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ECONOMICS OF NUTRITION

by

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ECONOMICS OF NUTRITION*

I. INTRODUCTION

The main attention on the food front in India's five year plans has been focussed on the question of undernutrition rather than malnutrition. This preoccupation with the quantitative instead of the qualitative aspect of food problem is not difficult to understand, in view of the inadequate domestic output and low per capita consumption of all foods, low average calorie intake, and evidence of widespread "hunger" brought out by diet surveys undertaken in different parts of the country. However, the basic approach of the Planning Commission to the question of nutrition, as indicated briefly in the second plan document, is based on a preconceived notion that "it will not be possible to provide nutrition at optimum levels to everybody".[1] This presumption led them to the conclusion that "priority in improving nutrition should be given to vulnerable groups of the population" such as expectant and nursing mothers, infants, etc.[2] Though the broad approach and specific policies for special groups are spelt out in greater detail in subsequent five year plans, the basic approach does not seem to have undergone any fundamental change.

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* The author is grateful to Professors K.N.Raj and T.N.Krishnan and Dr. M.Ramachandran for their valuable comments and suggestions and to Sri Purushothaman Nair for his assistance in computation.

1 Planning Commission, Second Five Year Plan, Government of India, 1956, p. 551.

2 Loc.cit.

The presumption of the Planning Commission that it is not possible to provide optimum nutrition to all perhaps reflects the approach of the Indian Council of Medical Reseárc (I.C.M.R.) to the issue of nutrition. According to the result of the diet surveys sponsored by the I.C.M.R. there is considerable incidence of undernutrition and malnutrition. On the other hand, the requirements of various nutrients as estimated by I.C.M.R. are far above the present level of their intake. Presumably, the Planning Commission is influenced by the I.C.M.R.'s assessment of the actual nutrition levels, the desirable nutrient standards and its proposals for a balanced diet, and consequently reached the position that it is not possible to provide nutrition at optimum levels to everybody.

While the recommended allowances may have taken into account both the quantitative and qualitative aspects of the food problem, the I.C.M.R. has ignored the economic implicatio of the recommended balanced diet either from the stand point of the individual households or of the nation. Moreover, although the I.C.M.R. has analysed nutrition requirements of different population groups to some extent, their broad approa has been national, ignoring regional differences, which are considerable, in food habits and food resources. In the present paper we shall examine the economic implications of the I.C.M.R. proposals and attempt to suggest an alternative approach to the diet problem.

II. THE PROPOSALS OF I.C.M.R.

In the light of the above it is appropriate that we examine in detail the proposals of I.C.M.R. The recommended allowances of essential nutrients, the suggested balanced diet, the sources of nutrients in the balanced diet and alternative sources of the same and the cost of the proposed balanced diet are considered in this section. The discussion is with reference to an adult male.

The Balanced Diet

Let us examine the balanced diet for an adult male as suggested by the I.C.M.R. in 1966. The balanced diet proposed for a normal adult male is given below:

Table 1: Composition of Balanced Diet

Class of Food		Quantity (Grams per day)
Cereals	..	400
Pulses, Nuts and Oil seeds	..	85
Green leafy vegetables	..	114
Root vegetables	..	85
Other vegetables	..	85
Fruits	..	85
Milk and Milk products	..	284
Sugar and Jaggery	..	57
Vegetable oil, Ghee, etc.	..	57
Fish and meat	..	85
Eggs	..	40

Source: W.R.Aykroyd, et al, The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets, Sixth Revised Edition, Indian Council of Medical Research, New Delhi, 1966, p. 28.

The approximate nutritive value of the above balanced diet and the recommended allowances for normal adults are given in the following table.

Table 2: Recommended Allowances Compared to the Nutritive Value of the Balanced Diet (1966)

Nutrients	Unit	Recommended Allowances	Approximate Nutritiv Value of Balanced Diet
Calories	..	2400-3900	3000
Protein	grams	50-55	90
Fat	"	..	90
Calcium	"	1.0	1.4
Phosphorus	"	..	2.0
Vitamin A	I.U.	3000-4000	8400
Iron	mg.	20-30	47
Thiamine	mg.	1-2	2.1
Riboflavin	mg.	..	1.8
Nicotinic acid	mg.	..	22
Vitamin C	mg.	50	240

Source: Aykroyd, et al., op.cit., Tables I and II.

Thus, "the diet will supply all the essential nutrients in adequate amounts and keep the majority of individuals consuming it in a stage of good health".[3] However, the prescri balanced diet raises some doubts in one's mind.

