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METHODOLOGY OF NUTRITIONAL SURVEILLANCE

**Report of a
Joint FAO/UNICEF/WHO Expert Committee**

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CONTENTS

	Page
1. Introduction	7
1.1 General objectives of surveillance	8
1.2 Specific objectives	9
1.3 Definitions	9
2. Initial Assessment	11
2.1 The nature of the nutritional problems	11
2.2 Identification and description of groups at risk	12
2.3 Identification of causal factors and formulation of a working hypothesis	13
2.4 Sources of data for initial assessment	14
3. Indicators for use in nutritional surveillance	15
3.1 General characteristics of indicators	15
3.1.1 Introduction	15
3.1.2 "Cut-off points" and "trigger levels"	16
3.1.3 Characteristics of indicators related to measurements and the significance of observed trends	17
3.1.4 Characteristics of indicators related to the sample	18
3.1.5 Operational characteristics	18
3.2 The significance of causality in the choice of indicators	19
3.3 The use of agricultural and socioeconomic variables in specific nutritional surveillance systems	22
3.3.1 The importance of the food supply system	22
3.3.2 Suggested indicators	25
3.3.3 A simplified list of agricultural and socioeconomic indicators	29
3.3.4 The problem of global indicators	29
3.4 Health and dietary indicators of the nutritional status of the population	38
3.5 Sources of data for surveillance	39
3.5.1 Data collected by statistical and meteorological agencies of the government	40
3.5.2 Data collected in the usual operation of the health system	40
3.5.3 Data collected by agricultural services	41
3.5.4 Requirements for additional data sources	41
4. Planning and development of surveillance systems	42
4.1 Basic principles	42
4.2 Institutional structure	43
4.3 Steps in the design of a surveillance system	44

	Page
4.3.1 Summary of preliminary procedures	45
4.3.2 Sample design	46
4.3.3 Design of report format and questionnaires	47
4.3.4 Design of data collection system	47
4.3.5 Reporting timetable	48
4.3.6 Implementation of field operation	48
4.3.7 Data processing	49
4.3.8 The surveillance plan	51
5. Needs for further research	51
5.1 Causal relationships	51
5.2 Significance of health indicators	52
5.3 Operational research	53
6. Summary and recommendations	53
Annex 1. Examples of known relationships in food supply and nutrition . . .	56
Annex 2. Selected socioeconomic indicators	60

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Geneva, 1-10 October 1975

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1. INTRODUCTION

Surveillance of the nutritional status of populations has become a subject of increasing concern to both national governments and technical agencies in the fields of food, agriculture, and health, and the World Food Conference in Rome in 1974 made a specific recommendation ^a for the coordination of surveillance activities of international agencies and emphasized the need for a collaborative approach to planning in this area.

The aim of this report is to provide guidelines on the nature of a surveillance system, on the methods for setting it up, and on the principles for its operation. Although the Committee recognized that many of the fundamental causes of global malnutrition lie in the weakness of contemporary social organization, a field outside its terms of reference, it considered that technical guidance on systems by which nutritional problems can be characterized and quantified would increase social awareness of these aspects and contribute to their solution.

Surveillance is not an isolated activity, but goes hand in hand with the formulation and execution of policy. At the outset a dilemma has to be faced: on the one hand, it is impossible to develop an efficient system of collecting information without knowledge of the purposes for which the information is to be used. On the other hand, problems cannot be defined and policies formulated in the absence of information. Initially, any programme of surveillance and any definition of policy can only be based on the information that is available and on the objectives that appear to be important at that time. However, surveillance must produce feedback, which may be expected to modify the policy and the system itself, and lead to redefinition of objectives. Only experience can show how far the information collected is relevant, and thus the ways in which the surveillance system needs to be modified. For these reasons the proposals made in this report represent only a starting point for surveillance activities.

An obvious difficulty in specifying systems of surveillance is the very great diversity between different countries in conditions and available resources. The Committee has been particularly concerned with the surveillance of nutritional problems in developing countries, but this

^a *Resolution V.13* "... recommends that a global nutritional surveillance system be established by FAO, WHO and UNICEF to monitor the food and nutrition conditions of the disadvantaged groups of the population at risk, and to provide a method of rapid and permanent assessment of all factors which influence food consumption patterns and nutritional status."

should not be taken to imply that surveillance is considered unnecessary in developed countries. However, the system of surveillance may be different in these different situations.

Surveillance is a matter of great urgency in countries where the food supply and nutritional status of vulnerable groups is marginal and where malnutrition may be endemic. In many regions there is a constant threat that unusual variations in environmental factors may induce disaster situations in which malnutrition reaches epidemic proportions.

Where these conditions exist, the administrative and technical framework for collection, transmission, analysis, and presentation of data is usually deficient and poorly utilized by bodies responsible for planning and making decisions. As a consequence, the need for action is rarely anticipated and the disposal of resources, when committed, is often wasteful. Similarly, action to reduce the frequency and severity of both acute episodes and chronic situations requires longer-term planning, which again will only be effective when it is based on adequate information.

Thus surveillance is seen as providing at one and the same time an early warning system for nutritional disasters and a method of monitoring trends in a situation of chronic deprivation.

Global surveillance, as recommended in Resolution V.13 of the World Food Conference, must be based on integration of information systems operating at the national and local levels. Consequently, action directed towards establishing a global system must be initiated at these local levels and must concentrate on developing and improving systems of information as far as may be realistic for each country. Therefore, surveillance information should, whenever possible, be analysed and presented in such a way that international comparisons and global forecasts can be made.

1.1 General objectives of surveillance

Surveillance should provide ongoing information about the nutritional conditions of the population and the factors that influence them. This information will provide a basis for decisions to be made by those responsible for policy, planning, and the management of programmes relating to improvement of food consumption patterns and nutritional status.

Countries differ in their requirements for planning, their needs for information, and their sources of data. Although a single design for all surveillance systems is neither feasible nor desirable, some principles, examples, and characteristics of systems are presented in this report.

1.2 Specific objectives

Nutritional surveillance is a continuous process, that should have the following specific objectives :

(1) To describe the nutritional status of the population, with particular reference to defined subgroups who are identified as being at risk. This will permit description of the character and magnitude of the nutrition problem and changes in these features.

(2) To provide information that will contribute to the analysis of causes and associated factors and so permit a selection of preventive measures, which may or may not be nutritional.

(3) To promote decisions by governments concerning priorities and the disposal of resources to meet the needs of both normal development and emergencies.

(4) To enable predictions to be made on the basis of current trends in order to indicate the probable evolution of nutritional problems. Considered in conjunction with existing and potential measures and resources, these will assist in the formulation of policy.

(5) To monitor nutritional programmes and to evaluate their effectiveness.

1.3 Definitions

It is important at the outset to specify the way in which terms are used in this report.

Surveillance, from the French “*surveiller*”, means to watch over with great attention, authority, and often with suspicion. By contrast, the word “*survey*” is used in this report to refer to the collection of information at a particular point in time. Thus a surveillance system may indicate the need for special surveys of particular problems.

Assessment is the appraisal of available information to offer a preliminary description of the nutrition situation in a country.

Evaluation is the process of reaching a judgement, on the basis of clearly defined criteria, about the success of any operation. This includes considerations of effectiveness and efficiency.

The word *monitor* also implies an ongoing or continuous activity. It is used in this report to describe an activity that is more specific than surveillance. Thus to monitor rainfall may be a part of surveillance.

Surveillance is based on the regular collection of data. These data are analysed to give *indicators* of present or future change of nutritional

status. The types of information from which indicators can be devised cover a broad range, and the classifications used throughout this report are intended to be illustrative rather than comprehensive. These types of information can be grouped in a number of ways, and a classification based on causal sequence, from level A to level D, could be :

Level	
A	Ecology : demography : infrastructure
B	Resources : production
C	Income : consumption
D	Health status

Under these headings, further categorization of subjects can be illustrated as follows:

- Level A :* Ecology : meteorology, land, water, vegetation.
Demography
Infrastructure : communications, community services.
- Level B :* Resources and production : agricultural production, livestock, food imports/exports/stocks, fuel.
- Level C :* Income and consumption : market data, income, food consumption.
- Level D :* Health status : nutritional status, disease patterns.

This report considers first, in section 2, the information essential for the design of a nutritional surveillance system : what the nutritional problems are ; who suffers from them ; where, when, and why ; and finally, what data sources are already available that could be utilized for nutritional surveillance.

The report then considers the indicators for nutritional surveillance (section 3). These indicators are derived from measurements, and have certain required characteristics (3.1). Some indicators are predictive, others are indicators of nutritional outcome. Both can be used together for national and global surveillance. The choice of indicators determines the selection of sources for the collection of information ; these data sources should complement each other (3.5).

The next step is the planning and development of the nutritional surveillance system itself (section 4). The basic practical principles for such a system are presented (4.1), the institutional structure is outlined (4.2), and the necessary steps are reviewed for implementation (sample design, definition of output, data collection, reporting timetable, implementation of operation, and data processing) (4.3).

The report concludes with recommendations for future research (section 5) and for implementation of national and international nutrition surveillance systems (section 6).

2. INITIAL ASSESSMENT

Before a system of nutritional surveillance can be designed for any country there must be an initial assessment of the situation in that country. This assessment should include as far as possible information of four types :

- type, extent, and timing of the nutritional problems,
- identification and description of the groups particularly at risk,
- reasons for the existence of malnutrition,
- existing sources of data on which a surveillance system could draw.

Where no information is available, the first steps in setting up surveillance will have to be based on analogy with countries in which there are similar socioeconomic and ecological conditions. At the next stage qualitative information may be obtained from reports of cases of malnutrition in hospitals and spot surveys. This qualitative information may indicate what the nutritional problems are. At a more advanced stage data may be available from representative surveys that will give a quantitative answer to the questions "Who is malnourished?" "Where?" "How many?" and providing some information on "Why?". This progression in knowledge is illustrated by the history of the protein-energy malnutrition problem: in many countries, the situation has improved from one in which the problem was not even recognized to a situation in which there are reports from hospitals, and sometimes community studies of prevalence, severity, and causal factors.

2.1 The nature of the nutritional problems

In developing countries the deficiencies most likely to occur are of energy (calories), protein, and iron. Vitamin A deficiency is very common in some countries, but not in all. Other deficiencies that may be of public health importance are of iodine, B-vitamins, vitamin D, and vitamin C. A preliminary assessment should attempt to pinpoint the deficiency states that are most prevalent and most serious. There may, of course, be other kinds of deficiency that are not of proven public health significance, but these must be regarded as subjects for research rather than of surveillance.

In developed countries the situation is rather different ; in addition to the possibility of some undernutrition, there are the additional problems of overnutrition, such as obesity and the dietary factors implicated in cardiovascular diseases.

The assessment should include some estimate of the relative importance of the different nutritional problems. It should provide information, where possible based on adequate sampling, about those people in whom the problem is most serious. It is also useful to distinguish groups at risk by the time pattern of the nutrition problem that affects them, the main categories being : cyclical incidence, as with yearly "hungry seasons" ; random incidence, as with famines associated with variable rainfall ; and chronic incidence, usually associated with extreme poverty in both rural and urban contexts.

At the same time a check should be made on the possibility of the incipient appearance of conditions that did not previously exist (or had not been recognized), and for an increase in conditions that were previously uncommon. Examples are the increasing prevalence of obesity in some developing countries, and the re-emergence of rickets in a developed country.

2.2 Identification and description of groups at risk

The process of identification and description should start by answering the question "Who is at risk?". This is essentially a selection procedure, narrowing down the description to identify, as precisely as information allows, the group(s) to be considered. As examples, a group at risk in a particular country might be described as : preschool children living in a certain district, in an area of that district in which the mean annual rainfall is less than 600 mm, whose food is derived mainly from livestock or, the infants of recent urban immigrant families who are unemployed, in a certain town.

An approach to defining these groups is presented below in a three-fold classification :

(a) Biological situation :

- age group
- sex
- physiological status, e.g., pregnant women
- exposure to infectious disease and other health factors.

(b) Physical situation :

- rural or urban
- ecological zone : e.g., savanna, desert, rain forest, etc.

