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A PLAN FOR IMPROVEMENT OF NUTRITION OF INDIA'S POPULATION

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INTRODUCTION

The objective of the Five-Year Plans launched in India in 1951 is the improvement in the living standards of the people. Improved standards necessarily imply a reasonably satisfactory level of nutrition. It has been estimated that the per capita per day requirement for the Indian population is 2,100 calories of energy and 61 grams of protein as calculated by Panse (1961), on the basis of the scales prescribed by the Nutrition Advisory Committee (Patwardhan, 1960). As against this the per capita per day availability of calories and proteins averaged over the three years 1956-57 to 1958-59 was estimated by him to be 1,900 and 49.3 grams respectively. The deficiency is particularly striking in respect of proteins and serious for proteins of animal origin which are essential for satisfactory growth and tissue repair. The average Indian diet includes only about 6.7 grams or 13.6 per cent of animal proteins per head per day. The average proportion of animal protein to total protein is a key indicator of the status of nutrition of a population. Even in the dietary of the other relatively less well-fed countries of the world this proportion is higher, being 15.5 per cent. In the materially well-off countries it is as high as 49 per cent (Sukhatme, 1961). Further, Sukhatme (1962) has shown that even with the modest aim of meeting the needs for animal proteins of infants and children below six years of age and the partial needs of other vulnerable groups such as the ill and the pregnant and nursing mothers, a minimum amount of 10 grams of animal proteins together with 56 grams of vegetable proteins will have to be provided per day per head of India's population. Sukhatme has worked out by the application of linear programming technique the least cost combination of the quantities of major food groups needed per head per day to meet what he calls the minimum nutritional target of 2,370 calories and 66.6 grams of proteins including 10 grams of animal proteins. These quantities are reproduced in Table I for reference. The allowances for calories and proteins, also based on the recommendations of the Nutrition Advisory Committee, are slightly larger than those calculated earlier by Panse for the reason that the wastage of food between the physiological and retail levels and the unequal distribution of food among economically different groups of the population have been taken into account by Sukhatme. We accept the minimum targets proposed by Sukhatme as the foundation for a food production policy for the coming 10 or 12 years.

It will be seen from Table I that it is necessary to increase production of each and every group of items of food in order to make up the deficiency in achieving this policy. Although the emphasis on improvement in agricultural production continues to figure in the successive Five-Year Plans, the gap between the availability of food and requirements even to satisfy the minimum nutritional needs will widen as time progresses on account of the continuous growth of the population, unless a really determined drive is made according to a clearly laid

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TABLE I—PER CAPITA QUANTITIES OF MAJOR FOOD GROUPS AVAILABLE AND NEEDED TO MEET MINIMUM NUTRITIONAL TARGET

Item	Quantity per Day (grams)	
	Available	Needed
Cereals	375	403
Pulses and Nuts	65	104
Starchy Roots	30	46
Sugar	45	50
Fruits and Vegetables	80	137
Meat	4	7
Fish	7	17
Eggs	1	2
Milk and Milk Products	118	201
Fats and Oils	11	18

out programme of action. Unless this could be done, the present nutritional position in India, where according to Sukhatme, one in every four persons is underfed and one in every two malnourished, will steadily worsen and the task of lifting the Indian population to a minimum desirable level of nutrition will become increasingly impossible. What is necessary is to concentrate all efforts on a few key food items and aim at achieving the targets in respect of them over the next few years, without, of course, reducing the present scale of development of other items. We believe, in fact, that the momentum generated by concentrating a special drive on certain key items will have the effect of speeding up the tempo of an all round agricultural improvement. From this standpoint we have confined this paper to a study with the limited objective of bridging the gap between availability and requirement in respect of cereals, pulses and milk, at the end of Third, Fourth and Fifth Five-Year Plan periods. The vital position of these food groups in any plan of nutrition for Indian people can be realised easily. Over 60 per cent of the calories as well as proteins in the Indian diet are derived today from cereals alone and the contribution of pulses is needed to be increased in order to augment the supply of proteins in a diet which is predominantly vegetarian and will continue to be so in the foreseeable future. Milk is the only universally accepted source of animal protein in this diet and its supply must be augmented to raise the proportion of animal protein to a minimum desirable level. The present paper sets out the specific manner in which the production of cereals, pulses and milk can be stepped up to meet the requirements and the measures necessary to achieve this aim. It is assumed that in the course of normal development some increase in production of items like fats, meat, eggs, and protective foods such as fruits and vegetables, etc., which are at present particularly in short supply will also take place.