The components of the proposed balanced diet may yield 3,000 Calories, perhaps even more. From the composition of th diet in such broad groupings as cereals, leafy vegetables, roo vegetables, other vegetables, fruits and so on, one can hardly derive their exact caloric value. For, caloric content varies

[3] W.R.Aykroyd, et.al., op.cit., p.28; italics added.

according to the type of cereals, vegetables, fruits, etc., according to their respective edible portions, according to their maturity and period of storage, type of processing and preparation of meals, etc. But, more importantly, even the rationale of the recommended allowances it is difficult to judge. Calorific requirement after all, is a function of a host of variables concerning the individual in question — body weight, specific age, type and intensity of activity, atmospheric temperature, etc. Calorific requirement is known to vary directly with size and body weight, but inversely with external mean temperature. The concept of a "normal adult man" of the I.C.M.R. is so vague that it is not possible to estimate his energy requirement with any degree of accuracy. It may also be noted that the caloric content of the balanced diet recommended by the I.C.M.R. is almost as high as that recommended by the Food and Nutrition Board of the National Research Council in the U.S.A. in 1958. The Council's recommendation for an "average man" of 25 years and 75 kg. was 3200 Calories; and this is intended for persons normally active and living in a temperate climate.[4] There have been some experts in America who held the view that the Council's recommendations were too high and "if actually followed would increase the obesity of

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[4] Recommended Dietary Allowances, Rev. 1958, National Academy of Sciences, National Research Council Publication No.589, Washington, D.C.; quoted by Henrietta Fleck and Elizabeth Munnves, Introduction to Nutrition, Macmillan Company, New York, 1962, p. 143.

which we already have too much in this country".[5] Subsequently, it may be noted, the Council brought down the allowances to 2900 Calories for the "reference man", that is, a man of 25 years and 70 kg., and made corresponding reduction for persons of higher age groups. The recommendations were made on the assumptions of a mean environmental temperature of 20°C and moderate physical activity.[6] The F.A.O. has proposed 3200 Calories for its "reference man". The reference man is 25 years old, physically fit for active work, weighs 65 kilograms and lives in the temperate zone at a mean annual temperature of 10°C.[7] As against these, the I.C.M.R.'s "normal adult man" is of unspecified age and weighs only 55 kg.

But, the main difficulty with "the balanced diet" is that the suggested components are beyond the means of the vast majority of households in India at present and will remain so in the foreseeable future. We shall examine the reason for this next.

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5 Henry C. Sherman, Chemistry of Food and Nutrition, Eighth Edition, Macmillan Company, New York, 1952, p. 183.

6 Recommended Dietary Allowances, Food and Nutrition Board, National Academy of Science, National Research Council Publication No.1146, 1964, quoted by Proudfit-Robinson, Normal and Therapeutic Nutrition, Oxford and I.B.H. Publishing House, Bombay, 1967, p.108.

7 Food and Agricultural Organization, "Calorie Requirements", F.A.O.Nutrition Studies 15, 1957, quoted by R.W.Swift and K.H.Fisher, in Energy Metabolism, Nutrition, A Comprehensive Treatise, Vol.I, ed. George A. Beaton, Academic Press, New York, 1964, p. 249, footnote.

Essential Nutrients and Their Alternative Sources

Assuming that the daily allowances of essential nutrients recommended by the I.C.M.R. (1966) were the optimal requirements for an adult to maintain good health, it is doubtful whether the components of the proposed balanced diet are the most economical sources of these nutrients. A scrutiny of one or two items should suffice to illustrate this point.

Let us, for instance, take the case of the calorific requirements and their sources implied in the balanced diet suggested for a normal adult male. The recommended allowances range from 2400 to 3900 Calories per day, depending upon the type of work. It may be recalled that the approximate calorific value of the recommended balanced diet is 3000. Cereals are the principal source, which contribute, say, around 1400 Calories. Next to cereals, fat — vegetable oils, ghee, etc. — constitute a major source; this would probably account for 475 Calories or so. But fat is not an economical source of Calories in this country. (It is true that fat is a more concentrated form of energy than most other forms of food. Further, it can be a source of fat-soluble vitamins; it decreases hunger between meals; it offers protection against outside forces; last, but not the least, it adds to the palatability of food in general. But according to generally accepted scientific knowledge there is no irreducible minimum human requirement for fat. On the other hand, there is some evidence of a close association between excess fat in diet and coronary diseases. The American

Heart Association and the Food and Nutrition Board are in favour of a reduction in the intake of fat; and "fat-controlled diets" are being prepared by the U.S. dieticians and physicians. Similarly, sugar appears to account for a high quantum of Calories, say, over 200, in the balanced diet. But as in the case of fat, sugar is an expensive source of calories. (While an excess of sugar in the diet can lead to diabetes in the case of persons otherwise prone to get the disease, an insufficiency of it is not known to have any grave consequence.) It may also be noted that the recommended allowance of both fat and sugar represents a substantial increase over current consumption.

The obverse of the foregoing is that comparatively cheap sources of Calories are not adequately exploited in the I.C.M proposals. Thus, for instance, root vegetables like tapioca, colocasia, potato and sweet potato yield cheap Calories. This is true at least as far as Kerala is concerned. Pulses, legumes and oil seeds are rich in Calories and when allowance is made for proteins and other nutrients present in them, this group also will prove to be a more economical source of Calories. But the contribution of roots and pulses and nuts by way of Calories in the balanced diet is low, say, around 70 and 30 respectively. In sum, the source of Calories underlying I.C.M balanced diet is much more expensive than it needs to be under Indian conditions.

