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INTERPRETATIVE MODELS FOR SELECTION OF NUTRITION PRIORITIES*

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SUMMARY

The evolution of a theory of a causality model of malnutrition which permits the analysis and diagnosis of malnutrition for the planning process, and serves as the starting point for a nutritional surveillance system, is presented. The model has been utilized at local and national level, allowing the establishment of bases for the development of Food and Nutrition Policies. Although not verified, its utilization under real life conditions has permitted its modification, the determination of its possible defects and advantages, and the planning of its verification in some countries.

INTRODUCTION

One of the basic elements for adequate nutrition planning is the diagnosis of the magnitude of the problem and of its conditioning or associated factors. The majority of interventions of economic nature count with models and quantifiable indicators (econometric models, etc.) that not only permit adequate planning but also periodic readjustments and predictions of changes.[1] Another situation is faced in the social planning area where not even consensus exists on the definition of welfare and, therefore, where indicators are a subject of great controversy.[2]

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The phenomenon of how nutritional status of a population is the resultant of the general life conditions of a given population (income, education, health, etc.) becomes increasingly clear[3,4] and it seems possible that this factor is taken as a global indicator of them, indicator which is both quantifiable and concrete. Therefore, it would then be necessary to develop models that, as happens with those of econometric nature, permit the planning and programming of interventions as well as prediction of the expected results. This, in turn, permits selection of those more effective and efficient programs by means of which it would be possible to reach the goals and evaluate results.

The definition of the problem and the understanding of its mechanisms require the development of a series of hypotheses based on generalizations of real or experimental situations (a model) to define the indicators, qualify the individual effects of a given action, and forecast the expected changes. We shall now discuss the utilization of theoretical models for the diagnosis and selection of priorities at local and national level. Parts of this work have been previously presented.[5-7]

I. LOCAL LEVEL

The development and verification of a methodology for nutrition planning is presented. Briefly, the methodology includes the following:

1. A theory that considers the relations between a cluster of variables which affect the prevalence of malnutrition in a community, such as agricultural production (land area, selection of crops, technology and production, etc.), marketing (importation and exportation of foods from the and to the community, loss of crops before and after harvest (rodents, birds, deterioration, etc.), food distribution among the families (local marketing, income, etc.), food distribution among family members (food habits), environmental sanitation and health.[8, 9]

2. A diagnostic procedure which includes field measurements and methodology for data analysis and rationalization of conclusions in regard to the efficacy of the proposed solutions.

3. Design of solutions. An analysis of the proposed alternatives; for example, if the diagnosis indicates the need of a solution involving drinking water, the alternate solutions should be compared as to their effectiveness, implementation time, cost and stability of the solution.

4. Evolution of the solutions once they are implemented. This is a procedure to compare the predicted effects in the design phase, with the effects observed in the course of time.

A. Theory

The theory is presented as a model that can be described in two sections. The first one includes three variables: nutritional status, health status and the nutrient gap (difference between the required* and consumed nutrients) (Fig. 1).

