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FOOD AND NUTRITION SITUATION IN INDIA

PART II

P. V. Sukhatme

INTRODUCTION

In Part I we dealt with the deficiencies in the quantity and quality of the present diet. We saw that the calorie content of the diet is short of the average need by some 13 per cent and that the gap is shared by no less than a quarter of India's population. As regards quality, we noted that the diet is markedly deficient in protective foods and that children and the vulnerable groups in particular suffer from malnutrition due to the failure to obtain sufficient quantities of animal products, especially milk, during the period when they need them most. It will be our object in Part II of the paper to estimate the amounts of food needed for India's growing population so as to make good the above deficiencies in so far as feasible within a foreseeable future. Our object therefore will be to estimate future food needs based on desirable nutritional goals rather than to compute projections based on current consumer preference. In doing so however we shall take care to ensure that the suggested increases in food supplies are realistic from the economic and production points of view, although we are fully aware that any such programme will necessarily call for appropriate planning and policy measures to implement it. Finally, we shall briefly examine the implications of the suggested programme of increases in food supplies for future planning, and also the technical possibilities of raising the needed foods from domestic production.

NUTRITIONAL TARGETS

The formulation in quantitative terms of nutritional targets constitutes the first step in computing the future food needs of India. The guiding principles in formulating them are clearly : (*i*) to ensure quantitative adequacy, and (*ii*) to improve the quality of the diet by increasing the intake of protective foods, especially of animal origin, to a level approaching that in the well-fed countries in so far as this is feasible and advisable under conditions in India.

Ideally, the criterion of quantitative adequacy implies that the calorie target should be equal to the average per caput calorie requirement for the country, with the calorie target for each age-sex group equal to the respective requirement, and that, further, the calorie supply should be so distributed that everyone in the population eats sufficiently to meet his energy needs. The latter in its turn depends upon the distribution of the population by activity, weight, and other factors influencing the energy needs, and may well vary from one group to another. The calorie requirement for the country as also for each age-sex group is based on the assumption that the average activity of the population is the same as that of the reference man. Even if adjustments for activity and other factors influencing requirement were available, it is doubtful whether sufficient data would exist to allow estimation of variation in requirement of the population. Further, even if information on the expected variance of requirement within groups became known, there would be no means of ensuring that the calorie supply within groups

would be distributed accordingly. In practice, the calorie supply would be unequally distributed with variance different from the expected variance with each group. As an example, the richer may take more calories than they need for a healthy life while the poor may have an intake considerably below their requirements. It would therefore seem that the calorie target for each age group should be higher than the specified calorie requirement in order to cover the additional needs arising from inequality of distribution between different strata of the population. There is also another consideration as to why the calorie target for each group ought to be higher than the corresponding national average requirement based on current desirable values of the determining factors. Calorie requirements should strictly be looked at from a dynamic rather than a static aspect[1] and therefore ought to provide for increasing levels with improvement in stature and body weight resulting from better nutrition. This observation however applies to a long-term objective for years possibly beyond 1980, with which we shall not concern ourselves here. For years up to 1980 it will be assumed that the calorie target is 12—15 per cent higher than the corresponding calorie requirement at the physiological level in order that this increase should cover the wastage of food between the physiological and retail levels as also needs due to inequality in distribution. Calorie targets so specified are shown in Table I.

TABLE I—INDIA: TARGETS FOR CALORIES AND PROTEINS UNDER THE MINIMUM AND MODERATE LEVELS

Age Groups (years)	Population Per cent	Calories† (Per caput per day)	Vegetable Proteins (grams per caput per day)		Animal Proteins (grams per caput per day)		Total Proteins‡ (grams per caput per day)	
			Minimum Target	Moderate Target	Minimum Target	Moderate Target	Minimum Target	Moderate Target
< 1 ..	3.2	440**	5.8 (3.8)	5.8 (3.8)	6.0	6.0	11.8	11.8 (9.8)
1—6	15.4	1500	30.1 (19.9)	30.1 (19.9)	20.0	20.0	50.1	50.1 (39.9)
7—12	14.4	2150	69.9 (46.1)	54.4 (35.9)	7.8	18.0	77.7	72.4 (53.9)
13—19	14.4 (1.2)*	2850	101.2 (66.8)	76.1 (50.2)	7.4	24.0	108.9	100.1 (74.2)
20—45	37.1 (6.0)*	2750	54.2 (35.8)	49.7 (32.8)	9.0	12.0	63.2	61.7 (44.8)
> 45	15.5	2350	50·4 (33.3)	50·4 (33.3)	8·7	8·7	59·1	59·1 (42.0)
All age groups	100.0	2350	56 (37)	48 (32)	10	15	66	63 (47)

* Represents pregnant and lactating mothers.
† Revised NAC allowances (ICMR, 1960) at retail level.
‡ Revised NAC allowances (ICMR, 1960) at retail level.
** After deduction of food received from mothers.
N.B. Figures in brackets denote 'reference' protein equivalent.

1. N. C. Wright, Hunger : Can it be averted ?, The British Association for the Advancement of Science, London, 1961.

The formulation of targets for quality presents more difficulties since there is no single measure of the quality of a diet. Except for proteins standards have not yet been established for other nutrients, and even for proteins the recommended standards are tentative. In Part I we saw that the FAO allowances for protein are definitely on the low side to provide a basis for judging the inadequacy in the dietary proteins available in the country. On the other hand, the allowances recommended by the Nutrition Advisory Committee (NAC) are probably on the high side for children. We have now further examined the suitability of the NAC allowances for the different age groups by comparing their contribution to total calories with that recorded by different workers on healthy children. The comparison which is shown in Table II confirms that the NAC allowances for the age group 13-15 are on the high side and that the allowances for two other age groups, namely, 10-12 and 16-19 are also probably somewhat high.

TABLE II—PERCENTAGE OF CALORIES DERIVED FROM PROTEINS IN THE FAO AND NAC ALLOWANCES AND RECORDED BY DIFFERENT WORKERS

Age Groups	FAO	NAC(1958)	Observed by Different Workers
< 1	14.0	14.0	13—16
1— 3	9.7	14.3	14—17
4— 6	8.5	16.0	14—20
7— 9	8.2	13.8	11—15
10—12	9.7	14.9	8—15
13—15	9.9	17.4	8—16
16—19	7.5	13.8	8—14

Source: Appendix I of 'Human Protein Requirements and Their Fulfilment in Practice,' Proceedings of a Conference in Princeton, 1955, FAO, Rome, 1957.

For the population as a whole, however, the NAC allowances would appear to be well within the acceptable limits. This is confirmed by Table III, which shows the percentage of calories derived from proteins for a wide range of enquiries together with the values derived from NAC and FAO allowances applied to India. The latter are clearly far too out to be applicable to normal healthy populations, but the former are seen to be well within the limits to provide a reasonable basis for judging the inadequacy of the protein content in the diet.

The fact that the NAC allowances for protein appear to provide a reasonable basis for judging the inadequacy of the dietary proteins does not, in itself, suffice to lay down standards for the quality of the diet. Fortunately, most foods rich in proteins are also good sources of other essential nutrients, and this is particularly true of foods of animal origin. It has been accordingly a custom to use the protein content of a diet, with a suitable proportion derived from animal origin,

TABLE III—PERCENTAGE OF CALORIES DERIVED FROM PROTEINS IN DIFFERENT SURVEYS

Country	Survey	Per cent Calories
Japan	National survey, 1954	13
	Kyushu, small town, 1955	14
South Africa	Bantu, near Johannesburg	11
Venezuela	National survey, 1949	14
Italy	National food use, 1950	14
Spain	Vallecas (Madrid), 1952	12
Netherlands	National food use, 1954	11
U.S.A.	National food use, 1952	13
Finland	Wood cutters	11
U.S A.	U. S. Army, 44 messes	14
U.K.	Peasants' diet in 15th Century	12.5
	Diet of St. Bartholomew's Hospital, 1687	11.9
	Navy ration in 1811	11
Morocco	Israelitic settlement, Marrakesh, 1955	11
	Israelitic settlement, Casablanca, 1955	12.5
France	Marseilles, 1953/54	12.2
	Nancy, workers, 1952/53	12.1
	Nancy, free professions, 1954/55	12.8
	Vendee, rural, 1955	11.3
	Sarthe, rural, 1957	12.5
South Viet-Nam	1960	13
India	FAO Allowances	7.6
	NAC Allowances	11.8

as a measure of the quality of diet. The problem of formulating targets for quality can therefore be approached as one of principally supplementing the protein content in the available diet, so that (*i*) it has adequate amounts and balance of essential amino acids, judged in terms of the allowances specified by the Nutrition Advisory Committee (NAC, 1960); and (*ii*) a minimum proportion of it is good quality protein of animal origin required to cover the special needs of the vulnerable groups as also to supply other essential nutrients. In well-fed countries like the U.K. about half the protein content in the average diet is of animal origin. The consensus of opinion appears to be that one-third on the average of the total protein in the diet should be of animal origin and higher proportions should be provided during growth, pregnancy and lactation. To aim at a proportion of even one-third where protein content of animal origin accounts for less than one-eighth of the total protein of some 50 grams in the average diet is clearly not practicable. To increase animal protein content in the diet even by a moderate amount implies increasing several fold the per caput availability of animal products, and the latter requires much more land per protein gram and are therefore more costly than products of vegetable origin. Even if therefore it were possible to produce the needed supplies of animal products, most people might not be able to afford them

until their purchasing power has gone up proportionately. It is also unnecessary to aim at so high a proportion as one-third because, malnutrition and protein malnutrition in particular is a condition important in infants and children, not in adults, and any deficiency in adults and in grown up children can be taken care of by providing adequate amounts of a mixture of vegetable foods. For while individual vegetable products are known to be deficient in one or more essential amino acids, a mixture is usually not. It is however a different matter with infants and children who need good quality, readily assimilable proteins to build up their tissues. Equally, the ill, the infirm and pregnant and nursing mothers need animal products with the accompanying other essential nutrients to replace quickly the tissues lost by 'wear and tear.' These considerations of minimizing the cost of the diet and yet of providing for the essential needs for animal protein and other nutrients of the vulnerable groups lead us to specify targets for quality by individual age groups, as in the case of calories. Targets so specified are shown beside those for calories in Table I.