CEREALS AND PULSES

Additional requirements : It will be seen from Table I that 403 grams of cereals and 104 grams of pulses are required per capita per day to meet their contribution to the minimum nutritional target. In accordance with these stan-

dards the total amounts of cereals and pulses which would be needed at the end of the current and subsequent Five-Year Plans are given in Table II. The figures of projections of population worked out by the Central Statistical Organisation taking into account the actual census figures for 1961 are assumed for the estimation. Other projections based on a smaller rate of increase in the population have been worked out on the assumption of a reduced birth rate resulting from family planning and other measures: but it will take much longer than a decade before any sensible effect of these measures is felt on population growth. With only a minimum nutritional target an under-estimation of food requirements through the use of lower population projections would have grave consequences.

TABLE II—PRESENT AVAILABILITY AND REQUIREMENTS OF CEREALS AND PULSES FOR HUMAN FOOD AT THE END OF THIRD, FOURTH AND FIFTH PLANS

Year	Population (millions)	Cereals Required	Pulses Required
		(million tonnes)	
1959-60 to 1961-62	438 (1961 census)	58.5*	10.5*
1965-66	492	72.4	18.7
1970-71	555	81.6	21.1
1975-76	625	91.9	23.7

* Present availability. One tonne = 1,000 kg.

It is estimated from marketing surveys that 12½ per cent of the production of foodgrains is utilized for purposes other than food such as seed, animal feed, wastage and manufacture of non-food products. Hence the gross production to be aimed at must be one-seventh more than what is actually available for human consumption, and is shown in Table III. The more reliable recent estimates from the sample surveys carried out by the Institute of Agricultural Research Statistics show that a much higher proportion of pulses is utilized as cattle feed than is allowed for conventionally. Nevertheless, the allowance to be made for cattle feed has been kept at the conventional level of 3 per cent of the production of pulses in the present calculation, as it is proposed by us that the supply of cattle feed should be increased through cultivated fodders like berseem. Feeding of pulses to cattle at a higher level would increase further the difficulty in the supply to the human population of proteins at the level aimed it.

TABLE III—PRODUCTION TARGET FOR CEREALS AND PULSES IN THIRD, FOURTH AND FIFTH PLANS

Year	Production to be Aimed at (million tonnes)		Additional Production over Previous Plan (million tonnes)	
	Cereals	Pulses	Cereals	Pulses
1959-60 to 1961-62	66.9*	12.0*	—	—
1965-66	82.7	21.4	15.8	9.4
1970-71	93.3	24.1	10.6	2.7
1975-76	105.1	27.1	11.8	3.0

*Present production.

It will be seen from Table III that by the end of the Third Five-Year Plan, whereas the production of cereals will have to be increased by about 24 per cent over the level of production during the base period 1959-60 to 1961-62, the production of pulses will have to be augmented by nearly three-fourths the current output. As compared with these figures of production of 82.7 million tonnes of cereals and 21.4 million tonnes of pulses required to meet the minimum nutritional targets, the Third Plan targets for 1965-66 are 84.3 million tonnes of cereals and 17.3 million tonnes of pulses. Evidently the planners were conscious of the need for increasing the output of pulses. The increase in production of pulses will, however, have to be still greater than what was envisaged. In the next two plan periods the annual production of cereals will have to be further increased by about 11 and 12 million tonnes while that of pulses will have to be augmented by about 3 million tonnes in each plan. Compared to the current level of production (1959-61), the annual production of cereals will have to be raised by 38 million tonnes or 57 per cent and that of pulses by 15 million tonnes or 125 per cent by the end of the Fifth Plan.

Methods of Meeting Shortfall

In considering ways and means of increasing production, the first point to note is that there is no possibility of increasing production by any extension of cultivated area. With an area under forests of only 17 or 18 per cent of the total geographical area, any further deforestation for bringing more area under cultivation is dangerous. In fact, the need is in the opposite direction. Out of the so-called culturable waste and permanent fallow land amounting to some 33 million hectares a careful recent study by the Wasteland Survey and Reclamation Committee, specially appointed by the Government of India, has shown that only about half a million hectares could possibly be made available for cultivation. This is an insignificant figure. Besides, a further shrinking of the grazing land already inadequate for the vast cattle population, will affect adversely even the production of food for human consumption.