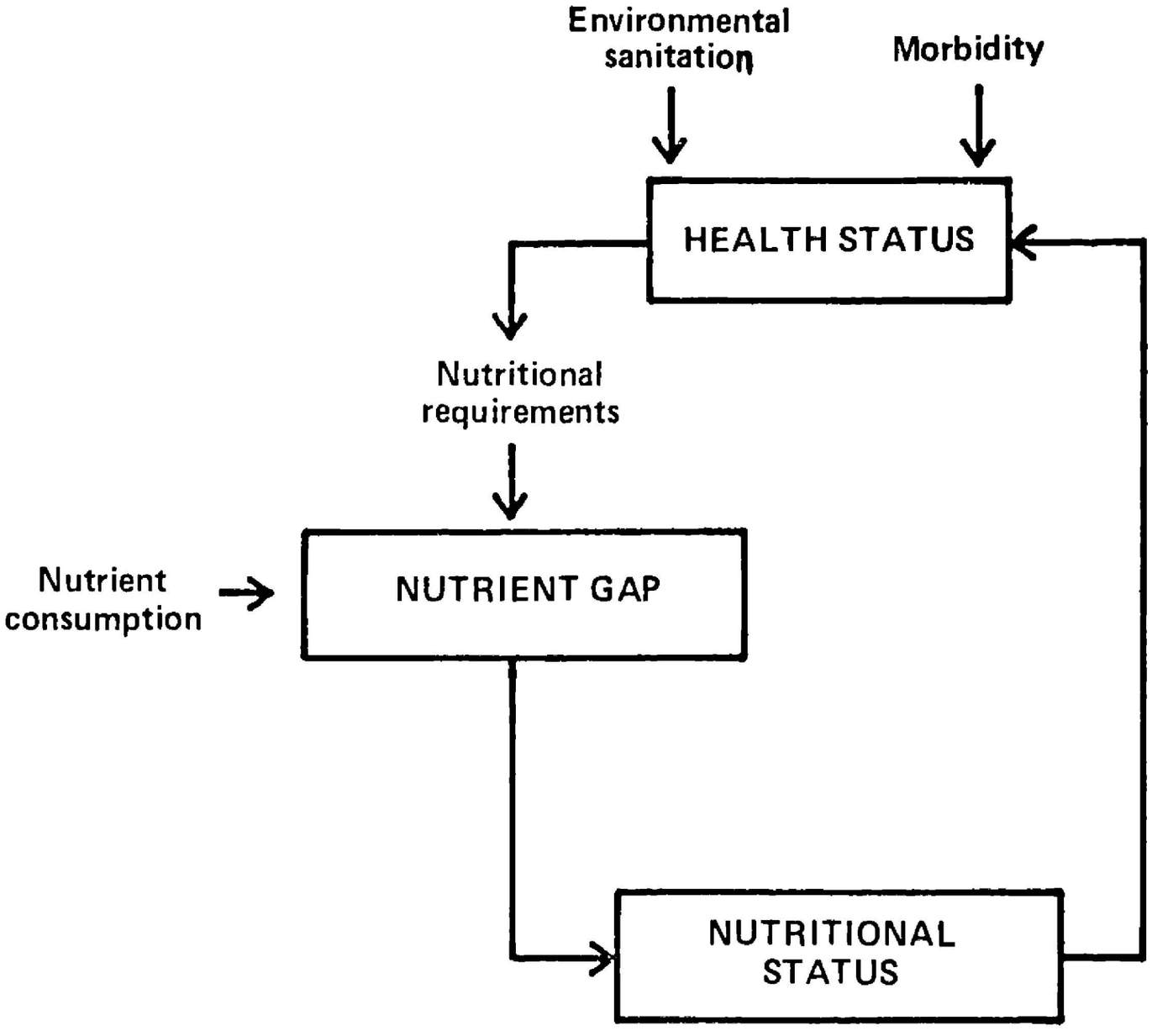

Fig. 1. *Association between nutritional status, health and nutrient intake (in foods). Health status refers mainly to the presence or absence of diarrheal disease.*

* Requirements refer to increased needs due to metabolic process during disease and recovery; increased losses and decreased intake during illness.

This section of the model or theory enunciates that nutritional status is a function of the nutrient gap, the health status and their interrelations. A reduction in the nutrient gap improves the nutritional status; an improvement in nutritional status improves health status, and an improvement of the health status will translate into a reduction of the required nutrients.

The second section is the consumption model (Fig. 2), similar to the food balance sheets which FAO has used for various years. It states that the nutrients consumed by a population depend on the nutrients produced plus the imported nutrients, less the nutrients* lost or exported. The nutrient losses occur in various stages: loss in the collection of crops, losses in storage and transportation, losses by rodents, insects and deterioration, losses on account of poor marketing, losses due to an unequal distribution among the families of the community (income), losses in the preparation of foods (at commercial and family level), and losses due to an unequal distribution of nutrients among the family members.

The output of this section of the model (nutrients consumed) feeds the first part of the model. The nutrients consumed are subtracted from the required nutrients in order to calculate the nutrient gaps (for individuals, families and communities). The third section is the biological utilization model related to disease frequency and duration, and its conditioning factors.

There exists another connection of the first section with the second section of the model, and this is a feedback from the starting point of health status: an improvement of the health status would increase production and, in its turn, this would produce an increase in income, which would translate itself into an increase in the nutrient consumption.

Description of the model may be better understood if the way how the analysis is carried out is illustrated. Considering first the flow of nutrients and cross-sectioning at community, family and individual level, it is possible to compare the flow of nutrients at each level with those required by it, and to estimate the communitary gaps of families and individuals.

B. Analysis

The logical framework for analysis is derived from the gap theory to which a decision scheme is added (Fig. 3). In other words, once the bottleneck in the nutrition flow is identified by measurement of the different gaps, the decision scheme emerging from each gap permits to analyze why and how said particular gap is produced and how it can be closed. A general statement concerning the gap theory indicates that when proceeding from the highest level gap (communitary gap) to that of the lowest level (individual gap), its size may remain constant or increase due to

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* Nutrients refer to the calorie and protein content of the food items.