It will be seen that targets are specified at two levels : the minimum and the moderate. Targets for calories are identical under the two levels. Targets for total proteins expressed in terms of the equivalent reference proteins are also identical, being equal to the respective NAC allowances for the various age groups. The proportions of proteins derived from animal origin however differ from one level to the other. Details are shown in Table I itself.

Broadly, the minimum level covers the needs for proteins of animal origin of infants and children below six and the partial needs of other vulnerable groups. It is admittedly very modest in that the proportion of animal protein to total protein under this level is only one-sixth to one-seventh, compared to one-half in the well-fed developed countries. But nevertheless it would appear adequate to take care of protein malnutrition in infants and children and other vulnerable groups. The moderate level in addition covers more fully the needs for animal protein of school-going children from 6-19 and provides for more adequate allowances for the other vulnerable groups with the resulting improved supplies of minerals and vitamins. Under it the proportion of animal protein to total protein in the overall diet works out to between one-fourth to one-fifth and, although still very small compared to the well-fed countries, should materially assist in ensuring distinct improvement in the nutritional status of the people. Targets under the two levels are distinguished in this way in order to envisage their attainment in successive periods with the growth in per caput national income. The difference between the two levels does not represent any intrinsic change in the per caput availability of either calories or total 'reference' proteins, but essentially emphasizes the shift in the composition of the diet intended to reduce the incidence of malnutrition in the population with the progress of development. The precise year by which one might expect to achieve the two levels would depend upon the planned rate of growth of economic development and the increase made possible as a result of development in the purchasing power of the people.

METHOD OF TRANSLATING NUTRITIONAL TARGETS IN TERMS OF FOOD

The next step is to translate the nutritional targets in terms of the quantities of different foods. There is however no unique method of doing it, since while

there are ten different food groups defining a diet, the nutrients for which the targets are specified number only three. Certain additional conditions need therefore to be imposed. The condition which seems to us reasonable in the context of the close relationship between hunger and poverty is that while meeting the nutritional targets the total food basket should cost the least to the consumer. This condition reduces the problem of computing quantities to one of linear programming and hence provides a unique solution.

Let

x_j denote the quantity per caput of food j (net) to be computed ($j = 1, 2, \ldots, 10$) ;

c_j denote the relative cost to the consumer of the jth food ($j = 1, 2, \ldots, 10$) ;

b_1, b_2, b_3 denote the targets for calories, animal proteins and total proteins (in terms of 'reference' protein equivalent), respectively ;

a_{1j}, a_{2j}, a_{3j} denote the number of calories, and the number of grams of animal proteins and vegetable proteins, respectively, in the unit quantity of the jth food (net), ($j = 1, 2, \ldots, 10$) ;

and B.V. denote the biological value of vegetable proteins available in the Indian diet relative to B.V. of animal foods.

We then have

$$\sum_j a_{1j}\, x_j \geqslant b_1$$

$$\sum_j a_{2j}\, x_j \geqslant b_2$$

$$(\text{B.V.})\left\{\sum_j a_{3j}\, x_j\right\} \geqslant (b_3 - b_2)$$

subject to the condition that

$$\sum_j c_j\, x_j$$

is minimum.

Table I gives relevant data for b_1, b_2, and b_3. As regards the values for a_{1j}, a_{2j} and a_{3j}, we have drawn upon the Food Composition Tables by Aykroyd, Patwardhan and Ranganathan.[2] Data on relative costs to the consumer of the different food groups are not readily available, but the related data on average

2. W. R. Aykroyd : The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets, Health Bulletin No. 22, Fourth Edition, fully revised by V. N. Patwardhan and S. Ranganathan, Government of India Press, New Delhi, 1951.

producer prices for the period 1952-56 expressed in the form of wheat price relatives are available. These price relatives, modified where necessary in the light of available information on consumer prices, have been used for computation in this paper.

It is a well-known fact that the solution of the problem as formulated above can yield positive values for, at most, three food groups, which is unrealistic both from the nutritional and production points of view. Additional constraints are therefore called for in order to provide realistic solutions in terms of all the food groups. Two types of constraints are necessary, of micro and macro types. The micro considerations are designed to ensure that no radical changes are introduced into the existing dietary pattern of the people in the different age groups, and where they are called for they will be introduced only gradually over years. The macro considerations mainly concern the economic and production feasibility and are designed to ensure that the computed changes are feasible of achievement and within economic reach of the people within a foreseeable future. A starting point for any solution must therefore be the existing levels of supplies for the different food groups modified as necessary to satisfy the micro and macro type considerations. As an example, it is conceivable that the target for animal proteins could be met by an increase in the supplies of fish alone which is the cheapest source of animal proteins. This however is clearly not desirable, especially for infants who need an appreciable proportion of animal protein in the form of milk. An upper limit on the quantity target for fish consistent with the dietary pattern among healthy people is therefore clearly called for. Equally, it is necessary to ensure that the overall target for fish is consistent with the production feasibility within the country. As another example, the calorie target could be met by increases in the supplies of cereals alone, entirely to the exclusion of fruits and vegetables. Any such solution to the food consumption basket, while achieving nutritional targets at the cheapest cost to the consumer, will clearly be undesirable as it would only add to the lack of balance in the diet. For this reason it is necessary to put an appropriate upper limit on the per caput supply in cereals. Furthermore, within the groups of plant and animal products it is necessary to place lower limits which are above the existing levels on some of the relatively costly products. Fruits and vegetables, for example, are the most costly source of calories and proteins among plant products, but they alone can provide many of the minerals and vitamins essential for good nutrition. Or, again, eggs are by far the most costly source of calories and animal proteins among animal products. Unless appropriate lower limits, higher than the existing supplies but consistent with what the consumer can afford and with what is agriculturally feasible, are placed on these food groups, we cannot provide for the desirable share thereof in the diets of the people. Much the same reasoning applies to the food supplies in fats which are one of the costliest items in the diet but which nevertheless are needed to improve the palatability and acceptability of diets.

Such are the considerations which have led us to formulate additional constraints in the form of lower limits for certain food groups and upper limits for others, in order to make the solutions realistic from the nutritional, economic and production points of view. An element of judgment has undoubtedly entered in putting these limits, but it is unlikely that it will seriously affect the order of magnitude of the results when dietary patterns for healthy persons of individual

age groups are available to guide in the matter. As progress is achieved in establishing standards for essential nutrients, the influence of judgment on the results will be even less important, but until then the necessity of using judgment in putting appropriate limits in the light of known nutritional patterns for individual groups and broad economic and agricultural considerations will have to be faced. In any case it seems important to stress that our object in this paper is not to work out what may be regarded as model diets—available nutritional knowledge does not permit working these out with precision. Rather, our purpose is to obtain an idea of the order of change in the quantities of individual foods needed to ensure a reasonably adequate level of nutrition to the people. These solutions to the per caput quantities of major food groups satisfying the minimum and moderate levels of nutritional targets are given in Tables IV and V for individual age groups.

It should be pointed out that although reached as solutions to the problem of linear programming, the computed per caput quantities of different foods do not quite satisfy the basic inequalities in all cases. As an example, the solution for the age group 13-19 in Table IV does not satisfy the inequality in vegetable proteins. We could easily have adjusted the solution to satisfy this inequality by increasing the quantity of pulses, but in doing so we would have exceeded the calorie supply well beyond the target. We have not done so because the NAC recommendation for protein allowances for children of the age group 13—19 is, as we already remarked, somewhat on the high side in our view. It therefore appeared to us more realistic to present the solution to the per caput quantities of different foods which gave a value for vegetable proteins lower than the target value but which satisfied the calorie target closely. The procedure adopted is equivalent to specifying a slightly lower target for vegetable proteins than the one given in Table I. The same remark holds for the solution of age group 7—12.

FOOD CONSUMPTION TARGETS AND CURRENT SUPPLIES

Table VI brings together in one place for the country as a whole the data on per caput food supplies available and needed under the minimum and moderate level of nutritional targets and the changes needed to improve the present diet to higher levels of nutrition implied under the specified targets. It also gives the resulting total values for calories, vegetable proteins, animal proteins and other indicators of the quality of diet together with the indices of per caput food required to attain the minimum and moderate nutritional targets. Table VII shows the total food supplies available and needed to attain the specified nutritional targets.

A comparison of total food supplies available and needed to attain the minimum level of nutritional targets shows that during 1956-59 India had a deficit of some 10 million tons in foodgrains, 9 million tons in fruits and vegetables, an equal amount in milk and 2 million tons in other animal products. Considering that the minimum level of nutrition is a level to which people have a right to aspire overnight as it were, these deficits imply that the basket of foods available today is barely three-quarters of what is absolutely essential for a healthy active life. The deficit is particularly large in protective foods, whose availability per person is only two-thirds of what is nutritionally desirable under the minimum target. The inadequacies in the current diet are strikingly brought out when the diet is

TABLE IV—DAILY PER CAPUT QUANTITIES OF MAJOR FOOD GROUPS SATISFYING THE MINIMUM LEVEL OF NUTRITIONAL TARGETS BY AGE GROUPS

Quantities (Q.) in g., Calories (C.) and Proteins (P.) in g.

Age Groups	< 1			1—6			7—12			13—19			20—45			>45			Average		
Food Items	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Cereals	40	141	3.3	200	706	16.4	380	1341	31.2	480	1694	39.4	500	1765	41.0	400	1412	32.8	403	1423	33.0
Starchy Roots ..	25	23	.3	40	37	.5	40	37	.5	50	47	.6	50	47	.6	50	47	.6	46	43	.6
Sugar	25	88	.3	35	123	.4	35	123	.4	50	176	.5	60	211	.6	60	211	.6	50	176	.5
Pulses and Nuts	10	31	1.9	60	188	11.5	150	470	28.8	200	626	38.4	85	266	16.3	80	250	15.4	104	326	20.0
Fruits + Vegetables	75	29	.8	125	48	1.4	100	38	1.1	150	57	1.7	150	57	1.7	150	57	1.7	137	52	1.5
Meat, Fish, Eggs	10	10	1.1	30	30	3.2	20	20	2.1	20	20	2.1	30	30	3.2	30	30	3.2	26	26	2.8
Milk* ..	135	113	5.0	460	386	17.0	150	126	5.6	150	126	5.6	160	134	5.9	150	126	5.6	201	169	7.4
Fats + Oils ..	—	—	—	5	44	—	5	44	—	10	88	—	30	265	—	25	221	—	18	159	—
Total Calories ..		435			1560			2200			2835			2775			2355			2375	
Animal Proteins			6.1			20.2			7.7			7.7			9.1			8.8			10.0
Vegetable Proteins			6.6			30.2			62.0			80.6			60.2			51.1			55.6
Per cent Calories from Proteins ..			11.2			13.4			12.7			12.5			10.0			10.2			11.0

*includes ghee and butter.

