3).

An attempt was made to use existing information from municipalities with coverage between 20 and 98 percent to estimate expected prevalences in other municipalities. Using discriminant analysis, municipalities were classified into

three categories based on the indicators of housing quality, water source, and number of physicians per 10,000 population. Mapping of these results showed that the central part of the country was in the worst condition. However, the lack of a high correlation between the indicator variables and nutritional status weakened the results. Operation Timbang functions well as a screening device but does not appear to be sufficient to allow the formation of accurate prevalence estimations (W3).

OPT data were also examined to determine their usefulness in assessing change over time. Although an overall improvement was noted between data collected in 1979 and 1980, conclusions were tentative because data were still incomplete and unreliable. It was found that when observed figures were unreliable, observed changes were even more unreliable (W5).

A second major source of nutritional data is provided by schools. In 1982, a national school survey was conducted to assess the usefulness of these indicators. School records included height, weight, birthdate, and sex of the child and occupation of the household head. Sixty percent of the schools responded, and data were examined for children six to eight and one half years of age. A cut-off point of 90 percent of height-for-age in comparison to the Philippines standard was employed to define stunting. Using Region IV as an example, a functional classification (based on height-for-age) was performed to define municipalities. These included municipalities with lower population density, less irrigated rice area, and more poor housing. Stunting was seen to be associated with distance to the center of town, fishing as the main occupation and residence in upland areas (R12). Stunting is indicative of long-term chronic effects, and appropriate intervention strategies include those designed to aid in the alleviation of poverty.

Mason, et al. (J12) discussed the need to enhance positive effects of development projects on nutrition. They described an attempt to include nutritional considerations in the planning of the multisectoral Palawan Integrated Area Development Project (PIADP). An initial assessment and rapid survey revealed greater rates of malnutrition at higher elevations, in inaccessible areas, and among farmers and subsistence fishermen. Malnutrition was not found to be closely associated with amount of irrigation or rice area cultivated, except in cases of families with less than one hectare. Researchers recommended that remote areas, smallholders and subsistence fishermen be targeted by encouraging diversification and by developing services and water supplies for remote areas. Recommendations such as these must be balanced against economic constraints and objectives to maximize the effectiveness of the development program in achieving both economic and nutritional goals.

COSTA RICA

Costa Rica first established an information system (SIN) in 1978, which is now a division of the Office of Control of Family Welfare. Data on height at school entry collected by schoolteachers and health data amassed by health workers during home visits (including pre-schoolers weight-for-age) are disaggregated using functional classification, socioeconomic status, geography, sanitation, and other variables. Additional data are available from census surveys and from the Ministry of Labor (W1). Analyses of these data showed that the number of children under twelve years of age in the household was the most important correlate of nutritional status in a bivariate as well as in a multiple regression analysis. Crowding was negatively related to nutrition. The presence of piped water within the home (versus an outside water source) was more important than toilet type in predicting nutritional status, although both were significant. Ownership of a refrigerator and higher per capita income explained additional variance in nutritional status (D4).

It was found that the risk associated with a particular socioeconomic characteristic varied among occupational groups. The differences among groups, in terms of effect on nutritional status, were related to the degree of risk associated with a particular characteristic and the relative proportion of households within the group with that characteristic. An unexpected finding was that the presence of septic tanks for several of the agricultural subsectors appeared to be associated with higher risk than for the general population (even for latrine users). This suggested that perhaps systems were inadequately constructed and had contaminated the water supply. The nutritional status of children in households employed by banana plantations was close to the national average, indicating that conditions may recently have improved for this group (D4).

In sum, substantial regional and occupational variation in the prevalence of malnutrition was noted. These results were used by the Planning Office to develop basic needs strategies and for targeting purposes. The areas with the worst problems were identified and resources were redirected to them.