The main sources of protein in the balanced diet seem to be (a) pulses, nuts and oil seeds, (b) milk and milk produ

(c) fish and meat, and (d) eggs. The I.C.M.R. appears to aim at raising the proportion of protein originating in animal foods as is evident from the greater weight given to the last three categories. However desirable this may be from the nutrition angle, the projected increase in their intake is not economically feasible.

Take, for instance, the case of milk, the allowance proposed for this item in the balanced diet being 284 grams per day. As against this, the net availability of milk in India in 1965-66 came to 110 grams per capita. There are considerable differences here too; per capita consumption of milk in Kerala, for example, came to 1.3 oz., i.e. 36.85 grams in 1956.[8] Moreover, recent years have witnessed a steady and significant fall in the net supply of milk per capita.[9] Similarly, fish and meat add upto 85 grams in the balanced diet. The net supply of meat in India in 1965-66 is estimated at 4 grams[10] and that of fish 3 grams per day.[11] The gulf between recommended allowance and available supply is perhaps wider in the case of eggs. As the present output of these animal foods is very low they are expensive and, in the nature of things, they are likely to remain so in the foreseeable future.

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8 Government of India, Livestock Census, 1956, cited by K.N.Raj, "Investment in Livestock in Agrarian Economies," Indian Economic Review, April 1969, p.77.

9 United Nations, Statistical Year Book 1968, p. 501.

10 Loc.cit.

11 Food and Agriculture Organisation of the United Nations, Production Year Book, 1969, p. 435.

While the cost of animal protein is prohibitively high for the typical household in India, there is no need to despair for there are alternative sources of protein which are cheaper than those suggested by the I.C.M.R. Let us compare the protein content of different food items.

Table 3: Protein Content Per 100 gm of Edible Portion

Food Items	Protein gms	Food Items	Protein gms
Bengal gram, dhal	20.8	Beaf	22.6
Black gram, dhal	24.0	Buffalo Meat	19.4
Cow gram	24.6	Duck	21.6
Field bean, dry	24.9	Fowl	25.9
Green gram, dhal	24.5	Mutton	18.5
Horse Gram	22.0	Pork	18.7
Peas, dried	19.7	Goat Meat	21.4
Red gram, dhal	22.3	Milk, cow's	3.2
Soya bean	43.2	Milk, buffalo's	4.3
Gingilly seeds	18.3	Eggs, duck's	13.5
Groundnut	26.7	Eggs, hen's	13.3
		Fish*	13.7 to 22.9

Source: Aykroyd, et.al. op.cit., Table of Food Values, I.

*Since fish is a large, heterogeneous group we have shown here only the range of protein content.

A glance at the table would show that pulses, nuts and oil seeds contain at least as much protein as animal foods like fish, meat and eggs. But the protein derived from a given expenditure on the former group would be much greater than that from the latter group, as we shall demonstrate below.

However, it is not only the quantity of total proteins in different foods that matters, but also their nutritional quality. The nutritive values of proteins depend essentially

upon the kind of amino acids which they contain and the quantitative proportion of each, their digestibility, etc. Some essential amino acids are believed to be in short supply in protein of vegetable origin; for instance, legumes are characterised in general by smaller quantities of methionine, and cereal proteins are low in lysine, tryptophan, etc. Further, proteins derived from vegetable foods, especially legumes and pulses, are generally held to be less digestible than animal proteins. In sum, proteins of animal origin are categorised as "complete" proteins while those of vegetable foods are "partially incomplete" or "incomplete" proteins.

On the other hand, proteins contained in certain vegetables, according to some authorities, are as complete as animal protein. Thus Hegstead observes: "Although leafy and root vegetables contain only small amount of total nitrogen, the proportions of amino acids may compare favourably with those in animal protein."[12] He also points out that "variability in digestability of proteins, is not under usual circumstances, and as far as is known, a major determinant in the nutritive value of proteins, since variations in digestibility appear to be relatively minor in normal individuals."[13] Proudfit and Robinson cite the observation of some investigators who studied a group of pure vegetarians for whom legumes, whole grains, nuts and vegetables

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12 Hegstead, "Proteins" in Nutrition, A Comprehensive Treatise, op.cit., p.117.

13 Ibid., p. 123.

provided a satisfactory combination of amino acids.[14] Professor Sherman remarks that "it becomes necessary to reform the traditional belief of speaking of 'animal proteins' as if it alone were efficient in this connection, for we now know that several of the plant proteins are similarly effective."[15] Aykroyd, Gopalan, et.al. on the basis of their research in Ind have come to the conclusion that "the relative inefficiency (of) amino acid of particular vegetable foods can be overcome through a judicious combination of vegetable protein food to provide a desirable pattern of amino acids almost approaching that of the reference protein."[16]

In sum, the sources of calories and proteins implied in the balanced diet recommended by the I.C.M.R. are relatively more expensive ones. Their implications may be briefly examin If the average household in India tries to adapt its food plan to the recommendations of this expert body, the consequences can be disastrous. Obviously, given the low income level in this country, even the quantitative goal of calorific sufficie will be hard to fulfil, and if this modest target is attained, it will be at the expense of qualitative improvement in diet. This may happen because, in the first place,

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14 Proudfit and Robinson, Normal and Therapeutic Nutrition, op.cit., p. 117.