- type of food source : e.g., settled subsistence farming, pastoral subsistence, market
- geographical region
- sanitary environment and pattern of endemic disease.

(c) Socioeconomic and cultural situation :

- ethnic or cultural group
- socioeconomic status, e.g., income group, cultivated land per family, income source, livestock holdings per family
- access to and utilization of health services.

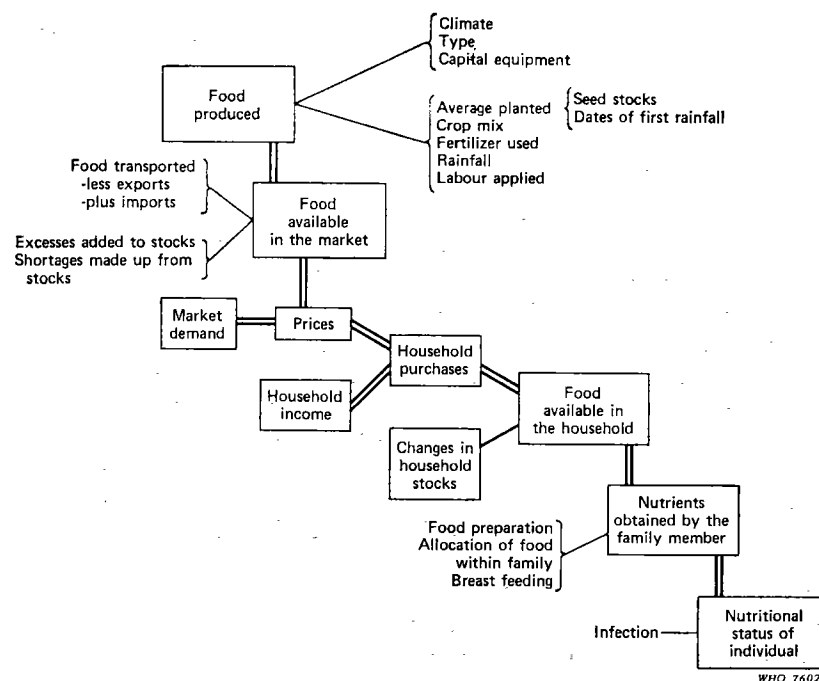
The accuracy with which groups at risk can be identified and described depends in the first instance on an analysis of existing information. Additional information might be needed and should be obtained by conventional survey methods as necessary. However, the information derived from a surveillance system itself would improve the identification of groups, so that the description would become more precise with operation of the system. Thus the description might need to be broader in the initial stages than in a fully developed surveillance system. Similarly, decisions will have to be made as to when in the agricultural and economic cycles surveillance measures should be taken. Such decisions will be modified as experience accumulates.

2.3 Identification of causal factors and formulation of a working hypothesis

The third aspect of preliminary description relates to cause, and should address the question “ Why is a particular group at risk ? ” From a consideration of existing data certain reasons for this should suggest themselves. These can be organized into a flow diagram or model as a working hypothesis (see below). The predictive indicators can then be chosen to monitor accessible factors in the food supply chain for the vulnerable groups. This process should highlight gaps in the existing information and indicate areas in which additional data may be needed.

This procedure, which is discussed in detail in section 3.2, together with a definition of who is at risk (section 2.2), provides the basic information for choosing predictive indicators. Again as surveillance progresses the procedure will itself become more precise, so that the less efficient indicators can be discarded.

At this point, the range of subjects (see page 10) to be considered must be taken into account, and an initial definition must be made of the type of food supply system operating for the identified groups at risk. These



classifications provide a framework for the initial assessment as much as for the design of a surveillance system. As an example, for a mixed, settled, subsistence/cash crop community, in the initial assessment existing data concerning ecology, meteorology, production, income, food prices, health status, and other subjects should be sought. For other food supply systems there will be a different list. This is discussed in more detail in section 3.3.1.

2.4 Sources of data for initial assessment

In the initial assessment, the sources of data must be identified and evaluated in order to define the nutritional problems, the groups at risk, and the possible causes. At the same time potential resources for the surveillance system must be appraised (see section 3.5). These clearly overlap in that the continuing data collection systems may be useful for both purposes.

Historical data from government statistical (including the meteorological service) agencies, the health system, and agricultural services, may

provide important information. In addition, previous survey data (for example, from household budget or food consumption surveys), where they exist, will be of value.

Finally, part of the initial assessment should include the identification of sources of suitable personnel for staffing a surveillance system ; these may be needed within the existing data collection system, for establishing new data sources, and for data processing and administration (see sections 4.2 and 4.3).

3. INDICATORS FOR USE IN NUTRITIONAL SURVEILLANCE

After an initial assessment has been made of the nutritional problems with which a surveillance system is to be concerned, the next stage is to consider the indicators for use in that system. First, the necessary characteristics of these indicators must be considered (3.1). Then the possible causes of malnutrition need to be examined (3.2) leading to a specification of the types of information, their predictive value, and hence the indicators, that are required.

The measurements from which these can be derived (3.3, 3.4) and the possible data sources can then be defined (3.5). This process, outlined in the following pages, is a prerequisite for the practical planning of a surveillance system (as discussed in section 4).

3.1 General characteristics of indicators

3.1.1 Introduction

Indicators are based on measurements but they are more than the measurements themselves. An indicator may be constructed from measurements taken from a population group, or an area. As an example, the weight for age of a single child is a measurement but not an indicator. However, an indicator may be constructed from the distribution of values of weight for age in a specific group of, say, two-year-old children.

Thus, it is not possible to discuss the general characteristics of indicators without reference first to measurements and the way they behave over time and, secondly to the characteristics and nature of the sample. Further, the necessary characteristics of indicators are not apparent until the purpose for which they are required is defined.

One purpose of surveillance is to predict or document a situation that requires action. In this context it is essential to know the distribution of any given measurement in order to be able to define the values that trigger action. When actual data support the assumption that the measurements follow the normal distribution, it is possible to use the mean and its standard deviation as an indicator. However, although it is common to assume a normal distribution for observed values, this is not always the case.

It is therefore often helpful to display the distribution of the variable as a frequency distribution curve, so that the proportion of the sample falling within critical limits can be observed. A special case is the specification of the proportion of the population that falls below a certain level (cut-off point).

3.1.2 “Cut-off points” and “trigger levels”

The value that marks the boundary of acceptability is called the “cut-off point” for individuals or for items of data. For instance, when the weight of a two-year-old child falls below a certain point, this indicates such a high risk of imminent clinical malnutrition that it is considered unacceptable for that child. Similarly when a family’s income relative to the cost of food falls below a certain “cut-off point”, the risk that members of that family will suffer from malnutrition might again be unacceptable.

One advantage of using “cut-off points” is that surveillance can concentrate its measuring resources on a restricted range of the variable. Another advantage is that the proportion of the population falling below a “cut-off point” may be calculated quickly by hand, can be displayed readily, and is easily understood.

The proportion of observations below this “cut-off point” required to initiate intervention may be termed the “trigger level”. To take the example of weight: the indicator might be the proportion of children below 70% of expected weight for age. Here the value of 70% weight for age has been chosen as the “cut-off point”. A decision to act may be taken when the proportion of children with weight for age below that value is, for example, 10%. Here 10% has been chosen as the “trigger level”.

Clearly, both “cut-off points” and “trigger levels” must be defined carefully, taking into account “usual” and “acceptable” levels, the resources available for response, and other local factors.

In practice, it may be better to consider a series of “trigger levels” against which a graded response can be planned. Similarly, a band of

values above the cut-off point could be defined to identify the proportion of the sample most likely to be affected should adverse conditions arise.

3.1.3 *Characteristics of indicators related to measurements and the significance of observed trends*

Indicators must be sensitive to critical changes in the present or future nutritional state of the population. The key word here is critical : this means that a change in nutritional status that is large enough to warrant intervention must be reflected in a clear change in the indicators. The predetermined "trigger level" for intervention may vary according to circumstances and this will affect the choice of indicators and of cut-off points. A change in an indicator, or its trend, is a reliable signal for action only if the change or trend is outside the range of so-called normal or usual variation.

Two situations may be distinguished : (a) from a sequence of indicator values over time, action should be triggered by the arrival of a value that is significantly outside the "normal" range of variation and fluctuation ; (b) at some point in an accumulating data series, the existence of a trend may become apparent, or a change may be detected in the rate of a previously established trend.

Well established statistical techniques for dealing with these situations are used, for example, in industrial quality control, in weather prediction, and in drug testing work. Problems will arise in achieving optimum efficiency of the system because, in general, the variability and normal fluctuations will not be known initially, and because of the need to adjust the sensitivity of the triggering criteria so as to retain a reasonable balance between reliable detection or prediction of emergencies on the one hand and the avoidance of false alarms on the other. The confident interpretation of change also depends on a standard technique of measurement and sampling over time.

The specificity of an indicator, and therefore its value for nutritional surveillance, may be different in different situations. For instance, where iron deficiency is a major cause of anaemia, changes in the prevalence of low haemoglobin levels are a good indicator of iron nutrition, but this will not be so in areas where malaria is the main cause of anaemia. Of equal importance in selecting the variables is that they must apply to the specific groups of people who are at risk. Knowledge of the nutritional situation of the poor will not be improved by successfully predicting the output of foods eaten only by the rich. Likewise, indicators of the food situation in urban markets may be of little use for understanding the situation in isolated rural areas that produce practically all their own food.

3.1.4 *Characteristics of indicators related to the sample*

The structure and characteristics of the sample have a bearing on the way indicators behave and therefore on their interpretation. Ideally a sample should be selected to be representative of the population under surveillance, and stratified to identify relatively homogeneous groups. When this is the case, indicators will behave with optimum sensitivity and specificity : they can be interpreted with a known degree of confidence in the knowledge that the sample represents its parent population adequately.

This ideal may be difficult to achieve in practice, owing to cost or to inaccessibility of certain population groups, or because existing data sources provide an incomplete coverage of the population and are therefore not representative. If data are obtained from a sample that is not representative, for example from MCH clinic records, they may still be useful—indeed of special significance—but should not be extrapolated to the population at large.

3.1.5 *Operational characteristics*

The value of an indicator for description or prediction must be balanced against certain practical considerations.

(a) *Ease of measurement.* Data that are readily obtainable with a minimum of equipment and require little processing have obvious advantages over those that require complicated methods. Occasionally, however, some information is more easily obtainable by advanced techniques : for example, by aerial photogrammetric techniques instead of measurements on the ground.

(b) *The speed and frequency of data availability.* If data are available continuously the indicators may gain in timeliness. This is important for early detection of change. The value of indicators may also be enhanced by an increase in collection frequency, but this must be balanced in turn against the extra cost involved.

Continuous measurement, however, is not synonymous with continuous availability, since data only become usefully available when they have been compiled. For instance, data from a representative sample may be collected continuously, but may be of value only when the full sample has been collected. It is no use making data available more speedily or frequently than they can be compiled.

(c) *Cost.* The cost of obtaining data is the overriding constraint against which the value of an indicator must be compared. Cost is related to all operational considerations and is influenced by the characteristics

described above. Therefore, major operational decisions are required when existing data sources are considered, within the context of the balance between value and cost.

However, the operational usefulness of each extra item of information, or each improvement in the reliability of data, must be clearly established. Information should not be demanded for its own sake, for purposes of academic study, or for the satisfaction of curiosity. An optimum balance should be struck in the use of scarce resources, on the one hand for data collection, and on the other for direct employment in problem solving.

3.2 The significance of causality in the choice of indicators

A working hypothesis as to why specific groups are at risk is useful in selecting predictive indicators of nutrition in a population. In this context, it is necessary to distinguish between *identifying variables* which identify the groups at risk, *causal factors* which explain why a group is at risk, and *indicators* themselves, which are used to monitor the situations that these groups face. In some cases a given variable might serve all three purposes ; in others, identifying and causal variables may not be associated with a variable that is suitable for use in a surveillance system.