KENYA

Kenya began incorporating nutrition modules into "integrated sample surveys" conducted by the Central Bureau of Statistics (CBS) in 1977. A second survey was included 1979, and a third in 1982. The integrated sample survey program, with a permanent field operation, was established in 1975, and the inclusion of nutrition modules required only the purchase of basic equipment, some additional training for existing enumerators, and the inclusion of expertise in the analysis of nutritional data. Data collected in these modules included age, weight, arm circumference, and feeding habits of preschool children. Outputs

included nutritional information by province, agroecological zone, cropping pattern, income group, landholding, and occupation (B1; W1; W3).

An analysis of the 1979 survey data revealed that the Coast and Nyanza provinces had the highest prevalence of malnutrition (defined as less than 90 percent of height-for-age) especially among smallholders with less than 1.5 hectares. There was also some evidence that households growing drought-resistant crops were better off than those growing hybrid maize only, and that those growing coffee (in Eastern province only) tended to be in the worst condition. Overall, 22 percent of households in rural Kenya included children with less than 90 percent of height-for-age, varying as much as 15 percentage points from Central Province to Nyanza Province (J22).

Trends in nutritional status were examined by comparing results from the three nutrition modules. Provinces in the Central region had the lowest prevalences, with little change over time, while deterioration was evident in Western and Nyanza Provinces, possibly due to fragmentation of landholdings and increasing population densities (W17).

Recently, the ACC/SCN, which is responsible for promoting effective, collaborative, nutrition-related action in the UN system, selected Kenya as a case study for improving agency-government action to combat food and nutrition problems. Identified needs included manpower development and strengthening of existing institutions with nutritional objectives. At the district level, further training, technical, and logistic support were all cited as requirements to improve local capability. Suggestions included an increased focus on agriculture and farming systems research and the addition of agricultural services and outreach for women. Suggestions for institutional development included the formation of a high-level steering committee, a Kenyan advisory group on nutrition, a national committee on health, and the coordination of nutrition activities by the Food and Nutrition Planning Unit (FNPU) in different areas. Interactions with donor agencies and input by ACC/SCN to the Kenyan system was evaluated for effectiveness and as a case study for procedures to be expanded to other countries. The major goal was to establish an effective donor consultative mechanism to enhance the effectiveness of nutrition actions (R18; R22).

BOTSWANA

Nutritional surveillance was initiated in Botswana in 1976, and a national system was established in 1978, with preschoolers' weights and heights taken in MCH clinics by nurses or family welfare educators (FWE). The objectives were to assess the levels of malnutrition at various geographic levels, to provide intervention for at-risk individuals, to set regional and national program priorities, and to set "trigger-levels" for localized famine relief (R2).

CNSP evaluations of the system revealed several problems. First, because the data are clinic-based, their representativeness is uncertain. Second, the use of a master chart for plotting weight-for-age was prone to error, resulting in potentially large mistakes in prevalence estimates. Furthermore, many centers did not report data, so actual coverage included some bias, and of those observed, inaccuracies were noted in weighing equipment and recording procedures. Finally, not all centers reported on the same schedule, or used the same age ranges, making data aggregation difficult. Simplification and standardization of reporting was improved by using clinics logbooks submitted on a monthly basis. Other advice included: the development of a standard reporting format for the Regional Health Education Nutrition Officers (RHENOs); improvement in training procedures for weighing techniques and use of the logbook by FWEs and RHENOs; historical data to develop "rules of thumb" for changes in prevalence that should signal action; and analysis of data that monitor changes in attendance and coverage. It was also recommended that the local programs be managed by the RHENOs, who should compile monthly reports for submission to regional and district offices and to the Central Nutrition Unit (CNU). These would provide feedback to health facilities. An additional post at the CNU was recommended to oversee the nutritional surveillance system. Finally, it was suggested that the Central Statistics Office (CSO) should produce monthly reports with prevalence figures, plus bi-annual reports with breakdowns by sex, age, and mothers' education (R6; R7).