For increasing agricultural production from the area cultivated at present by raising the yield per hectare the principal methods are extension of irrigation and of double-cropping, use of fertilizers and adoption of soil and water conservation measures. Use of improved seed can also contribute but except for hybrid maize, which we are going to take into account, there is no large scale programme for extending the use of improved seed at present which can add substantially to yield. Much of the improved seed being distributed is not of proven potentiality; secondly, some of the improved seed can claim improvement in factors other than yield such as earliness or resistance to pests and diseases. A programme with great possibilities for increasing the yield of rice is the use of strains derived from Indica-Japonica crosses, but the prospect of a large scale cultivation of such strains does not seem near yet. Similarly, all kinds of plant protection measures are important and should be extended as speedily as possible but their role is largely to save the loss of crop from pests and diseases and thereby ensure the gain in yield derived from other measures such as irrigation and the use of fertilizers.

Of the cultivated area of approximately 132 million hectares, about 65 million hectares are expected to be irrigated by the end of the Fifth Plan (1975-76) out

of a total potential of 71 million hectares for irrigation. This means that nearly 50 per cent of the cultivated area in India must continue to depend upon rainfall and over a greater portion of this area, the rainfall is low and precarious. The major problem of this area is one of maximizing the conservation of moisture in the soil by contour bunding and associated dry farming practices. A broad programme of soil and water conservation over 40 million hectares of agricultural land by the end of the Seventh Plan is mentioned. Of this about one million hectares are expected to have been brought under soil conservation by the end of the Second Plan and an additional 14 million hectares are proposed to be covered by the end of the Fifth Plan.

Next to irrigation in importance and complementary to it is the use of fertilizers which can raise yield substantially provided moisture in the soil is adequate. The most productive utilization of fertilizers, which are in short supply and will continue to be so for several years more, is to confine their application to irrigated crops and crops grown in areas with adequate rainfall, as for instance rice. Double-cropping is also tied to the availability of moisture either through irrigation or through adequate rainfall. Rice fallows and monsoon fallows before the cultivation of wheat are examples of the latter situation. An important point to note in connection with double-cropping of irrigated areas is that because of the limitation of water supply and seasonal nature of irrigation only about 15 per cent of the gross irrigated area is double-cropped. It is very necessary to extend this area by promoting cultivation of crops like pulses which would require only light irrigation.

The contribution of these factors to the achievement of the targets set out in Table III is considered in the present paper. Additional production is the product of the area brought under a particular improvement measure such as irrigation, fertilizers, double-cropping, etc., and the rate of increase in yield per unit area expected from that measure. Both aspects have been discussed. Information on the rates of increase in yield to be expected or yardsticks as they are termed frequently, is derived from all available results of past research. This research comprises field experiments at research stations and more recently extensive experiments on cultivators' fields, field surveys of various kinds and crop-cutting surveys. The data from these sources are assembled, analysed and summarised suitably to provide yardsticks for different items. Standardization of responses is an important aspect of this analysis, since doses, whether of fertilizers or irrigation are spread over a wide range in different investigations and the resulting responses have to be reduced to those for a standard dose before they can be averaged. Response curves of second degree or of the Mitscherlich type are found suitable for this purpose. The work of developing suitable yardsticks and of improving those already available by the use of additional data is continuously in progress at the Institute of Agricultural Research Statistics. A national index of field experiments which brings together results of agricultural field experiments carried out all over the country has been set up at the Institute and provides the chief source of data. Yardsticks used in the present paper are those formulated by the Institute.

Irrigation : As stated already, a gross area of 65 million hectares is expected to come under irrigation by the end of the Fifth Plan as against an availability

of irrigation to 32 million hectares at the end of Second Plan. The gross area likely to be irrigated by the end of Third, Fourth and Fifth Plans were worked out partly from data on major and medium irrigation collected from the publication on the Third Plan and other sources and partly by interpolation. The figures are given in Table IV. Approximately 80 per cent of the area under irrigation is utilized at present for raising foodgrains and of this percentage cereals account for 71.9 and pulses 7.7. We assume that the additional irrigation to become available in future will also be distributed among different crops in the present proportion so that each crop receives its due share in the new irrigation. This is a principle that we have followed all through. With a yardstick of additional production of 0.628 tonnes per hectare due to irrigation, the additional production obtained as a result of extension of the area under irrigation would be as given in Table IV. Using the proportions of irrigated area under cereals, 7.45 million hectares should be added to the irrigated area under cereals by 1965-66. The figure taken in Table IV, however, is 4.41 million hectares since as we shall discuss later, 3.0 million hectares of irrigated area is to be devoted by the end of the Third Plan to raising cultivated fodder or meeting the nutritional needs of cattle and buffaloes for additional milk production. Similar adjustments have been made in this table in the area under irrigation available to cereal production in the Fourth and Fifth Plans.