15 Henry C. Sherman, Chemistry of Food and Nutrition, op.cit.

16 Aykroyd, et.al. op.cit., p.3.

sufficient protein and other essential nutrients would not find a place in the typical diet. In the second place, what little protein is taken by persons subsisting on low-caloric diet would be oxidised to meet the energy requirements. Dr. Sukhatme, while analysing the protein problem has come to the interesting conclusion that "protein deficiency is, for the most part, the indirect result of a low level energy intake. As long as the energy intake is inadequate the body will use anything and everything, including its own tissues to meet caloric needs".[17] The sources of protein underlying the balanced diet are more expensive because greater reliance is placed on animal protein. Given the high density of population and land utilisation pattern, their current output is low and prospects of increase in production commensurate with the scale of recommended allowances of animal foods are not too bright in the near future. In brief, both the private cost and social cost of the proposed protein pattern will be unnecessarily high.

Cost of the Balanced Diet

The balanced diet of the I.C.M.R. is expected to keep the majority of individuals consuming it in a state of good health. But it is pertinent to ask what proportion of India's population can afford to consume it. We shall now proceed to work out the cost of this balanced diet.

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[17] P.V.Sukhatme, "Summation and Findings of the Protein Problems", Food and Agriculture Organisation, July 1971; See also, by the same author, "Incidence of Protein Deficiency in Relation to Different Diets in India", Food and Agriculture Organisation, 1969.

In the following exercise, the cost of the I.C.M.R.'s balanced diet is estimated in terms of food items generally available and popular in Kerala and prices prevailing in the region. The approximate cost of the balanced diet recommended for an adult male is given below:

Table 4: Estimated Cost of Balanced Diet

Food Item	Requirement for a period of 30 days (Kg)	Average price* (Rs.)	Cost of the Rec mmended allowar over a period o 30 days (Rs.)
Cereals	12.00	1.04	12.48
Pulses, nuts & oil seeds	2.55	1.62	4.13
Vegetables	8.52	0.75	6.39
Milk & Milk products (litre)	8.50	1.36	11.56
Sugar and Jaggery	1.71	1.80	3.07
Vegetable oil, ghee etc.	1.71	6.25	10.68
Meat and fish	2.55	6.06	15.45
Eggs (Nos.)	30	20.00	6.00
Total			69.76

Notes:

* Price of milk is per litre, that of eggs per 100 nos. and all the rest per Kg. Prices of milk, meat and eggs, relat to 1970 and are taken from the Bulletin of Animal Husbandry published by the Veterinary College, Trichur; data on other prices cover recent weeks and were collected for the present purpose.

Cereals: The prices of Bengal gram, black gram, green gram, cow gram, horse gram, field beans, dried peas, etc. form the basis of the estimate. Oil seeds like gingelly seeds groundnuts, etc. are less popular while cashew and other nuts are more expensive.

Vegetables: This is a mixed bag and no distinction is made between the three broad groups of vegetables given in Table 1. The average price Re.0.75, is a rough estimate since it is the arithmetic mean of all vegetables, generally arrivi in the markets. No further refinement is thought to be necess here.

(notes contd...next page)

Milk and Milk-products: Only cow and buffalo milk is considered; milk products like cheese, butter, etc. are more costly.

Sugar and Jaggery: Estimated in terms of the price of refined sugar; jaggery may be slightly less costly.

Vegetable Oil, Ghee etc.: The price of coconut oil, which is the most popular cooking medium here is the basis of the estimate; ghee is more expensive.

Meat and Fish: Calculated in terms of goat's meat; other varieties of meat and large varieties of fish are cheaper.

Eggs: On the basis of the price of hen's eggs.

It is seen that the cost of the food items included in the balanced diet, works out to about Rs.70 per month, or Rs.840 per annum. This figure, if anything, is apt to be an underestimate. For instance, the cost of cereals is estimated in terms of controlled price of rice. For want of suitable data, we have not included fruits in our estimate. Nor are the items listed in the balanced diet exhaustive of the outlay under the heading food in a typical family budget in this region; mention may be made of beverages, fuel, spices and condiments, coconut, etc. which are indispensable items of food. Thus, the balanced diet of the I.C.M.R., if accepted, would leave the family budgets of the vast majority of households in Kerala unbalanced, and the deficit on this score alone would be sizeable. The per capita income in the State has been estimated at Rs.505 for the year 1967-68, the latest period for which estimates are available. Judging by recent trends, the per capita income would not have registered any substantial increase since then. Per capita income at 1969-70 prices would be Rs.523.60.

It may also be borne in mind that a high proportion of the population is likely to be below it.