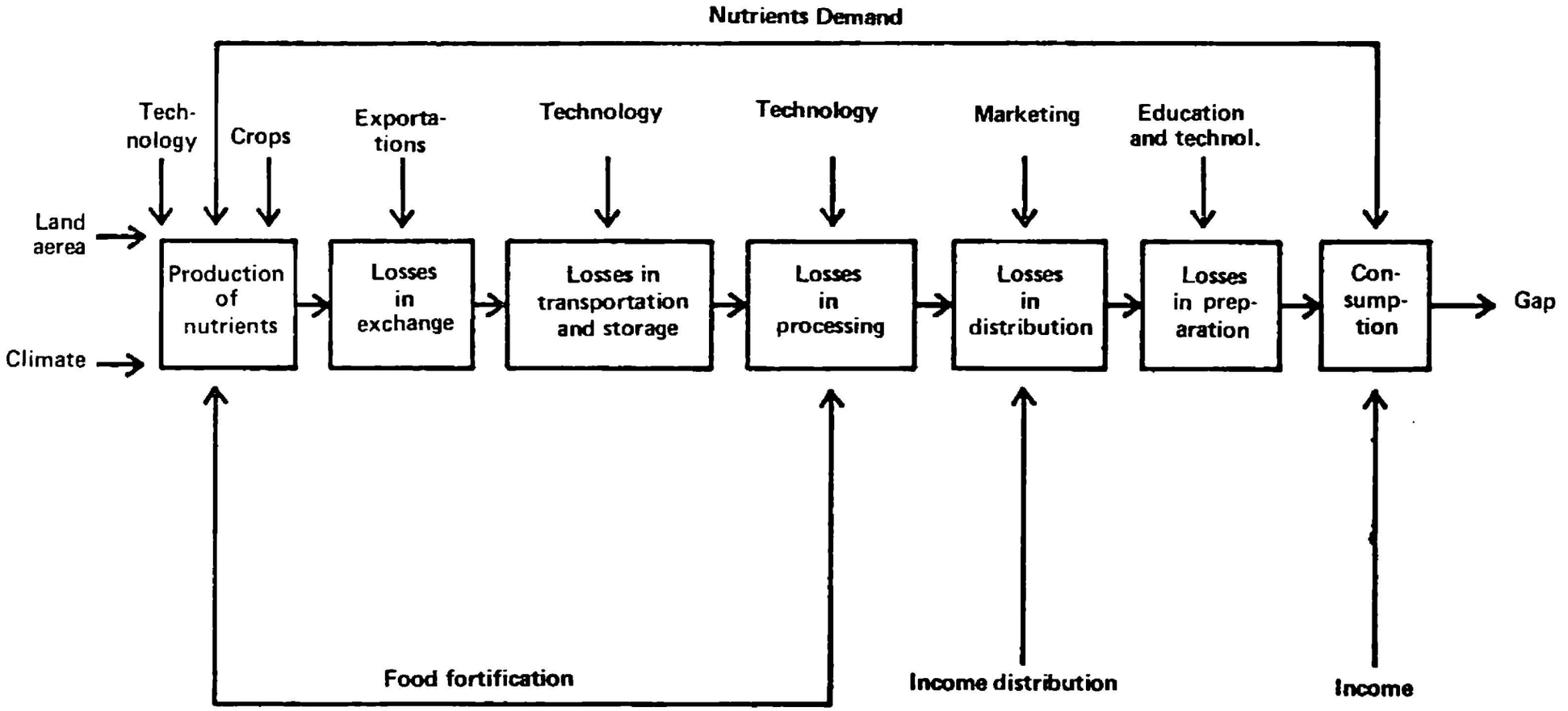

Fig. 2. *Nutrient flow model. (The output feeds the first section of the model).*

