

Tamil Nadu Nutrition Project

Non-Technical Summary of Study Reports

A study sponsored by :

**The Department of Food, Union Ministry of
Agriculture and Irrigation, New Delhi**

**ADMINISTRATIVE STAFF COLLEGE OF INDIA
HYDERABAD-500475**

PREFACE

This is a summary of various studies conducted by the Administrative Staff College of India, Hyderabad, under different phases of Tamil Nadu Nutrition Project. The main purpose is to consolidate the summaries of approach as well as findings of analytical studies conducted, in a single small document. We are grateful to the Department of Food, Government of India, for the financial support for organising the studies and their publications.

P K RAO/BALWANTH REDDY

Contents

1. Introduction	7
2. Integrated Nutrition Planning Models	9
3. Nutritional Aspects of Food Policy	23
4. Co-ordination, Monitoring and Evaluation	28
5. Demand for Nutrients	37
6. Child Nutrition	47

Introduction

The main thrust of the study is on evolving an integrated approach to nutrition planning with a view to reducing the nutrition gap to a reasonable limit and in reasonable time, within the demand and supply constraints. An appropriate methodology has been designed, and tested to achieve these specific objectives. However, we have encountered enormous problems in working out the broad nutritional intervention planning strategy for prescribing efficient solutions using Systems Models, due to limitations of relevant data. Granted that models could be evolved pragmatically to cover the limitations of data; but, however, such an effort would mean that at the present stage no optimising exercise can be done, since fundamental data on the impact of different nutrition programmes are lacking even on a representative sampling basis. Accordingly, part of the study is necessarily oriented towards evolving an approach for future usage as and when additional requisite data are forthcoming. This last requisite has a lot to do with effective concurrent and ex-post evaluation of all nutrition programmes on a scientific basis in different regions. With this in view, a separate supplementary report has been drafted dealing with co-ordination, monitoring, and evaluation aspects.

Whereas the IIM, Ahmedabaad, studied the Agricultural production sub-system, TNNP office, Madras, covered a number of features dealing with food processing, computer software, and other aspects.

The various study reports brought out by the Administrative Staff College of India, Hyderabad, are listed below :

1. Nutritional Aspects of Food Policy (November 1979)
2. Integrated Nutrition Planning Models (November 1979)
3. (a) Demand for Nutrients (May 1982)

(b) Co-ordination, Monitoring, and Evaluation of Nutrition Programmes — Supplementary Report (May 1982)

(c) Child Nutrition supplementary Report (1982)

4. Integrated Nutrition Planning—A Synthesis (May 1982). The main objective of this non-technical summary is to disseminate the findings and recommendations, along with a brief statement of approach, (wherever necessary) to a wider section of readers; those interested in more details can look into the specific reports published separately. The summary here is based on the various studies carried out by the Administrative Staff College of India, Hyderabad.

2. Integrated Nutrition Planning Models

This report attempts to logically analyse the different activities, and decisions of the various programmes (governmental and non-governmental, sectoral, and other categories) as these have a bearing on the nutrition status of the society. To start with, the fundamental question of prescribing the minimum nutrition requirements should be clarified in terms of the criteria for such prescription, along with the objectives and the present state of knowledge. This report subsequently deals with formal approaches to integrated nutrition planning, using systems approach.

The nutrient supply, for this, has been viewed as a multi-stage process involving the production of different items, processing, trade, and distribution. The exercise should, in this case, focus on meeting the aggregate nutrition requirements, by designing proper policy intervention schemes affecting the above constituents of an effective supply system.

The broad categories of intervention affecting the nutrition system include the following :

- (a) Types (by variety and quality) of agricultural inputs — quantities and prices
- (b) Procurement, trade, and pricing operations for agricultural products so as to achieve the desired food production
- (c) Public distribution and other modes of supplying different varieties of food items, and their pricing.
- (d) Integrated health and environment and other systems— so as to increase the efficiency of utilisation of nutritional intake
- (e) Information dissemination, including training, and skill formation
- (f) Differential policies of supporting
 - (i) Consumption in different age groups,
 - (ii) Production activities in various regions by different classes of farmers.
- (g) Regulation on acreage allocations and procurement operations
- (h) Buffer stock policies ; public distribution system (quantity and pricing extensity and intensity of intervention)
- (i) Integrated health, nutrition, family welfare, and education programmes
- (j) Supplementary foods, and feeding programmes.

The intervention strategies should aim at an integrated approach affecting both the producer and consumer systems at macro and micro levels. The intervention should be so

optimally designed to bring about, behaviourally, a rapprochement between the desired socio-economic objectives and the existing realisation of the same. The analysis for designing the intervention can best be done by examining the decision-making process by different units in their production and consumption behaviour under differing sets of available alternatives and information associated with the decision making processes.

It is desirable, therefore, to relate the nutrition intervention programmes with the desired health status of the population, rather than simply with the desired nutritional status, since the health status has greater relevance to the societal status and welfare. It is well-known that there is a type of cyclical relationship, to some extent, between the nutritional status in a period and the general health status of an individual in the same or subsequent period.

Since the body resistance is related, among others, to environment, which includes sources of infection—such as, air, water—and hygiene, it is necessary to examine the relative impact of intervention in one or more forms affecting the environment. This is also needed to ensure greater utilisation of nutrient intake. Thus, schemes like the protected water supply, sanitation programmes, etc., deserve more attention. Hence the question arises as to which programme, or combination of programmes, is most effective to improve the nutritional status. In order to know the answers, one has to attempt establishing the empirical relationship between nutrition status and different combinations (by type and intensity) of intervention programmes. That is, we may require different functional relationships (may be linear or non-linear) between N_t and different combinations of Y_i s. The differential inputs of Y_i s and the statistical significance of the same can be depicted by proper estimation of relations. However, for policy purposes, it is necessary to make a choice of intervention programmes under the cost-effective criterion: find the schemes which cost the least to achieve a desired target of nutritional status.

In an integrated approach, we are required to consider the total set of instruments for achieving the nutritional goals. It is quite likely that the fiscal and administrative costs involved in using this approach are significantly less, compared to nutrition intervention programmes carried out only by direct intervention in demand and supply sub-systems. A single comprehensive optimisation model, with the objectives of cost minimisation and using the functional relationships, targets of nutritional intake and status, budgetary and other constraints relating to traditional factors, policy intervention limitations, etc, is indeed a formidable task for computational purposes. It is meaningful, therefore, to approximate such a model by decomposing it, without losing the integration aspects, into smaller sub-models which can be employed separately, and then integrate them later in a consistent manner.

For this purpose, it is advisable to isolate the intervention programmes, which, in a sense, are indivisible with respect to individuals — like nutrition education, sanitation and preventive medicines, natural betterment of disease resistance by improving quality of water, etc. The programmes can then be designed by using the cost-effectiveness analysis.