TABLE V—DAILY PER CAPUT QUANTITIES OF MAJOR FOOD GROUPS SATISFYING THE MODERATE LEVEL OF NUTRITIONAL TARGETS BY AGE GROUPS

Quantities (Q.) in g., Calories (C.) and Proteins (P.) in g.

Age Groups	< 1			1—6			7—12			13—19			20—45			> 45			Average		
Food Items	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.	Q.	C.	P.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Cereals ..	40	141	3.3	200	706	16.4	340	1200	27.9	400	1412	32.8	470	1659	38.5	400	1412	32.8	375	1324	30.8
Starchy Roots ..	25	23	.3	40	37	.5	40	37	.5	50	47	.6	50	47	.6	50	47	.6	46	43	.6
Sugar ..	25	88	.3	35	123	.4	45	158	.5	45	158	.5	75	263	.8	60	211	.6	56	197	.6
Pulses and Nuts	10	31	1.9	60	188	11.5	120	376	23.0	180	563	34.6	80	250	15.4	80	250	15.4	95	297	18.2
Fruits + Vegetables ..	75	29	.8	125	48	1.4	200	76	2.2	200	76	2.2	150	57	1.7	150	57	1.7	158	60	1.7
Meat, Fish, Eggs	10	10	1.1	30	30	3.2	50	51	5.3	80	81	8.5	50	51	5.3	30	30	3.2	47	47	5.0
Milk*	135	113	5.0	460	386	17.0	340	286	12.6	410	344	15.2	190	160	7.0	150	126	5.6	277	233	10.2
Fats + Oils ..	—	—	—	5	44	—	10	88	—	20	177	—	30	265	—	25	221	—	20	177	—
Total Calories ..		435			1562			2272			2858			2752			2354			2378	
Animal Proteins			6.1			20.2			17.9			23.7			12.3			8.8			15.0
Vegetable Proteins			6.6			30.2			54.1			70.7			57.0			51.1			51.9
Per cent Calories from Proteins			11.2			13.4			12.7			13.2			10.1			10.2			11.3

*includes ghee and butter.

TABLE VI—PER CAPUT QUANTITIES OF MAJOR FOOD GROUPS AVAILABLE AND NEEDED TO MEET NUTRITIONAL TARGETS TOGETHER WITH THE RESULTING VALUES OF CALORIE AND PROTEIN LEVELS AND OTHER INDICATORS OF THE QUALITY OF DIET

Item	Available	Needed		Per cent Needed/Available	
		Minimum Target	Moderate Target	Minimum Target	Moderate Target
	(grams per day)				
Cereals	375	403	375	107	100
Starchy Roots	30	46	46	153	153
Sugar	45	50	56	111	124
Pulses and Nuts	65	104	95	160	146
Fruits and Vegetables	80	137	158	171	198
Meat	4	7	10	175	250
Fish	7	17	32	243	457
Eggs	1	2	5	200	500
Milk and Milk Products	140	201	277	144	198
Fats and Oils	11	18	20	164	182
Calories	1970	2370	2380	120	121
Animal Protein (g.)	6.4	10.0	15.0	159	238
Vegetable Protein (g.)	48.3	55.6	51.9	115	107
Per cent Calories from Cereals, Starchy Roots, Sugar	79	69	66		
Per cent Calories from Proteins	10.4	11.1	11.3		
Per cent Animal to Total Proteins	12.4	15.2	22.4		
Overall Index	100	134	154		

TABLE VII—TOTAL FOOD SUPPLIES AVAILABLE (1956-59) AND NEEDED TO IMPROVE THE CURRENT LEVEL OF NUTRITION TO THAT IMPLIED UNDER THE MINIMUM AND MODERATE TARGETS

(in million tons per year)

Item	Minimum Target		Moderate Target	
	Needed	Deficit	Needed	Deficit
Cereals	60.8	4.3	56.5	0.0
Starchy Roots	6.9	2.4	6.9	2.4
Sugar	7.5	0.7	8.4	1.6
Pulses	15.6	5.9	14.3	4.5
Fruits and Vegetables	20.7	8.6	23.8	11.7
Meat	1.1	0.5	1.5	0.9
Fish	2.6	1.5	4.8	3.7
Eggs	0.3	0.1	0.75	0.5
Milk	30.3	9.2	41.8	20.7
Fats	2.7	1.0	3.0	1.3
Foodgrains (cereals and pulses)	76.5	10.2	70.8	4.5
Animal Products	34.3	11.3	48.8	25.8
Total Foods	148.6	34.2	161.7	47.3

compared against the food supplies needed to attain the moderate level of nutrition. The protective foods and fats and oils available per person are seen to be only a half of what they ought to be and the diet as a whole is seen to fall short of what is desirable under this target by one-third. In effect, this means that the available supplies per person in animal products, especially milk, fruits and vegetables, oils as also pulses, must be increased by at least 50 per cent to attain the minimum level of nutrition and generally doubled to attain the moderate level of nutritional target.

POPULATION GROWTH AND ITS IMPLICATIONS

The discussion so far relates to current deficits in total food supplies. With the increase in population, the total need would also increase. To calculate the latter we need to know the probable trend and size of the population during the next two decades.

The broad facts regarding India's population are as follows. Over the period 1951-61 the rate of natural increase in population was slightly over 1.8 per cent per annum compound. The current birth rate is of the order of 40, and the death rate 20, per thousand, giving a rate of natural increase of 2 per cent per annum. As against this, the rate of natural increase during the first quinquennium 1951-56 was approximately 1.6. The accelerated growth of population with the progress of the decade was the result of a fall in the death rate due to better control of public health and sanitary conditions during the two Plan periods 1951-56 and 1956-61. Measures to improve public health provided in the Third Plan are expected to bring down the death rate still further, but with the success of major schemes like malaria control already achieved the rate of fall is unlikely to be as large as in the last decade. The birth rate may also undergo a change as a result of the development of the campaign in family planning. It seems unlikely however that there would be any perceptible decline during the Third Plan period 1961-66. Family limitation implies education to a level where people can think for themselves on the attitude towards life and avail of the help and services offered by Government in translating their attitude into action. With about three-fourths of the people living in rural areas, a large majority of whom are illiterate, a successful development of the programme in family planning is therefore bound to take time. Countries of Western Europe took several decades to bring down their birth rate. There was however no acute population pressure on the land in those days, as areas outside Europe were available to colonize and expand. By contrast, the experience of the Eastern European countries and Japan has shown that the birth rate could be brought down by as much as one-fourth to one-third in the course of a decade. The difficulties are admittedly larger in India. On the other hand, ten years have already passed since the Government endorsed the policy of education in family planning and initiated active measures to implement it during the two Plan periods. Measures to further intensify the campaign with provision of supplies and services at costs within reach of the population provided in the Third Plan should help to yield perceptible results. One would therefore expect the birth rate to show an appreciable decline, at least during the second half of the current decade. It seems probable however that over the decade as a whole the reduction in birth rate may offset the decrease in death rate with the resulting average natural increase of about the same order as at present, namely 2 per cent per annum.

As for the next decade, namely 1971-81, the fall in birth rate is likely to be greater than the fall in death rate. Once the people become aware of the need and the possibilities of limiting the family size, and services and supplies within their reach are available, the campaign ought to gain momentum. We may therefore well expect an accelerated fall in birth rate during the decade 1971-81. The death rate may fall too but relatively slowly. For, once the major impact due to improvement in public health services has been made, further fall in death rate will depend on the improvement in the level of living of the people. The precise magnitude of the fall in birth and death rates can only be speculated within this broad framework. It does not however appear unreasonable to assume that the population would grow at the rate of 1.8 per cent per annum during the quinquennium 1971-76 and 1.5 per cent during the quinquennium following it, *i.e.*, 1976-81.

Population projections based on these assumptions are given as Projections I in Table VIII. We also give side by side Projections II given by the Planning Commission in their Third Five-Year Plan. As can be seen, Projection I estimates are appreciably lower than those used by the Planning Commission. It may well be that we have over-estimated the influence on the birth rate of the family planning campaign in arriving at Projection I estimates. On the other hand, the acceptance of Projection II estimates of the Planning Commission would imply that the campaign will not be waged as a nation-wide movement with the determination it demands at influencing the basic attitudes of the people towards life. Recent work by the UN Population Division on the revision of population projections suggests that the population is likely to reach the 650 million mark by 1976. This is much higher than the estimate of the Planning Commission under Projection II and would lend support to the view that Projection I estimates are probably on the low side.

TABLE VIII—PROJECTED GROWTH OF INDIA'S POPULATION

	1958	1961	1971	1976	1981
Projection I					
Population (millions) ..	413	438	535	585	630
Index	100	106	130	142	153
Rate of increase		2.0%	2.0%	1.8%	1.5%
Projection II					
Population (millions) ..	413	438	555	625	690
Index	100	106	134	151	167
Rate of increase		2.0%	2.5%	2.5%	2.0%

Projection I estimates show that with 1958 as a base, the population is expected to record an increase of 30 per cent by 1971, 42 per cent by 1976 and some 53 per cent by 1981. This means that even at the present level of diet, and under favour-

able assumptions regarding population growth, food supplies would have to be increased by approximately one-third by 1971 and by well over half by 1981. If the population were to grow according to Projection II, food supplies needed by 1981 would have to be two-thirds higher merely to sustain the population at the present level of diet. Clearly, much larger food supplies would be needed if in addition to providing for the growth in population, allowance is to be made for improving the present level of nutrition.