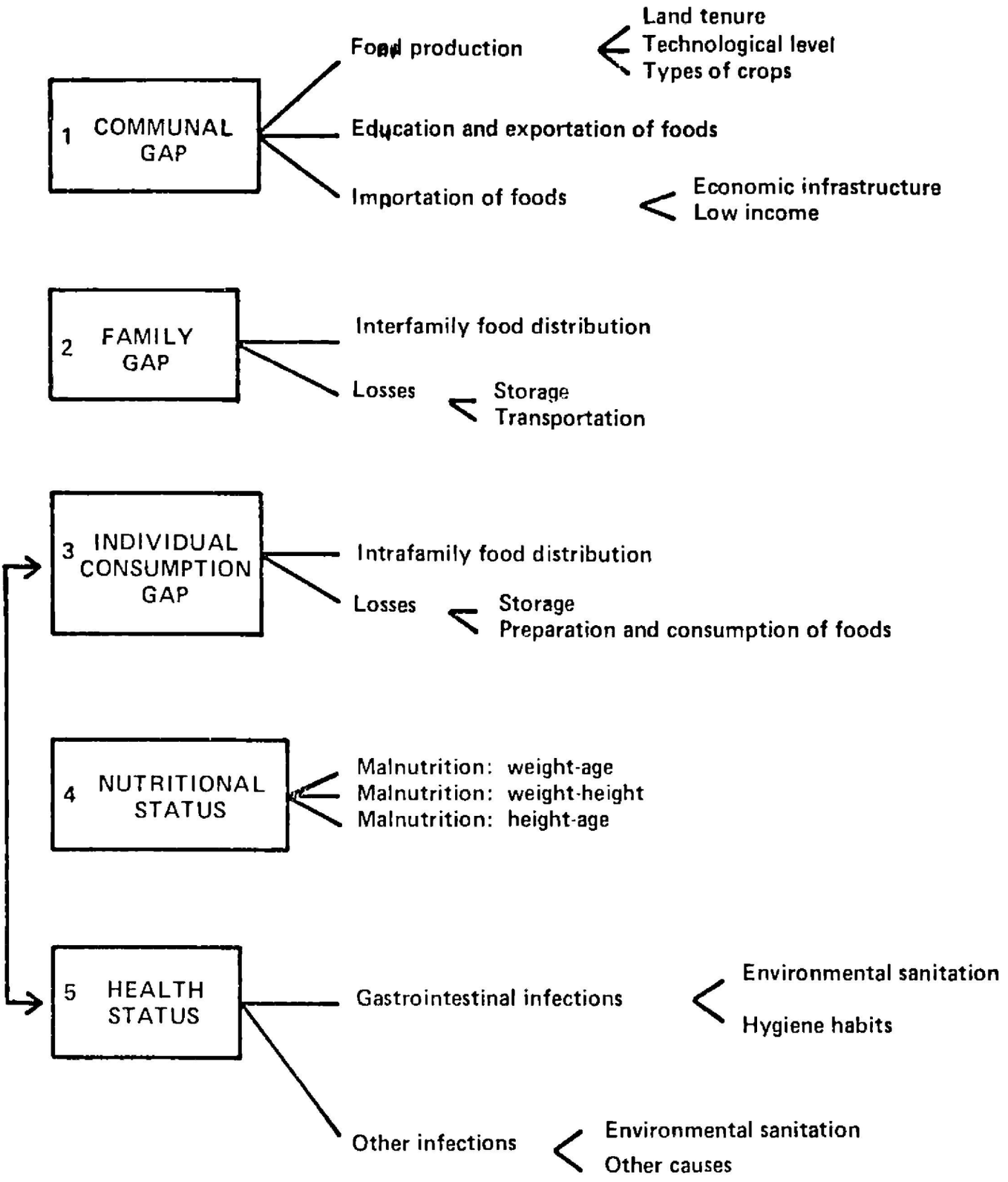

Fig. 3. *Decision scheme for the selection of analytical steps.*

the losses analyzed in the decision scheme (a biassed food distribution among the family members and among the families of a community is considered as a loss).

A sequential procedure is followed for the diagnosis and analysis:

1. The first variable measured and analyzed is nutritional status. If there is no malnutrition, no nutrition interventions are required nor is the measurement of the other variables of the model necessary. If a malnutrition rate that justifies an intervention is found, then the family gap is analyzed.

2. Analysis of the family gap. If the families are consuming more than the normally required nutrients (taking into account the individual requirements of the family members), and if malnourished persons in these families are found, the requirements for these families are abnormally high or the distribution of nutrients among their members is not proportionate to the requirements of each of the members of the family. This analysis would indicate that the following measurements would be those concerning the intrafamily distribution of nutrients:

- If a poor intrafamily distribution does not explain the high malnutrition rates, then the next factor to analyze is diarrhea incidence.

- If a low diarrhea incidence is found, a general morbidity analysis should be considered.

3. Analysis of the communitary gap, if the nutritional gap in the community is 0, but there are positive gaps at family or individual level, the existence of a poor interfamily distribution in the community or among the family individuals is indicated.

In this case, the appropriate interventions would be of economic type (re-distribution of income or of foods).

If the average community family has a nutrient deficit, the following variables should be analyzed at community level:

Nutrient production

Nutrient importation

Nutrient exportation

When availability of nutrients is greater than nutrient consumption, this indicates the existence of losses within the process and studies to determine these losses at the marketing and family level are required.

If availability of nutrients is almost equal to the consumption of same, interventions should be oriented towards the production or importation of nutrients.

C. Example Case

The results of the diagnosis procedure designed for the population of Villa Rica, Colombia (with an area of approximately 30 km^2), are presented in a summarized form. The anthropometric survey showed that the malnutrition percentage among preschool children is of approximately 60% when calculated on the basis of a weight-for-age deficit (Gómez method) and approximately 55% when calculated as a deficit of weight for height. This high rate of malnutrition can be related to:

- Deficient nutrient intake (a positive nutrient gap).

- Deficient health status which reduces the biological utilization of food and increases nutrient requirements at individual level.

Analysis is made of how both deficitary states have been generated, as well as their proximate magnitude.

The individual gap for all age and sex categories is an average of 30% both for calories and proteins. As the nutrient gap for the families is also of 30%, it can be assumed that there does not exist any nutrient loss within the family, except that related to intrafamily distribution.

Analysis of the intrafamily food distribution shows that preschool children of Villa Rica receive a portion of the foods available to the family which is in agreement with their requirements (Fig. 4). In contrast, lactating mothers and pregnant women as well as school children receive a nutrient quantity (in relation to their requirements and family availabilities) significantly lower. The other categories of individuals proportionally receive more nutrients.

If 60% of the preschool children are malnourished and they receive an adequate proportion of the nutrients available to the family, it can be inferred that their nutrient intake deficit is due to a deficit in the availability of foods at family level, which in the case presented is in the magnitude of 96 g of protein and 4,000 calories per family to close the nutrient gap.

The nutrient deficit is not the same for all the families: 22% of them consume more than their requirements (they have a negative gap) while 78% of the families have a positive nutrient gap of approximately 50%. If the excess of nutrients consumed by the 22% of the families could be channeled towards those families with a positive gap, the result would be that the gap for this latter group would be reduced in 20% (from 50% to 30%). This is the measurement of the bias in the interfamily food distribution.