In addition to routinely collected clinic data, Botswana initiated the "Continuous Household Integrated Program of Surveys" (CHIPS) to produce data that could be cross tabulated. A nutrition module with height, weight, and age data was planned for inclusion every two to three years. These surveys were implemented by the CSO under the auspices of the National Household Survey Capability Program of the United Nations. Analysis of recent data collected as part of this survey system — "The Primary Health Care Evaluation Survey" — revealed a prevalence of low weight-for-age (less than 80 percent of standards) of 29 percent. Age specific data showed that prevalence was greatest during the weaning period. It was also found to be higher in rural than in urban areas. Prevalence was positively correlated with distance to water source, number of persons per room and lack of toilet facilities (R23; W14).

The Early Warning Technical Committee, with assistance from several ministries and the Inter-Ministerial Drought Committee (M7), developed and coordinated a timely warning and intervention program to prevent food crises (M7). CNSP assisted in the construction and testing of indicators for this system. Using data from the agricultural reporting system and from the Ministry of Health for the period 1978-1983, associations among agricultural indicators and

later prevalence of malnutrition were examined across regions and over time. Agricultural indicators included water sufficiency indices for maize and sorghum based on actual rainfall and evapotranspiration rates in relation to stage of growth, and a livestock index based on weight.

Because drought occurred in some areas in 1979, 1982, and 1983, prevalences of malnutrition in 1980 and 1981 were used as standards for comparison. It was found that, in drought years, the prevalence of malnutrition failed to improve after the rainy season as it did in non-drought years, and it was demonstrated that of eighteen cases of serious malnutrition, the maize index would have correctly predicted sixteen. The sum of sensitivity and specificity (SSS) were 1.6. If the predictive ability were random, SSS would have been about 1.0. The livestock index also resulted in a sum of 1.5 to 1.7. Positive predictive values for the two were 0.76 and 0.85 to 0.91 respectively. Thus, they appeared to be useful indicators. Based on this information, decisions concerning drought relief activities could be made in May, eliminating malnutrition-related problems that would occur during the vulnerable part of the year, July through January. From July onwards, monthly prevalence figures could be used to pinpoint crisis areas (J25; M7).

Intervention strategies include labor-based relief projects, seed distribution, dispersal of subsidized agricultural feed, and food distribution. An evaluation of the relief effort in 1982/83, however, noted poor design of labor-based relief programs and inaccurate targeting of intervention strategies, indicating a clear need for development of an efficient timely warning and intervention system (R5).

LESOTHO

Lesotho currently collects anthropometric data on preschool children attending MCH clinics. Nutrition activities are overseen by the Food and Nutrition Coordinating Office (FNCO). There are plans to expand the nutritional surveillance system, to develop a timely warning system, and to initiate a national household survey capability program to provide representative data on nutrition, socioeconomic status, and agriculture (W14).

Currently, information collection mainly includes preschool growth monitoring at health centers and feeding programs. Two different charts are used: the "growth surveillance chart," where weight-for-age percentiles are measured on the vertical axis, and "the road-to-health chart," which plots actual weights on the chart. Because these two methods of recording weight cause confusion and preclude the development of a county-wide surveillance system, CINSP was asked to assist in an evaluation of the two for growth monitoring purposes.

The purpose of growth monitoring in Lesotho is to screen individuals for

follow-up and to collect information to be used in planning at local and national levels. Current implementation varies widely. Some mothers receive individual consultations, others are referred to nutrition rehabilitation clinics or feeding programs, and some get follow-up care from Village Health Workers or nurses. Observation of procedures revealed that mothers generally received information only when adequate staff were available, which was often not the case. Haaga (R21) noted that the 80 percent weight-for-age cutoff classifies so many children as malnourished that it is not possible to provide intensive care for all of them. This tended to dilute resources away from the most severely malnourished.