<i>Example of identifying factor</i>	<i>Example of causal factor related to the identifying factor</i>	<i>Example of indicator for surveillance related to cause</i>
Unreliable rainfall	Rain too little and/or too late	Rainfall (quantity and timing)
Ethnic group	Food habits of that group	None useful, if habits only change slowly
Income level	Inadequate income	Amount of income
Land tenure system	Large land rents by tenants	Usually none useful unless land tenure conditions change rapidly

The first step in formulating a working hypothesis is to prepare a generalized model of the factors affecting nutritional status. This organizes the possible causes that suggest themselves from an initial consideration of the available data into a conceptual framework from which indicators can be chosen on grounds of practicality, speed of availability, cost-effectiveness, usefulness as predictors, and so on. The model is also of use in defining and interpreting the indicators (see section 3.1.1).

The working hypothesis on which the initial model was based should, of course, be continually modified and refined in the light of the infor-

mation provided through the surveillance operation. Surveillance not only provides data needed for planning, directing, and evaluating action programmes, it also provides data that will be useful in improving the understanding of the causal forces at work. One outcome will be to improve the surveillance system itself, and another will be to enhance the effectiveness of intervention.

As an example of the kind of model of the factors affecting nutritional status that is being discussed, the following series of hypotheses are considered :

The nutritional condition of an individual depends in large part upon his nutrient intake ; his nutrient intake depends heavily upon food consumption patterns within the family ; family food consumption depends in turn upon its ability to obtain adequate quantities of food ; and the family's ability to obtain food is largely dependent upon its own levels of food production, or upon its ability to purchase food in the market place.

Such a conceptual model can be represented by a schematic diagram like that on page 14 which illustrates some of the principal variables involved. The figure applies to a market economy, as is shown by the fact that the link between the quantities of food available in the market and the quantity available in the household occurs through a market in which families compete with each other for purchase of food. Thus, incomes and prices become crucial variables.

In a subsistence economy the cells labelled " food available in the market " and " food available in the household " may be collapsed into a single cell. In a mixed market-subsistence economy the present diagram will serve for that part of food consumption that passes through the market, but a direct link will exist between " food produced " and " food available in the household ". In some economies, this direct link may represent 90% or more of the food intake of the household; in other it may be quite a minor proportion.

The way in which individual elements of the whole complex of determining variables and relationships may find their place in the system is illustrated on page 14. From such an organized set of determining variables, which may include many more than are shown in the illustration, it is then possible to select a limited number to provide indicators. Examples of possible indicators are given in sections 3.3 and 3.4.

As the process of producing and marketing food takes time, indicators of events at those stages may be useful predictors of changes in nutritional status. In general, the earlier the stage in the production system that an indicator relates to, the earlier the warning of nutritional change. On the

other hand, the greater the interval between the event being measured as an indicator and the ultimate nutritional result, the less certain that result becomes, for during that interval many other events may occur that will also affect the nutritional outcome.

Some chronic nutrition problems, where the main causal factor is endemic disease or lack of nutrition education, may not be so sensitive to differences among food supply systems and a different, although related, approach will be needed.

An understanding of causality also helps in the interpretation of various indicators. Just as an indicator that is highly useful with respect to one group at risk may have little merit for another group, an indicator that means one thing in one setting may mean another in a different setting. For example, rain at the beginning of the planting season may mean early planting and good harvests in some areas. In others, excessive rainfall may make fields too wet to work and delay planting, or even cause flooding, leading to reduced yields or crop failures. In general, the better the causal relationships are understood, the easier the interpretation becomes.

Similarly, the associations between socioeconomic indicators may be expected to vary both between localities and with time. This point is illustrated by the nonuniformity of the associations given in the examples in Annex 1, page 57. These results showed large geographical variation in the correlations (1) between the general appearance of a household and the sanitation therein, and (2) between family food production and schooling. Similarly, in Central America a correlation has been shown between socioeconomic index and serum vitamin A level, but not between socioeconomic index and vitamin C level.

This discussion is intended to underline the points that where causal relationships are not well understood, surveillance systems should be designed in the light of local conditions, and that most associations between variables, and their interpretation, will have to be elucidated as the surveillance system progresses.^a

^a Expressing his personal opinion, one member of the Committee, Professor Cresta, suggested that in order to formulate a causal hypothesis concerning the factors affecting nutritional inadequacy in populations at risk it was necessary to consider the following indicators: land use in relation to food requirements of the population as an indicator of population location in ecologically marginal areas; education and professional facilities given to ethnic or regional groups as an indicator of discrimination against workers on ethnic or regional grounds; distribution of income in the population as an indicator of inequalities in the distribution of economic resources; types and amount of agronomic inputs as an indicator of the exploitation of land natural resources.

3.3 The use of agricultural and socioeconomic variables in specific nutritional surveillance systems

The selection of predictive indicators of food supply requires a series of logical steps starting from the initial assessment (section 2), through setting up a preliminary model (section 3.2), to describing the food supply system itself. This description leads to a working selection of the subject areas, which may be specific to the type of food supply, from within which data and hence indicators are required. This process is therefore one of increasing specificity in defining the information needed from the system. General headings are given in section 3.3.1 of the areas of interest for different situations, whereas specific indicators will depend on the characteristics of specific situations.

3.3.1 *The importance of the food supply system*

The characteristics of most problem situations will vary as the nature of the food supply system varies. For example, it will obviously be necessary to distinguish groups that depend for their food supply on pastoral subsistence, settled subsistence farming, and on purchasing their requirements in the market. On page 10 three headings or levels (A, B, C) were given for factors that determine the fourth, health status. The relevant factors under each heading can be listed for the different types of food supply system, and examples of types of data that have been found to be useful in assessing food availability for the different types of food supply are given below :

Pastoral subsistence

A. Ecology

- Meteorology : rainfall
- Vegetation : pasture carrying capacity
- Land : pasture area

B. Resources and production

- Livestock : productivity, herd numbers, structure, seasonal movements, disease
- Food stocks and losses
- Fuel

C. Consumption

- Food consumption, pattern of food choice, household distribution

Settled subsistence farming

A. Ecology

Meteorology : rainfall, water availability periods
Land : cultivable capacity
Demography : cultivable area per family member
(nutritional density)

B. Resources and production

Cultivation requirements : seed, draft animals, equipment
Crop progress, predicted yield, crop production
Food, stocks and losses
Fuel

C. Consumption

Food consumption, pattern of food choice, household
distribution

Market economy

A. Ecology

Meteorology : rainfall
Land : patterns of land utilization (cash *versus* food crop)
Demography : rural/urban division

B. Resources and production

Food stocks, imports and exports
Food losses
Price of inputs
Fuel

C. Income and consumption

Market data : selling prices for produce, buying prices for
food (especially staples)
Demand : employment, income
Cost-of-living
Income and price-elasticity
Food consumption, pattern of food choice, household
distribution.

Overlap between these classification will frequently occur. For example, cash-crop farmers may grow much of their own staple food, but use part of their income for further food purchases ; similarly pastoralists may trade animal products for grain. Where several groups are at risk in a given country, it will usually be a useful initial step to distinguish the major categories of each system. Table 1 provides a more complete illustrative listing of some common categories. It is unlikely that there would be groups at risk in all the categories in the tabulation in any one country or region, although the listing could be expanded to show even more complex groupings where households obtain their food and incomes from more complex multiple sources. Usually, however, the more diversified the household occupations, the greater is the stability of the nutrient intake, so that the complexity required to describe all household income patterns should not be required for nutrition surveillance purposes.

A difficulty may arise in rural communities where part of the household production is sold in local rural markets and the proceeds are used, in part at least, to purchase other foodstuffs. Such exchange is common across the boundaries of major ecological zones, for example, or between

TABLE 1. A TYPOLOGY OF FOOD SUPPLY SYSTEMS ^a

Subsistence-dependent systems	Mixed systems	Market-dependent systems
Subsistence cropping	Subsistence cropping with cash cropping	Cash cropping
Subsistence cropping and subsistence livestock	Subsistence cropping with non-agricultural self-employment for cash income	Cash cropping and commercial livestock Cash cropping with supplementary wage employment
Subsistence livestock	Subsistence livestock with cash sales Subsistence livestock with wage employment	Commercial livestock
Subsistence fishing	Subsistence fishing with cash sales	Commercial fishing
Subsistence fishing with subsistence cropping	Subsistence fishing with wage employment	Non-agricultural self-employment for cash income Wage employment Wage employment with non-agricultural self-employment

^a Only certain major categories are listed ; the typology can be expanded and adapted to specific country situations.

specialist livestock raisers and settled agriculturists. The problem can be avoided in certain instances by changing the unit of analysis from the household to a higher level of aggregation. The village or community level might be the correct choice to economize on data. All the food exchange activity within the village would be ignored, information only being required on food exchange outside this unit. However, this "averaging" procedure might obscure vital information if significant socio-economic stratification occurred within the village, e.g., between the landlord, merchant tenant farmer, and landless labourer classes. In this case, it would be desirable to sample all local exchange activities, or at least those of the most vulnerable groups.

Having specified the type or types of food supply system, and thus likely subject headings of interest, the next step is to use this information to select possible indicators.

3.3.2 *Suggested indicators*

Table 2 provides specific examples of the selection of indicators for the food supply systems listed in Table 1. The indicators needed for complex systems can be compiled by adding together those from two or more simple systems. By way of illustration, the three food supply systems outlined in section 3.3.1 are now considered in more detail.

Pastoral subsistence

The most serious problem to face a pastoral subsistence economy is the possibility of severe or complete collapse of the system. A prediction model is required (a) to estimate the medium-term secular trends in the relationships between grazing and water resources, cattle numbers, and human population, and (b) to provide an early warning of the advent of disaster or acute nutritional problems arising from short-run random variables, especially weather, livestock disease, or pasture pests.

The magnitude of the nutrition problem in the medium-term might be summarized in the statement that n thousand people living in Zones A, B, and C have a 1 in 10 risk (with 95% probability) of failing to meet r % of their basic nutritional requirements. The short-term problem would probably be stated in less precise terms, e.g., failure of the main rains in Zone A suggests that animal mortality will rise sharply over the next four months with the probability that a large proportion of the population with less than m animals per family will require famine relief.

TABLE 2. POSSIBLE SOCIOECONOMIC INDICATORS FOR NUTRITION SURVEILLANCE SYSTEMS

Food supply system	Direct cause(s) of the incipient nutritional problem (per family or community)	Related independent variables	Other associated events	Possible indicators	Constants useful for predictive purposes
A. Subsistence cropping	Decline in subsistence food production	Rainfall, temperature, crop pests, plant diseases	Decline in rural food stocks, abnormal intrarural and rural-urban migration patterns	Rainfall distribution. Area planted to staple crop(s). Yield forecasts. Harvested quantities. Crop pests and disease incidence. Abnormal migration. Upstream river levels	Adequate staple food quantity per family. Crop production/water balance relationships
B. Subsistence livestock	Decline in herd productivity. Decline in cattle numbers	Rainfall, pasture pests, animal disease, grazing and surface water availability	Abnormal intrarural migration patterns	Rainfall distribution. Livestock distribution. Pasture pest and animal disease incidence. Grazing and surface water availability. Abnormal migration	Minimum herd size per family required for subsistence. Indices of rangeland productivity
C. Subsistence fishing	Decline in fish landings	Fish migration. Overfishing	Change in numbers of boats operating. Increased voyage length	Number of fishing trips. Catch per fishing trip. Catch per boat. Length of longest trip	Adequate fish consumption per family
D. Cash cropping	Decline in cash-crop output. Decline in cash-crop prices. Rise in purchased food prices. Rise in prices of non-food purchases	Rainfall, temperature, crop pests, plant diseases, price expectations, input cost or availability, food prices, non-food prices	Change in staple food purchases and prices	As for system A—plus: cash-crop prices, input costs, input availabilities	Adequate nutrient intake per family

E. Commercial livestock	Decline in herd productivity. Decline in cattle numbers. Decline in cattle prices. Rise in purchased food prices. Rise in prices of non-food purchases	As for system B—plus : cattle prices, input cost or availability. Food prices, non-food prices	Change in staple food purchases and prices	As for system B—plus : cattle prices, input costs, input availabilities	Adequate nutrient intake per family
F. Wage employment	Decline in days employed. Decline in wage rate. Rise in purchased food prices. Rise in prices of non-food purchases	Inflation, recession, statutory wage levels. Labour supply. Food shortages in urban areas	Interurban migration. Urban-rural migration. Social unrest	Ratio of cost of nutrition to minimum wage rates. Ratio of cost of nutrition to informal sector earnings (or estimated income levels). Levels of employment and unemployment	Adequate nutrient intake per family

The information output from a rather comprehensive surveillance system could cover :

- distribution of livestock ownership by family
- the minimum herd size per family that is required for survival in the major ecological zones
- livestock productivity (e.g., as a rangeland productivity index) related to rainfall distribution
- the actual rainfall distribution in the observation period
- surface water distribution
- unusual migration patterns.