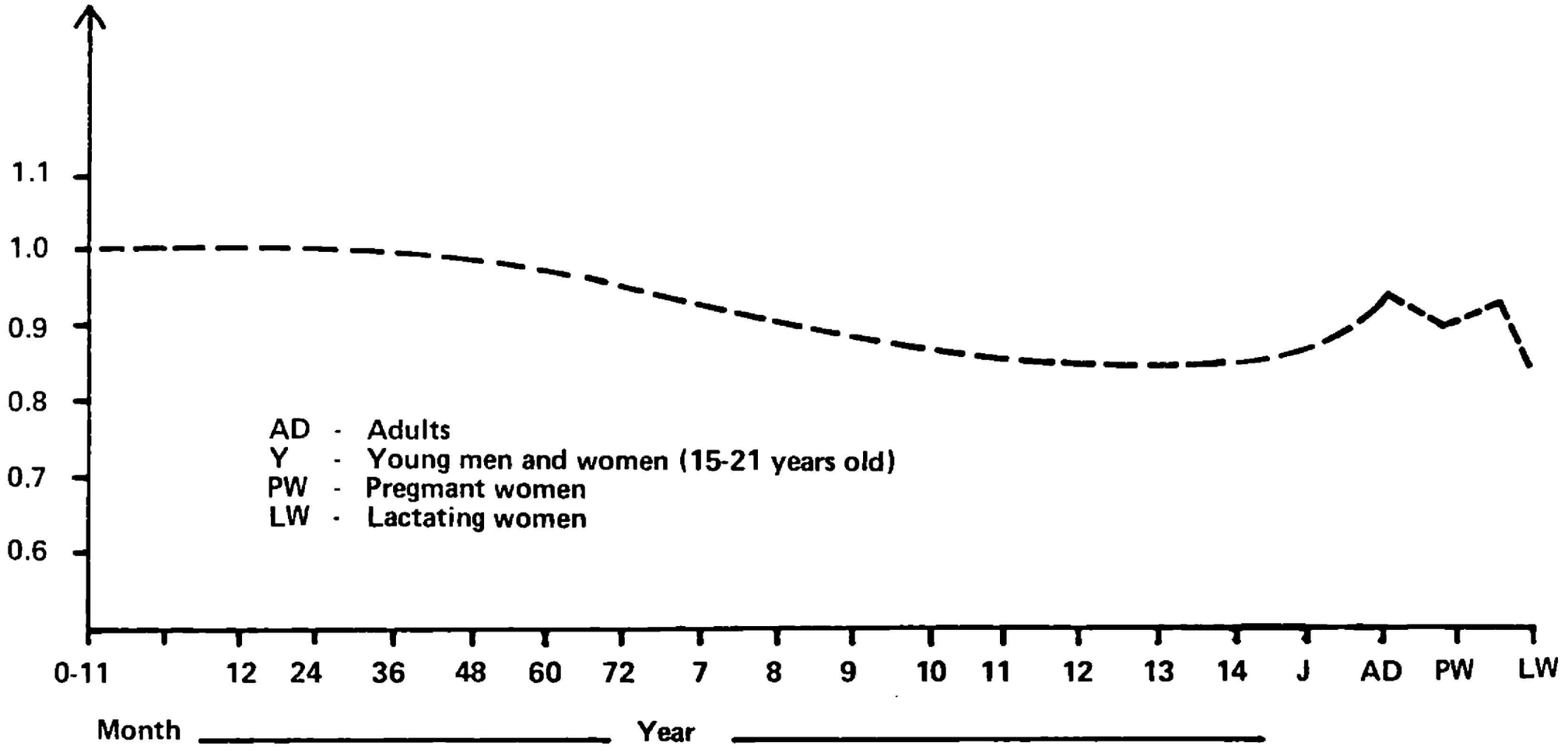

Fig. 4. *Intrafamily nutrient (calories and protein) distribution. Ideal distribution will give 1.0 for all members, regardless of the amount.* $I = \frac{Ci/Ri}{Cf/Rf}$ *where I is intake, C, consumption of individuals (i) and family (f), and R, requirements.*

In practice, this bias is measured by calculating the excess in the amounts of nutrients necessary at community level, to ensure that no family has a positive nutrient gap. This calculation is made on the basis of two hypotheses: first, if it is assumed that the tendencies in the interfamily distribution of nutrients is not changed, an excess of nutrients of the order of 45% would be required with respect to the calculated nedds. If a controlled food distribution is assumed, only an increase of 11% would be required in the amount of the needs calculated for each family. These two quantities are important since for each intervention the real value would be found between these two extremes.

By adding all foods available at the family level and comparing it with the foods available at the community level (production plus imports less exports) information is obtained as to the losses that occur during the flow of nutrients in the community (transportation, storage, distribution). These losses are of the order of 10 to 12% in food availability at the community level in the present sample.

In conclusion, it can be stated that the family nutrient gap in Villa Rica is a direct consequence of the existence of a nutrient gap at the community level, aggravated by a poor interfamily distribution of foods. For the urban sector, the family gap could be explained by a low purchasing capacity of the families, while in the rural sector the causes could be the inadequacy of: land tenure system (95% of the peasants own only 30% of the land), low level of technology, scarce and inadequate technical assitance and lack of credit and infrastructure.

Nutritional conditions worsen in the area even more, due to the tendency of exporting foods produced in the area (soybean, beans), to import others of lower quality (rice), thus raising the cost of the nutrients available for family consumption.

The second malnutrition cause in Villa Rica is found in the high morbidity observed: 65% of the children under 6 years of age suffered one or more episodes of diarrhea in a 15-day period; the hygiene conditions which explain this high prevalence lie in the wretched environmental conditions prevailing in the area. Suffice it to say that only 50% of the population use letrines (the rest does not use any built facility). The main source of water consumption is derived from the family open cisterns without any protection.