Field evaluations of the use of the two types of growth charts was conducted with both health workers and mothers. Fifty-nine (59) nurse assistants/midwives from four hospitals were taught how to use the two different growth charts (RTH and GS) in order to determine if one was easier to use, understand and interpret. Two hospitals were randomly chosen to be trained to record weights with the RTH chart one week and the GS chart the next. Two other hospitals received the opposite schedule of training. Post tests were used to evaluate the participants' capabilities in age calculations to carry out weight plotting, interpret growth patterns and to make decisions based on the growth monitoring data, which they collected. Researchers then assessed how easy, relatively, each chart was to use and whether data generated by them were comprehensible. The results showed that nurse-assistants/midwives with no prior knowledge or experience with growth charts could learn to use either chart equally well. After learning to use a second chart, nurse-assistants/midwives who learned the RTH after prior training with the GS chart scored higher than those who began with the RTH chart first. It thus appears that prior knowledge of the RTH chart does not facilitate learning about the GS chart and may even confuse health workers. The last finding is important because it reflects a situation typical in many African countries: health workers that have used a RTH-type chart for many years are forced to change to the GS system when a CRS Food and Nutrition Program is introduced.

A second study included mothers from nine under-five clinics. It evaluated mothers' understanding of the two growth monitoring charts. Results showed that the mothers learned the RTH chart more easily than the GS chart, regardless of their prior chart exposure or baseline results. The mothers also had more difficulty observing the direction of growth of a child when weight was plotted on a GS chart rather than when plotted on a RTH chart.

These two studies showed that even though the two charts were comprehended equally by inexperienced *health workers, mothers* understood the RTH chart more readily.

MALAWI

As the result of a national workshop on nutrition in 1984 that called attention to the very high levels of chronic malnutrition (56 percent of under-fives are stunted), CNSP was asked to assist with the development of a nutritional surveillance program on a pilot basis in one of the eight Agricultural Development Divisions (ADD) in Malawi. The work began in 1985 with the posting of a CNSP staff member at the University of Malawi's Centre for Social Research, which is the local institution that provides technical support for government ministries in the area of nutritional surveillance.

One of the on-going projects in Malawi has been the analysis of the 1980/81 National Sample Survey of Agriculture. The analysis focused on household-level correlates of child malnutrition, emphasizing the implications for agricultural development strategies. The results were disseminated at the Principal Secretaries Symposium on Nutrition and Development in 1986 (CSR, 1986), at a Review of the Performance of the National Rural Development Programme in 1987, through the UNICEF/Malawi Government's Situation Analysis of Women and Children (UNICEF/GOM, 1987), and through a World Bank/Malawi Government seminar on the reorientation of the National Rural Development Programme.

A second major activity arose in response to the rapid and unexpected destruction of the staple food crop (cassava) by an insect pest in one district of the country beginning in 1986. A rapid survey was undertaken to determine which socioeconomic groups were most affected nutritionally by the disaster, and to assist in the planning of medium- and long-term strategies to avert malnutrition caused by food shortages (which are expected to persist for ten to twenty years). A multisectoral Nutritional Surveillance Subcommittee was formed within the Regional Primary Health Care Team to assist with the dissemination and use of these results, as well as with future surveillance activities.

The Subcommittee realized that appropriate intervention strategies were beyond the resources available at the regional level. They worked through the National Committee on Disaster Preparedness and Relief to convene a national workshop on the problem and to develop intervention proposals. This workshop, held in July 1987, yielded a set of fifteen integrated interventions, which were approved by the Office of the President and Cabinet (OPC) soon after (NSS, 1987). The USAID mission was asked to fund three-year proposals for agricultural rehabilitation (crop diversification and related measures) and OPC approached other donors for support of other projects.

A third area of work related to the possible effects of agricultural market liberalization on household food security and nutrition. Market liberalization

was initiated in 1987 as part of a package of reforms recommended by the World Bank. These were aimed at rectifying some major financial problems in the national marketing board (ADMARC). A system was proposed (and accepted by the government) to monitor the effects of these changes on local food security for two purposes: 1) to identify local areas experiencing food shortages (timely warning); and 2) after a few years of operating the information system, to analyze the overall effects of the marketing changes *per se* on local food security, household food security, and nutritional status of children. A modified version of the proposal has been implemented through the Ministry of Agriculture and the Food Security and Nutrition Unit in OPC, with assistance from CNSP and UNICEF.