It may be argued that the foregoing comments on the 1966 proposals of the I.C.M.R. are pointless in view of the fact that the Nutrition Expert Group (I.C.M.R.) has subsequently reformulated their recommendations regarding nutrient allowance and balanced diet in 1968. But the Expert Group observes: "The Nutrition Advisory Committee of the Indian Council of Medical Research, in 1944, recommended dietary allowances for various nutrients for different population groups. These allowances were based on recommendations of the League of Nations, the National Research Council (N.R.C.) of the United States of America, the National Research Council of Canada, and the Medical Research Council (M.R.C.) of the United Kingdom, and partly on data collected by Indian workers. The original recommendations made nearly twenty five years ago, have not been revised, except for calori and proteins, which were revised in 1958."[18] But, the I.C.M.R. has prefaced its 1966 (sixth, revised) edition of the Health Bulletin No.23 with the bold claim that "the Bulletin has been thoroughly revised, enlarged and brought uptodate."[19] The nat and extent of the recent revision seem to justify our earlier comments rather than invalidate them.

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18 Nutrition Research Laboratories, Recommended Daily Allowanc of Nutrients and Balanced Diets", Indian Council of Medical Research, June 1968, p. 1.

19 Aykroyd, et.al., op.cit., p.V.

The 1968 revision cuts into both nutrient allowances for different population groups and the composition of balanced diets. For instance, the allowance of calories for adult man engaged in heavy work has been brought down from 3900 to 3000 per day; the calcium requirement for adult man has been cut to one half its former level; similar downward revision is noticed in respect of Vitamin A and Vitamin D.

But the more important change lies in the composition of the balanced diet. Broadly speaking, the revised balanced diet for adult man contains less of pulses and nuts, fruits, milk, fats and oils, sugar and jaggery, meat, fish and eggs. More liberal allowances of cereals and vegetables are recommended for adult males doing moderate and heavy work. Greater importance to cereals and less enphasis on animal foods are the two broad changes; such changes are bound to bring down the cost of the balanced diet considerably. The Nutrition Expert Group has proposed two types of balanced diet for an adult man of moderate work, viz., one vegetarian and the other non-vegetarian. The cost estimated along the lines in Table 4 works out to Rs.43.28 and Rs.48.52 respectively. However the cost of balanced diet can be reduced still further by selecting the most economical sources of different nutrients as attempted in the next section.

III. MINIMUM COST DIET

In the foregoing section we examined the balanced diet proposed by the I.C.M.R. and analysed its economic implications. The search for a minimum cost diet will follow next.

Methodology

The method used in this exercise may be briefly explained now. Following George Stigler,[20] we first selected a list of "potential commodities" covering the major food groups such as cereals and millets, pulses, nuts and oil seeds, leafy vegetables, root vegetables and other vegetables, milk and milk products, meat, fish and eggs, fruits, vegetable oils and other fats, sugar and jaggery, etc. Only such food items as are available and consumed in Kerala are included in the list. The total number of items came to 57.

Next we estimated the cost of each food item per 100 grams of edible portion and their nutritive value in terms of calories, proteins, minerals and vitamins. These estimates are made on the basis of the Food Value Tables prepared by the I.C.M.R.[21] On the basis of this data we proceed to set up a table giving the nutritive value of food items in the list of potential commodities per rupee of expenditure (at 1970-71 prices) along the lines of Table A in Stigler's pioneering work.[22] This Table is given in the Appendix. Next through a series of elimination process we identified the most economical sources of each nutrient. From this we eliminated a few more items: we have left out dry tapioca chips since this is not at all palatable. Carrot, cabbage and corriander leaves are omitted since they

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20 George J. Stigler, "The Cost of Subsistence", Journal of Farm Economics, May 1945.

21 Aykroyd, et.al. op.cit.

22 George Stigler, op.cit., pp. 306-307.

are not usually available in most parts of Kerala; wheat flour ('atta') is dropped because it is not popular in this part of the country.

Upto this stage we have followed the method used by Stigler. Then we attempted to derive the minimum cost diet for an adult man by applying linear programming. However, with the limited computational facilities available, which consisted of a manually operated desk calculator, one had to keep down the number of variables in the model, viz. that of nutrients and foods, to a minimum.

The nutrient requirements underlying this exercise are the daily allowances recommended by the Nutrition Expert Group in 1968 for a normal adult man of moderate activity. It is assumed that those engaged in sedentary work and moderate work together would constitute the vast majority of the adult male population in Kerala. In this connection it may be borne in mind that the Nutrition Expert Group is rather ambivalent on the minimum requirements of certain nutrients. For instance it is pointed out that "in the absence of precise information on calcium requirement of different groups, a range of allowance has been suggested."[23] On vitamin D, the Group observes: "Since the exact requirement of vitamin D is not known, an arbitrary allowance of 200 I.U./day is made".[24] Further, vitamin D is obtained freely from exposure to sunlight which,

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23 I.C.M.R."Recommended Allowances of Nutrients and Balanced Diet", op.cit., p.3.