The second and third items listed above require a considerable body of information before they can be reliably calculated. Knowledge about the distribution of livestock ownership requires a livestock census or the use of sample survey methods (see section 4.3), and the use of observed migration patterns as an indicator requires a body of knowledge about "normal" patterns. Initially, therefore, a much cruder model may have to be used relying primarily, say, on rainfall distribution data and qualitative observations on grazing and surface water distribution.

A subsistence cropping system

For a subsistence cropping system data should preferably be obtained only for the staple foodstuffs in the dietary pattern, rather than for all foods. Care must be taken, however, not to exclude substitute sources of food which families may fall back on in times of emergency; e.g., cassava replacing millet in some diets in the African savanna zone following poor harvests.

In a crop-based subsistence economy, the following data might be collected: timing, and area sown and harvested, for the major staple crop(s); yield estimates for the staple crop(s); the rainfall distribution pattern.

Additional information might be required in certain cases, about the potential output of other major food crops, crop pests, and disease incidence, liability to natural hazards such as flooding, frosts, etc., and the levels of food stocks in the rural economy at a given time.

A market supply system

The situation is quite different when the family food supply is derived predominantly from the market. This usually occurs in an urban context, but may occur in a rural setting. Two "at risk" groups can often be usefully distinguished: (a) the lowest-paid groups in the formal sector, i.e., where statutory wage protection is effective: here the daily

common labour wage rate, the numbers of days employed, and the number of workers per household would be the required data ; (b) the population in the informal sector, typified by part-time unprotected-wage employment and self-employment activities, compounded often with periods of unemployment.

The basic data requirements are estimates of monetary and real income distribution and the cost of basic nutrition. Indirect estimates of family income may have to be used, such as housing quality (including hygiene facilities), type of employment, ownership of consumer durables, and "conspicuous expenditure" patterns. Measurement of the cost of nutrition could be restricted either to the major staple(s) or, alternatively, to the cost of a standard food basket related to the expenditure patterns of low-income groups.

Interpretation of data concerning food prices and income, in terms of the ratio of the cost of a nutritionally adequate diet to family income is discussed in section 3.3.4.

3.3.3 A simplified list of agricultural and socioeconomic indicators

Where resources are limited it should be possible to set up a useful surveillance system using only a small number of indicators. Examples of these are given in Table 3.

TABLE 3. SIMPLIFIED LIST OF AGRICULTURAL AND SOCIOECONOMIC INDICATORS

Subsistence cropping systems (key crop(s) only)		
<i>Early indicators</i>		<i>Later indicators</i>
Rainfall patterns	Crop areas Crop yields Flooded areas	Harvested outputs
Major crop pests		
Major crop diseases		
Upstream river flows		
Subsistence livestock systems		
<i>Early indicators</i>		<i>Later indicators</i>
Rainfall patterns	Pasture availability Water availability	Livestock productivity Livestock numbers
Pasture pests		
Animal diseases		
Market-dependent food consumption		
(a) <i>Formal sector employment</i>		
Cost of adequate diet, or	}	In relation to minimum wage rate
Cost of adequate quantity of staples		
Numbers employed in the formal sector by wage class -		
(b) <i>Informal sector employment</i>		
Cost of adequate diet, or	}	In relation to informal sector incomes or hourly/daily earnings × number of hours/days worked per period
Cost of adequate quantity of staples		

3.3.4 *The problem of global indicators*

A basis for global comparison. In view of the variation that exists in the nature of the nutritional problems, the characteristics of the groups at risk and, in particular, the conditions of food supply, it is clear that the set of indicators to be used as predictors of changes in nutritional status will vary considerably—both between countries and between groups within a country. This raises the question of whether a small number of indicators could be devised that have global significance in the sense that they provide statistics useful for the comparative evaluation of the nutritional situations that exist in a wide range of different countries.

It is clear that some measure of how a family's access to food compares with its nutritional needs is essential to any measurement of the nutritional situation that it faces. The important issue is the relation between the quantities of food that a family can obtain and the nutritional needs of that family. Neither total food supplies available nor the capacity of a given family to obtain a share in them (through purchase or otherwise) is significant in isolation. Thus, a convenient summary measure would be the ratio between the purchasing power available to a family and the cost of obtaining adequate nutrition. Such a measure, for a family representative of the group, could summarize the socioeconomic situation for any particular group at risk; and this same measure could be used for global comparisons. The nutritional significance of any economic variable is manifested through its effect on the ability of the family to obtain nutritive foods. In families whose income just equals the cost of adequate nutrition there are likely to be, sooner or later, some members suffering from undernutrition, for part of that income must be spent on items other than food.

A ratio cannot indicate why the situation is changing; only knowledge of its components will do that. These components are the available food supplies on the one hand and access to food supplies on the other.

Food supplies available. Indices of food supplies available are already being constructed for most countries of the world. FAO publishes indices of *per caput* food production (see Annex 2) but these of course do not take account of foreign trade and changes in stocks. The FAO food balance sheet calculations consider these items. From these data FAO has developed methods of calculating the national *per caput* availability of energy (calories) and protein. These indicators should certainly be included in any global surveillance system.

FAO is developing methods for using the information now available through the Global Information and Early Warning System to provide

advance indicators of the national *per caput* availability of energy (calories) and nutrients (see Annex 2), although there are some problems in interpreting the nutritional significance of the usual measures of protein availability.

The principal problem with using these or any other *per caput* indicator is that they measure only average availability in the nation. In most cases they provide little or no information about the situation facing specific groups at risk. Where food supply estimates are available for these individual groups, say for example from a recent baseline survey, *per caput* nutrient availability for specific groups should be calculated. FAO is working on such an approach, but more research is needed to develop the methods on the basis of actual experience.

Food availability data can be obtained or estimated at the local level, for specific groups at risk, and many of the indicators discussed in this section have exactly this purpose. For particular groups, regular surveys could also provide the necessary information.

There are alternative approaches that start with national *per caput* figures and attempt to derive from them estimates of food or nutrient availability for particular groups at risk. However, indirect estimates of this sort may lead to an undue sense of confidence concerning knowledge of the food situation. Such indirect approaches, by their very nature, are likely to produce estimates containing a large amount of error—error that may go undetected until direct information becomes available about the groups at risk.

Access to food supplies. Various indicators of the degree of family access to the food supplies available also exist, some of which could rather easily be adapted to nutritional surveillance. Others may be less useful than at first thought. The prices of staple foods have been suggested as advance indicators of crop shortages, but an increase in price might also result from a general inflationary rise in prices and wages—which might in fact be in favour of the people for whom this product is an important food. If inflation is the cause of the rise in prices, it may be accompanied by an increase in the incomes of the poor that increases the quantity of the staple they can buy; or the reverse effect may occur. Prices of food are thus not very informative, but a ratio of the cost of food to family income does give useful information about the nutritional situation that is developing.

Indexes of the cost of food and of wages paid are already generally available for urban areas. A ratio of the two, or even simple comparisons between them, could be useful components of a global surveillance system. Many such existing indicators do not apply specifically to the

groups at risk, but often more specific indicators could readily be made available, either for labourers in a city or for all workers receiving the minimum wage.

Unemployment and underemployment pose a much more difficult problem, but progress has been made by ILO and others concerned with labour statistics in estimating the amount of employment obtained by particular groups within the labour force.

For greater usefulness in global comparisons it is desirable to define the level of nutrition to be provided in terms of the cost-of-the-food index. A useful basis for international and intergroup comparison, and for evaluation of the nutritional situation, would be the cost of purchasing a nutritionally adequate diet.

A summary ratio. Ultimately, any measures of the actual availability of food or of the ability to obtain (purchase) food are useful only when these two aspects of the problem are integrated. An index of the cost of food or of nutrition provides a partial integration, for the prices used in this index reflect the conditions of availability. Even if rationing measures or other government controls mean that prices do not indicate availability, and variations in procedures become necessary, the problem remains soluble. Comparing the index of the cost of adequate nutrition with an index of family incomes within a group completes the integration. In a market economy, a ratio of the cost of a nutritionally adequate diet to family income provides a single summary figure that takes into account all the consequences of the socioeconomic variables on the nutritional situation. Such a ratio can be compared across groups at risk and, for global comparisons, across nations. It becomes a predictive indicator when its value is estimated for three months, six months, or a year ahead. It is a record of performance when its value is measured at a given time.

Variants on this measure can be used if the data are limited. If income figures are not available, the number of hours of common labour required for adequate subsistence may be calculated or estimated. Comparing this figure with the length of the normal working week in a given group at risk would provide a measure of the relative ease or difficulty of obtaining adequate access to food. Unemployment and underemployment pose a problem, but progress has been made in this field as described above.

As a first approximation to measuring the ratio between the cost of an adequate diet and the income of a representative family in a given group at risk, one might calculate simply the ratio between the expenditure required to obtain an adequate energy intake and family income (or total family expenditure). FAO is currently making such calculations.

In subsistence economies, the fundamental information needed consists of estimates of food outputs. These can be advance estimates, for use in prediction, or estimates of actual outputs or harvests, as measures of production performance. Measures of food output *per caput* within the group at risk (or better, ratios of nutrient output to nutrient needs) are predictors of nutritional status at some later date.

Lastly, for global comparisons, there should be continuing estimates of the number of people included in each group at risk. In each group, the data on nutrients available *per caput* (in the subsistence sector) or on the ratio between income and the cost of adequate nutrition (in the market sector) provide the means for predicting changes in the degree of nutritional risk faced by each group. For example, given a measure of the ratio of the cost of an adequate diet to the size of the family income, it is possible to determine the statistical relationship that holds between this variable and the frequency with which malnutrition occurs in any given group. Research is likely to be necessary in order to establish this relationship.

Alternatively, given information on the way in which families in the group divide their incomes between food and other expenditures (the Engel curve^a relations), it is possible to determine at what level of income a family will in fact spend enough on food so that it can purchase a nutritionally adequate diet. FAO calculates such a figure for the expenditure needed to meet calorie needs.

Given a figure for the income or expenditure level at which a family is likely to spend enough on food to be able to buy a nutritionally adequate diet, one can determine, in any group, the number of families that have smaller incomes. This number can serve as a measure of the number subject to nutritional risk because of inadequate incomes.

A somewhat analogous method for determining the number of families at risk is to compare the fraction of family income actually spent on food with the fraction of income needed to purchase an adequate diet. If the fraction of income spent on food is known for individual families, a simple count of the families for whom this fraction is too small determines the number at risk (and in this case also identifies the individual families).

Whatever the method employed, the ultimate objective is an estimate of the number of people in each group at risk that must face a situation of potential nutritional inadequacy because they have low incomes.

^a See HOUTHAKKER, H. S. An international comparison of household expenditure patterns, commemorating the centenary of Engel's law. *Ergonometrica*, 25 : 532-551 (1957).