It is possible to formulate a comprehensive model to arrive at optimal nutrition intervention policies. This could be accomplished in the following manner: Formulate an input output frame in respect of each possible intervention sub-system, for instance, school feeding, processing of foods, etc. When inputs are in terms of economic parameters like prices of commodities, and other inputs (like labour, etc) and outputs are (linear) functions of the resultant nutrient gain (in respect of different nutrients) in terms of, say, some of the anthropometric features. Once this frame is arrived at, optimisation models incorporating the least cost objective, and input-output relations as well as other relevant constraints can be worked out. However, it will have to obtain the in

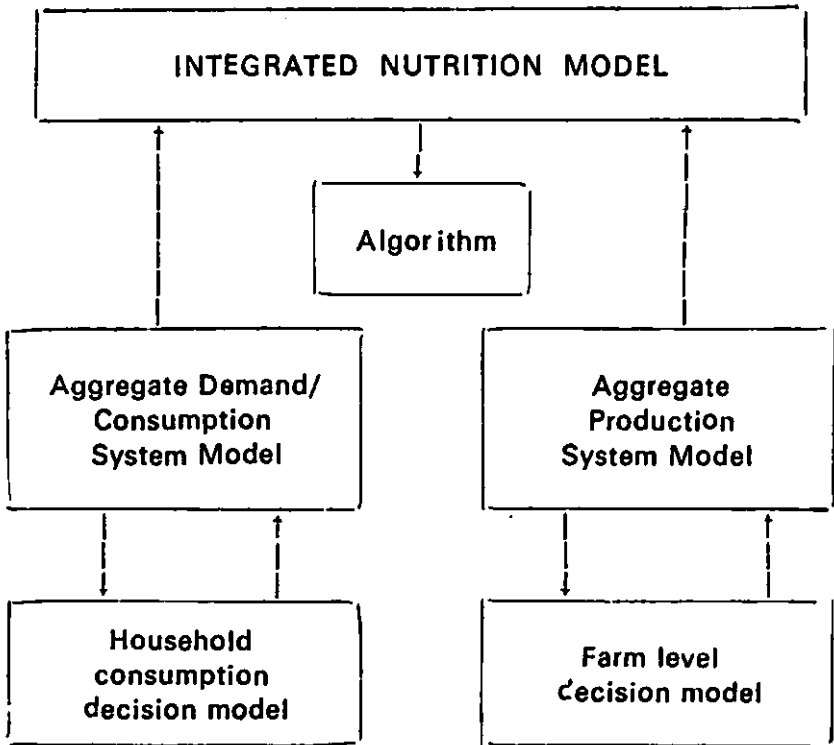
put output relations using the existing knowledge. Hence, the need for formulating models which can reasonably approximate the above type of general model.

Now, we turn to the type of features we would like to impose in the formulation. The first system pertains to accommodating some of the important traditional consumption factors so as to ensure that the solution prescribed by the model is not far away from the existing system. The minimal quantities to be consumed in the case of some of the essential items for various age, sex, occupation groups are prescribed in this part of the constraint system. The second part of the structure ensures that the effective consumption (affected by various intervention strategies, etc) meets the physiologically required nutritional intakes considering age, sex, and occupation (in case of some nutrients, prescription of maximum consumption limits may also be necessary). The third part of the constraint system ensures that the effective supply of nutrients (considering both production and imports) meets the effective demand for nutrients. Various natural constraints like the non-negativity of quantities involved will be operative.

Demand function may be linear or non-linear in the arguments, income, prices of commodities, substitute commodities price, issue price, and dummy variable representing the cultural, social, and other factors. Production function may be expressed in terms of commodity price, price of the substitute commodity on the production front, support price, if any, procurement price, input prices, and the quantity of inputs provided, and a dummy variable representing the institutional parameters like the size of land holding, etc. It may be possible that some of the administrative and legal reforms/sections turn out to be as effective as the intervention strategies *via* prices, etc, in affecting, particularly the production system so as to satisfy certain requisitioned properties.

As one would notice, the problem is very complex for mathematical modelling and computation. Broadly, though a single monolithic formulation may be possible, it poses significant computational difficulties. Therefore, we prefer to arrive at an integrated formulation *via* various inter-connected sub-models. The following block diagram indicates the comprehensive system. Various institutional factors like land reforms, alternate systems of feeding programmes for vulnerable age groups, and marketing systems, etc, need to be examined carefully; some of these may be brought into the formal models later. Similarly level of disaggregation, both in the consumer system (in terms of classes of farmers, regional demarcation, etc,) and production sub-system needs to be examined and incorporated in formal models.

Integrated Model



From the flow chart, it is clear that an integrated model should accommodate the decision models at each of the four units—household, farm level, aggregate demand system, and aggregate production system. Also, the interactions-feedback need to be explicitly recognised.

ANNEXURE

Formulation Of Biological Demand-Based Optimising Models

The mathematical optimisation model given in Chapter V of the report incorporates certain simple cases of the problem of attainment of nutritional goals with respect to a standard man. Generalisation of these models to cover the planning for intervention strategies with respect to various biologically defined species of persons and / or age-groups under specified sex, work and climate classifications can be carried out. The main problem, however, will remain as one of finding the input-output relation between nutritional intakes and physical growth activities for each of these classifications of human population.

In a dynamic frame, as one would expect in case of any system, the initial conditions of the system governing the take-off and/or terminal situations, that is, in case of health and nutritional status of humanbeings, the genetic characteristics inherited from the parental genes, and more specifically and crucially on the state of health of a pregnant woman before delivery, is very important. The irreversability of certain effects of deficiencies in the health status of the

baby in the earliest childhood age prevails to a large extent, but there is no denial of the fact that some major effects like that of blindness due to deficiencies of Vitamin 'A' are avoidable. Certain other growth characteristics like bone formation under varying nutritional intake possibilities, given an initial status or statute of the body of the child are not quantitatively investigated; and hence it is difficult to accommodate, in the mathematical models, the exact relationships and thus the difficulty in arriving at accurate prescription of nutritional intervention strategies still persists. We can take, let us say, N age-groups spreading throughout the span of life of a human being, M physical characteristics, and Z number of nutrients affecting the physical system. It is desirable to find out the impact of varying of levels of intake of one or more of these nutrients on one or more of the characteristics in different age-groups. Obviously, this is a very complex problem. If this type of information is available (hopefully researchers will concentrate in the next two decades on this), it will be possible to evolve efficient optimal nutrition intervention strategies under varying objectives and goals. We can easily see that the structure is that of a dynamic multi-period non-linear optimisation problem.

The discussions that follow deal with the role of various nutrients during the life cycle, highlighting the consequences of the absence of different degrees of the same, the factors contributing to the determination of nutritional requirements, under certain normal conditions of the specification of nutritional requirements, etc. Some of these discussions are not necessarily of use in the mathematical models. These will help in evolving policy intervention strategies on a qualitative logical basis given the criticality of lack of certain nutrients in different stages of growth of a person.