From the previous analysis a pertinent question arises: "Which is the problem responsible of malnutrition considered as the most serious and, therefore, worthy of prioritary attention?"

Results of the analysis demonstrate that when the prevalence of infectious diseases is high, the relation between the intake level of nutrients and the nutritional status of the children is quite low. On the other hand, when the prevalence of infectious diseases is low, the nutritional status of the children is determined mainly by their intake level. Consequently, reduction of morbidity and improvement of the sanitary conditions in this community are the prioritary interventions. A second priority, of course, is that related with an adequate food consumption.

II. NATIONAL LEVEL

A. Basic Assumptions

1. Although various sectors of human activities (and in this case in particular of the Government) should participate in the analysis and solution of the problem, not all of them have to do so in each of the stages. In some moments or circumstances, one or two sectors will have to play the main role, while in other places other sectors will have to do it. Acceptance of this assumption make it possible to establish an order of importance and a sequence of restrictions which should be eliminated to simplify the analytical and planning work.

2. Countries which require an adequate diagnosis of nutritional status are precisely those with less resources to carry it out. This is why complicated surveys and sophisticated analysis of data processes should be reduced, using a maximum of the structures and information already available.

3. In the majority of cases, available information can be utilized to obtain valid conclusions in regard to nutritional status and associated factors.

4. In most of the developing countries there are regional, district or geographic differences as to the prevalence and severity of malnutrition and its causal factors. Disaggregation of the information at each level makes it possible to identify sites of greater risk, as well as the sequence of restrictions that should be eliminated to solve this problem. The previous statements imply disaggregating information from each sector to the smallest territorial component (geographic, political, etc.) and re-grouping it by each of the geographic units. If it is possible to identify areas at greater risk, interventions can be more effective and efficient. Determination of the main causes in each region can then lead to the design of adequate interventions for each one of them.

5. It is an accepted fact that a simplified model must be utilized for planning purposes. Only the sectors, causes, and more important relations should be included. The temptation of adding factors and relations leads to very complicated models that in the long run are of restricted use, and if applied to a certain limit, can become a development model for the country. In practice, a simple causal relation scheme is necessary among some quantifiable factors, the association of which with malnutrition is known.

6. Selection of the information to be compiled, analyzed and interpreted, is determined by the nature of the decisions to be adopted. This is why such decisions must be previously identified. Decisions can be related to budget, preparation of an international loan, creation of intersectoral mechanisms, basis for evaluation and surveillance, etc.

B. Model Utilized

When participation in the nutritional analysis of three Central American countries became necessary (nutrition assessment)[10-12], for which purpose only little resources and limited experience were available, decision was taken to start with a simple model. The purpose was selecting indicators, identifying the more at-risk regions and, consequently in need of prioritary actions; identify some of the existing restrictions for improvement of nutritional status and to rationally organize responsibilities among the members of the evaluation or assessment team.

All the relations used are supported by generalizations of studies carried out in different parts of the world.[5] The model had to assume causal relations between the different factors. Two general hypotheses are accepted in the model: the first is that malnutrition is due to two causes, the amount-quality of the ingested foods and their biological utilization in relation to requirements. The second hypothesis proposes that both are associated with income and education.

The conditioning factors of the biological utilization of foods correspond to the frequency and duration of illness, mainly of diarrheal disease, which in turn is conditioned by environmental factors (water, excreta disposal, crowdiness, etc.) modified by the hygiene habits of the population. In its turn, duration of the disease depends on the access to curative health systems.

Coverage of immunizations, especially for measles and whooping cough, would also have a positive effect on nutritional status.[14,15] The quality and quantity of the ingested foods is a function of the availability of foods at individual level (intrafamily distribution, purchasing power, nutrition education and local availability) and at communitary level (production, exportation, importation, losses, marketing).[16,17]

Purchasing power and education are perhaps the variables that determine and influence the greatest number of factors in this model. There exists abundant evidence in the literature that support this fact.[2,4,16,17] (See Fig. 5).

C. Indicators

In accordance to the type and validity of the available information in each one of the countries, it was necessary to choose a series of indicators for each of the steps in the theoretical scheme. Table 1 presents a list of the indicators used.

D. Analysis of the Information

By using detailed maps of the countries, ponderal scales were decided upon for each variable. All the selected geographic units were stratified (municipio) in accordance to scales previously defined for each indicator which fluctuated from adequate or sufficient to inadequate or insufficient.