TABLE 4. HEALTH AND DIETARY INDICATORS OF NUTRITIONAL STATUS

Phenomenon	Measurement	Indicator	Suggested parameters for reporting
Growth and body dimensions	birth weight	birth weight	proportion ≤ 2.5 kg
	weight	weight for height	{ proportion $< 80\%$ ^a of reference mean + distribution
	height	height for age	{ proportion $< 90\%$ ^a of reference mean and distribution
	age	weight for age	{ proportion per level of classification ^b
		weight for height	— ^c
	arm circumference (AC)	AC for height AC by year	proportion $< 75\%$ of reference ^d
Sexual development	age at menarche		distribution and mean
Nutritional status			
clinical examinations	angular stomatitis Bitot's spots oedema xerophthalmia night blindness other major signs with high prevalence		proportion of paediatric patients seen
biochemical examinations	haemoglobin		see WHO indices ^e
	other examinations only for follow-up		see footnote ^f
dietary information	specific foods for specific deficiencies ^g		
	breast feeding	proportion breastfeeding over 1, 3, 6, and 12 months	
	total energy ^h (staples)		
	food expenditure	proportion of disposable income	proportion below a certain level ⁱ
	all foods for all nutrients ^j	food patterns nutritional intake	means and distribution
Demography	sex ratio ^k		
Mortality	maternal infant 1-4 years of age		per 1000 live births per 1000 live births proportion of total deaths by year of age

Collecting system and target population			Reflects nutrition	
Health services	Government statistics	Family data	Now	Past
MCH			X	
MCH, children 1 and 2 years old	schools at 7 years of age	all ages	X	
			X	X
				X
MCH, pregnant women	army induction		X	
to replace height and weight if these are not feasible			X	
				X
not really different from morbidity data			X	
MCH		preschool children and other vulnerable family members	X	
			X	
X		X	X	
X		X	predictive	X
X		X	X	
X	X	X	X and pre-dictive	
		X	X	
				X
	vital statistics		?	
			X	
			X	

Phenomenon	Measurement	Indicator	Suggested parameters for reporting
Morbidity	marasmus		proportion of paediatric patients seen, or of paediatric hospital admissions
	kwashiorkor		
	anaemia		
	other nutritional diseases		
	keratomalacia		
	goitre		proportion of school children
	diarrhoea	}	excess cases above usual prevalence
	contagious diseases of childhood		
Health services	immunization status	proportion of population covered	proportion of areas below a certain level of coverage
	water supply		
	waste disposal		

These indicators are offered as suggestions. The specific choice will depend on the particular nutritional problems under surveillance and on the available sources of data, but in the compilation of this table the Committee has concentrated on the problems of developing countries.

^a The cut-off points used for nutritional surveillance should be based on a stated reference value but may be modified to reflect local growth patterns, health resources, and other local factors. Data related to anthropometric indicators of nutritional status can be usefully presented for surveillance as prevalence rates of the indicator in question. When available, statistical distributions and standardized tabular presentations of the data should be compiled from time to time to facilitate international comparisons. Reliable and inexpensive scales for weighing (for example, Salter scales or Rasmussen steel-yard) now make reliable weighing in the field feasible.

^b Although weight for age has been in use for many years, recent discussion has pointed out the additional value of a combination of weight for height (representing acute energy under-nutrition) and height for age (representing more chronic protein-energy undernutrition).

^c The Committee recommends that appropriate research be undertaken urgently to establish the cut-off points for maternal weight for height that indicate when there is a greater risk of the baby weighing less than 2.5 kg.

^d For children below the "cut-off" point of 75% of the standard mid-arm circumference for a certain height there is a considerably increased risk of death than for children with greater arm circumference, in 1- to 4-year-old children (see SOMMER, A. & LOEWENSTEIN, M. D. *Am. J. clin. Nutr.*, 28: 287-292 (1975)). A simplified method for measuring the full range of arm circumference has been described by ZERFAS, A. *Am. J. clin. Nutr.*, 28: 782-787 (1975).

Collecting system and target population			Reflects nutrition	
Health services	Government statistics	Family data	Now	Past
primary care and paediatric wards		} X	} X	
also eye clinics				
primary school children				X
primary health services			} predictive of future epidemics of clinical malnutrition in marginally nourished populations	
total population				

* It is suggested that the proportions of subjects with haemoglobin levels below the following values should be reported :

Sex	Age	Haemoglobin level * (g/100 ml)	Age groupings
both	1½-6 years	11	by year
both	6-14 years	12	by year
males	14 years	13	by decade
females, non-pregnant	14 years	12	by decade
females, pregnant		11	all ages

* From WHO Technical Report Series No. 503, 1972, Annex 2.

There is no assurance that these cut-off points will be sensitive indicators of changes in the prevalence of clinically important anaemia. Changes in mild anaemia are difficult to interpret in terms of health.

¹ For laboratory tests for the assessment of nutritional status, see : SAUBERLICH, H. E. et al. *CRC Critical Reviews in Clinical Laboratory Science*, 4 (3) (1974).

² Where deficiency of a specific nutrient is a nutritional problem, consumption of foods containing that nutrient may be a sensitive and specific indicator for that specific type of malnutrition.

³ Total energy can always be estimated from a complete dietary survey but can often be estimated by much grosser measures of the staple foods consumed.

⁴ See for example : ORSHANSKY, M. Counting the poor. *Social Security Bulletin*, January 1965.

⁵ This is necessary for initial assessment of the nutritional problems and for periodic validation of the surveillance indicators. This measurement can often be replaced by one of the other less expensive indicators of dietary intake.

⁶ Where maternal mortality is due to malnutrition, the sex ratio will reflect malnutrition. Otherwise it is a "risk" factor (see section 2.2).

3.4 Health and dietary indicators of the nutritional status of the population

In addition to the characteristics of indicators discussed above, there is a further problem with health status indicators, which relates to the "iceberg" concept of malnutrition. This concept derives from the fact that where clinical malnutrition is present in a population, those individuals with low values for the anthropometric or biochemical measures of individual nutritional status but without clinical signs are much more numerous than those with clinical signs. On this basis, it may sometimes be wrongly assumed that where low values for the measures of individual nutritional status are common, there is a high prevalence of clinical malnutrition. However, since the "iceberg" concept of malnutrition has been neither quantified nor tested, the prevalence of asymptomatic cases is a poor predictor of the prevalence of symptomatic cases. For example, serum albumin levels of less than 3.5 g/100 ml are defined as low in the ICNND manual,^a but this value is too high to provide a useful cut-off point for defining the risk of kwashiorkor. Knowing only the number of children with serum albumin levels below 3.5 g/100 ml gives no indication of the number below, for example, 2.0 g/100 ml, the point at which the risk of kwashiorkor is significant. In short, the usefulness of any indicator of malnutrition that is not clearly related to a prevalence of symptomatic ill health must be examined critically. Similarly, if a mean is used as the indicator, the pitfalls must be recognized; that is, changes in the population distribution around the mean may have public health implications but may not be reflected by any changes in the mean. Since this is an area in which little work has been done, the interpretation of means as nutritional indicators is especially difficult.

Indicators that are considered most useful for the surveillance of nutritional status are summarized in Table 4 with explanatory notes. Detailed discussion of these individual measurements is not considered to be relevant here, because with a few exceptions they are well established tools of conventional surveys of public health statistics. As mentioned earlier (3.1.2) the choice of cut-off point is inevitably arbitrary, based on available experience.

An abbreviated list of suggested indicators, with particular emphasis on low cost and ease of measurement, is presented in Table 5.

^a INTERDEPARTMENTAL COMMITTEE ON NUTRITION FOR NATIONAL DEFENSE (ICNND), Manual for nutrition surveys, 2nd ed. Bethesda, MD, National Institutes of Health, 1963.

TABLE 5. ABBREVIATED LIST OF INDICATORS OF NUTRITIONAL STATUS

Phenomenon	Indicator
Maternal nutrition	birth weight
Infant and preschool child nutrition	proportion being breast fed and proportion on weaning foods, by age in months mortality rates in children aged 1, 2, 3, and 4 years, with emphasis on 2-year-olds If age known : weight for height height for age weight for age If age unknown : weight for height arm circumference clinical signs and syndromes
Schoolchild nutrition	height for age, and weight for height at 7 years or school admission clinical signs

3.5 Sources of data for surveillance

In the initial assessment, existing data are used to identify and describe groups at risk. At the same time, the available resources of data for surveillance must be identified and the requirements for additional sources determined (see section 2.4).

Data sources can be classified as :

(a) Data currently recorded or potentially obtainable within the present systems of collection.

(b) Additional (new) data that should be obtained either through the existing services (e.g., agricultural, health, education, etc.) or by recruitment of personnel specifically for the purpose. The major decision in connexion with new data is whether individual or household level data are also to be collected.

The choice of a data source depends mainly on an assessment of its capacity to generate indicators that fulfil the characteristics given in section 3.1. Data sources should be complementary to each other so as to cover the broad range of information likely to be needed. In practice, the additional data may be obtained from the following sources :

- government statistical and meteorological agencies
- health systems
- agricultural services (including extension services).

Each of these sources has advantages and disadvantages, and these are discussed in detail below. The sources complement each other.

When they have been assessed and evaluated as potential sources of surveillance data, considerations can be given to the requirements for further data sources.

3.5.1 *Data collected by statistical and meteorological agencies of the government*

This statistical information has two uses. It provides indicators directly and to a certain extent it can be used to validate data derived from other existing sources, e.g., the health services (hospitals, MCH centres, etc.). The great advantage of these statistics is that they are designed to cover the whole country and to be representative of the whole population (meteorological data, census, family budget surveys, vital statistics, military conscription, etc.). This objective is, however, not always achieved in reality. Nevertheless, single-purpose services may be more successful in collecting data representative of the population than those with other responsibilities. Those who collect such data are often trained in interview techniques and may use better methods of interview, although such systems usually cannot be used to collect clinical information.

A disadvantage of these sources is that even though collection of data may be continuous, compilation is not done continuously because the information would not be representative.

3.5.2 *Data collected in the usual operation of the health system*

Much of the health data that may be relevant to nutritional surveillance is collected from mothers and children and originates from maternal and child health (MCH) services. Other points at which data may be produced within the health system are mentioned in Table 4.

Information collected through the health services has one disadvantage that it is rarely representative of the whole population. On the other hand this might be an advantage if the health services data are systematically slanted towards the "vulnerable" groups of the population or towards selecting for malnutrition, so long as this slant is not different in different regions of the country and does not change substantially with time. Constancy in bias cannot, however, be taken for granted and would have to be verified from time to time by other data.

The main advantage of data from health services is that they can be collected and compiled continuously within the context of current programmes that cover simultaneously many different areas of the country. This may often mean that enough information is available

over the country to allow disaggregation of data relating to specific groups at risk. Since the operational costs of administration and implementation is already largely covered, the resources devoted to this aspect of nutritional surveillance could be very small compared with those required for the health services themselves. This is an important consideration, because within health services the shifting of resources away from the actual delivery of health care is usually difficult.

Finally, there is a benefit to the health services system itself in the collection of such data. This feedback is also necessary to improve and maintain the quality of the data. If there is a systematic feedback of these nutritional statistics, those who gather the information and provide the service will become more conscious of nutrition as a determinant of health, and consequently they will become more effective in the delivery of health care.

3.5.3 *Data collecting by agricultural services*

The data available from agricultural services will depend on local conditions. On the one hand, agricultural products that enter the market system, particularly cash crops for export, may be estimated with some precision; at the other extreme, subsistence crops are usually assessed, if at all, considerably less accurately. Nonetheless, crop-reporting systems do exist in many countries, and a strengthening of these, and arrangements to improve data flow, could allow them to form an important element of a surveillance system. In addition, further data, for example concerning crop development and crop and animal diseases, might be obtained through agricultural extension services, but the quality of the data needs to be appraised realistically. Similarly, the data related to livestock vaccination programmes, for example, could be used to estimate livestock numbers and herd structures. These activities would probably require recruitment and training of local people, and would be an intermediate step towards establishing new data sources *per se*.

3.5.4 *Requirements for additional data sources*

In addition to those discussed above other sources will be required. These new sources may be needed to check on the validity of data from other sources, and for the surveillance of specified target groups, in order to ensure that the surveillance system fulfils its objectives adequately. Some possible additional sources are discussed in section 4.3. These are mainly concerned with data at the level of the family or the community, and would be particularly useful for collecting information

such as anthropometric measurements on preschool children, estimates of food consumption, and other kinds of information that are not obtainable in a representative way by the other methods. The great advantage of this approach is that it can be tailored to fit any particular situation, and to provide many different kinds of information at the same time, e.g., on family income and expenditure, food production, as well as information on health status. Thus, the multidisciplinary nature of surveillance may apply both at the level of data collection and at the stage of interpretation. In many countries a system of this kind could form part of an existing activity, such as a family budget survey or community development services. However, in contrast with the usual type of survey the collection and compilation of data can be continuous.