TABLE IV—ADDITIONAL PRODUCTION DUE TO EXTENSION OF IRRIGATED AREA IN THIRD, FOURTH AND FIFTH PLANS

Year	Gross Area Irrigated (million hectares)	Additional Gross Area under Irrigation over Previous Plan (million hectares)		Additional Production (million tonnes)	
		Cereals	Pulses	Cereals	Pulses
1960-61	31.9	23.0*	2.5*	—	
1965-66	42.3	4.41	0.80	2.77	0.50
1970-71	53.8	7.48	0.88	4.69	0.55
1975-76	64.8	6.44	0.84	4.04	0.53
Total addition by 1975-76		18.33	2.52	11.50	1.58

*Total area irrigated currently.

Soil conservation measures : It is proposed to extend soil conservation measures, *viz.*, contour bunding and other dry farming practices over areas of 2.12, 4.05 and 8.09 million hectares of cultivated land respectively in the Third, Fourth and Fifth Plans. Forty-nine per cent of the unirrigated area under crops other than rice is at present under cereals while 21 per cent is under pulses. It is assumed that the same proportion will be maintained in the allocation of area to different crops in the areas brought under the soil conservation programme also. The yardstick of additional production due to contour bunding is 0.085 tonnes per hectare and that due to dry farming is 0.171 tonnes per hectare. It is assumed that wherever contour bunding is done, other dry farming practices will also be adopted. Hence the yardstick of additional production due to soil conservation methods may be taken as 0.256 tonnes per hectare. The additional production expected to accrue from this measure is given in Table V.

TABLE V—ADDITIONAL PRODUCTION DUE TO SOIL CONSERVATION MEASURES IN THIRD, FOURTH AND FIFTH PLANS

Year	Additional Area to be Brought under Soil Conservation Measures in each Plan (million hectares)		Additional Production (million tonnes)	
	Cereals	Pulses	Cereals	Pulses
1965-66	1.04	0.45	0.27	0.11
1970-71	1.98	0.87	0.51	0.22
1975-76	3.95	1.73	1.01	0.44
Total addition by 1975-76	6.97	3.05	1.79	0.77

Use of improved seed : Our calculation of additional production from this source is confined to hybrid maize for reasons we have discussed earlier. It is reported that the proposal is to cover 20 per cent of the area under maize by hybrid maize seed in each of the Third, Fourth and Fifth Plan periods. From the results of a limited number of comparative trials on hybrid maize and local varieties the additional yield per hectare from hybrid maize would seem to range between 30 and 50 per cent over that from local varieties (Rockefeller Foundation, 1962). We may accordingly take the increase in the average yield per hectare due to the introduction of hybrid maize to be 40 per cent. The estimate would appear liberal and needs a careful re-examination in order to assess how much of this increase would be available at the current level of manuring of the maize crop and how much would be accounted by the greater response of the hybrid to heavy applications of fertilizers. Data for such analysis are not available readily and we have to adopt the present estimate provisionally. The estimates of additional production resulting from the use of hybrid maize seed would be as shown in Table VI.

TABLE VI—ADDITIONAL PRODUCTION DUE TO HYBRID MAIZE IN THIRD, FOURTH AND FIFTH PLANS

Year	Additional Area Brought under Hybrid Maize in each Plan (million hectares)	Additional Production (million tonnes)
1965-66	0.88	0.33
1970-71	0.88	0.33
1975-76	0.88	0.33
Total addition by 1975-76	2.64	0.99

Fertilizers : Next to irrigation, fertilizers are the most powerful means of raising agricultural yields. In fact the level of agricultural prosperity of a country can be measured by the level of fertilizer use. In India also thousands of experiments not only at experiment stations but on cultivators' fields have shown that large increases in yield can be secured from the application of fertilizers specially from irrigated crops. With adequate rainfall also the increase in yield is considerable. It is of the utmost importance to the country's economic development to make firm estimates of the requirements of fertilizers in the successive Five-Year Plan periods and set up the corresponding manufacturing capacity, whatever the cost. The priority needed for fertilizer production in relation to agriculture is so high that it may be regarded as being analogous to that for power in relation to industry.