Estimates of the needs in total supplies can be obtained by multiplying estimates of the per caput quantities required to achieve the different nutritional targets with the projected population for the years by which nutritional targets are aimed to be achieved. These are shown in Tables IX and X. A more accurate

TABLE IX—TOTAL FOOD SUPPLIES NEEDED TO ACHIEVE THE MINIMUM TARGET BY 1971 AND 1976 AND THE MODERATE TARGET BY 1976 AND 1981

(in million tons)

Item	Available	Minimum Target				Moderate Target			
		1971	Per cent Needed/ Available	1976	Per cent Needed/ Available	1976	Per cent Needed/ Available	1981	Per cent Needed/ Available
Cereals	56.5	78.7	139	86.1	152	80.1	142	86.2	153
Starchy Roots ..	4.5	9.0	200	9.8	218	9.8	218	10.6	236
Sugar	6.8	9.8	144	10.7	157	12.0	177	12.9	190
Pulses	9.8	20.3	207	22.2	227	20.3	207	21.8	222
Fruits and Vegetables ..	12.1	26.8	221	29.3	242	33.7	278	36.3	300
Meat	0.6	1.4	233	1.5	250	2.1	350	2.3	383
Fish	1.1	3.3	300	3.6	327	6.8	618	7.4	673
Eggs	0.2	0.4	200	0.4	200	1.1	550	1.1	550
Milk	21.1	39.3	186	42.9	203	59.1	280	63.7	302
Fats	1.7	3.5	206	3.8	224	4.3	253	4.6	271
Cereals and Pulses ..	66.3	99.0	149	108.3	163	100.4	151	108.0	163
Animal Products	23.0	44.4	193	48.4	210	69.1	300	74.5	324
Total	114.4	192.5	168	210.3	184	229.3	200	246.9	216

TABLE X—TOTAL FOOD SUPPLIES AVAILABLE AND NEEDED TO ACHIEVE NUTRITIONAL TARGETS UNDER POPULATION PROJECTIONS II

(in million tons)

Item	Available	Minimum Target				Moderate Target			
		1971	Per cent Needed/ Available	1976	Per cent Needed/ Available	1976	Per cent Needed/ Available	1981	Per cent Needed/ Available
Cereals	56.5	81.6	144	91.9	163	85.5	151	92.3	163
Starchy Roots ..	4.5	9.3	207	10.5	233	10.5	233	11.3	251
Sugar	6.8	10.1	149	11.4	168	12.8	188	13.8	203
Pulses	9.8	21.1	215	23.7	242	21.7	221	23.4	239
Fruits and Vegetables ..	12.1	27.8	230	31.2	258	36.0	298	38.9	321
Meat	0.6	1.4	233	1.6	267	2.3	383	2.5	417
Fish	1.1	3.4	309	3.9	355	7.3	664	7.9	718
Eggs	0.2	.4	200	.5	250	1.1	550	1.2	600
Milk	21.1	40.7	193	45.8	217	63·2	300	68.1	323
Fats	1.7	3.6	212	4.1	241	4.6	271	4.9	288
Cereals and Pulses ..	66.3	102.7	155	115.6	174	107.2	162	115.7	175
Animal Products	23.0	45.9	200	51.8	225	73.9	321	79.7	347
Total	114.4	199.4	174	224.6	196	245.0	214	264.3	231

estimation requires that the changes due to shifts in the age and sex composition of the population should be taken into account. We have elsewhere analyzed the effect of the shift expected by 1981 on the average per caput calorie and protein requirement[3] and found that the effect on calorie requirement will be a small decrease of the order of 1 per cent, but that on protein needs will be an increase of 1 to 2 per cent. It is likely however that the decrease in calorie requirement due to shift in the age, sex composition of the population might be offset by higher requirements due to gain in body weight, should the diet be improved in the meantime. The net effect of the shift in the age, sex composition of the population is thus likely to be an increase in food supplies of 1 to 2 per cent. We have left out these refinements in estimating future needs in total food supplies under the short and medium term nutritional targets, though it is likely that they may have an appreciable influence on long-term needs.

3. P. V. Sukhatme, "The World's Hunger and Future Needs in Food Supplies," *The Journal of the Royal Statistical Society*, Series A (General), Vol. 124, Part 4, 1961, London.

FUTURE FOOD NEEDS

Achievement of the Minimum Target

We have seen that in order to attain the minimum level of nutrition the available per caput food supplies would have to be increased from about 5 per cent in cereals to 60 per cent in pulses, 70 per cent in fruits and vegetables, 120 per cent in meat, eggs and fish, 45 per cent in milk and 65 per cent in fats and oils. Although the change needed in foodgrains (cereals and pulses) amounts to only 15 per cent it accounts for some 50 per cent of the share in meeting the calorie shortage. This is in line with the basic aim of minimizing the additional cost to the consumer in attaining an improved level of nutrition. Even so, as Table VI shows, the change needed in animal products is substantial, amounting to about 50 per cent in keeping with their importance of improving the quality of diet. The large increase in fruits and vegetables also enriches the diet by providing an increased supply of vitamins and minerals.

Interpreted in terms of future needs, the minimum goals of nutrition imply that for every 10 million increase in population, India will need to raise a total of some 2 million tons of additional foodgrains, half a million tons of fruits and vegetables, and one million tons of additional animal products, mostly milk. As the annual rate of increase in population is of the order of 10 millions, this implies that India would have to raise her food availability by nearly 4 million tons annually, merely to provide the minimum nutritional needs of the additional population. If in addition to providing for the increase in population, India is also to wipe out the current deficit by say, 1971, then Table IX shows that India would have to increase the available total supplies by some 40 per cent in cereals, 110 per cent in pulses, 120 per cent in fruits and vegetables, and 100 per cent in animal products. This means that the quantity index of total food availability based on price weights specified already would have to be increased from 100 to approximately 175 by 1971 under population Projection I and to 180 under population Projection II. Table XI shows that this works out to roughly an annual geometric increase of the order of 4.5 per cent in total food supplies or 2.3 per cent in per caput supplies. The required rates of increase would be smaller when the effort to reach the desired goals of nutrition is spread over a longer period. For example, the total supplies would need to be increased by nearly 4 per cent instead of 4.5 per cent per annum and the per caput food supplies increased by 1.6 per cent instead of 2.3 per cent per annum, should the target be aimed to be achieved by 1976 in place of 1971.

The trend of increase in total food supplies over the last decade is known to be a little over 3 per cent and that of per caput food supplies of approximately one and a quarter per cent per annum. It is evident therefore that with the past trend the minimum target of nutrition cannot be achieved until about 1981. The minimum target represents a level of nutrition which as we remarked already people have a right to expect overnight as it were. With ten years of planning already over and the Third Plan in progress, it is therefore of the utmost importance to achieve it as speedily as possible. On the other hand, any attempt to push up the rate of increase in total and in per caput availability in food supplies must be accompanied by a proportionate effort to increase the purchasing power

TABLE XI—RATES OF INCREASE IN PER CAPUT PER ANNUM FOOD SUPPLIES AND INCOME AND THE CORRESPONDING TOTAL INCREASES NEEDED TO MEET NUTRITIONAL TARGETS IN 1971, 1976 AND 1981

(Base year=1958)

	Population Projection I					Population Projection II				
	Minimum Target			Moderate Target		Minimum Target			Moderate Target	
	1971	1976	1981	1976	1981	1971	1976	1981	1976	1981
Population (millions)	535	585	630	585	630	555	625	688	625	688
Per cent rate of increase in population (compound per annum)	2.0	1.96	1.85	1.96	1.85	2.3	2.3	2.3	2.3	2.3
Per cent rate of increase in per caput food supplies (compound per annum) ..	2.3	1.6	1.3	2.4	1.9	2.3	1.6	1.3	2.4	1.9
Per cent rate of increase in per caput income (compound per annum)	2.6	1.8	1.4	2.7	2.1	2.6	1.8	1.4	2.7	2.1
Per cent rate of increase in total food supplies (compound per annum)	4.3	3.6	3.2	4.4	3.8	4.65	3.9	3.6	4.8	4.2
Per cent rate of increase in total income (compound per annum)	4.7	3.8	3.3	4.7	4.0	5.0	4.1	3.7	5.1	4.4
Per cent increase in population	30	42	53	42	53	34	51	67	51	67
Per cent increase in total food	74	90	105	119	136	80	102	124	133	157
Per cent increase in animal products	94	112	128	202	226	100	125	149	222	256
Per cent increase in income ..	82	96	111	129	146	89	106	131	145	170

of the people, so that they may absorb the additional per caput availability of foods. The relationship between consumption and income at per caput level varies with the commodity and the level of income, and is generally expressed in terms of income elasticity. The coefficient of income elasticity of consumption for foods in India expressed in terms of farm value taking the price weights as specified earlier, is of the order of 0.9[4]. This means that for every 1 per cent increase in income the value of the food consumed is expected to go up by 0.9 per cent. The rate of increase in per caput income achieved during the two Plan periods was of the order of 1½ per cent. As against this, the Third Plan aims at increasing the per caput income by over 3 per cent per annum. Assuming income elasticity of 0.9 and constant prices, one could therefore expect the food consumption to increase by 2.7 per cent per annum during the Plan period. The calculation assumes that the percentage increase in food consumption is linearly related to the percentage increase in income irrespective of the level of income. However values of income elasticity for total foods at the average level of income are not known to vary greatly with the consumption function. Goreux[5] estimates that in general for a given income, the values of income elasticity for individual commodities can be indicated with one decimal accuracy. An examination of the

4. Food and Agriculture Organization of the United Nations : Agricultural Commodities —Projections for 1970, Rome, 1962.

5. L. Goreux, "Income and Food Consumption," *Monthly Bulletin of Agricultural Economics and Statistics*, Vol. IX, No. 10, 1960, FAO, Rome.

values of expenditure elasticity derived from the analysis of different rounds of the NSS during 1951 to 1956 shows that the accuracy that can be attached to the coefficient for individual commodities is probably less than 0.1, even after allowance is made for the time factor. Compared to this, the error arising from the assumption of linearity between total food consumption and income at the average income level is almost certainly smaller within the range of the change in income envisaged in the paper. Even allowing for a reduction of 0.1 in the overall income elasticity of food consumption it would appear that the expected increase in food consumption corresponding to the planned income growth of 3 per cent per caput would be higher than 2.3 per cent per annum needed to attain the minimum target by 1971.