Nutritional status at
time t of individual i $f_j^i(t) = [f_1^i(t), f_2^i(t), \dots, f_n^i(t)]$
also, $f_j^i(t) = f_j^i [t, \{ f_j^i(t-c) \} c(t), I(t)] \rightarrow (1)$

Where $c(t)$ is intake, and $I(t)$ a parameter depicting genetic character and /or influence of infection or other diseases when (1) is recursively worked backwards, the impact of parental genes and statue of initial health are seen to have impact for subsequent periods.

More generally, (1) can incorporate the inter-dependencies of different $f_j(t)$'s for an individual.

$$f_j^i(t) = f_j^i [t, f_j^i(-1), f_{k \neq j}^i(t), c(t), I(t)]$$

Since $C(t)$, the nutritional intake vector $(c_1(t), c_2(t), \dots, c_m(t))$ has differential impact on f depending on the choice of combinations of c_1 's, we need to have

$$\frac{\partial f_i}{\partial c_1}, \dots, \frac{\partial f_i}{\partial c_m}$$

These expressions are rather difficult to arrive at numerically. If there is a well-defined desirable set of nutritional characteristics in each group for persons with specified racial background, sex, occupation, and climate conditions, the problems of optimal nutritional intervention strategies is soluble by obtaining solutions to the following type of optimisation problem for each specific age - group (assuming the intervention strategies continue for the successive ages)

$$\text{Min } J_j = \left| f_j(t) - \overline{f_j(t)} \right|, \quad j = 1, 2, \dots, n$$

with respect to 2 set of parameters (controls) $C(t), I(t)$ etc., subject to the behavioural/physiological interdependency relations-

- i) $f_j(t)$ expressed explicitly with reference to the specification (1)

$$\text{ii) } C_k(t) = C^k [I(t), P(t), P^0(t), H(t)], k=1,2, \dots, r$$

$$\text{iii) } f_1(0) = f_{j0}, J = 1,2, \dots, n$$

It may be noted that C_k can be food consumption quantities or nutrients of different types (the index set of k will obviously vary depending upon the choice of one or the other type of specification) with the difference that the policy interventions in the first case are in terms of pricing, income and other policies so that the effective consumption meets the requirements of nutritional status.

Since the specifications of requirements according to ideal nutritional status and also empirical establishment of f_j 's in (i) are still open problems for nutritionists, we may have to satisfy ourselves at this stage with an approximation.

The minimum physiological requirement of a nutrient has been traditionally defined as the least amount of nutrient that will prevent symptoms of clinical signs of nutrient deficiencies, maintain bio-chemical levels in tissues and tissue fluids commensurate with a normal health state of the body and mind, and maintain normal physiological function. To quote Olcott (1978) : "Primarily we need proteins, fats, carbohydrates, and, in smaller amounts vitamins and minerals. But these categories can be broken down to fifty or sixty separate items necessary for optimal nutrition. We do not know what 'optimal' means for man. Goal choices are : fast growth, athletic ability, resistance to disease and toxins, mental health, and longevity, all reasonable goals; but we simply do not know if they require the same relative nutrient intakes".¹ There are mainly two difficulties in the measurement of requirement of nutrients : (i) the variety of criteria (as stated above) that have to be taken into account when

1. Olcott H S (1978) : What is known about human nutritional needs ?
American Journal of Agricultural Economics, 60.5 pp. 800-802

recommending a suitable number or range of given nutrients, for instance, the problem of lumping of a vector of parameters into a scalar measure; (ii) the intra-individual and inter-individual variations in the requirement of nutrients for a given physiological population group.

Apart from these, the other factors which bring in distortions in the accuracy of determination of nutrition requirements are :

- a) All symptoms and consequences (using clinical/ anthropometric or bio-chemical methods) of deficient of one or more nutrients are not fully known in medical sciences; the several metabolic functions of a nutrient make it difficult to decide which function should be tested and whether the test provides the most appropriate index of the impact of the nutrient.
- b) Individuals, overtime, adapt to reduced intakes when the reduction is in a certain range and the impact of the reduction may be difficult to measure, and is also function of the length of the period over which the reduction occurs.
- c) Metabolic inter-relationships exist between nutrients to the effect that the requirement of one depends upon the level of intake of another. The functional inter-relationships are not clearly known.
- d) The body has a capacity to store some nutrients, particularly vitamins which are subject to seasonal fluctuations in supply. A slight deficiency of a nutrient might go unnoticed due to a state of compensation by the body when reserves are diminished. It is difficult to specify accurately the level of nutrient intakes that will maintain body stores at optimal levels.

Given these salient features that need to be taken into account wherever meaningfully accurate estimates of minimal nutrition requirements of an individual or class of individuals with given description of characteristics are to be prescribed, the problem still remains a complex one, and more so when certain important aspects (like physical environment including sanitation, infectious diseases etc.) affecting the utilisation of nutrients are to be treated as fixed and given parameters. These environmental factors are also very important whenever they are not expected to undergo changes in the period for which the prescribed nutritional requirements are taken as targets for interventionist schemes affecting the nutrient supply and intake in the community. Since the ultimate objective of such intervention schemes in the context of public policy is to achieve certain desired nutritional (more generally, health) status of the community, we cannot confine ourselves to the prescription of nutrient requirements assuming perfections of the environment (i. e. of complete absorption of nutrient intake). Also, we need to examine whether and to what extent the intra-individual and inter-individual variations in nutrition requirements as noticed on a daily or weekly basis are relevant for planning nutrition intervention over periods like a few years.

The greatest pitfall lies in the use of recommended intakes for comparison with consumption figures and then making judgment on the nutritional status of the individual. Measured intakes of nutrients can only be compared with physiological requirement levels, given the estimates of probability of deficiency. Since the intake of nutrients as well as the physiological requirement of nutrients follow certain different probability distributions, the design of an observation experiment on the intake of nutrients for an individual with given characteristics need not hold good for a group of individuals with heterogeneous characteristics even if they belong to the same age-sex occupation group. However, in order to get an understanding of the process and to estimate under nourishment, it is worthwhile to examine the properties of an approximate probability distribution which might govern an

individual's nutrition requirements over different time periods and of a reasonably homogeneous groups of individuals in a period of time.

To sum up, the state of present knowledge is thoroughly inadequate to prescribe the minimal nutrition requirements for different types of individuals. Also, the alternatives suggested by some for correcting the traditionally used specifications of nutrition requirements are based on weak foundations and are unacceptable for the purpose of policy planning and aimed at betterment of the nutritional status of the affected sections of the society. The estimation of the magnitude of poverty can at best be guided only partially by the nutrition norms. Further research work on the relevant issues in nutrition science should be taken up on a top priority basis.