The disadvantages of such a system may be its cost, and the demands it may make on trained manpower for supervision and analysis, although in some countries simple and inexpensive systems have been set up at the village level.

4. PLANNING AND DEVELOPMENT OF SURVEILLANCE SYSTEMS

4.1 Basic principles

The surveillance system must be developed to fulfil the information needs of the intervention programmes planned. The first consideration is to ensure that the information obtained is used to produce or modify action directed towards the groups under surveillance in order to give a sense of participation in the community concerned, and ultimately as the only justification for establishing a system at all. Within this context the system must use the most sensitive indicators that are feasible. The indicators must fulfil the requirements discussed in section 3, and data from the surveillance system itself must be constantly re-examined to see whether changes are required in the indicators to improve the timeliness and the sensitivity to change of the surveillance system. The basic principles underlying the selection of indicators (section 3) were, first, the definition of sensitivity in terms of "triggering" action (3.1) and, second, the choice of causal variables to give suitable predictors of future changes in nutrition.

From these two considerations an appropriate sampling design can be formulated, which together with a consideration of data sources (section 3.5) leads to the design of a structure for data collection. These

principles, qualified by feasibility, also underlie the choice of the measurements on which the indicators are based (sections 3.3 and 3.4). This section deals with the institutional structures (section 4.2) required, and the implementation of an effective surveillance system (section 4.3).

4.2 Institutional structure

The points at which information from a surveillance system are interpreted and utilized can range from the local (e.g., village) level, through district (local government) to central level. The choice depends both on capacity for processing and interpreting data, and the ability of each level to produce action. The output from surveillance could well be useful at more than one level. This will vary according to local circumstances, and the design of an institutional structure for nutritional surveillance can be given in outline only.

Surveillance information is primarily needed at decision-making points for immediate action and long-range planning. If authority is decentralized, so that local government is able to take effective action, then this information must be available to it. Nonetheless, while the design of the system should allow interpretation of data as locally as possible, professional expertise for analysis of data over the range of subjects covered may not be available within, for example, a local government office. In this case, there is no alternative, at least in the early stages of a surveillance system, to reliance on centralized interpretation.

Central interpretation of data will also be needed to facilitate objective decisions concerning the allocation of resources to different regions. In practice, interpretation could take place both locally and centrally the only requirement being that the data are also transmitted reliably and with minimum delay to a central point for processing and interpretation. This fits with the technical and administrative needs for handling large quantities of data.

A central unit for a national or regional surveillance system would be required to provide technical support and administrative back-up and to recommend action. A processing system, possibly using computer methods, will therefore need to be established. This unit would be responsible not only for processing the data in a statistically valid manner, but for presenting the results in a way that is immediately understandable and useful to those responsible for planning. For example, interpretation that simply gave quantitative changes in nutritional status would be incomplete: the meaning and implications for action of these changes will be the essential requirement.

The specific functions of the central unit would be :

- providing the essential link with the planning and response mechanisms in the government and other agencies
- planning the surveillance system
- administering the system in operation
- providing data processing and interpretation.

Under certain conditions, some separation of the surveillance and evaluation functions may be desirable, in the interest of independence of the evaluation.

It is essential that the multidisciplinary central unit should be entrusted with sufficient responsibility and communicate directly with a high level of the government concerned. In countries where food and nutrition institutes exist, those might fulfil certain of the functions of the central unit, or serve as a focus for its establishment.

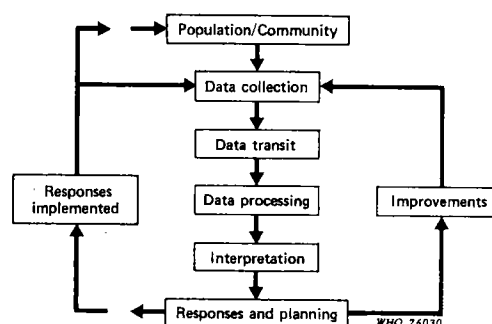
The central unit should, however, be closely associated with, or part of, the planning apparatus in the government and be capable of obtaining a wide range of technical support to cover the multisectoral nature of the activity. It should thus not be within the responsibility of a specialized ministry itself (e.g., agriculture or health), but should rather provide them with the information they require. This proposal should be distinguished from previous approaches in which food and nutrition committees with representation from relevant departments were set up but with neither a supporting secretariat nor executive responsibility.

The practical problem remains concerning where in the government structure the initiative should be taken for the setting-up of a surveillance system. This clearly depends on the structure in individual countries and on the state of development of the planning and implementation machinery. The initiative could arise from a ministry of development planning authority or from a national nutrition institute, where these exist, or alternatively it must come from other high levels in the government. In any event, the essential consideration is that the initiative must come from a sufficiently high level to ensure that action follows.

4.3 Steps in design of a surveillance system

A schematic outline of the functioning of a surveillance system is given below. This scheme shows the flow of information from the population to the decision-making levels. It also indicates the passage of this information in the form of recommendations for action to the

government agencies that must implement them. This action lies outside the scope of this report, and therefore the arrows to and from response implementation are shown as interrupted lines in this scheme. Data collection to monitor implemented responses should, however, be part of the surveillance system and this is represented by an uninterrupted arrow. Similarly, some of the responses to information issuing from the surveillance system will be improvements to the surveillance system itself.



4.3.1 Summary of preliminary procedures

As described in an earlier section of this report, certain preliminary steps will have to be taken before the definitive planning of surveillance can begin. For completeness they are listed here with appropriate action references. It is clear that in many countries information will be available that will make some of these steps unnecessary.

The steps are :

- (a) Evaluation of the problem (see section 2.1).
- (b) Identification of areas and/or population groups at risk in order to establish surveillance priorities (see section 2.2).
- (c) Definition of food supply system(s) (section 3.3.1) and a working hypothesis of likely causal relationships (see sections 2.3 and 3.2).
- (d) Definition of the information required for intervention and for programme evaluation (see section 3.1).
- (e) Selection (from (c) and (d)) of variables considered to be valuable and feasible to measure (see sections 3.3 and 3.4), as an initial working proposal.
- (f) Inventory of existing data collection services and of the information they collect (see section 2.4 and 3.5).

4.3.2 Sample design

Stratified, multistage, random sampling will usually be found the most practicable and efficient method of selecting units for the surveillance system.

Stratification. Conventional stratified sampling methods can be used to allow data to be interpreted as representing the situation :

- by area (administrative, geographical, ecological)
- by population group (socioeconomic and cultural)
- by biological status (sex, age, etc.).

The specificity of the system in monitoring disadvantaged groups depends on this process. However, some collection of comparative information from other sectors of the population may be needed. Stratification consists in dividing the population into groups or areas in such a way as to make them as homogeneous as possible with respect to the most important variables to be measured. However, because administrative boundaries do not necessarily coincide with the boundaries of homogeneity, a homogeneous population may also have to be subdivided by administrative regions. The basis for stratification can vary widely, from the geographical region in which the food supply system operates to a variety of economic and demographic factors. The choice of criteria for stratification should always reflect the information needs of the action programmes.

Sampling procedure. It will not be possible in all cases to select a random sample from each stratum of the population at risk, although this is the aim. The required sample size depends on the variance present in the population under observation and this can be reduced by careful stratification. Preliminary estimates of variance may be available from pilot studies or surveys.

Within strata it will usually be convenient to locate data units (e.g., households) in two stages, with a cluster of data units as the first stage of sampling, and a data unit within this cluster as the second stage. Every endeavour should be made to select a random (probability) sample within each stratum. The number of data units needed to monitor the condition of a target group will depend on several considerations, e.g., resources in staff and money and the precision desired. Present experience indicates that when households are the data units, 100–200 of these are likely to be adequate.

A longitudinal design in which measurements are repeated on the same sample may have certain advantages over a design in which repeated cross-sectional measurements are taken on different samples. These are :

(1) in facilitating interpretation, particularly with respect to the predictive value of measurements ; (2) under certain conditions (e.g., for settled communities), in simplifying the sampling requirements after the initial sample has been selected, and (3) in enhancing the sensitivity of the system to change. Alternatively a partially replacing sample may be used and indeed may be essential where migration is significant. A partially replacing sample will remain representative of the changing population over time and still offer the advantages of interpretation arising from repeated observations. However, particularly for mobile populations, these types of longitudinal design may be impracticable and repeated selection of new samples may be needed.

4.3.3 Design of report format and questionnaires

These two procedures should be considered together and in the order given. The report format should answer as completely and as precisely as possible the objectives of the surveillance system, although these may differ depending on the type of food source of the target groups—settled subsistence, pastoral, market, or combinations of these. Careful collaborative work should be done by representatives of all the technical fields involved, in consultation with a statistician. Only when the report format is settled should questionnaire design be considered.

If computer based processing is necessary it is important that the data collection forms be laid out in such a way that the information can be punched directly on to computer cards without an intermediate transcription stage. At the same time it should be possible to read the information directly. Coding methods must be worked out in conjunction with those operating the computer system. It may be that different questionnaires will be required if information is gathered on population groups that differ significantly even though the report format may or may not be the same. Allowance should be made when initial formats are laid out for subsequent modifications and developments.

4.3.4 Design of data collection system

Data obtained through existing channels was discussed in section 3.5. Possible additional sources have different applications depending on data requirements, but in principle can be classified as :

- Data collection stations at the village level, not obtaining data from households (e.g., for rainfall, prices, wage-rates, local stocks)

- Data collection stations, obtaining data from households within a limited area (e.g., for income, consumption, expenditure, family stocks, nutritional status)
- Mobile field teams (e.g., as above except rainfall)
- Remote-sensing methods—satellite or aircraft (e.g., for area measurement, pasture conditions, location of mobile groups).

Each of these methods has a specific advantage for different types of information and the choice of method will depend on resources available and data requirements of each specific situation. The methods should be designated to provide a continuous flow of data, rather than be seen as a means for periodically repeated surveys.

On the basis of the strata defined and the sample size required, the density and location of data collection sources can be established. Once an overall plan has been determined existing sources can be examined and adjustments made to utilize them.

4.3.5 *Reporting timetable*

The frequency with which surveillance reports are *required* will depend largely on the rapidity with which change is expected and may have to be adjusted from time to time. The frequency with which reports are *possible* will depend largely on the capacity of the system to observe, process, and report after a year's delay.

A feasible reporting timetable should be established and the resources required to meet this timetable can then be calculated.

4.3.6 *Implementation of field operation*

Training. It is possible to train field staff to collect information from a number of different technical areas and this is desirable if resources are to be concentrated. Field personnel already employed in dispensaries, agricultural field stations, schools, and the like will require in-service training that may be carried out at a local or regional centre, whereas newly recruited staff may require a longer training period. It is important that field staff should be aware of the overall scheme of things and understand their contribution to the system. Training, therefore, should emphasize the importance of careful measurement and recording and should include a background on the way measurements can be interpreted. Depending on their technical capacity, priority should be given to recruitment and training of local people in order to strengthen the participation of the community.

For staff engaged in administration, data processing, and interpretation a higher level of training will be needed, for which external assistance may initially be required.

Equipment and supplies. It is desirable that field equipment be standard throughout an area, or indeed internationally. This may not be possible initially if a considerable amount of equipment is already in the field. A regular supplies system should be established and maintained to ensure that adequate stationery and other consumable items are always available. Similarly, regular equipment maintenance is essential.

Supervision and quality control. To maintain standards and ensure comparability between population groups and areas, an efficient liaison between the central unit and field personnel must be established. Thus regular supervisory visits to all field stations will be needed. The equipment and the measurement techniques should be monitored and the necessary encouragement and correction offered. Samples of data should be checked continuously in the field to ensure that forms are correctly completed, and assessments of data quality should be carried out, for example by ensuring that variances are consistent. Central quality control procedures, such as monitoring the constancy of variance, should be an integral part of data analysis. Rapid correction will clearly be necessary when mistakes are found.