A fourth activity is a three-year prospective study of maternal and child nutrition, which began in December 1986 and will continue through December 1989. A sample of about 950 women were enrolled in the study in mid-pregnancy and are being followed on a monthly basis through the birth of the child and up to 32 months postnatally. The study focus is unusually broad in the types of data being collected and the issues covered. Some of these include the identification of household risk factors predictive of child malnutrition to assist in targeting preventive interventions; an examination of the heterogeneity of low birthweight and the variation in its causes and consequences; an analysis of seasonal variations in nutritional status in children and in their mothers, and its association with subsistence strategies, health status, and a variety of other household factors; and an assessment of the predictive ability of anthropometric indicators and household characteristics with respect to subsequent child mortality. The study is being undertaken in collaboration with the Centre for Social Research, and has received funding from USAID (external staff costs), WHO, UNICEF, IDRC, The Rockefeller Foundation, and the Carnegie Corporation of New York.

4. LESSONS LEARNED AND FUTURE DIRECTIONS

Since 1980, CNSP has been involved with the conceptual and methodological development of "nutritional surveillance" and has attempted to operationalize surveillance in a number of developing countries. A major general lesson learned in the process is that, despite the clear common goal shared by all forms of nutritional surveillance, a very broad range of activities is actually subsumed under its umbrella. This diversity of activities implicit within surveillance itself, combined with the varied situations found in developing countries, presents the greatest challenge to developing and disseminating unified methodologies. The discussion that follows highlights some issues that CNSP helped to clarify since 1980, but mainly identifies potential areas for future work, which became clear because of CNSP's experiences in operationalizing surveillance. The discussion is organized according to the different types of nutritional surveillance, although it is recognized that some of the issues are generic to more than one type.

NUTRITIONAL SURVEILLANCE FOR POLICY AND PLANNING (NSPP)

As noted earlier, CNSP was very active in formulating functional classifications of populations by nutritional status using results from national sample surveys. In part, this reflects the availability of these types of unanalyzed data sets in many countries and the countervailing unavailability of trained staff and other resources to perform the analyses. As an input to national planning, this represents a useful contribution and an efficient use of existing data. However, there are a number of issues that will require more attention in the future.

First, because of the protracted and diffuse nature of national planning processes, it is unclear to what extent analyses actually contribute to decision-making. This depends in large measure on whether the results are consistent with the agendas of various parties (politicians, senior government bureaucrats, various donors, etc.) and the activity and power base of the advocacy element. Although the same could be said of all types of surveillance information, it is especially true when the actual decision makers and decision points are not clearly identified.

Quite apart from the question of political commitment, however, it is worth-

while examining exactly how far results such as these can go in assisting the planning process, and what types of complementary activities may be required. While functional classifications generally indicate which groups are especially prone to malnutrition, they are often less reliable in confidently identifying the reasons why risk is elevated for certain groups. The data are likely to be difficult to disaggregate by geographic area to the extent often deemed necessary. Moreover, the design of effective measures to remedy the situation must take into account not only the actual causes of malnutrition in various groups, but also the way in which the population would respond to intervention strategies.

In large measure, therefore, this type of analysis suffers from the same limitations imposed by all bureaucratic, "top-down" planning approaches. While such planning is probably more effective when functional classifications *are* available, limitations still need to be recognized, and surveillance activities should focus on further improvements to aid the planning process. In the future, CNSP might address this issue by examining methods for "rapid rural appraisal" and the use of more qualitative sources of information for the design of development programs and projects. Such approaches have recently been applied in the planning and implementation of some area-based projects. It remains, however, to determine whether and how these can be combined with more conventional planning at the national level.