24 Ibid., p.5.

afterall, is not a scarce source in a tropical region like Kerala. Regarding folic acid requirements also the Expert Group is not very definitive.[25] Riboflavin and nicotinic acid also seem to be marginal items, for they were not included in the previous recommendations of the I.C.M.R. Therefore, we have excluded Vitamin D, folic acid, riboflavin and nocotinic acid from the following exercise. The recommended allowances and food items included in the model are given below:

Nutrients		Foods
1. Calories	2800	1. Rice
2. Protein	55 gm	2. Tapioca (raw)
3. Calcium	0.5 gm	3. Groundnut
4. Iron	20 mg	4. Horse gram
5. Vitamin A	3000 I.U.	5. Oil sardine
6. Vitamin C	50 mg	6. Cow gram
7. Thiamine	1.4 mg	7. White bait
		8. Curry leaves
		9. Amaranth
		10. Sardine
		11. Wheat (whole)

As mentioned earlier, the main consideration for excluding most of the food items of the original list and a few of the recommended nutrients from the analysis was to reduce the problem to manageable proportions, in terms of the limited computational facilities.

We proceed to work out the minimum cost diet on the basis of the above. The model is presented below:

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[25] Ibid., p.4.

a_{ij} = the number of units of the i-th nutrient in 100 grams of the j-th food.

b_i = the number of units of the i-th nutrient required.

x_j = the number of units of the j-th food to be purchased.

c_j = cost per 100 grams of the j-th food.

The solution is got by minimising the cost function, $\sum_j c_j x_j$ subject to:

$$\sum_j a_{ij} \quad x_j \geq b_i \quad \text{and}$$

$$\text{all} \quad x_j \geq 0.$$

The Solutions

(a) The solution yielded by the computation is given below:

Table 5: Minimum Cost Diet

Food Item	Quantity (gm)	Cost (Rs.)
1. Rice, parboiled, milled	412	0.43
2. Tapioca (raw)	464	0.13
3. Groundnut	97	0.16
4. White bait	61	0.06
5. Sardine	42	0.07
6. Curry leaves	24	0.03
Total:		0.88

This is an optimum solution in the sense that it provides sufficient amounts of all the nutrients included in the model at the rates recommended by the Expert Group in 1968 at a minimum cost. The estimated values of the nutrients in the least cost diet and their recommended allowances are given in the Table below.

Table 6

Nutrients	Nutrient Value of the diet	Recommended allowances
Calories	2800	2800
Proteins (grams)	75	55
Calcium (mg)	947	500
Iron (mg)	27	20
Vitamin A (I.U)	3085	3000
Thiamine (mg)	1.9	1.4
Vitamin C (mg)	118	50

Thus the minimum cost diet contains all the essential nutrients in adequate quantities. Incidentally, the diet will also provide sufficient quantity of nicotinic acid and riboflavin although in the case of the latter there is a slight deficit. We whall examine the limitations of the above diet.

Since each of the nutrients is derived from the most economical source, the minimum cost diet comprises only six items. Further, rice and tapioca dominate the diet to an excessive extent though they are a usual combination among large sections of the population in Kerala. It may be borne in mind that the cost of rice is calculated in terms of controlled price and that this may account for its predominance in the minimum cost diet. Though some typical items of consumption in Kerala such as parboiled rice, tapioca and two varieties of fish find their place in the above diet it lacks variety. The search for the minimum cost diet when made relentlessly would inevitably lead to the kind of result which earlier Stigler got. Stigler's minimum cost diet comprised wheat flour,

evaporated milk, cabbage, spinach, dried navy beans, pancake flour and pork liver.[26] As Gazz remarks: "Such diets, although quite inexpensive are certainly unpalatable over any period of time, and the selection of foods would do justice to the chief dietician of a slave-labour camp".[27] But, then, Stigler himself pointed out: "No one recommends these diets to anyone, let alone everyone....".[28]

We have got an optimum solution to the problem as stated, viz. minimizing cost, but the diet is not a wholly acceptable one. The sacrifice of variety and palatability is too high a price to be paid for the gain in economy. Therefore, one has to look for alternate optimum solutions which offer greater palatability. Needless to say, the provision for more palatability would add to the cost of the diet. But, then there is no diet which is equally acceptable to all and hence there is no single optimum solution. Any number of sub-optimal solutions are conceivable. We shall, however, attempt an alternative model.

(b) An alternative solution where we sought to reduce the quantity of rice and tapioca in the diet and introduce coconut oil to add to platability is given next.

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[26] Stigler, op.cit., p. 311.

[27] Gass, op.cit., p. 229.

[28] Stigler, op.cit., p. 312.

Table 7: Minimum Cost Diet

Food item	Quantity	Cost (Rs.)
1. Rice	370	0.38
2. Tapioca (raw)	231	0.07
3. Groundnut	100	0.17
4. White bait	60	0.06
5. Sardine	85	0.13
6. Curry leaves	25	0.03
7. Coconut oil	50	0.31
Total		1.15

This solution is an improvement over the previous one; it contains less of rice, in the case of which Kerala has a sizeable deficit, and a reasonable amount of tapioca, and includes two items of fish and coconut oil. The diet comprises seven foods as against only six in the previous one. The diet would provide 2800 Calories, 80 grams of protein, 869 mg. of calcium, 25 mg. of iron, 3213 I.U. of vitamin A, 1.8 mg. of thiamine, 60 mg. of vitamin C. In addition, though nicotinic acid and riboflavin are not included in the model, they too are yielded by the diet at the rates of 37 mg. and 0.91 mg. respectively.