Based on all available data yardsticks have been derived at the Institute of Agricultural Research Statistics for increase in the yield of various crops from the application of nitrogenous and phosphatic fertilizers. These differ according as the crop is irrigated or unirrigated. It is estimated that there would be an additional yield of 430.4 kg. of a cereal crop for every 44.8 kg. of Nitrogen per hectare (40 lbs. per acre), the water requirement of the crop is met satisfactorily. If instead, 22.4 kg. N and 22.4 kg. P_2O_5 per hectare (20 lbs. N and 20 lbs. P_2O_5 per acre) were applied, the increase would be 418.0 kg. The response of cereals goes down to 299.3 kg. for 22.4 kg. N and 22.4 kg. P_2O_5 per hectare for unirrigated crop.

Based on these yardsticks it is necessary to estimate the area under cereals required to be fertilized in order to increase production sufficiently to meet the shortfall in the additional production of cereals required by the end of the Third, Fourth and Fifth Plans respectively, which would still be left after taking into account the contributions to production due to extension of irrigation, adoption of soil conservation measures and introduction of improved seed. There will be a further gap in cereal production resulting from the diversion of 3.0, 3.8 and 5.2 million hectares respectively of the area under cereals to the growing of a fodder crop such as berseem in order to meet the additional demand for cattle feed to be explained in a later section. Since berseem will have to be grown on irrigated land, the diversion of this area from cereals to berseem will result in the loss of cereal production on two accounts. One is that the additional area under irrigated cereals would be reduced to this extent and this loss has been allowed for in Table IV already. The other loss is that of the entire yield from the original unirrigated area under cereals that would be diverted to berseem. This loss will have to be recouped by use of fertilizers on the area under cereals.

For calculating the increased production of cereals from the use of fertilizers, we may pool together the entire area under rainfed rice with the irrigated area under rice and other cereals since unirrigated rice is generally grown in areas with a high rainfall and its response to fertilizer may be treated as being equal to that of an irrigated crop. The area under assured water supply through irrigation or a high rainfall available to cereal cultivation, calculated in this manner, and the unirrigated area under cereals other than rice at the end of the Third, Fourth and Fifth Plan periods are given in Table VII.

VII—AREA UNDER CEREALS UNDER ASSURED WATER SUPPLY AND UNIRRIGATED AREA UNDER CEREALS OTHER THAN RICE IN THIRD, FOURTH AND FIFTH PLANS

Year	Cereal Area under Assured Water Supply (million hectares)	Unirrigated Area under Cereals other than Rice (million hectares)
1965-66	42.3	44.8
1970-71	44.6	41.6
1975-76	46.2	38.6

A simple calculation shows that if at the end of the Third Five-Year Plan (1965-66), 3.0 million hectares of area under cereals is set apart for growing berseem, a shortfall of 1.8 million tonnes of cereals in addition to the amount of 15.8 million tonnes already shown in Table III will have to be made up to meet the minimum nutritional target. Of this 3.37 million tonnes may be expected to be made good from the extension of irrigation, soil conservation measures and improved seed. The balance of 14.22 million tonnes will have to be raised by increasing the average yield due to the application of fertilizers. If irrigated cereals were to be fertilized at the rate of 44.8 kg. N per hectare. 33.0 million hectares of irrigated area will be required to be fertilized to produce 14.22 million tonnes. Making allowance for the consumption of 0.126 million tonnes of nitrogen on cereals, by the end of Second Plan, this would amount to a total of about 35.8 million hectares of cereals grown under conditions of assured water supply being fertilized by the end of the Third Plan. It is seen from Table VII that this is within the realm of feasibility.

By the end of the Fourth and Fifth Plans, however, the additional area under cereals under assured water supply not yet fertilized would be only 8.8 and 1.6 million hectares respectively. These could be fertilized at the rate of 44.8 kg. N per hectare in the Fourth Plan and 22.4 kg. N and 22.4 kg. P_2O_5 per hectare in the Fifth Plan. It will be necessary, however, to extend the application of fertilizers to unirrigated area under cereals other than rice in order to make up the gaps of 5.53 and 7.21 million tonnes respectively in the additional production needed to meet the nutritional target. About 5.9 and 21.9 million hectares of unirrigated cereals will have thus to be fertilized and this could be done at the rate of 22.4 kg. N and 22.4 kg. P_2O_5 per hectare. It should be noted that in so far as cereals are concerned the suggested application of fertilizer is confined to nitrogen in the Third Plan and it is only in later plans that the application of phosphatic fertilizers is introduced. The additional yield of cereals from 22.4 kg. N and 22.4 kg. P_2O_5 on irrigated area is almost equal to that from 44.8 kg. N.