3. Nutritional Aspects of Food policy

The objective of this study is to analyse in retrospect, and in contemporary features, the bearing of major components of food policy on nutrient availability and intake by the population. The study addresses itself to pre-independent era as well as the subsequent developments. The major components have been analysed and qualitative inferences drawn from the analysis. The broad observations are summarised below:

(i) Historically, the prime emphasis of the food policy was on the quantity dimensions of food consumption; this was consistent with the chronic state of shortage of food-grains in the country till mid-seventies. Until the Fourth Plan, explicit recognition could not be accorded to nutritional aspects of food policy, probably due mainly to shortages of foods in terms of quantity. Even after incorporating the nutritional dimensions of food policy in the Five-Year Plans commencing from the Fourth, it is apparent that concerted effort was not made to progressively eliminate the nutrition gap. A number of schemes are operated by a number of departments simultaneously in different areas in the country; there seems to be

no systematic pattern in identification of priorities in terms of geographic location and target groups for nutritional development, with the result that the scarce resources are thinly spread. At present, the nutrition sector stands as a residual component in the five-year plan formulation.

(ii) (a) The pricing policy, especially the procurement prices for food commodities have to be carefully designed to encourage the augmentation of nutrient supply effectively at the farm production level; this can be done by evolving prices in favour of nutrient-rich commodities/varieties within specific commodities.

(b) A study of earlier agricultural policies reveals that the nutritional dimension of this policy instrument can be made positive, if the support prices were announced early which cover the cost of production; these prices should be offered to the producers who adopt high-yielding varieties and seeds of high nutritive value.

(c) We recognise that [the quantity as well as the price of procurements have impact on production (and also consumption). The optimal policies reserving commodities to be covered for governmental procurement along with the quantity and price specifications can be derived after formulating models governing the production and supply of nutrients (for different classes of producers, if need be) in terms of these variables, among others. However, there are other intervention mechanisms like 'guaranteed price scheme, crop insurance etc, which also have significant impact on production in that they reduce the risk factor governing the behaviour of producers.

(iii) The public distribution system has to be stabilised and strengthened, and should have the following aspects carefully incorporated with special attention for vulnerable groups:

(a) The areas for constant public distribution of food grains need not be concentrated only in urban areas: priority

should be given to those pockets in which significant nutrition gaps are identified.

(b) The pricing of food commodities through the public distribution system should be the reverse of the policy suggested for procurement, namely, lower price for commodities which have greater relevance to bridge the nutrition gap (by increasing the effective consumption at lower prices).

(c) Coverage of food items should be more comprehensive so as to supplement the nutrition requirement in different areas more effectively: obviously, the list of items to be covered and the quantities to be distributed have to differ from one region to another depending upon the assessed nutrition gaps in magnitude and type.

(d) There should be a long-term policy of commitment regarding the distributions of foodgrains with the aim of progressively reducing the nutrition gap partially: the portion of the gap that needs to be eliminated using this intervention mechanism should be arrived at after assessing the existing magnitude and type of nutrition gaps and the estimated impact of other direct and indirect intervention strategies (like rise in real incomes, changes in relative prices, health facilities, and preventive medicine, nutrition education, etc).

(e) Special categories of food items catering to specific age groups, especially children, must be channellised through a distribution network in order to reduce the long-term costs of mal-nourishment to the society: similarly, on a priority basis whenever drought situation or other seasonal and periodic shortages occur, necessary augmentation in the food supplies should be made, particularly to meet the increased nutrition requirements of pre-school children and pregnant and lactating women. The experience of, and subsidy scheme for, the pregnant women in countries like Britain may be relevant and should be carefully examined.

(iv) The state of prevailing knowledge is inadequate to prescribe the minimal nutrition requirements for different types of individuals. Also, the alternatives suggested by some for correcting the traditionally used specifications of nutrition requirements are based upon weak foundations and are unacceptable for the purposes of policy planning, and moreover aimed at the betterment of nutritional status of the affected sections of the society only. The estimation of the magnitude of poverty can at best be guided only partially by the nutrition norms. Further research work on relevant issues in nutrition science is therefore urgently called for.

(v) The poor are not attached to inferior cereals/millets because of palatability or things like that, but their menu is mainly affected by price mechanism. The issue in production system is how best to maximise the quantity and quality of nutrients per unit land per season at a least cost. The need to activate inferior cereals (as suggested by some) production should be selective, and these may not be produced (unless HYV varieties are brought in) at the expense of cereals.

(vi) Improving the network of dairy farms will enable the proper and judicious distribution of milk. Apart from this, animal husbandry schemes have been introduced to ensure the optimum (improved) yield and better health to the animals. Following the Anand pattern, and adopting the cross-breeding programme of animals, it is worthwhile to develop milk production as a subsidiary industry in rural areas. The programme should be aimed at small and marginal farmers by giving the necessary facilities in view of the lack of purchasing power of the lower income groups in rural areas; what is more, this also generates employment.

(vii) Some measures like fortification of foods with specific desired nutrients, and processing and preserving of foods to make even the availability across regions and in different periods are also necessary. In order to evolve specific programmes in this direction, the identification of nature and

extent of nutritional deficiencies in different regions by different classification of the population is needed. With this information it should be possible to arrive at a combination of factors in terms of commodities to be covered in public distribution system and other supplementary programmes like fortification, quantities and prices at which these are to be supplied.

(viii) The present method of allocating food stocks from the Central Pool to States is not based upon food and nutrition gaps in different States, and guidelines can, therefore, be issued so that these factors are also taken into account, in addition to administration and political considerations.

4. Co-ordination, Monitoring and Evaluation

Supplementary Report

The purpose of this study is to examine the salient features of implementation of nutrient programmes. It is of interest to analyse the practical features governing co-ordination at different levels of the multiple nutrition programmes simultaneously being implemented by various departments. Closely related to this aspect is the data-base and information system for administrative decision-making. Accordingly, the efficacy of the existing monitoring and evaluation systems of the programmes needs to be carefully reviewed. It is considered an important feature of the integrated nutrition planning, since planning is not supposed to confine itself only to formulations of different plans and resource allocation but is also concerned with the constant review of plan performance to enable remedial steps at the planning and implementation levels for co-ordinated development. Whereas the formal optimisation models developed elsewhere under the study are useful for rigorous planning purposes, they would not suffice for effective integrated nutrition planning. Hence the need for this separate supplementary investigation.

The monitoring function generates information based on improved quality of decisions, mainly in respect of ineffective implementation taken to reduce costs and time to minimal. The evaluation of programmes can lead to proper future planning so as to optimise the scarce resources. Co-ordination can be treated as a process of decision-making based on a set of guidelines and information derived from monitoring and evaluation. The value of information may be defined as the net gain in resources for attaining specific levels of nutrition development.

It appears that there are at least two steps needed to meet the situation at an early stage. These are : (1) setting up of a Directorate of Monitoring and Evaluation under the Social Welfare/Food Departments for constant feedback on the efficacy and progress of programme, and (2) evolving the necessary procedures and proforma for monitoring and evaluation with necessary frequency of processing information. Close rapport with the State level machinery for monitoring and evaluation is needed to ensure that the State governments take effective steps in this direction. If necessary, subsidy by the Union Government may also be provided for strengthening the monitoring and evaluation units at the State level.