The cost of the diet has gone up by 27 paise per day; but strictly speaking, the cost cannot be considered to have increased very much in view of the facts that (1) more variety is introduced and (ii) the diet is more palatable with the inclusion of coconut oil, which is generally an indispensable ingredient in the preparation of food in this part of the country.

The limitations of the foregoing analysis may be mentioned now. The main limitation arises from the quality and coverage of the data used here. Data on certain food items like fish are not readily available, and that used in the present exercise is partly based on data furnished by the State Bureau of Economics and Statistics and partly collected from selected markets that are not a strictly representative sample. The coverage and reliability of these data, especially that of fish, leave very much to be desired. It must be kept in mind that fish is a highly nutritious and popular food in this region and the State is very advantageously placed in its production.

Secondly the model is based on very few foods. The larger the number of foods included in the model, the lower is likely to be the cost of the diet. This limitation is imposed by the constraint of computational facility. However, as Frazer observes: "In general mathematical models do not portray an actual situation with complete accuracy and are only an approximation of the true situation. Since the mathematical solution to the problem is actually a solution to the mathematical problem, the solution is no better than the mathematical model. If model which represents the actual problem is greatly different from the true situation, the solution arrived at will be of very little value. On the other hand, even when the actual situation is not accurately depicted by the model, if the model approximates the true conditions reasonably well, we find that the solution arrived at for the model is also a working solution to the problem."[29]

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[29] J.Ronald Frazer, Applied Linear Programming, Prentice-Hall Inc., Englewood Cliff, 1968, p.3.

IV. SUMMARY AND CONCLUSIONS

To sum up, the least cost diet would involve an outlay of Re.0.88 per day or Rs.26.40 for a period of 30 days, as against the estimated cost of Rs.69.70 in the case of the balanced diet recommended by the I.C.M.R. in 1966. It even compares favourably with the 1968 versions of the I.C.M.R. the estimated cost of which comes to Rs.43.28 and Rs.48.52 for vegetarian and non-vegetarian diets respectively. Further, the cost of our alternate solution, which provided for some measure of palatability, come to only Rs.34.50, for a period of 30 days, which is again lower than that of the revised versions of the I.C.M.R.

It may be interesting to convert these estimates made in terms of an adult male into per capita terms. Applying the coefficients suggested by Aykroyd[30] to the age structure of the States' population we estimate the value of the least cost diet at Re.0.73 per capita per day or Rs.21.90 per period of 30 days. That is, on an expenditure of Rs.21.90 per month on food at current prices, an average person can obtain a sufficiency of all essential nutrients. Alternatively, assuming that expenditure on food forms on the average 66 per cent of total consumer expenditure in this region,[31] a person who incurs a monthly per capita consumer expenditure of Rs.32.85, at current prices, need not be undernourished.

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[30] Aykroyd, et.al., op.cit., p.8.

[31] National Sample Survey, 15th to 18th Rounds.

Recently, Professor Dandekar and Dr. Nilakantha Rath, on the basis of the National Sample Survey data, suggested the possibility of phenomenal undernutrition in Kerala. According to them, 90.75 per cent of the rural population in Kerala, the highest among the States in India, lie below the desired Calorie level, viz. 2250 Calories per day. The corresponding proportions in Rajasthan, and Jammu and Kashmir, for instance, are 13.29 and 13.69 per cent respectively. The proportion of the urban population in Kerala lying below this critical level is placed at 88.89, also the highest in India.[32] For, according to them, the desired Calorie level is not reached until total consumer expenditure, at 1961-62 prices, is as high as Rs.34-43 in the rural areas and Rs.43-55 in the urban areas in Kerala, while the level is reached with considerably lower expenditure in the other States.[33] The reason given for the presumption that 90.75 per cent of the rural population of the State appear to have diets below the desired level is more curious. "It happens because, in Kerala, tapioca is widely used as a substitute for foodgrains and, weight for weight, tapioca has a calorie value of only one-third that of foodgrains. It is possible therefore that in Kerala 90 per cent of the rural population in fact lives on diets inadequate even in respect of calories."[34] We have shown that with a per capita expenditure of Rs.32.85

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32 V.M.Dandekar and Nilakanth Rath, Poverty in India, Indian School of Political Economy, 1971.