Implications for Planning Production Targets

It is of interest to compare the per caput consumption for different foods to attain specified nutritional goals with the demand based on consumer preference and assumed rate of income growth. Such a comparison is shown in Table XII. The data for projected demand for different foods shown in this table are taken from "Agricultural Commodities—Projections for 1970" (FAO, 1962) and correspond to assumed income growth of 2.9 per cent per caput per annum. As we saw in the last section, with this income growth the overall food consumption can be expected to increase at a rate adequate enough to ensure achievement of the minimum target by 1971. The two series would thus appear to be comparable.

TABLE XII—COMPARISON OF THE PER CAPUT SUPPLIES NEEDED TO MEET MINIMUM NUTRITIONAL TARGETS WITH THOSE PROJECTED ON THE BASIS OF INCOME ELASTICITIES

Items	Available 1956-58	Needed under the Minimum Target	Based on Income Growth of 2.9%/ caput/annum + Estimated Known Income Elasticities	Coefficients* of Income Elasticity
		(grams per day)		
Cereals	375	403	428	·5
Starchy Roots	30	46	32	.2
Sugar	45	50	64	1.2
Pulses and Nuts	65	104	72	.3
Fruits and Vegetables	80	137	108	1.0
Meat	4	7	6	1.4
Fish	7	17	11	1.5
Eggs	1	2	2	2.2
Milk and Milk Product	140	201	223	1.7
Fats and Oils	11	18	16	1·2
Calories	1970	2370	2380	
Animal Proteins	6.4	10.0	10.2	
Vegetable Proteins	48.3	55.6	51.1	
Per cent Calories from Cereals, Starchy Roots, Sugar	79	69	75	
Per cent Calories from Proteins ..	10.4	11.1	10.8	
Per cent Animal to Total Proteins	12.4	15.2	16.6	

* These are taken from Agricultural Commodities—Projections for 1970, FAO, Rome, 1962.

It is important to stress the difference between the two. The method of projecting consumption based on income elasticity does not explicitly take into account nutritional considerations although it is likely that in practice the consumer may show his preference for certain foods which are nutritionally desirable. Equally the approach based on nutritional goals does not explicitly take into account consumer preference for individual commodities but the method employed for translating nutritional goals into quantities of different foods ensures that the suggested changes in food consumption do not show any radical change from the consumption pattern of the people, cost the least to the consumer and are feasible from the economic and production points of view. The table shows that the two series agree with regard to the calorie content of the total foods as also the animal protein content, but the series based on consumer preference falls short of the target for total proteins. The latter gives a higher proportion of animal protein to total protein due to very low income elasticity for pulses and the relatively high value of income elasticity of animal foods compared to other foods. There are also wide differences between the two series in their relative emphasis on the different food items. For example, the projected demand for cereals relative to pulses based on consumer preference is much higher than that based on nutritional goals. Again it would appear that a somewhat larger amount of money is spent on sugar which might better be used for the purchase of more nutritious foods. Likewise, the projected requirement for milk is higher when based on demand analysis than on nutritional and other accompanying considerations set out in the paper. As we shall show later, in view of the limited land it is unlikely that India would ever be able to produce a sufficient quantity of milk to meet consumer demand. We have consequently no alternative but to make available whatever milk we can produce, to children and expectant and nursing mothers, and attempt to meet the protein requirements of other sections of the population by increasing pulses and fish (which does not compete for land) which is precisely the principle we have observed in formulating nutritional targets.

The implications of the above comparison for planning production targets for individual foods are important. Unfortunately, the Third Five-Year Plan does not specify production targets for individual foods, except for foodgrains, to permit detailed analysis. However, "Approach to Agricultural Development in the Third Five-Year Plan," by the Ministry of Food and Agriculture (1960), gives production targets for cereals, pulses, milk and non-food crops. These targets are computed using estimated income elasticity of demand and assumed growth rate for income of 3 per cent per caput and population growth of 2 per cent per annum. The Plan in its final form as prepared by the Planning Commission incorporates only the increases for cereals as recommended by the Ministry of Food and Agriculture but not those for other foods. The Plan however gives in some detail the programme for increasing production of individual foods. An analysis of this programme suggests that the programme for increasing protective foods is very meagre compared to that for cereals. As an example, the programme for increasing milk production is so very meagre that far from satisfying the demand for milk, which is increasing three times as fast as the demand for cereals, it is grossly inadequate to cover even the basic nutrition needs of the children and other vulnerable groups. The argument which has undoubtedly weighed with the Planning Commission in not suggesting a nutritionally adequate target for milk is that any major shift in emphasis from cereals to milk production would only increase the already

heavy pressure of population on land at a time when measures to overcome under-nutrition through the easiest and cheapest method must receive higher priority. While not denying this need, to which we shall revert in a later section, one cannot but infer that the provision of so inadequate a programme for milk production during a period when the proportion of children relative to the total population is increasing can only increase the imbalance between the demand for and the supply of milk and result in a further rise in the price of milk and possibly increased incidence of malnutrition. The conclusion appears to be that if India is to attain even a modest improvement in the level of nutrition such as implied under the minimum target, then within the planned overall rate of production the imbalance between the targets for foods of animal and crop origin and that between pulses and cereals for foods of crop origin should be made good as soon as possible. This perhaps would appear to be the main direction along which the food plan during the Fourth Plan period would need to be orientated so that India will not only have eliminated calorie deficiency by concentration on increases of food-grains as in the Third Plan period, but will also have brought about appreciable improvement in quality of diet by the end of the Fourth Plan period to the extent implied under the minimum target.

Achievement of the Moderate Target

The moderate target calls for changes in the available diet which range from no change in cereals to an increase of 50 per cent in pulses, 100 per cent in fruits and vegetables, 300 per cent in meat, eggs and fish, and 100 per cent in milk. When the per caput food targets for the moderate level are compared with those for the minimum level, the changes are seen to range from a small decrease in plant products to an increase of some 40 per cent in animal products. This brings out the emphasis placed on the quality of the diet as we pass from the minimum to the moderate target. This improvement in quality is seen to be reflected in the increase of percentage of animal proteins to total proteins which in the available supplies is 12.4 and is seen to go up to 15.2 and 22.4 under the minimum and moderate targets. Correspondingly, the percentage of calories derived from cereals, starchy roots and sugar which is an inverse indicator of the quality of diet, is seen to decrease from 79 in the existing diet to 69 in the diet under the minimum target and 66 in the diet under the moderate target.

The moderate target represents what may be called a reasonably good level of nutrition to which people can rightfully aspire in the course of 15 years or so. Its achievement by 1976 is seen to call for an increase of some 125 per cent in total food supplies and of well over 200 per cent in total food supplies of animal origin. These work out to roughly compound growth rates of the order of 4.5 per cent per annum in total food supplies, and 2.5 per cent in per caput supplies. These rates are more or less the same as those needed to achieve the minimum target by 1971. We may therefore infer that continuation of the efforts needed to attain the overall rate of increase envisaged under the minimum target by 1971 should help to achieve the overall rate of increase in food supplies envisaged under the moderate level target by 1976.

EFFECT OF THE TARGETS

What would be the incidence of under-nutrition and malnutrition in the population with the attainment of the minimum and moderate level targets ?

The answer so far as under-nutrition is concerned is already contained in the section dealing with the formulation of the calorie targets. As may be recalled, the target was formulated not only with the view to closing the calorie gap within each age group of the population but also to be large enough to cope with the possible extra needs of unequal distribution. It would therefore be probably safe to infer that with the attainment of the calorie target the incidence of under-nutrition would be negligible.

As to malnutrition, the indicator we have used to measure its incidence is the proportion of total calories derived from cereals, starchy roots and sugar. With the attainment of the minimum and moderate level targets, the mean value of this indicator is expected to drop down from 0.80 to 0.69 and 0.66, respectively. In a well-fed country such as the U.K. this indicator has a mean value of approximately 0.50 with hardly any household having a value exceeding 0.80. By contrast, the mean value of this indicator for Maharashtra is 0.80 with over 55 per cent of the households having a value exceeding 0.80, so that by comparison with U. K., one in every two households in Maharashtra is malnourished. This approach suggests that the answer to the probable incidence of malnutrition with the attainment of the target lies in estimating the proportion of households exceeding 0.80 when the mean value of the indicator in the population is 0.69 and 0.66, respectively.

The observed distribution of the indicator of malnutrition among households in Maharashtra suggests that it is of the form given by

$$f(z) = \frac{1}{\beta(p, q)} \; z^{p-1} (1-z)^{q-1} \quad .. \quad .. \quad .. \quad (1)$$

where z stands for the indicator, namely the proportion of total calories derived from cereals, starchy roots and sugar ;

and $\beta(p,q)$ for the complete Beta function.

Expression (1) suggests that as the mean value of the indicator decreases, the distribution becomes less and less skew, until when the mean value is 0.50 it is symmetrical, as it probably is for well-fed countries like the U. K. Household distributions of the indicator for well-fed countries are not available, but by analogy with Maharashtra may be inferred to be of the type given by Expression (1). The precise values of the parameters in the expression would however have to be determined from the known magnitude of the variance among households in these countries.

Analysis of the food consumption surveys in limited areas in developed countries suggested that the standard deviation of the indicator was of the order of 0.10, and led us to conclude that whatever the form of distribution, at most one in every ten households would have a value of z exceeding 0.80.[6] We find no

6. P. V. Sukhatme, *Op. cit.*

means of verifying how far this estimate of the standard deviation of z holds for national distributions. The difficulty is that national food surveys such as for the U. K. do not measure consumption in individual households but only the quantity of food purchased during the week each household is surveyed. Over sufficiently long periods however the average purchases per household can be assumed to approximate closely to the average consumption per household, provided the number of households covered is large, as in fact is the case with the national food survey of the U. K. Calculations of the mean proportion of the calories derived from cereals, starchy roots and sugar on quarterly samples of national food surveyed over the past few years have provided an indirect means of estimating the standard deviation per household in the U. K. Removing the linear trend from these estimates and also the mean seasonal deviation, and treating the resulting values as the means of independent samples, each from the same universe, Clayton (1961) in an informal communication addressed to us has estimated that the standard deviation per household of the population in the U. K. is approximately 0.15. This value is of the same order as that observed for Maharashtra. It would therefore seem reasonable to infer that while the skewness of the distribution diminishes with the mean value of the indicator, the form of the distribution is probably given by Expression (1), with the variance remaining constant. The distribution curves for different values of the mean indicator with known household variance of 0.019 as for Maharashtra are shown in Chart 1. The probability of the indicator exceeding 0.80 when the population has a given mean value is represented by the area of the corresponding curve beyond the ordinate at $z=0.80$ and can be read from the chart directly in order to estimate the incidence of malnutrition. Alternatively, this probability can be obtained from the tables of the incomplete Beta function.[7] The chart shows that the incidence of malnutrition would be reduced from one in every two as at present to approximately one in every five, with the attainment of the minimum level target, and one in every six with the attainment of the moderate level target. In actual fact, the incidence of malnutrition would be smaller if the additional supplies of animal products are made available only to the needy and the protein requirements of other sections of the population are met from the increases in pulses and fish, as in fact we have suggested in formulating nutritional targets. In this context, it is instructive to study the figures for the mean value of the indicator for the different age groups under the two levels of targets. As will be seen, with the attainment of the moderate level target the value of the indicator is expected to be less than 0.60 for all age groups below 19, and that even for adults and the aged it barely exceeds 0.70.