Arrangements for data transit. The practical problems involved in transmitting data for processing and analysis, and for returning to the field the results of the analysis, should be considered. Information will be required regarding the existing communication system and, if necessary special arrangements will have to be made for areas where communications are poor. The channels through which data will flow are partly determined by the institutional structure of the system (4.2).

A steady flow of data, from collection through processing to an interpreted stage is critical to the concept of surveillance. Any accumulated backlog would have to be discarded in favour of fresh data.

4.3.7 Data processing

Once the system is fully operational, the capacity for processing and interpretation of data has to be adequate to absorb incoming data, so that interpretation keeps pace with collection and interpreted information is rapidly available. Data must remain retrievable, first, while retrospective analysis is undertaken to evaluate and develop the system itself, and to understand the events that occur and, second, to determine whether predictive indicators do in fact correlate with subsequent events.

The output from the data processing is required to : (1) describe contemporary conditions ; (2) identify trends ; (3) predict changes ; (4) elucidate underlying causes of the situation.

Data should be processed with the following aims :

(1) To establish the levels of each variable for each stratum within the area under surveillance, at time intervals related to frequency of measurement, to produce regular " contemporary " reports.

(2) To highlight results giving evidence of actual or predicted deterioration of food supply or nutritional status using predetermined " trigger levels ".

(3) To record changes observed in variables over time with further statistical analysis where possible.

(4) To establish relationships between variables in order to build up a quantitative model of the food supply system to allow better prediction of future events and their probabilities.

Although the following description envisages a centralized processing apparatus, relevant features could be abstracted for use in local processing systems.

The need for a two-way flow of information must be emphasized. Data should not disappear into a processing unit with no return of results. If circumstances dictate centralization of processing, the participation of local people must be maintained by informing them of relevant results.

Data processing may be divided into the following component parts : editing, tabulation, analysis, and report preparation. Each step should maintain an uninterrupted flow of information. This requires an organization different from that of survey operations that are not intended to be repeated.

A management decision will be required on the advantages and disadvantages of computer processing. The capacity required to edit and tabulate a constant stream of data from the field is considerable—certainly in excess of that required to apply statistical tests of significance. It is perfectly feasible to process surveillance information by hand if enough calculators are available, and even if a computer system is used, manual processing will be needed for some time while the computer system is developed.

If computer processing is envisaged, adequate card punching, verification, and mechanical editing capacity must be ensured. The data-processing capacity will need to be increased as data from previous years

are accumulated, to define trends and deviations from an established "norm". Data bank facilities will then also be required for data retrieval.

Statistical resources will be required to provide continuous evaluation of data quality, to develop and refine the assessment of relationships between variables, and to obtain information about the way variables behave over time when changes are observed within the system.

4.3.8 *The surveillance plan*

A draft surveillance plan containing all implementation steps, with details of the timetable, manpower, and funding required, should be prepared. This would include the broad justification in terms of the quantity and quality of the additional information generated, the use of this information in making decisions about nutrition situations and programmes, and the final expected impact upon the population involved. Alternative substrategies should be identified. This should then be related to possible resources (including donor funds, technical assistance, etc.). If necessary, it will be modified in the face of resource constraints before the final surveillance plan (for say 5 years) is written and distributed to all management staff (and circulated for information to all relevant agencies).

5. NEEDS FOR FURTHER RESEARCH

It is apparent from this report that in designing a system of surveillance it is necessary to know more about the characteristics and the interpretation of indicators. This applies to all types of indicator, from the agricultural, social, and economic to the health status indicators. It is not the function of this Committee to propose specific research projects, but attention may be directed to certain general points.

5.1 **Causal relationships**

In many cases prediction of a change in nutritional state from change in an indicator (e.g., rainfall) implies a causal relationship. These relationships must be defined more precisely in a quantitative manner for various situations and various levels of food shortage.

It is likely that many cause-effect relationships will often be nonlinear or discontinuous and better definition of them will provide a more logical basis for the choice of cut-off points. Finally, some useful indicators will

not be in the direct causal chain. For all these indicators operational research is needed on sensitivity, i.e., the relationships between change in indicator and subsequent or coincidental change in nutritional state.

Some examples of research in this area that should be undertaken are :

- construct and test general system approaches to areas of information relevant to country-specific surveillance systems ;
- study over time the proportion of individuals at different levels of nutrition to see if changes in the prevalence of one level predict or reflect the prevalence of the other levels. For instance :
 - (a) the relation between household food stocks at the end of the harvest period and the nutritional status of family members during the ensuing months,
 - (b) the effect upon family nutritional status of competition between production for export and production for household consumption,
 - (c) the effects of family income and the cost of subsistence (nutrition) upon the body weight of children or other measures of the existence of undernutrition,
- examine the possible use of statistical models in predicting the prevalence of undernutrition.

5.2 Significance of health indicators

Many indicators of health status are used, whose biological significance is not understood. The kinds of question that have to be answered are : what are the risks attached to a given degree of weight deficit in terms of risk of death, of physical or mental handicap, of decreased resistance to infection, etc. ?

A similar problem arises in relation to anaemia. If the indicator is based on a certain haemoglobin level, the question is, at what level is functional capacity affected ? A beginning has been made in this kind of research, as regards the risk of death in relation to body weight in the hospital setting^a and in relation to arm circumference in a famine situation.^b There is some quantitative information relating to that form of malnutrition represented by overweight. Experience has established a rough relationship between degree of overweight and increased risk of death, and hence a cut-off point at which the increase in risk begins to be

^a GOMEZ, F. ET AL. *J. trop. Med.*, 2 : 77-83 (1956).

^b SOMMER, A. & LOEWENSTEIN, M. *S. Am. J. Clin. Nutr.*, 28 : 287, 292 (1975).

appreciable. The distinction has already been made between the choice of a cut-off point and the "trigger level" at which action should be initiated (see 3.1.2). These two choices, although different, are related. Without a better understanding of the biological questions outlined above, interpretation of changes in indicators as guides to action must remain empirical.

Some specific areas of research are :

- Investigation of the significance of indicators based on physical examination for risk to performance, health, or survival at different ages, and of the advantages and disadvantages of pooling data of several age groups.
- Identification of suitable reference data for populations that will facilitate international comparisons of health related indicators of nutritional status. This research should also include the question of standardized formats for the presentation of data.
- The magnitude and significance of the intra-individual variation in determining cut-off points and trigger levels.

5.3 Operational research

The efficiency of planning, organization, sampling, data collection, data flow, and data reduction and presentation determine the efficiency and often the success of nutritional surveillance.

Some examples of research in this area are :

- Identification of the determinants of success and failure of nutritional surveillance systems in the past ;
- Development of data bank methods of storage and retrieval of surveillance data for retrospective study of the performance of new indicators ;
- Examination of relationships between sampling methods, survey methods, and costs and the sensitivity of indicators : calculation of the marginal benefit of indicators in different situations ;
- Development of remote-sensing techniques for nutritional surveillance from aircraft or satellites.

6. SUMMARY AND RECOMMENDATIONS

Introduction

Nutritional surveillance is an essential instrument for the detection of nutrition problems, for the formulation of policy, and for the planning and evaluation of action programmes for both development and emerg-

ency situations. Without an adequate surveillance system at the national and local levels, a progressive deterioration of health may proceed undetected or acute disasters may recur with inadequate prior warning. The resulting absence of information results in a continued state of unpreparedness leading to inadequate response and waste of resources. In view of the critical world situation regarding food supply and human nutrition, no government can ignore the need to develop nutrition information systems to protect the health and welfare of people on a national and global scale.

1. In this context, the Expert Committee strongly recommends to the national governments that :

1.1. Nutritional surveillance systems be established as a matter of priority. These should be of a multisectoral nature and should function at regional and local government levels and be primarily concerned with vulnerable population groups.

1.2. These systems should be responsible for continuous surveillance on the basis of selected indicators and standardized procedures. An initial assessment, based on existing information supplemented, if required and if feasible by additional data may be necessary. This assessment should make use of information from health, agricultural, socioeconomic and other relevant sources. Continuous surveillance should be based on a standard set of indicators selected according to the findings of the initial assessment and collected primarily by existing information systems in the relevant sectors (e.g., the health, agriculture, and socioeconomic sectors), which may require strengthening in certain respects.

1.3. The system should be organized within the framework of existing information channels and directed by a central unit, which should have statutory functions and authority to obtain relevant data from sectoral systems and make appropriate recommendations for action. Further the unit should obtain, assemble, and interpret data with the participation of the relevant communities concerned.

1.4. The unit should have formal authority to convene meetings of senior representatives of sectoral agencies to state specific requirements for information and to present alternative strategies for action.

The unit should have full-time staff and be headed by a director of senior status, experienced in government administration and familiar with the food and nutrition situation of the country. It should be supported by high-level technical and administrative personnel from relevant government departments. It must have adequate resources for operational

costs, for preparation and analysis of data, and for dissemination of information at national, regional, and local levels. Finally, it must have access to statistical expertise.

1.5. The unit should provide for a suitable training scheme, including manuals and teaching aids for personnel engaged in data collection and processing for the surveillance system, to be implemented through sectoral educational programmes, both basic (pre-service) and in-service.

2. The Expert Committee strongly recommends that the international agencies respond jointly to recommendation No. V.13 of the World Food Conference by :

2.1. Establishing machinery to coordinate their undertakings towards setting up a global nutritional surveillance system and to provide appropriate feedback and interchange of information between national systems.

2.2. Promoting the development of national nutritional surveillance systems through :

- (a) cooperating with countries in the setting up of such systems ;
- (b) organizing regional intercountry seminars for orientation on their objectives and methodology. These seminars should be aimed at senior technical and administrative staff of national agencies responsible for planning and development of sectoral systems.

2.3. Preparing reference manuals on surveillance organization and procedures, covering all sectors and all levels, to provide a basis for training and for the development of instruction material for local use. These should be complementary to and compatible with specialized sectoral manuals related to food and nutrition developed by international agencies.

2.4. Stimulating and assisting research projects to improve nutritional surveillance methodology.

2.5. Convening a second Expert Committee on Nutritional Surveillance in not more than 5 years' time (1980) to assess and evaluate the progress and to advise on future developments.

EXAMPLES OF KNOWN RELATIONSHIPS IN FOOD SUPPLY AND NUTRITION

Water availability for crop growth

Periods in which ground water is available for crop growth can be calculated from agroclimatological data (2, 3, 6). Although ideally, complete water budgets should be constructed, simple approximations can be made to estimate water availability periods. For example, in the Sahel, the relationship :

$$\text{days available for growth} = \text{rainfall (mm)} / 5.5$$

holds over a wide area (3).

Pasture carrying capacity

The capacity of vegetation to support livestock, and the relation between vegetation production and livestock production may be expressed in a number of ways (4, 9). As an example of one method, vegetation yield can be calculated, for different ecosystems, in terms of "forage units" (FU), the requirements of one cow being n FU/year. Changes in FU/hectare are known for a range of conditions, and for example, again in the Sahel, a difference of approximately 1 mm total rainfall causes a difference of 1 FU/hectare in vegetation production.

Animal productivity can be calculated, as in Ethiopia, in terms of "standard stock units". The number of units per head needed to provide for energy requirements (typically 1.5, where 1 unit is approximately 500 kg of livestock) is known for different conditions.

Crop growth simulation models

Simulation models for the growth of several crops exist (1, 12, 13), and this method is being developed with some success to predict crop yields in North America and Australia. It is proposed (10) to use such models, combined with weather assessments and remote-sensing techniques (including area measurement), to give crop production and yield forecasts over extensive regions of the world. When developed these methods could provide valuable inputs for nutritional surveillance systems.

Production and stocks related to nutritional requirements

From nutritional requirements themselves (15) the adequacy of food production and stocks can be calculated. Thus, to provide 8.37 MJ/head/day^a about 180 kg/head/year of, for example, a cereal need to be made available. Therefore for a subsistence economy, adequacy can be calculated from yield data and the area of cultivable land per head of population (nutritional density). Similarly, adequacy of food stocks can be calculated from nutritional requirements.