33 Ibid., pp. 9-11.

34 Ibid., p.10, Italics added.

at 1970-71 prices it is possible to ensure enough and more of not only Calories, but other essential nutrients also; let us recall that the minimum consumer expenditure levels suggested by Dandekar and Rath are in terms of 1961-62 prices. It is true that tapioca is a common item of consumption, especially among the low income families; but, in a region with a chronic deficit in foodgrains, tapioca is the food which ensures sufficiency of Calories, which is, rupee for rupee, perhaps the cheapest source of this nutrient. Our analysis seems to indicate that the extent of under-nutrition in Kerala has been grossly exaggerated by Dandekar and Rath. This is not the place to examine fully the implications of the inferences of Dandekar and Rath on undernutrition in Kerala or elsewhere. That we shall attempt on another occasion.

In its nutrition policy, the Planning Commission presumably on the basis of I.C.M.R.'s assessment of nutrition levels and requirements, has abandoned the goal of optimum nutrition to all and chosen a modest objective of catering to the needs of the more vulnerable groups among the population. The above policy conclusion and the underlying analysis arise from the failure to identify the most economical sources of various nutrients. On the other hand, if we look for relatively inexpensive foods, a balanced diet will not remain beyond the means of everyone.

Such an attempt was made in this exercise and the results bear out the above argument. It is seen that a balanced diet can be obtained at a cost of Re.0.88 per day for an adult

male. Notwithstanding the limitations of the model, it brings out clearly that a minimum cost diet which provides sufficient levels of essential nutrients is possible. If the analysis is correct, then the Planning Commission's limited, if not negative, approach to India's nutrition problem is unwarranted.

The foregoing analysis does not however imply that there is no undernutrition or malnutrition in Kerala. On the contrary, there is great scope for quantitative and qualitative improvement in the diet of the people of the State.

Finally, the approach of both the I.C.M.R. and the Planning Commission to nutrition ignores regional differences in food habits and food resources. Food habits are the most inveterate of all habits and any attempt to change it will prove to be infructuous and hazardous. Foods available in different regions also vary considerably, reflecting partly local preference and partly differences in resource endowments. Any policy on nutrition must take into account these factors.

P.G.K.Panikar

APPENDIX I

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Sl.No	Food Item.	Average price per 100 Kg (Rs.)	Value of 100 gm of Edible portion (Rs.)	Edible portion obtained per expenditure of Re.1 (Gms.)
1	Rice (par boiled, milled)	1.60	.160	625.0
2	Wheat (whole)	1.19	.119	840.3
3	Wheat flour (aata)	1.16	.116	862.1
4	Wheat flour (maida)	1.24	.124	806.5
5	Bengal gram	1.39	.139	719.4
6	Black gram	2.24	.224	446.4
7	Cow gram	1.48	.148	675.7
8	Greengram	1.78	.178	561.8
9	Horsegram	0.98	.098	1020.4
10	Redgram	2.08	.208	480.8
11	Peas dried	1.38	.138	724.6
12	Cashew nuts	10.79	1.078	92.8
13	Gingelly seeds	4.17	.417	239.8
14	Coconut kernel	2.44	.244	409.9
15	Cabbage	1.15	.131	763.4
16	Corriander leaves	1.50	.214	467.3
17	Curry leaves	1.00	.133	751.9
18	Spinach (amaranth)	0.76	.087	1149.4
19	Beetroot	1.02	.120	833.3
20	Carrot	1.11	.117	854.7
21	Colocasia	0.84	.084	1190.5
22	Onions (small)	0.56	.056	1785.7
23	Onions Large (Savola)	0.70	.070	1428.6
24	Tapioca (raw)	0.29	.029	3448.3
25	Potato	0.89	.089	1123.5
26	Sweet potato	0.61	.061	1639.3
27	Yam (ordinary)	0.58	.058	1724.1
28	Yam (elephant)	0.50	.050	2000.0
29	Beans	0.88	.149	671.1
30	Bitter-guard	1.01	.104	961.5
31	Brinjal	0.78	.086	1162.8
32	Cauly flower	1.87	.267	374.5
33	Cucumber	0.46	.055	1818.2
34	Drumstick	1.20	.145	689.7
35	Ladies-finger	0.82	.098	1020.4
36	Gooseberry	0.66	.074	1351.4
37	Pumpkin	0.41	.052	1923.1
38	Milk (cowsmilk	1.41	.141	709.2
39	Milk (buffalo)	1.72	.172	581.4
40	Milk (goat)	1.29	.129	775.0
41	Butter (cow's)	13.13	1.313	76.2
42	Ghee (cow's)	16.38	1.638	61.1
43	Ghee (buffalo's)	14.75	1.475	67.8
44	Cocorut oil	6.25	.625	160.0
45	Vanaspathy	6.36	.636	157.2
46	Meat (cattle)	2.39	.239	414.6
47	Meat (buffalo)	2.47	.247	404.9
48	Meat (goat)	6.06	.606	150.2
49	Eggs (fowl)	4.16	.416	240.4
50	Eggs (duck)	4.96	.496	201.6
51	Sardine	1.06	.161	621.1
52	Oil Sardine	0.91	.130	679.2
53	Mackeral	1.58	.259	386.1
54	Prawn	8.11	.811	123.3
55	White bait	1.00	.100	1000.0
56	Groundnut	1.67	.167	598.8
57	Tapioca chips (dried)	0.57	.057	1754.4