LONG-TERM TARGET AND FOODS NEEDED TO ACHIEVE IT

The achievement of the minimum level target by 1971 and the moderate level target by 1976 presupposes that additional supplies of animal products would be administered to the needy as proposed in the formulation of these targets. Although such feeding programmes have been successfully undertaken in the developed countries through schools, clinics and hospitals, their implementation under Indian conditions is bound to take time before the entire needy population

7. Karl Pearson : Tables of the Incomplete Beta-Function, prepared under the direction and edited by Biometrika Trustees, Cambridge, 1956.

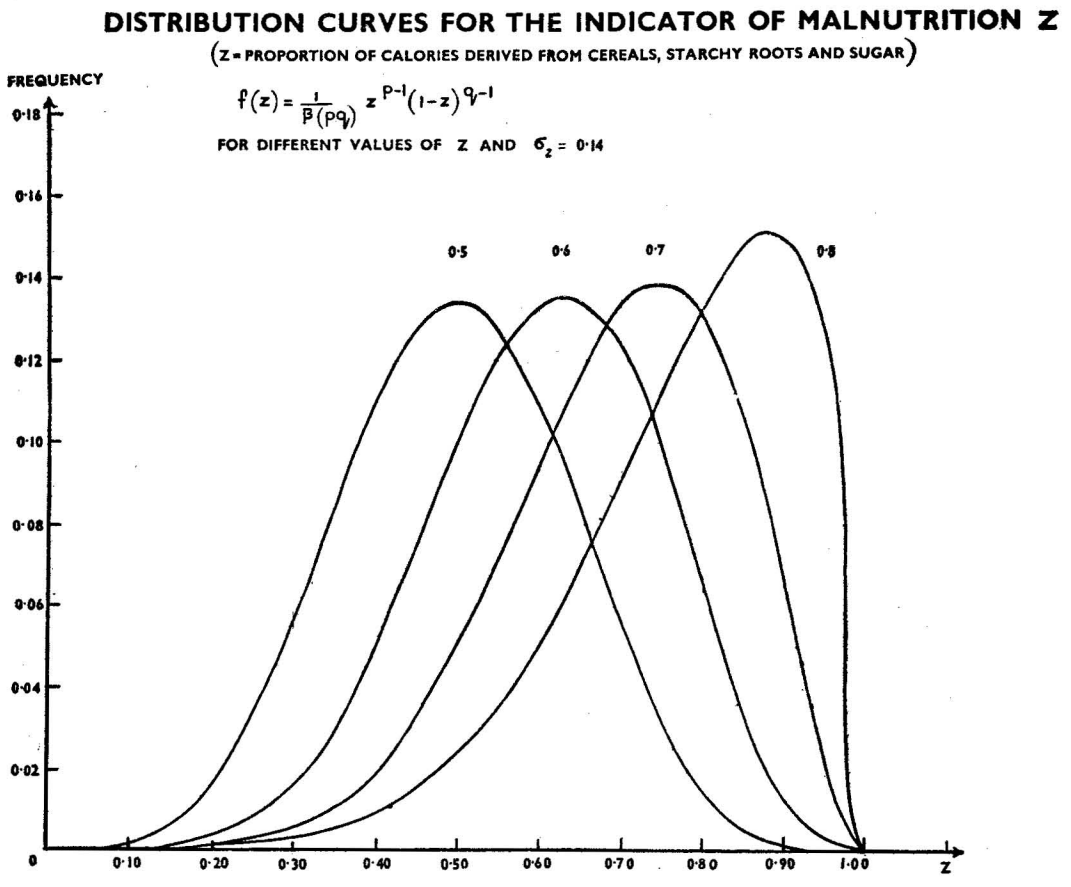

CHART 1

can be covered. The cost of administering such a programme is likely to be particularly heavy and has in fact been the main deterrent in tackling malnutrition in this manner. In practice, the usual economic considerations would largely determine the distribution of available supplies between households of different income levels. Within households also, the earners may often satisfy their needs at the expense of the needy ones. Apart from education in sound nutritional practices, the ultimate remedy for reducing malnutrition therefore lies in increasing as quickly as possible the purchasing power of the people to a point where they can absorb the needed supplies in animal products. It follows that much larger supplies in animal products than needed to attain the minimum and moderate level targets, would have to be made available to ensure a reasonably adequate level of nutrition to the people. Some idea of this order can be obtained by proposing a higher target for animal protein content in the diet of say, 20 g. per caput per day. Such a target would necessarily be a long-term target since it is unlikely that it can be attained in less than 20 years. We must accordingly visualize higher levels for the calories and total protein requirements, for with the improvement in the diet these requirements are also expected to go up due to gain

in body weight and stature. We shall assume that the calorie and protein requirements would go up by approximately 5 per cent, which would roughly correspond to the assumption of an increase of 5 Kg. in the body weight of the adult reference man. In particular, we shall assume that the calorie requirement under the long-term target would be 2450 and the protein requirement in terms of the present day dietary pattern, 75 g.

Table XIII shows the supplies needed under the long-term target and the changes needed to improve the present diet to the level of nutrition implied under

TABLE XIII—PER CAPUT QUANTITIES OF MAJOR FOOD GROUPS NEEDED UNDER THE LONG-TERM TARGET TOGETHER WITH THE CALORIE AND PROTEIN LEVELS AND OTHER INDICATORS OF THE QUALITY OF DIET

Item	Grams per caput/ day	Calories per caput/ day	Proteins per caput/ day	Index Needed/ Available
Cereals	375	1324	30.8	100
Starchy Roots	46	43	.6	153
Sugar	60	211	.6	133
Pulses and Nuts	90	282	17.3	138
Vegetables and Fruits	200	76	2.2	250
Meat	14	22	1.9	350
Fish	70	43	6.2	1000
Eggs	6	9	.7	600
Milk and Milk Products	300	252	11.1	214
Fats and Oils	22	194	—	200
Total Calories		2456		
Animal Proteins			19.9	
Vegetable Proteins			51.5	
Per cent Calories from Cereals, Starchy Roots and Sugar ..		64		
Per cent Calories from Proteins		11.6		
Per cent Animal to Total Proteins			27.9	
Overall Index: Total Foods ..	175			
Overall Index: Animal Products	292			

it, together with the resulting total values for calories, proteins, other indicators of the quality of diet and the overall index of per caput food needed to attain it. As can be seen, the attainment of the long-term target calls for an increase in the overall index of per caput food from 100 to 175 and that in animal products from 100 to approximately 300. Expressed in terms of total needs this means that even under the population Projection I, overall supplies would have to be increased by some 170 per cent by 1981 and those in animal products increased by some 350 per cent. The increases needed would be larger if the population were to grow faster as under Projection II, and when the effort to achieve the target is spread over longer periods. For example, should the population grow according to the UN medium assumption which places India's population at about one billion, by the year 2000, then the total food supplies would need to be quadrupled and those in animal products increased to seven times their present size in order to ensure a reasonably adequate level of nutrition to the people.

The implications of these phenomenal increases in terms of annual growth rate are worked out in Table XIV. Assuming that one aims at realizing the long-term target by 1981, the annual rate of increase in total food supplies would work out to roughly 4.4 under Projection I and 4.9 under Projection II. In other words, the attainment of the long-term target by 1981 would call for a continuation of efforts on even a larger scale than under the Fourth and Fifth Plan periods. Even if the effort at realizing the long-term target were spread out to 1991 or the year 2000, the rates of increase in total food supplies needed are substantial, approaching 4 per cent and 3.5 per cent, respectively.

TABLE XIV—RATES OF INCREASE IN PER CAPUT PER ANNUM FOOD SUPPLIES AND THE CORRESPONDING TOTAL INCREASES NEEDED TO MEET THE LONG-TERM NUTRITIONAL TARGET IN 1981 AND 2000

(Base year=1958)

	Projection I		Projection II	
	1981	2000	1981	2000
Population (millions)	630	836	688	1000
Per cent rate of increase in population (compound per annum) ..	1.85	1.7	2.3	2.1
Per cent rate of increase in per caput food supplies (compound per annum)	2.5	1.35	2.5	1.35
Per cent rate of increase in total food supplies (compound per annum)	4.4	3.1	4.9	3.5
Per cent increase in population ..	53	102	67	142
Per cent increase in total food ..	168	254	192	324
Per cent increase in animal products	347	490	388	607

With the attainment of the long-term target the proportion of total calories derived from cereals, starchy roots and sugar is expected to drop down to approximately 0.64. Assuming that the distribution of food among people is governed by the same economic and other considerations as at present, one would expect by reference to Chart 1 that the incidence of malnutrition would be reduced by about two-thirds. In other words, the incidence would be reduced from one in every two as at present to one in every six. The incidence of malnutrition might well be smaller than one in every six if education in home economics and nutrition would make an impact on the population to the extent of bringing home to them the value of mixed vegetable foods to supply the protein and other nutrient requirements of adults and the need for reserving the costly animal proteins for the vulnerable groups.

POSSIBILITIES OF RAISING THE NEEDED FOODS

Can India achieve the increases in food supplies of the order indicated in the preceding section in order to ensure a reasonably adequate level of nutrition to her people ? Viewed in the context of the anticipated demand based on estimated income elasticities and current plans of increasing national income, at the rate of over 5 per cent per annum, it ought not be unduly difficult to make available to the people the specified increases in food supplies with appropriate planning and policy measures to implement such a programme. The policy of conserving foreign exchange for importing capital equipment however makes it necessary that these supplies should be raised from domestic production as far as possible. In this section we shall examine whether the needed supplies can be raised soon enough from the acreage in the country. As the question has already been studied in considerable detail by the Planning Commission and in other reports, we shall deal with it here only briefly.