The additional areas needed to be fertilized and the additional production of cereals expected at the end of the Third, Fourth and Fifth Plans are given in Table VIII.

VIII—ADDITIONAL PRODUCTION OF CEREALS DUE TO FERTILIZERS IN THIRD, FOURTH AND FIFTH PLANS

Year	Additional Area under Assured Water Supply to be Fertilized in each Plan (million hectares)	Additional Production (million tonnes)	Additional Unirrigated Area under Cereals other than Rice to be Fertilized in each Plan (million hectares)	Additional Production (million tonnes)	Total Additional Production (million tonnes)
1965-66	33.04	14.22	—	—	14.22
1970-71	8.76	3.77	5.88	1.76	5.53
1975-76	1.59	0.66	21.88	6.55	7.21
Total addition by 1975-76	43.39	18.65	27.76	8.31	26.96

Fertilizer application to pulses and extension of area under pulses : In regard to pulses the study of yardsticks shows that an additional production of 180.5 kg. may be expected per hectare from 33.6 kg. of $P_2 O_5$ (30 lbs. per acre) applied.[1] It will not be possible to fertilize the entire area under pulses since most of the area is unirrigated and the soil moisture would not be adequate in all the cases for obtaining a satisfactory response to fertilizer, because most pulses are grown under conditions of relatively low rainfall or on residual moisture in the post-rainy season. It is, therefore, suggested that only half the area under pulses may be fertilized by phosphate at the rate of 33.6 kg. of P_2O_5 per hectare. Calculation would show, however, that the additional production of pulses due to the application of phosphate to half the area under pulses, *i.e.*, to 11.89 million hectares would only amount to 2.14 million tonnes which together with the additional production from extension of irrigation and soil conservation measures to pulse growing areas would not meet the gap between additional requirements and production in any of the years under consideration. The only means left for raising the additional production of pulses would be to extend the area on which a second crop of pulse is taken in rotation with a cereal or other crop. This would be possible in many cases in single-cropped areas and can be of benefit to the main crop as well. In rice areas, for example, it is often possible to grow a short duration pulse such as *mung* after rice. In wheat areas also it is possible to raise an early variety of a suitable pulse, like cowpea, blackgram, etc., before the sowing of wheat. Extension of double-cropping by about 18 million hectares by the end of Fifth Plan to raise the additional pulse crops is an unavoidable necessity if the minimum nutritional target is to be met at all and selection of suitable areas and pulse crops and a programme of implementation should be taken in hand immediately. The additional area in which it will be necessary to introduce a pulse as a second crop in order to bridge the gap in production and the additional production resulting from the added area as well as from the application of phosphate at the rate of 33.6 kg. $P_2 O_5$ per hectare to half the entire area under pulses including the added area are given in Table IX.

1. Partly for the reason that the bulk of the pulses are unirrigated and also because it was found that in the case of gram, which alone has an appreciable area under irrigation, the response is of the same order as for the unirrigated crop, we have adopted a common response of 180.5 kg. per hectare from 33.6 kg. of P_2O_5 per hectare as the best available yardstick for pulses based on a very large number of experiments in cultivators' fields. One rather important gap in our information is that there are no data on the response to fertilizers of *tur* or *arhar* which is a pulse crop of considerable importance. This deficiency will have to be made good in future trials.

TABLE IX—ADDITIONAL PRODUCTION OF PULSES DUE TO DOUBLE-CROPPING AND PHOSPHATE APPLICATION IN THIRD, FOURTH AND FIFTH PLANS

Year	Additional Area to be Brought under Pulse in each Plan (million hectares)	Additional Production (million tonnes)		
		Due to additional area	Due to phosphate application to half the area	Total
1965-66	11.15	5.58	3.15	8.73
1970-71	3.32	1.66	0.30	1.96
1975-76	3.49	1.75	0.31	2.06
Total addition by 1975-76	17.96	8.99	3.76	12.75

In the first place it may be pointed out that it would be quite within the limits of feasibility to bring in an additional area of 18 million hectares under pulses as a second crop. The total area under rice and wheat was 45.4 million hectares in 1958-59 whereas the total double-cropped area was 19.7 million hectares. About 25 million hectares may thus be taken to be under a single crop at present of which about 45, 13 and 14 per cent respectively are required to be brought under double-cropping in the three plans. In calculating the production from the additional area an average yield of 500 kg. of pulses per hectare which was obtained in the triennium 1959-60 to 1961-62 has been assumed. Although the calculations are based on double-cropping here, extension of the cultivation of pulses in mixture with cereals and other crops is also visualized as an important measure for extension of area under pulses.