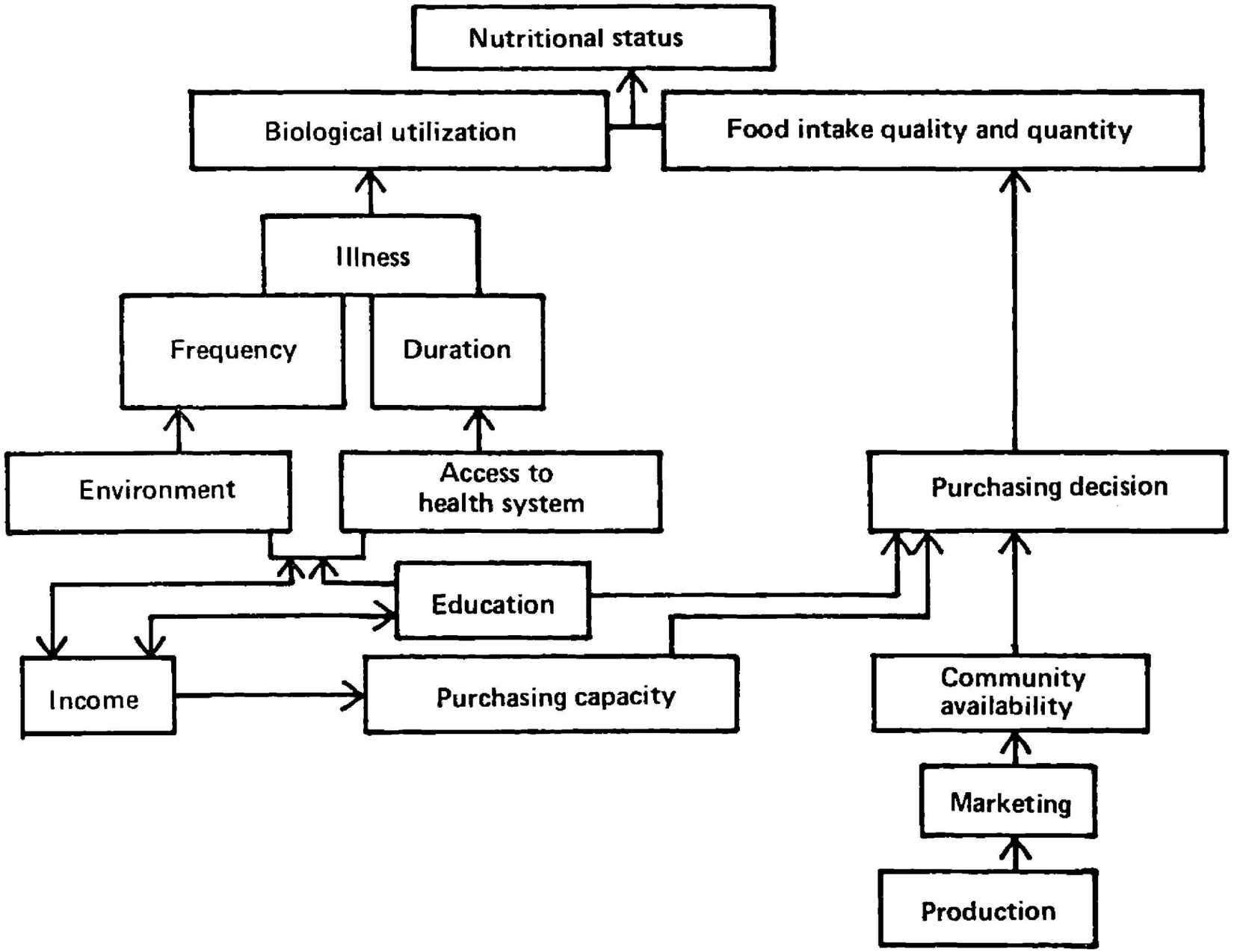

Fig. 5. *Global level diagnosis model.*

TABLE 1

INDICATORS USED FOR THE ANALYSIS OF NUTRITIONAL STATUS

Variables	Direct	Indirect
Nutritional status	Anthropometry	Demographic
Biological utilization	. . . . .	. . . . .
Frequency of illness	1. Morbidity surveys 2. Consultation rates for diarrheal disease	1. Water 2. Excreta disposal 3. Immunized population 4. Housing condition
Duration of illness	. . . . .	1. Presence of Health Service 2. Access to Health Center 3. No. of consultations per inhabitant 4. % of population on social security
Quality and quantity of ingested foods	1. Dietary surveys	
Food availability	Food balance sheets Food production per person. Per municipio. Related to per person requirements	1. Land tenure 2. Agricultural credit 3. Extension service 4. input availability
Marketing	Agricultural marketing studies	1. Access to communication means 2. Type of transportation 3. Storage systems 4. Processing plants
Income	Income and expenses surveys	1. Demographic (rural disperse population pyramid) 2. Minimum salaries 3. Index of prices 4. Food prices 5. Type of agricultural and livestock production (export)

Variables	Direct	Indirect
Education	1. Literacy 2. School matricula with relation to school population	1. Coverage and type of social promotion in the area. 2. Coverage of massive communication systems and type of propaganda 3. Number of schools and teachers in relation to school population
Infrastructure	Administrative Transportation Political Tribal etc.	