It is highly desirable that the monitoring and evaluation activities are centralised under one Department (either Social Welfare Department/Food Department or Planning Department) in order to ensure proper implementation and realisation of objectives in the context of multi-department involvement in implementation. In this case, it is essential that the planning function is centralised so that policy objectives and guidelines are evolved in common for all the implementing Departments/Agencies. The functions of the Co-ordination Committee should be seen in this light.

The single most important factor that emerges through a proper co-ordination is the surveillance of poverty and quantitative assessment of the type and degree of malnourishment/

poverty. This is particularly important considering the fact that the poverty line concept in India is based on nutrition intake volume.

More important than the specific composition of the co-ordination committee is the working arrangements: the number of meetings, the type and number of issues dealt, degree of participation (number of members participated in meetings, etc.), the efficacy of implementation of decisions, and access to new information (including monitoring and evaluation reports). It must, however, be noted that various inter-departmental/institutional communications (in the form of GOs, DO letters and circulars) are only partial substitutes for any reduction in transactions in Co-ordination Committee Meetings. But these cannot be the adequate substitutes for periodic co-ordination meetings, followed by effective implementation of collective decisions.

It may be observed that although the State-level co-ordination committees are generally constituted, the meetings are not held every quarter as suggested in the Report cited above. Also, the feedback information system (expected via monitoring and evaluation activities) is very weak, thus rendering some of the tasks of the committee impossible to fulfil.

There is thus need for improved co-ordination between the Departments, Agencies both at the Central and State levels. The conventional approach categorises most nutrition programmes as independent set of activities, often in the form of distribution of foodstuffs to appease a few groups of vulnerable population. The costs of these programmes are considerable, and the benefits are either assumed to accrue automatically or not properly monitored. An important desirable departure in the approach towards these programmes, especially at the planning stage, is to integrate these as important inputs strongly linked to other parameters of

socio-economic development, especially the potential to raise human capital leading to higher levels of labour productivity. The economic benefits due to improved nutrition status discussed in the Main Report (Demand for Nutrients) advocates the need for this approach.

From the operational development planning view point, a quantitative assessment of poverty reduction over time in different areas is a very useful exercise. This can be properly carried out only after assessing the socio-economic conditions with special reference to intakes of nutrients. This co-ordinated effort in this direction is very relevant. For this purpose, it is desirable to constitute a high-power National Committee on Nutrition, with the Prime Minister as the Chairman and all Secretaries of all economic Ministries/Departments and those dealing with different nutrition programmes as members, so as to ensure effective co-ordination. Alternatively, the National Children's Board (formed in 1974) can be made to take more effective steps in co-ordinating programmes relating to children which form the main thrust of the activities; this would require the strengthening of the Board with skilled manpower, and organising a relevant data-base system enabling effective decision-making. Constitution of a sub-committee which can serve as a Standing Committee of this National Committee would be useful, so that it can meet at desirable frequencies.

The functions of the aforesaid Co-ordination Committees should include co-ordination, both at the planning level and implementation levels. Given generally the financial outlay of resources by the Planning Commission/ Finance and Planning Departments, the Committees should attempt to obtain optimal utilisation of organisational, administrative, technical, and raw material inputs under different programmes, and continuously update information based on monitoring and concurrent evaluation. This would facilitate getting over the possible bottlenecks in

implementation, taking corrective steps in operational planning of activities and properly assessing the results. The accountability will be considerably greater in this approach than with the present arrangements of co-ordination. Invariably experts from nutrition and social sciences should be associated closely, especially in the planning, monitoring, and evaluation exercises, both at the Central and State levels.

This is to recognise that various seemingly non-nutrition programmes like provision of protected water supply, drainage facilities, expansion of preventive medicine schemes, improved medical facilities, etc, have as much a bearing on nutrition status as some of the nutrition feeding programmes.

The recognition thus accorded would imply that in various Co-ordination Committees, whether, at State level, project level, or national level the concerned ministries dealing with the programmes/projects having significant bearing in nutrition status should be involved. Thus, a number of Ministries/ Departments like Panchayat Raj Department, Rural Development Department, Health Department, etc, (depending upon the inclusion of different functions under different Ministries/ Departments) should be represented in the Co-ordination Committees. It is essential that necessary information, mainly based on surveys, monitoring and evaluation activities regarding different schemes in operation is made available to the Co-ordination Committee in order that its functioning is effective and a co-ordinated effort be made to maximise the nutrition benefits for a given total set of resources allotted to various Departments/Ministries.

An important and useful aspect of co-ordination at the sub-State levels (like at the Block/District/Project Specific areas) would be to combine the training programmes for the middle and junior level functionaries with the co-ordination meetings.

The important pre-requisites for an effective co-ordination may be summed up as under :

1. The political will and administrative commitment to achieve improved results — results not based on expenditure statistics, resource allocation indicators, but based on factual information relating to type and magnitude of nutrition benefits (whether based on clinical, anthropometric or other measures of improved nutrition status — or as a next approximation, to improved intake of nutrients by target groups) ;
2. Proper composition of the Co-ordination Committee representing various departments/agencies involved in policy formulation and implementation of schemes which have direct and indirect bearing on nutrition status of target groups ; this would also include proper selection of the Chairman of the Committee, mainly based on his status in the Government so that the Chairman can effectively control various activities and give directives to various departments and other agencies;
3. Information-base for decision-making is an important consideration for effective functioning of co-ordination activities. The availability of dependable and timely data based on various surveys, monitoring, and evaluation activities on time; this includes evolving feedback information systems for proper planning and implementation, and timely action for corrective measures;
4. The frequency of meeting should be need-based, that is, depending upon the type and intensity of different activities and seasonality, the meetings should be held; it appears that quarterly meeting is a must for any effective co-ordination.

In order to evolve effective methods of monitoring and evaluation of nutrition programmes, it is essential to clarify precisely the short-term and long-term objectives of nutrition programmes. Closely linked with this aspect is an assessment of the criteria for identification of geographic regions

and sections of population being covered under nutrition programmes of different types, either directly or indirectly, that is, through applied nutrition programmes or through other nutrition intervention strategies including betterment of environment *via* protected water supply schemes and sanitation, etc. The criteria could be of three types : (i) based on the physiological, and/or (ii) socio-economic parameters, (iii) administrative and political choice. The last consideration applies to the higher level of decision-making in terms of choosing the geographic regions for the operation of one or more of nutrition programmes and also possibly to set certain guidelines in terms of possible choice of criteria under (i) and/or (ii). However, even after the guidelines are available, certain amount of judgment is inevitable in operationalising the criteria either using physiological specifications or the precise observance of socio-economic features while selecting various groups of beneficiaries under different nutrition programmes.