Apart from sample surveys, administrative sources such as health clinics, community-based programs, schools, etc. can also provide information. A number of countries are collecting or are planning to amass such information (e.g., Indonesia, Philippines, Costa Rica). While these data are generally more readily available and can be disaggregated to lower levels, their validity has not been sufficiently examined to assess levels, trends, and correlates of malnutrition in the general population, under various circumstances. Given the tremendous potential for the use of these data sources in surveillance systems, work to assess and improve their validity is essential.

As noted above, one concern is the loose links between information and decision making. Surveillance workers could accept on faith that the planning process is improved when objective information is made available; However, if methodologies were developed that accurately described the decision-making process within and among various institutional frameworks, strengths, weaknesses, and conflicts related to the use of surveillance information in a given setting could be clarified. In some cases, these are obvious, in others less so. A logical complement to this would be to develop a variety of measures (sensitization and training sessions, seminars, in-house conferences, etc.) that would increase the effective interaction among relevant parties. Equipped with such knowledge and techniques, it would be possible to design surveillance systems

that are more appropriate to the local bureaucratic arrangements and, thus to increase the likelihood that the information will be used in the planning process.

PROGRAM MANAGEMENT AND EVALUATION

To date, CNSP's role in program management has been to clarify the different activities often subsumed under the term "monitoring and evaluation" and to indicate under what circumstances each is appropriate as part of a nutritional surveillance system. This has been especially useful in the case of "evaluation" activities that cover a broad spectrum and can fall well outside of the normal boundaries of nutritional surveillance.

As described elsewhere (Habicht, 1988), there has been very little success in implementing surveillance systems for management of on-going activities, although there is good reason to believe that this would be helpful if it were built-in to the original design of the program. The reasons for difficulty are basically two-fold: program personnel are threatened by the possibility that the information system might uncover faults in the implementation or operational activities; and at several levels in the program, the collection of data is viewed as a competing activity with the delivery of services or performance of other job duties.

The latter problem is probably the easier of the two to correct, although there are still serious obstacles to overcome. "Data" are often perceived by those at lower levels in the program as a simple collection of numbers in a monthly report that have no intrinsic meaning and that cannot be readily used to support decision making (which is often a correct perception). Moreover, whatever uses to which the data are put at higher levels in the program (if any) are hidden from them. Often this is a fault in the design of the information system itself, rather than with the program staff *per se*. In order to be successful the information should be useful to those involved in data collection and processing at various levels. Flexibility must be built into the system to allow collectors to alter activities in response to new observations or information. For this reason, greater success would be anticipated if the information system was designed from the "ground up." The question remains, however, as to whether and how a more effective information system can be built into an on-going program that may, itself, be poorly targeted, inefficiently operated, and inflexible in decision-making and program redirection.

The problem of threats perceived by program personnel results, to some extent, from the same lack of flexibility that prevents workers from making changes in program staff, activities, budget, etc. in response to local conditions and to messages generated by the information system. It is also, however, a common feature of most program bureaucracies and the way in which they relate

to individu. 's within a bureaucracy. As in the case of nutritional surveillance for planning and policy, perhaps what is needed next is to combine the technical aspects of information collection, processing, and interpretation with more explicit attention to management and organizational issues that have such a large bearing on the eventual use of the information.

Another characteristic of these types of information systems is that they are generally capable of indicating whether and where the program is proceeding as planned, but are much less useful in indicating the *reasons* behind a poor performance. In most cases, it is necessary to know why before a solution can be implemented. If the problem is internal to the program (staff, logistics, supplies, etc.), this can normally be ascertained through the usual internal channels of communication. If the problem is external, however, as in the case of poor acceptance or participation on the part of the target population, some form of more detailed investigation will be required. Although this would seem to be self-evident, often follow-up investigations are not made, and corrective action is either not taken or is misguided.

In most cases, the most appropriate method may be to use informal surveys to determine the sources of the problem. This may be sufficient by itself, or it may sometimes be necessary to follow-up these observations with a more formal sample survey to determine if the results can be generalized across the population. In either case, the ability to undertake such *ad hoc* investigations in response to messages from the on-going information system is usually lacking and is a logical complement to these systems.