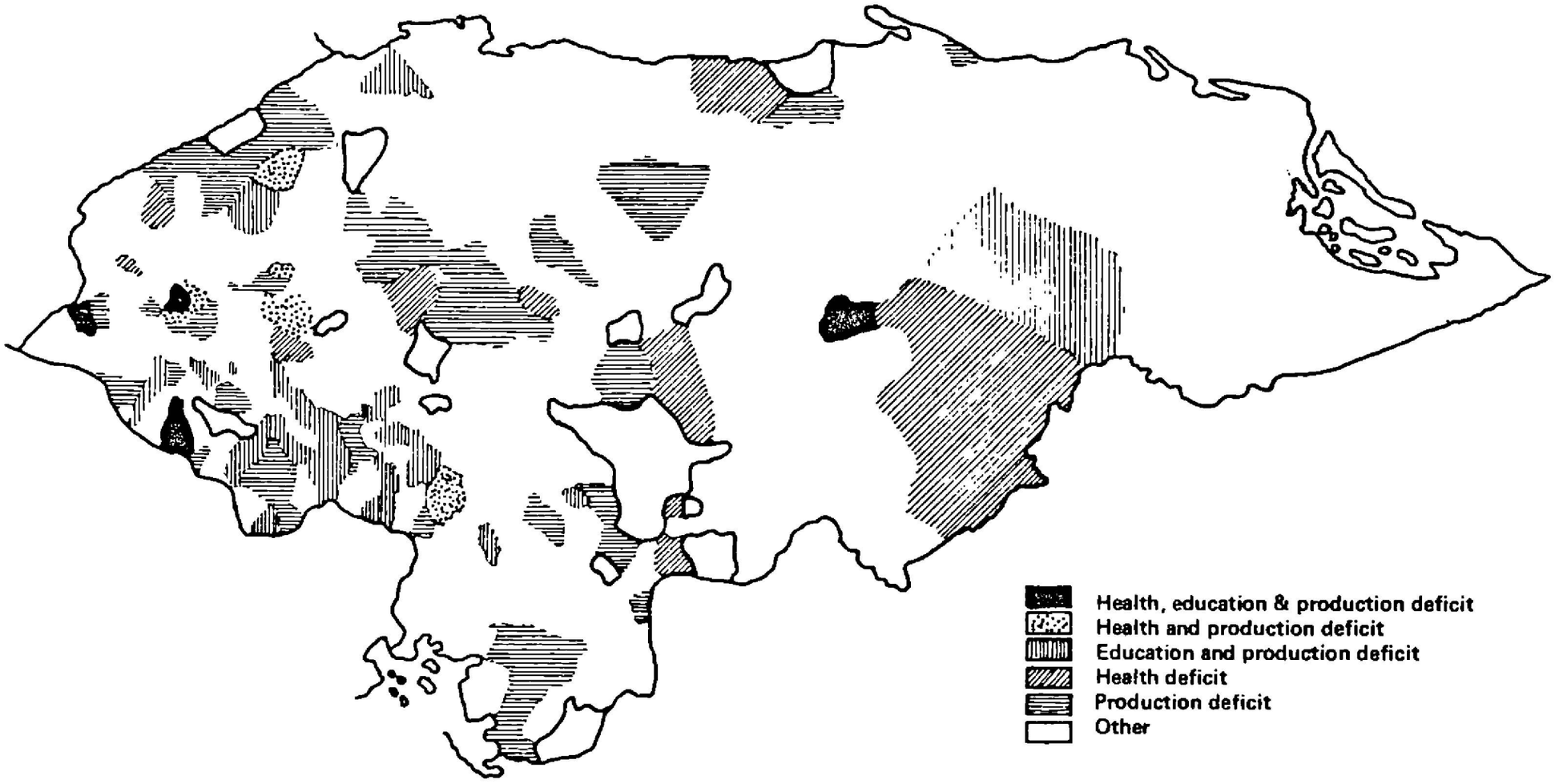

Fig. 6. *Highest mortality, 1-4 years to total. Its association with health, education and production deficits. (Clear areas have lower mortality rates).*

It then became apparent that there are places where the nutritional problem is more critical. Besides this fact, not all the associated factors appear as confluents in these same sites. There is a whole series of possible combinations of the different variables by means of which those interventions of greater impact on nutritional status are identified. Some of the associations found in a Central American country are demonstrated in the map (Fig. 6) which show the deficits of some factors associated to the nutritional problem.

The model thus served to identify geographic areas at greater risk of suffering from malnutrition, though it is not proved that these are the more affected areas (the limiting factor here is information). At least it creates a certain logic for regional monographs or for selection of samples for in-depth surveys, and for defining the type of needed surveys.

The apparent result consists in the identification and localization of information in the country, and the defects and inconsistencies of some data. It is possible to anticipate that a theoretical model is useful as a starting point for the establishment of a surveillance system which uses infrastructure and the existing indicators. Their verification is required as well as the desighn of a flowing system that permits its utilization in the different decision-taking levels. Another result of the analysis is the detection of limiting elements in the administrative structure for the adoption of decisions, institutional coordination, or for the appliance of measures oriented to solve the problem.

RESUMEN

MODELOS INTERPRETATIVOS PARA LA SELECCION DE PRIORIDADES EN NUTRICION

Se presenta la evolución de una teoría modelo de causalidad de la desnutrición que permite un análisis y diagnóstico de la desnutrición para el proceso de planificación y como punto de partida para un sistema de vigilancia nutricional. Este modelo ha sido utilizado a nivel local y a nivel nacional permitiendo sentar las bases para el desarrollo de Políticas de Alimentación y Nutrición. Aunque no está verificado, su utilización en condiciones de la vida real ha permitido modificarlo, determinar sus posibles defectos y ventajas y planear su verificación en algunos países.

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