There are mainly three aspects of monitoring and evaluation :

- i) *Managerial aspects* : Monitoring and evaluation should provide information on implementation in relation to project planning and its objectives, identify the bottlenecks, if any, and also suggest ways in which the project management can be taking remedial actions on time. Experience shows that very few managers are highly committed to monitoring to improve the systems through feedback information. Also, information produced by the monitoring units is not always of the same quality and its timing is also not always as per the project management requirements. Excessive information irrelevant to management needs often dissuades the potential users from proper utilisation of necessary data. The need for evolving the key indicators for project monitoring and

also giving the highest priority to the timeliness and dissemination of information is obvious.

Evaluation consisting of an analysis of the case of success or failure of different components of the project implementation is necessary to improve the on going as well as future efforts.

- ii) *Technical aspects of monitoring* : Judgment of the composition of key indicators is an important prerequisite for maintaining reasonable quality of data/information. Very elaborate questionnaire often erode the goodwill and co-operation of the recipient of the questionnaire. The choice of proper sample size for information gathering is thus an important aspect of monitoring. Statistical analysis could be carried out only if the sample design is properly made. Estimation with relatively smaller sample size should be adequate in a situation where the target population is either from large or from reasonably homogeneous households. Transforming data into information is vital for an effective monitoring and evaluation system. This would warrant identification of requirements of information at different levels for decision-making.
- iii) *Institutional aspects of monitoring* : In the long run, the creation of a monitoring and evaluation organisation within the projects is highly desirable since this would not only provide continued information throughout the life of the project but also provide more direct feedback to the management at significantly lower costs. Although the project managers are not expected to be very familiar with the techniques of monitoring and evaluation, the symbiotic relationship between the project management and the monitoring evaluation unit should be clearly recognised.

For monitoring purposes it is useful to define the project inputs, project effects, and project impact. Monitoring would confine to gathering of information on project inputs, outputs, effects, impact, and also of complementary activities that are critical to the attainment of the objective of the project.

5. Demand for Nutrients

The purpose of this study is to analyse the consumption behaviour of different food items for the last few years for Tamil Nadu as a whole, analyse the household survey data collected under regional Tamil Nadu Nutrition Project study in order to examine the determinants of intake of nutrients and provide demand projections for nutrients and food items until 1986-87 for the State as a whole, and on District-wise basis. Some of the major observations are summed up below :

a) Analysis of per capita net availability of food items (1966-67 to 1978-79) :

An analysis of per day per capita consumption (approximated by per day per capita net availability) of different food items in Tamil Nadu for the period 1966-67 to 1978-79 indicates the following :

i) The consumption of rice has been increasing, whereas that of wheat does not seem to have any positive trend. The

consumption of ragi is nearly stationary. But the overall per capita consumption of the cereals as a whole increased marginally in this period.

ii) Among the non-cereals, only sugar consumption seems to have marginally increased. The trend of all others was either stationary or downward. In the latter category, it is important to mention that a disturbing trend is taking place in the case of milk and fruits. The State which is already significantly deficient in respect of Vitamin 'A' can ill afford this situation. Considering that common man's fruit like banana has considerable Vitamin 'A' component and considering the potential for improving milk production it appears that steps are required to increase the production and consumption of these items. The horticulture department can play a vital role in this direction.

iii) The balance at aggregate level Tamil Nadu State imports about 7.5 per cent of food items only, amounting to about 9 lakh tonnes of foodgrains. It imports about 2.3 per cent cereals and 3.1 per cent of grams and pulses, compared to its own production. In the case of fruits and vegetables the imports and exports seem to be very negligible. Considering the fact that the per capita availability of fruits is declining over time, steps should be taken to import (along with necessary cold storage facilities) various seasonal fruits for mitigating short-term problems of the near future.

iv) In quantity terms, the availability of cereals account for 49 per cent. The total non-cereal foods available account for 34.8 per cent and the remaining 16.6 per cent accounted for by animal foods. On an average, the per capita per day requirements of food is 974 grams, based on ICMR standards, while the availability is only 790 grams. However, the distribution patterns of these quantities is skewed. In terms of nutrients, on an average, 2048 k calories and 43 grams of protein per day per capita are available, as against the need

of 2,242 k calories and 45 grams of protein. The fulfilment of Vitamin 'A' requirement is only 64 percent of the need (2,545 I U).

v) The gains in marginal increase in per capita per day availability of food seem to be mainly due to the declining trend in population growth rate since 1972-73, rather than due to any significant increase in the production of food commodities.

vi) It is estimated that, on an average, about 86 k calories and 2 gms of protein per day per capita are wasted. Although it is practically impossible to eliminate completely the wastage component, it is possible to reduce it. It is very useful to investigate the social cost-benefit implications of varying investment patterns for reducing wastage at different levels. From observations it is possible to identify the relative priorities in intervention in food processing system in reducing wastage. It emerges that improved food processing and preserving methods, especially in the case of perishables like fruits, are likely to be specially profitable and might justify investment in this direction for reducing wastage.

vii) The value of food items wasted, on an average, works out to about Rs. 350 crores at current prices. Even if 10 per cent of this loss is invested in food processing by spreading the network of community canning and food preserving centres with emphasis on processing seasonal fruits, will go a long way in Tamil Nadu nutrition programme, both in reducing wastages and in shrinking the nutrition gap in respect of Vitamin 'A' apart from giving the benefit of improved and increased consumption of food items to the society.

We examined the determinants of intake of specific nutrients, such as calories, protein, Vitamin A and iron which

are considered relatively critical for the overall nutrition development. The socio-economic parameters, as well as certain environmental factors which are applicable at the household level are treated as the eligible set of explanatory variable/causal factors. We have selected food (and total) expenditure, education level, composition of the household in terms of number of adults and children, occupation, rural/urban location, vegetarian/non-vegetarian food consumption habits, and caste as possible multiple parameters. The main limitation of these investigations is that since the data base is drawn from a cross-section survey, and also since the sampling procedure was not evolved with a view to isolating the relative effect of different supplementary feeding programmes administered by the governmental/voluntary agencies, we will not be able to assess the relative roles of various socio-economic parameters *vis-a-vis* the feeding programmes. Separate supplementary analysis based on fresh field data will be useful for drawing inferences on the nutrition intervention programmes.