Fertilizer requirements : The additional requirements of fertilizers for increasing the level of production of cereals and pulses will be as shown in Table X.

TABLE X—REQUIREMENTS OF FERTILIZERS FOR PRODUCTION OF CEREALS AND PULSES IN THIRD, FOURTH AND FIFTH PLANS

Year	Additional Nitrogen Requirement for Cereals in each Plan (million tonnes of N)	Additional Phosphate Requirement (million tonnes of P_2O_5)		
		Cereals	Pulses	Total
1960-61 (calculated availability)	0.13	—	—	0.06
1965-66	1.48	—	0.59	0.59
1970-71	0.52	0.13	0.06	0.19
1975-76	0.53	0.53	0.06	0.59
Total addition by 1975-76 ..	2.53	0.66	0.71	1.37

Foodgrain crops consume two-thirds of the total nitrogenous fertilizers and about four-fifths of phosphatic fertilizers at present. On the assumption that the intensity of fertilizer application to non-food crops will increase correspondingly in the future also, the total requirements of fertilizers for all crops together be worked out for various years from the reported figures of fertilizer consumption in 1960-61, *viz.*, 0.23 million tonnes of nitrogen and 0.07 million tonnes of phosphoric acid. These figures are presented in Table XI. They also include the requirements of 0.14, 0.17 and 0.24 million tonnes of P_2O_5 at the rate of 44.8 kg. per hectare for raising berseem in 3.0, 3.8 and 5.2 million hectares of irrigated land in the three plan periods to meet the needs of bovines for milk production.

TABLE XI—GROSS FERTILIZER REQUIREMENTS IN THIRD, FOURTH AND FIFTH PLANS

(million tonnes)

Year	N	P_2O_5
1960-61	0.23*	0.07*
1965-66	2.4	0.9
1970-71	3.2	1.2
1975-76	4.0	2.0

*Availability.

It will be seen from Table XI that the gross requirement of nitrogenous fertilizer at the end of the Third, Fourth and Fifth Five-Year Plans will be about two and a half, three and four million tonnes of N respectively. The corresponding requirement of phosphatic fertilizers is estimated to be about 0.9, 1.2 and 2.0 million tonnes of P_2O_5. The Third Plan provides targets of only 1.01 million tonnes of N and 0.41 million tonnes of P_2O_5 by the end of 1965-66. These will have to be revised to two and a half times the present levels if the production of cereals and pulses is to be increased adequately to meet the minimum nutritional requirement of the population by the end of the Third Plan. It is interesting to note that the gross fertilizer requirements by the end of Fifth Plan (1975-76) come close to the long term targets of nitrogenous fertilizers (4.1 million tonnes of N) as well as of phosphatic fertilizers (2.0 million tonnes of P_2O_5) mentioned in the publication on the Third Plan.

MILK

Milk Protein Requirement and Availability

As mentioned earlier, it has been estimated that for providing a minimum of 10 grams of animal proteins per head per day it will be necessary to make available 201 grams of milk per head per day contributing 7.4 grams of protein to the total. The requirements of milk protein for different years can be worked out from the population projections. On the other hand, livestock population figures can be projected and the amount of protein which would become available from cow milk and buffalo milk if no change took place in the current levels of production of cows and buffaloes can be worked out. The difference would be the shortfall in milk protein which has to be met. For projecting livestock numbers, population growth has been assumed to take place at the same rate during the three Five-Year periods from 1961 to 1976 as estimated from the livestock censuses in 1956 and 1961. Such an assumption seems reasonable since the coverage in these two quinquennial livestock censuses was good and the censuses well conducted, and it is not likely that any policy aimed at reducing the numbers of cattle or their composition will have any sensible impact on the cattle population in the next decade. The widespread prejudice against slaughter and the non-availability of any sure and simple method of sterilization make it unlikely that the present growth rate of cattle population will be checked in the near future.