There are three principal ways of raising the needed foods : (*a*) by extending the area under land and water use ; (*b*) by increasing crop and livestock yields ; and, (*c*) by reducing losses. Table XV shows that only about 10 per cent of

TABLE XV—STATISTICS OF LAND USE BY REGIONS

Regions	Per cent of Total Area				Per Caput	
	Under Cultivation	Meadows + Pastures	Forests	Other	Cultivated	Other
					acres	
Far East (Incl. China)	18	13	23	46	0.6	1.5
Near East	7	17	11	65	1.5	15.0
Africa	9	23	26	42	2.6	12.4
Latin America ..	5	18	48	29	1.3	7.4
North America ..	11	13	34	42	2.9	11.4
Europe	31	16	30	23	0.9	0.7
U.S.S.R.	10	17	39	34	2.6	9.0
Oceania	3	53	6	38	5.2	60.1
World	10	19	30	41	1.2	4.6
India	48	4	15	33*	1.0	0.6*

* Of which 20 per cent is reported as unused but potentially productive and 80 per cent as built-on area and uncultivable.

the world's land is under cultivation and suggests that *prima facie* there must be considerable scope for bringing new land under cultivation. This certainly seems true of thinly populated regions like Africa and Latin America, but not of India which, as the table shows, has already about half of its total area under cultivation. Moreover, with only 4 per cent of its total area under grasses and 15 per cent under forests, where much larger proportions are needed to feed the livestock and to exercise a moderating influence against floods and erosion as the corresponding data for agriculturally developed areas like Europe and North America would show, the difficulty of finding spare land is evident. Of the 31 per cent, or roughly 250 million acres classified as 'other land' it is estimated that only some one-fifth or 50 million acres are potentially productive. The reclamation of this new land will however call for capital, heavy equipment and enterprise if it is to be brought under cultivation profitably and soon enough. Further, it will be necessary to provide efficient administrative organization for technical services and appropriate institutional set up in order to ensure a sustained functioning of productive enterprise in the areas so brought under cultivation.

The other method of extending acreage under cultivation is double cropping. Of the total cultivated area of some 400 million acres, some 50 million acres are double cropped. The limiting factor to the extension of area under double cropping is water. As irrigation is extended India should be able to extend her double cropped area. The area under irrigation at present is some 60 million acres but according to the Planning Commission it could be extended to something of the order of 175 million acres. This would mean that with the realization of irrigation potential India should be able to bring under double cropping well over 100 million additional acres.

Some additional areas could also be brought under double cropping from unirrigated areas receiving good water supply from rainfall but estimates are not easy. It is clear however that compared to the possibilities of the extension of double cropping in irrigated areas the scope provided for by unirrigated areas can only be of a very small order.

The pattern of land use under double cropping shows that the crops most suited to growing as second crops are pulses, legumes and grasses. These are protein-rich crops needed by India's people and cattle for their nutrition. However any such programme of extending double cropping would require speedy integration of livestock with crop farming and efficient organization for technical services. Since the newly reclaimed land will usually be of low fertility suited largely to the growing of minor cereals and the double cropped area suited mostly for pulses and legumes, it follows that India will have to raise the needed food supplies in major cereals partly by increasing the output of her arable land through intensive farming and partly by extending acreage by freeing a proportion of land now under minor cereals by diverting them to the newly reclaimed areas. However, as we shall see later, the possibility of extending acreage is small, so that most of the needed supplies in major cereals will have to be found by increasing production per acre.

Evidence available indicates that there is large scope for increasing the yield per acre through the adoption of intensive methods of cultivation. Although

the average yield per acre in India is among the lowest in the world, there is large variation in the country with some farms giving yields comparable to the best in the world. The large variation of yields is due to a variety of factors. Sometimes this is due to the use of large doses of manures and fertilizers. In other cases it is due to the use of improved varieties. Yet in other cases the differences are due to differences in farm practices, better drainage, better tools, etc.

Taking fertilizers first, the amount of N+P+K nutrients per acre of arable land used in India during 1956-58 was only a little over 1 lb. compared with 70 lbs. in France, 120 lbs. in U.K. and 225 lbs. in Japan in the same period. This large variation in fertilizer use is reflected in the yield-rate which for grain crops is very small compared to that on other crops especially in India, it is a powerful causative factor and does seem to provide an index of yield per acre.[8] This is confirmed by evidence in India which shows that even a small application of fertilizer dose gives appreciable response. As an example, results of 2,692 sample trials on paddy conducted during 1953-56 at 22 centres distributed over all the paddy-growing areas of the country showed that an application of 20 lbs. of N can give an average response of 350 lbs. per acre and that an increase in dosage from 20 lbs. of N to 40 lbs. of N can bring a further increase of some 150 lbs. per acre.[9] Applications of phosphates give somewhat smaller response being some 300 lbs. for 20 lbs. of P_2O_5 and give an additional response of 200 lbs. when applied over 20 lbs. of N. Applications of 40 lbs. of N+20 lbs. of P_2O_5 give well over 600 lbs., response to potash was however smaller and localized. Responses to fertilizers and farm manure were additive. Similar though slightly smaller responses are reported from experiments on wheat under irrigated conditions with N and other nutrients when sensibly used with N.[10] Response under unirrigated conditions on wheat and other foodgrain crops is less than under irrigated conditions, and indicates that as irrigation is extended there would be further addition to the yield rate with fertilizer application. These results show that if the entire area under foodgrain crops were to be covered with fertilizers, then even a moderate application at a rate of 20 lbs. of N can bring in an additional production of 25 million tons, and that an application at a rate of 40 lbs. of N would bring in an additional 40 million tons. In other words, fertilizer application alone under existing conditions would bring about an increase in foodgrain production of between 33 to 55 per cent. The increase would be much larger if, as one expects, fertilizer application brings with it improved cultural practices and improved husbandry. Such an increase naturally presupposes that the technological possibilities of extending irrigation are fully realized and that if the full benefits of this extended irrigation are to be reached in actual practice, the availability of fertilizer nutrients would have to be raised to at least 30 times the quantity available today. This estimate tallies well with that of the Planning Commission which places the eventual requirements of chemical fertilizers at 4 million tons of N, 2 million tons of phosphates and a million tons of potassic fertilizers.

The use of improved seed also presents large possibilities. Although seed farms have been established in most of the development blocks, these need to

8. F. W. Parker : Fertilizers and Economic Development, F.A.O., Rome, 1962. See also M. S. Williams and J. W. Couston: Crop Production Levels and Fertilizer Use, F.A O., Rome, 1962.
9. Indian Council of Agricultural Research : Fertilizer Trials on Paddy, New Delhi, 1959.
10. Indian Council of Agricultural Research : Fertilizer Trials on Wheat, New Delhi, 1959.

be increased several fold in order to meet adequately the needs for the multiplication of improved varieties of seed and distribution thereof at the gates of the farmers. Furthermore, hybrid maize and sorghum seed offer large possibilities of increasing the yield per acre. If research is intensified for evolving improved seed suited to the local conditions and steps are taken to cover the entire agricultural area with the seeds so evolved, one can, as a very conservative estimate, expect a further increase of some 10 to 15 per cent in the yield levels.

Even after the possibilities for extending irrigation are fully realized about half of the cultivated land will depend upon rainfall so that soil and moisture conservation measures would have to be implemented by mobilizing local labour, thereby bringing further gains in yield. At a very conservative estimate, therefore, we expect that the productivity per acre of foodgrain crops can be pushed to one and a half its present size and possibly much higher, the degree of success depending upon the efficiency with which the different programmes for agricultural development are properly integrated and executed in practice. As improved husbandry gains footing and soil fertility is built up through organic manures, we may well expect further continuing increases in land productivity. And finally losses in the field and in storage in the warehouses and homes are known to be so large that here again possibilities definitely exist of substantially reducing them through the widespread use of insecticides and of improved storage and processing methods. We may therefore conclude that as far as foodgrains are concerned India has an adequate potential to provide for her growing population with the supplies needed for the next 20 years to bring the level of nutrition of her people to that implied under the moderate target. The actual accomplishment and the speed would however depend upon (1) capital and technical knowledge for extending irrigation, for producing fertilizers and pesticides and building storage facilities ; (2) provision of credit to acquire farm requisites and of facilities for marketing the farmer's produce ; and (3) education of the farmer and appropriate incentives to arouse his enthusiasm for adopting improved agricultural practices to raise the productivity of his land. With goodwill and international assistance the first of the above factors should not present too great a difficulty. The second is more difficult of solution. It calls for setting up an appropriate organization for providing credit and for marketing the produce and implies rationalization of farming, which is inconceivable without some radical changes in the prevailing set up. As an example, a large expansion of employment opportunities in non-agricultural industries is an essential pre-requisite to rationalize farming. The third in our view is likely to be the limiting factor. A farmer brought up in the traditional method of farming is apt to resist changes in farming practices and social changes designed to eliminate small, uneconomic and fragmented holdings. On the other hand, without these changes a farmer will be handicapped in better utilizing his land and input resources. Measures to introduce sound tenure systems, provision of adequate economic incentives and an organized effort to educate and guide the farmer are essential to help in overcoming his inertia in raising the productivity of his land.

Turning next to the needs in protective foods we see that the achievement of the minimum target by 1976 would call for increasing their production by well over 100 per cent. This is a big task, calling for intensive and organized efforts at all levels. Nevertheless, its achievement does not appear to be outside the

range of present possibilities in so far as we can assess them in general terms. As an example, large variation is known to exist in the production per acre of fruits and vegetables showing large scope for increasing production, especially on the periphery of urban areas with readily available outlets for marketing, using intensive methods of agriculture.

Again, India has a large coastline and also abundant inland water resources. She has already developed requisite scientific techniques for raising the productivity of her inland fish ponds. Although the spread of these techniques would take time it does not seem unduly difficult for India to take care of her increased needs in fish production by 1976 provided that simultaneously with the increased production demand is created through appropriate development of marketing, storage and processing facilities.