An exercise using average State income per capita at 1970-71 prices, and altering it by 5 per cent rise, indicated that the per capita increase in calorie consumption per day could be of the order of 70 k calories. It must be noted that for every increase by a rupee (at 1970-71 prices) in food expenditure at the household level, the improvement in calorie consumption for household is around 2,300 k calories.

b) Analysis based on statistical relationships :

A number of multi-varied statistical relationships were formulated in order to establish a linkage between different factors regarding which data are available. Some of the relationships resulted in conforming our familiar notions and hypotheses, whereas a few others did throw light on intrinsic features of the consumption systems in Tamil Nadu. Also,

The quantifiable relative impacts of some of the economic and non-economic parameters have been provided with this analysis.

i) The relative roles of various economic and non-economic parameters effecting the intake of the main nutrients, such as calories, protein, Vitamin A and iron, are rather uniform among the nutrients; education parameters, for the reasons discussed elsewhere in the report, did not have any positive impact in influencing the intake of any of the nutrients. Food expenditure is the major determinant of the intake of any of the nutrients.

ii) In the estimated relations, the co-efficients corresponding to the food expenditure variables indicate that the marginal propensity to consume calories with additional expenditure is considerably high and the amount of calories derived comes close enough to the calorie available by choosing the low cost food items.

iii) It appears that under the existing price structure and market mechanism governing the traditional food commodities, unless drastic improvements in income take place for the majority of the population, it is not possible to eliminate the nutrition gap as far as Vitamin A is concerned. The remedy thus appears to lie in popularising the relatively less common foods like drumstick leaves, in addition to administering the dose of Vitamin A through chemical methods.

iv) Combining the information summarised in Chapter II with the behavioural analysis governing the consumption of proteins, it appears that the protein gap can be automatically eliminated if only the calorie gap is eliminated. It, therefore, suffices to focus attention on the nutrition deficiency in respect of calories; the equally important nutrient would be Vitamin A.

v) Food habits, caste variables, and education levels do not seem to have any significant impact on the intake of any of the nutrients, for the same expenditure group, urban location, however, does adversely affect the intake of any of the nutrients.

In order to assess the implications of the varying prices and incomes during the period up to 1986-87, the functional relationships between consumption and these parameters are estimated and also used for the projections in respect of food items, as a consequence of attainment of different levels by income and price variables. The projections in respect of these explanatory variables are based on trend method using time series data. An estimation of several forms of Engel curves was attempted; in order to capture the effect for income/expenditure in smaller intervals, the Engel curves were estimated for different expenditure groups.

c) Multiple Regression Equations :

The demand for cereals, rice, wheat, jowar, bajra, ragi, minor cereals, and all cereals is estimated using the regression model.

The regression results regarding all the cereals, except rice and all cereals, are rejected for processing low correlation co-efficient and insignificant co-efficients.

In order to facilitate the analysis of demand for different food items under varying conditions governing prices and incomes, a number of linear and non-linear relations have been estimated.

It is found that the food gap is decreasing for all commodities, except for fruits in which case the gap is increasing over a period 1980-81 to 1986-87. Rice, and grams and

pulses would become surplus in the years 1983-84 and 1982-83, respectively, whereas the overall deficit of cereals would remain till 1985-86 with a decreasing trend. The surplus of milk is decreasing and that of sugar is increasing. The gap of fish requirement remains almost the same over the period.

d) Interim Recommendations :

a) i) As regards trends in the net availability of different food and nutrition elements, it appears that Vitamin A deficiency in Tamil Nadu, which is the second most important nutrition deficiency (the first being calorie), is going to be on the increase, especially since there appears to be a declining trend in the net availability of milk and fruits. Urgent steps, therefore, are needed to rectify this situation.

ii) It is generally observed that if the calorie requirements are met, protein and iron requirements are also automatically met. This is not true as far as Vitamin A is concerned. Special attention is needed in this regard either in terms of artificial doses of Vitamin 'A' or augmenting the supply of natural foods, rich in Vitamin 'A' mainly leafy vegetables, fruits and milk.

iii) The gains in marginal increases in per capita per day availability of food seems to be mainly due to a declining trend of population growth rate since 1972-73, rather than due to any significant increase in the production of food commodities.

iv) It is estimated that, on an average, about 86 k calories and 2 gms of protein per day per capita are wasted. Although it is practically impossible to eliminate completely the wastage component, it is possible to reduce it. It is very useful to investigate the social cost-benefit implications of the varying investment patterns for reducing wastages at different levels;

from observations, it is possible to identify the relative priorities in intervention in food processing systems in reducing the wastages. It emerges that improved food processing and preserving methods, especially in the case of perishables like fruits, are likely to be socially profitable and might justify investment in this direction for reducing wastage.

b) i) Based on a number of considerations, economic and non-economic, it is clear that the top-most priority in attending to nutrition problems should be accorded to pre-school children. It is doubtful if some of the policies aiming at the development of school going children compared to the above vulnerable age group have any greater advantages, except that it is convenient to administer the problems in the latter case. However, when we recognise the need for breast-feeding of children upto about one year, it is evident that the practical feasibility of implementing nutrition programmes aimed at the development of children in the age group 0 - 1 year is considerably greater, if we operate *via* proper feeding of lactating mothers. The child age group 1 - 4 years could, however, be a problem for practical implementation of feeding programmes in the absence of institutional arrangements for the distribution of different supplementary foods. This aspect can be overcome possibly through market mechanism by producing and supplying low-cost weaning foods.

ii) The major determinant of number of days of illness of children seems to be the provision of protected water supply. Thus, urgent priority needs to be given to problems ensuring proper assimilation of the given intake of nutrients by children. Preventive medicine, improved hygiene and sanitation also fall in this category. Further studies dealing with disease, specific determinants of illness may be more useful if the necessary data are available.

iii) The calorie/protein content of diet consumed by children is a poor indicator of nutrition status of children, and

much less the health status of children. This is mainly because the food basket composition for children is as important as the actual nutrition content of the basket. Again, the role and need for evolving weaning-foods becomes apparent.

iv) The officially classified categorisation of castes in Tamil Nadu into backward and other groups did not help us to identify these parameters as relevant in determining the health status of children. Similarly, the food habits in terms of vegetarianism and non-vegetarianism also did not provide any significant explanation to the illness phenomenon.

v) For the same income group, the source of earning does make a difference in determining the intake of nutrients by children; the children belonging to the working class families are the worse-off, compared to those in other occupations for the same level of income, possibly because of the intra-family distribution of food in favour of the head of the household may be valid in many categories, but the relatively higher need in view of the occupation of the head of the household seems to adversely affect the residual available nutrition for the children,

vi) The popular belief that male children are preferred to female children does not seem to have any validity, at least in terms of consumption of nutrients. A disaggregated analysis for the different socio-economic groups might, however, provide further insights into this problem.

c) i) The urban location of a household does adversely affect the nutrition intake, compared to a household located in rural areas, for the same expenditure levels; the adverse impact of literacy possibly leading to occupation in an urban area also affects in the same way.

ii) The marginal propensity to consume calories is of the order of 2,300 k calories per additional rupee (at 1970-71 prices) expenditure; the corresponding increase in the case of

proteins is about 50 gms, in the case of Vitamin A it is about 60 I U, whereas in the case of iron it is about 34 mgms. It appears that the protein gap can be automatically eliminated if calorie gap is eliminated, and therefore, it suffices to focus attention mainly on Vitamin A. It also appears that under the existing price structure and market mechanism governing the traditional food commodities, unless drastic improvements in income take place for the majority of the population, it is not possible to eliminate the nutrition gap as far as Vitamin A is concerned. The remedy appears to lie in the popularisation of relatively less common foods like drumstick leaves, in addition to administering doses of Vitamin A through chemical methods.

d) The food gap is likely to decrease for all commodities except for fruits in which case the gap is increasing over a period of 1980-81 to 1986-87. The overall deficit of cereals remains till 1985-86 with a decreasing trend. At the State level for the major foodgrains the projections of gap are given below.