TIMELY WARNING AND INTERVENTION INFORMATION SYSTEMS (TWIIS)

Through its experience in Indonesia and Botswana, CNSP achieved a high level of specificity concerning the design of surveillance systems of this type (Habicht, 1988). Design and implementation of TWIIS systems is greatly facilitated by the fact that decision points and alternative courses of action are clearly specified beforehand and, once this is accomplished, other elements are built into the system. Thus, there is a much closer and more explicit linkage between information and action, which is not generally found in other types of surveillance activities.

While it has been possible to specify the prerequisites for a successful TWIIS, what remains is to learn what can be done in situations where one or more of the prerequisites is not met. For instance, what can be done when the infrastructure for collecting even semi-quantitative information is either non-existent or is not trusted; or when no delegation of authority exists with respect to mobilizing interventions; or when the resources and capacity for maintaining relief pre-

paredness do not exist? These situations are commonly found in African countries and pose serious obstacles to developing a successful TWIIS.

When the political will to act is less than optimal, the burden placed upon the *specificity* of an indicator becomes more important than its sensitivity or positive predictive value (i.e., there is a desire to minimize false positives, which usually implies tolerating more false negatives). This means that late-stage indicators, such as population movements, nutritional wasting, mortality, etc., will tend to receive more attention than earlier ones, which would normally be considered "timely."

In such a situation, the use of first-hand observations by fairly high-level and trusted officials may provide more lead time in mobilizing interventions, insofar as earlier indicators that are observed first-hand may be more believable than similar ones reported second-hand. However, this type of system would clearly be more cumbersome and expensive to operate in a routine fashion. It may also be impossible in a large country with many localized food problems in any given year. Nonetheless, it would be worth exploring whether this basic method could be used as the last stage of a cascade model, with the earlier stages being based on methods similar to those in use in Indonesia and Botswana. It is possible that after several years of using these methods, decision-makers may grow more confident in relying on earlier indicators reported from the local level and forego the step of first-hand verification.

IMPLICATIONS FOR BUILDING NATIONAL CAPACITY

One of the most important lessons gained from CNSP's experiences in developing various types of surveillance systems in developing countries is that it requires a much larger administrative and fiscal effort than is often assumed. The intensive project in Indonesia lasted six years in one small area of the country, and only now has the difficult process begun of expanding to other areas. The Malawi project is in its third year and is still very far from being able to leave a self-standing system behind, even in one area of the country. Botswana received over four years of regular input from CNSP, and a number of important issues still remain unresolved. In many more countries, the collection of data of unknown reliability and for unspecified reasons continues as it has in the past, or is even being accelerated, with little local capacity for deciding how to reorient these efforts in more productive ways for in-country decision-making.

As more and more experience is gained in nutritional surveillance, and some of the issues raised above are addressed through further case studies, the major question will become how to transfer this experience to the wider set of developing countries. This question is especially difficult in the case of most

African countries, which do not possess the broad base of highly trained professionals that work in many of the Asian and Latin American countries. Unfortunately, this general scarcity of skilled human resources cannot be overcome simply by training a few professionals from each country in nutritional surveillance through short courses, on-the-job training or even degree programs. While these may be effective methods for training individuals, too often the general technical skills acquired through such training are of value to other government departments or the private sector as well, leading to job transfers. The result, therefore, may be a contribution to the general pool of skilled professionals in the country, but much less towards building national capacity for nutritional surveillance. Such surveillance training can be a complement to long-term national training, but until the latter is present, it will seriously constrain efforts to truly institutionalize surveillance.