Income/price/consumption relationships

The economic literature abounds with demand regressions measuring the effects of income and prices on quantities consumed (see, for example, 5, 7, 11, 14). In most such regressions the income variable has a statistically significant effect on the quantity consumed; on the other hand, price as a variable, despite strong *a priori* arguments for its importance, does not always have a quantitative effect that can be measured with confidence.

It often happens that satisfactory analysis of a demand relationship requires estimation of a complete system of relationships that includes both demand and supply functions. For simple predictions, however, estimation of a demand or a supply relationship by itself is often appropriate.

Although many demand relationships have been calculated, such relationships, in general, are rather specific with respect to the situations to which they apply. It follows that it is rather unlikely that the demand relationships that apply for a specific group at risk in a particular country will already have been determined.

Socioeconomic correlations

An example of correlations between selected socioeconomic factors can be taken from studies carried out by INCAP in Central America (Guzman, personal communication 1975).

Associations examined	Country 1 Locality		Country 2 Locality	
	A	B	A	B
For the household :				
appearance—sanitation	0.59	0.46	0.54	0.03
For the family :				
food production—schooling	−0.78	0.78	0.56	0.41
food production—income	0.43	−0.12	−0.04	−0.33

^a According to the international system of units, energy is measured in joules (J). 1000 kcal = 4.184 MJ.

Income/dietary intakes/nutritional status relationships

Positive correlations of dietary intakes with family income, and of intakes with nutritional status, have been shown in a number of studies (for example, 8).

Energy intake/infection/body weight change relationship

In Gambia, the relation between infection and mean monthly dietary energy intakes for individual children over the period July to February was studied. A multiple linear regression analysis gave the following equation relating weight velocity, energy intake and infection rate (J. B. Mason, personal communication):

$$\text{weight velocity (g/day)} = -3.0 + 0.18 (\text{kcal/kg/day}) \\ -25 (\text{proportion of days sick})$$

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SELECTED SOCIOECONOMIC INDICATORS

A few indicators are described below that may serve as quantitative measures of important nutritional aspects of the current food situation in a country, trace the recent trends, and detect impending or developing changes. It is, however, necessary to realize that the early operation of a surveillance system will have as its objective, not only the assessment and prediction of nutritional change, but also research and development to test the indicators chosen with a view to a gradual modification and extension of the indicator matrix leading to a more efficient system. Furthermore, the list is to be considered mainly illustrative and needs to be modified in relation to the particular conditions of each country.

Factors affecting demand for food*Price of staple foods*

If a country has a rationing system or "fair-price" shops in the urban areas it is necessary to obtain the controlled price and quantity allowed *per caput* as well as the open market prices. Prices are often unfailing advance regional indicators, since any anticipated shortfall in production is almost certain to be reflected in a rise in prices in the region. Such a price rise will eventually become diffused to neighbouring regions or will be attenuated by crop prospects in other regions depending on the weight of the region's production on national aggregates.

Wage-rate at which an unskilled worker is willing to take a day's work, expressed in terms of national currency and value-equivalent quantity of staple food

Some countries collect information on prevailing wage-rates while others do not. As the data are useful for various policy decisions, all countries should be persuaded to collect the information. Such wage-rates, where available serve as supplementary regional indicators. Any anticipated reduction in the size of harvests is likely to bring down wages owing to a reduction in labour requirements in spite of a rise in the prices of staple foods, to which wage-rates are generally related. Clearly the amounts of staple foods that the prevailing wage-rates would buy are the appropriate indicators for nutritional surveillance.

Wage index, cost of living index, cost of food index

These indices are generally calculated for the urban areas and can serve as indicators of the probable effect of inflation on the nutritional status of urban workers. These indicators could be computed for different cities and as such serve as regional indicators, but the national average could also be calculated to provide a national indicator.

Frequency distribution of labour force by hours worked, as a percentage of the total economically active population

These indicators, based as they are on sample surveys, are generally baseline measures but should be split into rural and urban sector indicators.

Activity-rates by age and sex

These are estimated and compiled by the International Labour Organisation. ILO estimates these baseline measures by sectors of economic activity, at national levels. Any national statistical office can make available such information by regions as well.

Indicators of poverty

There are a number of ways of identifying and quantifying poverty. In the context of nutritional surveillance, one way is to set certain norms for food consumption in terms of energy protein and on the basis of foods predominantly eaten, in proportion to the actual dietetic pattern and value, to arrive at a realistic figure for the expenditure on food *per caput* or per household to provide the barest requirement of energy/protein. From the Engel curve fitted to food and total expenditure data from household surveys it is possible to estimate the corresponding total expenditure, including expenditure on the other basic necessities of life. In the absence of household survey data, this allowance for other necessities will have to be estimated.

Households with incomes below the total expenditure line may be considered in direct poverty. By replacing the prices of the base expenditure line by current prices it is possible to redraw the poverty line to reflect the effect of changing prices. It is useful to compute these indicators for urban and rural sectors separately. The latter may then be linked up with other information available on small farms and on landless labourers.

Rate of growth of per caput demand for food

This index together with the implied rise in *per caput* consumption of energy and protein will be significant if the recent trends in GNP growth continue, and other conditions remain unchanged. These will be mainly national indicators.

Income-elasticity of demand for foodstuffs

This indicator will enable the decline in consumption to be estimated if income decreases; it can be calculated at national as well as regional levels.

Price-elasticity of demand for foodstuffs — national indicators

Factors affecting food supply

Index of food production

Factors affecting food supply are by far the most important determinants of the nutritional status of the people and are, in the very nature of things, liable to considerable fluctuation. Generally speaking, domestic production is the major component of the total food supply and its expansion, properly planned, can more effectively raise the nutritional status of the people in the developing countries than any other measure. Index numbers of food production can serve as indicators of trends and year to year changes in food production of individual countries that can be compared with the indicators of growth of *per caput* demand for food in order to judge the extent to which the latter can be met by domestic sources of supply. FAO constructs and publishes index numbers for *per caput* food production in most countries of the world. To these the following may be added:

- index numbers of *per caput* cereal production
- index numbers of *per caput* livestock production

Indicators of per caput availability of energy and nutrients

Almost all countries are now included in FAO's food balance sheets, which are the main source of regular information on energy, proteins, and other nutrients available each year in individual countries from different foodstuffs. These data are used extensively for temporal and intercountry comparisons of trends and patterns of nutritional status. The food balance sheet has proved to be an effective tool for evaluation and planning in the food sector and should be utilized for work on

nutritional surveillance. The work on food balance sheets has recently been computerized by FAO and thus all the indicators that can be derived from them can be quickly made available. All the basic estimates of production, trade, stock, and prices and of utilization in different ways, and the related indicators for individual countries are being processed together through the newly-installed Interlinked Computer System (ICS), within the framework of supply/utilization accounts (SUA). The ICS can produce fairly quickly food balance sheets, and related indicators of the food and nutrition situation, based on the latest estimates of supply and utilization to provide one component of the proposed Global Nutritional Surveillance System. For measuring trends of the current state of energy and nutrient supply the following indicators are suggested.

- (a) — Total protein : protein supply/protein requirement
 - Animal protein : animal protein/total protein
 - *Per caput* availability of milk, and the milk equivalent of milk products
- (b) — Total energy : energy supply/energy requirement
 - Proportion of energy derived from protein
 - Proportion of energy derived from fats
 - Proportion of energy derived from carbohydrates
- (c) — Proportion of energy and protein derived from cereals
 - Proportion of energy from non-cereal vegetable sources
- (d) — Self-sufficiency ratios.

It is recognized that there could be other approaches and that more research is called for on the subject.

Advance indicators of per caput availability of calories and nutrients

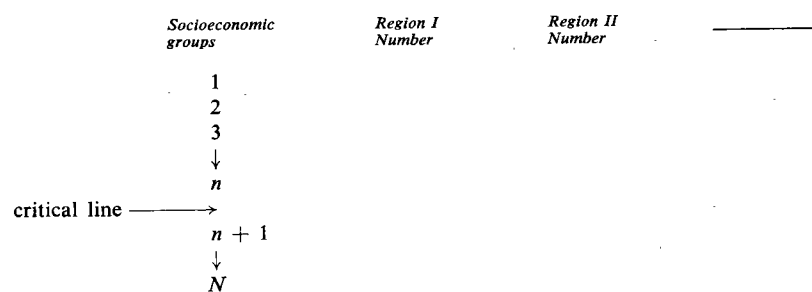
Apart from providing those social indicators bearing on the current situation, ICS can be used to estimate the expected values of such indicators on the basis of advance estimates of crop harvests that are available or can be collected through the Global Information and Early Warning System on Food and Agriculture. These estimates and the related changes will no doubt provide incomplete information, even concerning crop production, but those for the crops of major importance are likely to be available and can be fed into the ICS to work out an advance series of indicators. Some of these related changes have to be worked out within the framework of the SUAs, such as the apportionment of crops between food and fodder use, and the consequences of

the latter on production of milk and other livestock production. The other related changes have to be estimated from external sources of information, as for example, changes in exports and imports which are related to the country's trade relations with other countries, constraints of foreign exchanges, flow of food aid from other countries, etc. Essentially, an iterative process will be used, but as the computer can provide results fairly quickly, the advance values of indicators issuing from the process can serve as a useful input in the proposed nutritional surveillance system.

The number of advance indicators of the availability of food and nutrients will depend on the stage and extent of the information available through Food Information and Early Warning System. Starting off with *per caput* availability of energy and protein and self-sufficiency ratios, it will be possible to estimate all the indicators listed above as more and more advance reports of crops become available.

Micro and regional indicators based on household survey data

It is necessary to draw upon a baseline household consumption/nutrition survey or an expenditure survey to obtain information on the distribution of available food among the households by region and to assess the state of nutrition of the "disadvantaged" groups from the probable shift of the distribution to the right or left with every rise or decline of average supply estimated from food balance sheets. The information available in the baseline household survey data can be represented in general terms as follows :



The critical line indicates the hunger line or poverty line depending on whether the baseline data are drawn from household food consumption surveys or expenditure surveys. Regions should be broken down

into urban and rural sectors. Any large increase, current or anticipated, in production due to technological advances, such as use of high-yielding varieties, can be translated into an increase in the *per caput* availability of energy and nutrients and this may result in the movement of one or two socioeconomic groups above the critical line. The opposite would occur if there were a decline in production. If the production increases or decreases are localized in certain regions, the *per caput* availability of energy and nutrients has to be re-estimated taking into account the size of the population in the regions in relation to the total population. Thus, food balance sheet data could be used to carry out this exercise every year to monitor the improvement or deterioration in the nutritional state of a country taking into account the values of the other indicators suggested above. When abnormal weather conditions develop and threaten a food crisis, more intensive studies have to be made by observing the signals given by the indicators and assess the situation at closer intervals as indicated below :

<i>Intensity of food crisis</i>	<i>Number of persons likely to be affected if no remedial action is taken</i>		
	<i>Region I</i>	<i>Region II</i>	<i>Region III</i>
Rise in the prices of staple foods and in the basket of foods commonly eaten			
Wage rates			
Anticipated shortfall in <i>per caput</i> availability of energy and nutrients			
Anticipated decline in the degree of self-sufficiency			
Actual signs of the crisis deepening as reported or gathered through other indicators, including those falling within the spheres of responsibility of WHO and UNICEF such as rise in specific mortality rates, incidence of deficiency diseases, etc.			

Seasonal shortages

The indicators so far discussed do not reflect the effects of the seasonal fluctuations in food distribution that occur in many of the developing countries. It must be kept in mind that large seasonal shortages could have disastrous effects, particularly for children. It is therefore necessary for each country to obtain information on the time profile of food availability or consumption and on the relative importance of different staple food groups for different seasons by region. The most

effective method of building up data on the seasonal pattern of food consumption by regions is to carry out food consumption surveys at different times. When the basic data are available the implications of poor crop prospects reported through the food information and early warning systems can be worked out in combination with the food balance sheet. Further thought needs to be given to developing appropriate indicators of seasonal malnutrition and its effects.