Food gaps between requirements and production in Tamil Nadu

(000' tonnes)

Commodity	1981-82	82-83	83-84	84-85	85-86	86-87
Rice	742.0 (12.0)	782.2 (12.4)	820.8 (12.7)	871.1 (13.2)	886.8 (13.3)	930.1 (13.7)
All Cereals	927.2 (10.9)	951.6 (11.0)	974.1 (11.1)	1013.0 (11.3)	1005.2 (11.0)	1035.7 (11.1)
Grams & Pulses	279.9 (56.7)	283.2 (56.3)	286.6 (55.8)	290.9 (55.5)	292.7 (55.0)	296.7 (54.7)

Figures in the brackets are percentages of gap to requirement

(Revised, based on trend projections corrected by estimated irrigation growth)

6. Child Nutrition

(Supplementary Report)

The main objective of this study is to examine in depth the determinants of illness as well as the intake of nutrients of children since they are the most vulnerable segment of the population.

According to Tamil Nadu Nutrition Study, about 45 per cent of children in Tamil Nadu die before the age of 5 years and that, about 50 per cent of the pre-school children in the State were malnourished, as assessed during 1973 - 74. purely on humanitarian grounds alone, the problems of mortality and malnourishment in children assumes greatest urgency and importance. We will also look into the economic dimensions of the problems in subsequent paragraphs. It is also estimated that the pre-school children with nutrition related disorders account for about 23 per cent of all patients treated in government hospitals, although, the pre-school children constitute only 16 per cent of the State population. Another study, by the Institute of Child Health, Madras, found that nutrition was leading or associated cause of about 42 per cent of deaths of the pre-school children covered under the survey. The various nutrition programmes in operation in Tamil Nadu

reach hardly 10 per cent of the per-school children and even they have met with very limited success due to a number of factors, some of which are :

1. Feeding programmes failed to reach the targeted benefit ciariees due to non-compliance in selection of eligible children.
2. Substitutability in food consumption takes place at household level as a result of supplementary feeding given to children.
3. The government agencies operating on a "drop-in" basis rather than continued effort with fixed set of children with due monitoring and flexibility in operations governing the supply of nutrients, both in form and quantity.
4. Absence of adequate health care components to take care of infectious disease and diarrhoea.

The Union Ministry of Education and Social Welfare has set-up a study Group in 1972 on the development of the pre-school child, "to examine the question and to prepare an action plan for the devlopment of the pre-school Child through the mobilisation of local resources, especially in rural areas".

As regards plan and action, the Study Group recommended the following "strategies": 1) Community support involvement 2) employment of suitable local women in rural areas, 3) part-time employment of educated women in urban areas, 4) part-time employment of students, 5) maximum use of the existing institutions and facilities (including NSS, PHCs, etc.), for evolving a variety of models involving these institutions to suit local conditions.

The Fourth Five-Year Plan Mid-term Appraisal* while dealing with nutrition programmes, stated that the following

* Volume II, planning Commission, New Delhi, December 1971, pp. 126.

requirements be kept in view in the Plan : 1) since the resources are limited, it is necessary to establish priorities with reference to the needs, class, and areas, 2) it is important to improve the efficiency and extend the coverage of the organisations which serve the needs of the priority age-groups, classes and areas, 3) Programmes of distribution should be supported wherever this is necessary by programmes of unconventional foods for supplementing targets for foods like *balahar* weaning foods, groundnut flour, and soyabeans products.

For the purpose of analysing the socio-economic determinants of nutrition status of children, it must be noted that mean per capita household consumption of food or nutrients is not necessarily a good indicator of nutrition status of children individually, due to problems of intra-family inequitable distribution of nutrition. Since the poorer income groups have a substantially larger family size and number of children, the share of children that are malnourished tends to be larger than that of adults. Thus, at a given poverty line- whichever calories norm is used for defining poverty for the household, the household might fulfil nutrition needs only on the average and not necessarily in case of every member of the family and especially in case of children in the household.

The average days of illness of children is taken as one of the dependent variables and attempted to be explained in terms of a number of variables, such as average nutrient intake of children (in terms of calories and proteins), provision of tap water, nature of the household working class or otherwise, caste variables (classified in terms of upper caste, backward caste, and others), household expenditure, food habits (in terms of vegetarianism, vegetarian with egg consumption and non-vegetarianism), composition of family (in terms of number of children, age groups of children, number of adults, male/female children), education level of the head of the household and rural /urban location of the household.

The above set of explanatory variables which are assumed to have some bearing on the average days of illness of children are attempted in various combinations.

The analysis carried out in this section generally points to the fact that environmental parameters like improved hygiene, preventive medicine, nutrition and health education, improved diet composition of baby foods are likely to be more important factors in reducing the prevalence of illness in children than merely factors like income/expenditure and intake of calories/protein.

It is of interest to examine the relationship between nutrient intake of each child and various other socio-economic characteristics of the family to which the child belongs, in addition to the environmental parameters. The idea is to identify certain variables effecting nutrient intakes; significantly some of which might be controlled through appropriate intervention programmes. The dependent variables used were :

- Consumption of protein by the child; and
- Consumption of calories by the child.

The average age of children (given in months) is positively co-related with the average intakes of protein and calorie by children and also the co-efficient in the regression equation is statistically very significant. The explanatory variables, indicating the occupation classified in terms of working class and other, did not bear any significance in any of the relationships. However, wherever the statistical significance of the co-efficient corresponding to this variable is relatively better than the other specifications, yielded a negative co-efficient indicating that the working class feed their children less, compared to others. This seems to be valid in spite of the fact that the total expenditure of the household is positively co-related with the average intakes of calorie

and nutrients of children. In all the cases, this variable relating to total expenditure is also statistically significant. This obviously indicates that for the same level of income if we compare the working class household and a non-working class household, the children in the former category are relatively worse off than the later category, possibly due to higher nutrition needs of other members of the family in order to sustain the given level of income. The total number of female children in the family did bear a positive and statistically significant co-efficient, contrary to popular hypothesis that male children are fed better compared to females.

The education parameter classified into categories, that is, up to 4th standard (including illiteracy), 5th to 9th standard, and 10th standard and above, did not help in isolating the relative impact of varying levels of education on the illness pattern. It would have been a more useful exercise had education been treated as a continuous parameter and the pattern of illness (even if average illness) could be explained in terms of this parameter, among others. The existing data available with TNNP Data Bank did not lend themselves for adoption of this approach.

The phenomenon of positive correlation between education and proneness to illness may appear surprising, but the way the education parameter has been coded into the three groups mentioned earlier, and also considering the fact that relatively educated people may report less significant diseases as compared to others, it may not be an odd observation.