Although eggs are the most costly source of animal protein in India at present, it has been demonstrated in other developing countries that by good feeding and management and proper disease control total production as well as efficiency of production can be increased greatly with an appreciable lowering of cost. The establishment of processing plants for fallen animals can, by providing animal protein for poultry, do much to further poultry production.

The most difficult problem is that of increasing milk production, and yet this is the most important and urgent problem since milk is about the only acceptable source of good quality protein in the country, especially for children, with its additional value as protective food to supply minerals and vitamins and also animal fat which is grossly inadequate in the Indian diet. India has about one-fifth of the world's cattle population and most of it is under-nourished as can be seen from their emaciated appearance. Malnutrition is even more widespread among them. This is evident from the low milk yield, the late age at which they mature, their slow growth rate and large dry periods, and are suggestive of serious shortage of protein-rich feeds like green fodder and concentrates such as oilcakes, cottonseed and maize, gram and barley.

The three main lines of improving the productivity of cattle are breeding, disease control and nutrition. Improvement through breeding necessarily takes a long time and moreover is effective only when the cattle are fed with adequate and balanced ration. Castration of unproved bulls and weeding out or segregation of useless and unproductive cattle which are also a part of the breeding programme should however be quick to accomplish if carried out with the determination and urgency which they demand. Animal diseases seem fairly under control although much work needs to be done in eradicating the endemic foot-and-mouth disease which saps the animal of its vitality for appreciable periods every year. The quickest way of increasing milk yield is by better nutrition. Abundant evidence is available to show that milk yield can be increased at least 50 per cent and in many cases even be doubled through better feeding and management.[11] If in addition to providing adequate and balanced rations to India's cattle a long-

11. V. C. Wright : Report on the Development of the Cattle and Dairy Industries of India, Manager of Publications, New Delhi, 1937.

term programme of improvement through breeding is undertaken there definitely exist possibilities of more than doubling and even trebling the existing milk supply. Such a programme however presupposes as we shall see in the succeeding paragraphs simultaneous implementation of a number of measures such as removal of excess cattle, integration of livestock with farming production of the requisite feedstuffs and adoption of intensive agricultural practices to increase the output per acre.

The principal feedstuffs needed for milk production are green fodder and concentrates. Rough calculations based on nutrient requirements for maintenance, growth, work and milk show that some 20 million tons of digestible proteins, 250 million tons of total digestible nutrients and 450 million tons of dry matter are required in order to put the present numbers of cattle in adequate shape for work and to double the milk production. Further, of the total needs of 20 million tons of digestible protein it is desirable that some 6 millions should be derived from feedstuffs with high nutritive ratio. The available amounts of these feedstuffs are estimated at about 2 million tons only and are mostly fed to the bullock population. Since feedstuffs with high nutritive ratio like green fodder (berseem and alfa-alfa) and concentrates are essential for increasing milk production, India's problem of securing the requisite increases in milk production essentially becomes one of supplementing the available feed resources by green fodders with high nutritive ratio and concentrates. To meet these requirements we estimate that India would need to approximately double the production of maize, gram and cottonseed, increase the production of oilcakes to two and a half its present size, and bring some 15 million acres under green fodder grown under conditions of perennial irrigation. At the current levels of yield per acre, this implies that India would need to bring an additional 10 million acres under maize, 25 million acres under gram, some 20 million acres under cotton and 45 million acres under oilseeds, besides putting some 15 million acres under green fodder. The acreage needed for maize and gram could be found by growing them in rotation in irrigated areas of which only some 20 per cent is currently used for taking second crops. In any case, as irrigation is extended and improved husbandry gains footing with pulses and legumes grown in rotation as second crops, it should be possible to find the extra acreage needed for maize and gram production. The acreage needed may well be less than 35 millions, since 'hybrid' maize and intensive cultivation offer considerable scope for increasing the yield level. The acreage needed for green fodder will have to be found partly by freeing a proportion of land now under cultivation under irrigated conditions and partly with the extension of irrigation by shifting minor cereals now grown under non-irrigated conditions to newly reclaimed areas or by growing them as second crops. Part of the additional production of cotton and oilseeds may have to be found in the same way, but the major part of the additional production of these crops would have to come from intensive cultivation of the area already under cotton and oilseeds. Experimental evidence on cotton and oilseeds shows that as in the case of rice and wheat, the yield can be raised by well over 50 per cent through the application of intensive methods of farming in irrigated areas. Apart from the needs of animal feeding, increases of these orders in cotton and oilseed production are also needed for human consumption of the growing population, as seen in Table IV. Altogether, it would appear that the requisite potential for doubling milk production definitely exists in the country and that if this potential

could be realized before 1976 it should enable India to meet her minimum needs for milk.

To attain the moderate level of nutrition however the production of milk would have to be trebled by 1976 and increased by higher amounts in the years thereafter in order to keep pace with the growth of population. Increases of this order do not seem feasible with the available resources of land without reduction in cattle numbers. Rough calculations show that if the cattle numbers could be reduced by one-fourth, the extra feedstuffs with high nutritive ratio needed for trebling milk production can be found from saving the equivalent resources in land needed for doubling of milk production with the present cattle numbers. This however involves a change in attitude towards the cattle slaughter and, secondly, appropriate institutional changes to facilitate the introduction of mechanical power for farm and transport purposes on a scale adequate enough to replace the bullock population by at least a quarter of their numbers. To prepare public opinion for cattle slaughter is far from easy, in view of the religious considerations involved, but the trend of educated opinion is gradually favouring such a course. It is not however adequate to confine attention to stray, unproductive and old cattle, as they do not compete to an appreciable extent for additional land. Cows which are maintained primarily for providing the necessary bullock power rather than milk for human consumption will also have to be slaughtered if they are not economically productive. Such a course may however disturb the balance between the bullock and the cow population and it will therefore be necessary to change from bullock power to mechanical power at least to the extent needed to bring the bullock population in balance with the cow population. Alternatively, the cattle breeding programme will have to be reoriented to enable India to cut down the calving interval to compensate for the reduction in cattle numbers.

Even for doubling of milk production it will be necessary to ensure that farming is integrated with livestock and productivity is raised to at least 50 per cent of its current level through extension of irrigation and intensive methods of farming. Furthermore, it must be stressed that milk production is scattered, needs to be collected through co-operatives of cattle owners for pasteurization in plants and for marketing on organized basis to provide the farmer with the incentives necessary for adopting measures to increase milk production. Altogether the task calls for a stupendous effort. In this connection it is often said that milk production requires much more land per calorie than foodgrains and is therefore not profitable. The argument presupposes that cattle for milk production compete for land equally with foodgrains needed for human consumption. The argument is not wholly valid. The energy needed for the maintenance of present cattle numbers is largely provided by straw which is already available in the country. Additional land is needed mainly for producing fodder and concentrates and even here in the case of some of the concentrates like cottonseed and oilseed, the livestock are in fact usually the consumers of the unedible by-products. As Wright[12] puts it, "While Man consumes the refined flour of the wheat grain, animals subsist on the coarser milling offals and the straw; where Man derives his margarine from oilseeds, animals utilize the unpalatable cake and meal; where Man extracts his

12. N. C. Wright, Hunger : Can it be averted ?, *Op. cit.*

sugar from the beet, animals thrive on the rejected tops and pulp; where Man selects the choicer portions of the carcass, animals fulfil the role of scavengers in disposing of the offals of the slaughterhouse; where Man regales himself with beer, animals enjoy the cognate test of brewers' grains." India however just does not produce enough of the cotton and oilseeds and carcass to meet Man's needs, and to that extent India's cattle are starved of the essential feeds needed for milk production. Additional land is needed mainly for growing green fodders and concentrates. It is therefore clear that in producing a major part of the needed foodstuffs for animals, Man will in fact be helping himself not only by providing him with the needed foods of animal origin but also by contributing to the improvement of the productivity of his land by relieving the pressure on grazing lands thereby aiding in better soil management, by increasing the efficiency of draft animals and by providing more manure. This in fact is the way agriculture progressed in the developed countries. We may therefore well expect that as the market for milk is organized and the costs of maintenance relative to milk production is reduced through reduction of cattle numbers, in so far as this is feasible with reorganized agriculture, the farmer may find that milk production is a rewarding occupation.

We have so far dealt with the conventional methods of increasing production. There are also other possibilities, mostly unexploited or under-exploited, for getting more foods as from synthesis of natural foods and developments of yeasts and algae and similar micro-organisms. These sources are however mostly for the future, probably beyond the year 2000.

To summarize, India would appear to have adequate agricultural potential to ensure a minimum level of nutrition to her people over the next twenty years. It is doubtful whether the food supplies in animal products, especially milk, needed to attain the moderate target could be raised internally without far-reaching measures, especially if the attainment of this target be delayed beyond 1980. By then, however, the shape of the picture for years beyond will have become clearer. Should, in fact, India succeed in raising the productivity of her land and cattle to approach the level of nutrition implied under the moderate target this in itself might show the way to bring about further increases in productivity with the technology of 1980 in order to keep pace with the growth in population. Should on the other hand it be clear that India has about reached the limits of her food potential, India may well have to intensify her drive to educate people in family planning. In the meantime social and educational advance which will have occurred between now and 1980 will itself begin to influence parents into limiting the size of their families.

It is in this context that India's reaffirmation in her Third Five-Year Plan of stabilizing the growth of population to bring it in balance with her resources must be welcomed. It is important however to appreciate the scale of effort involved in implementing this policy. Stabilization of population implies that India which has currently a birth rate of around 40 per thousand would have to reduce it to a level which equals the current death rate of 20 per thousand and which is likely to decrease even further in the years ahead with the general advance in public health. In other words, it implies a reduction in birth rate by more than one-half. A reduction of this order is hardly feasible especially among the rural

masses, the majority of whom are illiterate, without an effort almost amounting to a revolution in the educational and social field. In the meantime India's hope of improving the level of nutrition of her people lies in realizing the agricultural potential as quickly as possible. The speed with which India can increase the productivity of her land and cattle and simultaneously bring about an educational and social advance which would affect the people's attitude towards life would thus seem to us the essence of the problem of food and nutrition in India and would determine whether in the immediate years ahead India would be able to bring about a reasonable improvement in the levels of nutrition of her people or face an increasingly precarious situation in the form of lower levels of nutrition.