In an overall sense, CNSP's work over the past eight years has solved some of the technical problems involved with nutritional surveillance and highlighted others that remain to be solved. Equally important, however, has been the fairly specific identification of wider constraints that affect the success of nutritional surveillance in the areas of organizational structure and behavior, political economy, staff and training requirements, etc.. The real challenge for the future will be to find ways to adapt the technical requirements of surveillance to the prevailing "environment" in a given country, and/or to make acceptable changes in selected aspects of the environment where possible. This will require an even more extensive perspective on the problem and a wider range of expertise. It will also require a more broad-based commitment to the importance of nutritional surveillance within developing countries and on the part of major donors in these countries, such that constraining influences are recognized and addressed at the same time that the technical problems are resolved.

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APPENDIX 1

CORNELL NUTRITIONAL SURVEILLANCE PROGRAM
LIST OF
PUBLICATIONS
DECEMBER 1987

BOOKS

B1 Mason, J.B., J-P. Habicht, H. Tabatabai and V. Valverde (1984). *Nutritional Surveillance*. WHO, Geneva, Switzerland.
PLEASE ORDER B1 DIRECTLY FROM WHO PUBLICATION CENTERS (see page 71).

B2 Jansen, A., E. Horelli and V. Quinn (1987) *Nutrition in Kenya: a Historical Review*, UNICEF/ESARO, P.O. Box 44145, Nairobi, Kenya.
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BOOK CHAPTERS (Some Reprints Available)

C1 Habicht, J-P. and C. Yarborough (1980). Efficiency of Selecting Pregnant Women for Food Supplementation During Pregnancy. In H. Aebi and R. Whitehead (Eds.), *Maternal Nutrition During Pregnancy and Lactation*. Nestle Foundation Series, Huber, pp. 314-336.

C2 Mason, J.B. and J-P. Habicht (1981). Nutritional Surveillance. In A.E. Harper and G.K. Davis (Eds.), *Progress in Clinical and Biological Research. Vol 77: Nutrition in Health and Disease and International Development*. Alan R. Liss, Inc., New York, pp. 539-547.

C3 Martorell, R., J-P. Habicht and R.E. Klein (1982). Anthropometric Indicators of Change in Nutritional Status in Malnourished Populations. In B.A. Underwood (Ed.), *Proceedings Methodologies for Human Population Studies in Nutrition Related to Health*. NIH Publication #82-2462, U.S. Government Printing Office, pp. 96-110.

C4 Habicht, J-P. and J.B. Mason (1983). Nutritional Surveillance: Principles and Practice. In D.S. McLaren (Ed.), *Nutrition in the Community*. John Wiley and Sons, Ltd., London, England, Chapter 12, pp. 217-244.

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ing Systems for Agricultural and Rural Development Projects, Volume I. FAO Economic and Social Development Paper 12, Rev. 1, FAO, Rome, Italy, pp. 59-70.

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C6 Habicht, J-P., J.B. Mason and H. Tabatabai (1984). Basic Concepts for the Design of Evaluation during Programme Implementation. In D.E. Sahn, R. Lockwood, and N.S. Scrimshaw, *Methods for the Evaluation of the Impact of Food and Nutrition Programmes.* United Nations University, Japan. Chapter 1, pp. 1-25.

PLEASE ORDER C6 DIRECTLY FROM UNITED NATIONS UNIVERSITY (see page 71).

C7 Mason, J.B. and J-P. Habicht (1984). Stages in the Evaluation of Ongoing Programmes. In D.E. Sahn, R. Lockwood, and N.S. Scrimshaw, *Methods for the Evaluation of the Impact of Food and Nutrition Programmes.* United Nations University, Japan. Chapter 1, pp. 26-45.

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C8 Habicht, J-P. and K.M. Rasmussen (1985). Model for Analysis of the Relationship Between Breastfeeding Data and Postpartum Anovulation Data. In J. Dobbing (Ed.), *Maternal Nutrition and Lactational Infertility.* Raven Press, New York, NY, pp. 119-127.

C9 Habicht, J-P. (1985). Areas of Agreement and Uncertainty. In J. Dobbing (Ed.), *Maternal Nutrition and Lactational Infertility.* Raven Press, New York, NY, pp. 139-141.

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