As regards the current level of milk production the official estimates based on marketing surveys carried out some years back are open to question as the surveys were by no means rigorous statistical investigations involving representative samples and physical measurements. The Institute of Agricultural Research Statistics has been conducting large scale sample surveys in typical tracts of the country for estimating the annual milk production and studying the practices of feeding and management of cattle and buffaloes. Such surveys were carried out

in the Punjab State (excluding hilly districts) in 1955-56, in Eastern districts of Uttar Pradesh in 1957-58, in Gujarat State in 1958-59 and in the coastal districts of Andhra Pradesh and Orissa and some interior districts of the former State in 1959-60. The survey was repeated in the Punjab State and extended to hilly areas of the State in 1960-61. Similar repeat surveys are being conducted in other tracts for assessing the changes in milk yield and animal husbandry practices during the Five-Year period. A suitable probability sampling design is employed according to which on any day of the year a representative sample from among all the cows and buffaloes which are in milk on that day is selected for being recorded for milk yield and feed consumption. The data on milk yield and feed are collected by direct weighment by the investigator present on the spot. Data on feed consumption of bovines of other categories, *viz.*, males and young stock are also collected by weighment and a great deal of other information such as the breed and age composition of animals, mortality and ailments, sale and purchase price of animals, composition, procurement and prices of feedstuffs, utilization of milk, etc., is collected through careful enquiry from sample households. The surveys thus provide objective and reliable estimates of milk production and rates of feeding of cattle and buffaloes averaged over all seasons of the year. Details of the survey design and the type of results which the surveys provide can be seen from the Punjab Report (1963). Similar carefully planned surveys have been carried out by the Institute for estimating the cost of milk production in Delhi State (Panse *et al*, 1961), the city of Madras, surrounding villages and a typical rural area with potentiality for milk in Madras State (Panse *et al*, 1963) and in Calcutta, its suburbs and a typical rural area in West Bengal.

From all these surveys the average daily yield in the country per milch cow and buffalo (*i.e.*, breeding females) has been estimated with some liberal extrapolations to be 450 grams and 1,336 grams respectively. The milk protein requirements of India's population as well as availability at the current yield level in different years, and the gap required to be bridged are presented in Table XII.

It will be seen that the shortfall in milk proteins amounts to 40.3 per cent of the requirement in 1960-61, 40.7 per cent in 1965-66, 41.3 per cent in 1970-71 and 41.7 per cent in 1975-76.

The Approach to Meet the Shortfall

Broadly there are three ways of improving the productivity of livestock, *viz.*, scientific breeding, improved feeding and management, and disease control. Breeding is a slow process in large animals and the rate of improvement even with most intensive selection is small. No immediate spurt in production can be expected from this source. With the mass campaign for control of Rinderpest and the widespread use of vaccines for protection against Anthrax, Black Quarter, etc., diseases of bovines seem to be fairly under control except for foot and mouth disease which debilitates animals with frequent attacks. The only rapid method of increasing milk production of cattle and buffaloes is to provide them better feeding. The current level of feeding is extremely poor and according to expert opinion (*e.g.*, Wright, 1957) and some experimental results in India better feeding alone can increase the average milk

TABLE XII—MILK PROTEIN REQUIREMENTS AND AVAILABILITY PER DAY IN DIFFERENT YEARS

Year	Projected Human Population (millions)	Total Protein Requirements (tonnes)	Projected Population of Milch Animals		Protein Availability at Current Level of Production			Gap (tonnes)
			Cattle (millions)	Buffalo (millions)	Cattle (tonnes)	Buffalo (tonnes)	Total (tonnes)	
1960-61	438	3,241	45.5	21.9	676	1,259	1,935	1,306
1965-66	492	3,641	49.9	24.8	738	1,420	2,158	1,483
1970-71	555	4,107	54.8	28.0	807	1,604	2,411	1,696
1975-76	625	4,625	60.1	31.7	883	1,813	2,696	1,929

1 tonne = 1,000 kilograms.

TABLE XIII—ALTERNATIVE AMOUNTS OF CATTLE FEED NEEDED TO MEET MILK PROTEIN REQUIREMENTS IN 1965-66

Alternative	Items of Cattle Feed (million metric tonnes per year)					Increase in Daily Milk Yield per Milch Animal (grams)		Cost per Year (million Rs.)
	Cakes	Brans	Husks	Straw	Greens	Cow	Buffalo	
1.	7.1	—	—	—	—	900	—	2,661
2.	0.4	7.5	—	—	—	900	—	1,313
3.	—	6.5	—	—	8.8	900	—	1,191
4.	—	—	—	—	47.1	900	—	1,038
5.	—	—	—	4.2	31.0	900	—	962

yield of an animal by 50 per cent or more. A comparison of the performance of non-descript animals in rural areas where the feeding standard is low with that of similar but better fed animals in the urban areas of the same tract made in the sample surveys carried out by the Institute also corroborates this. The immediate short-term approach must then be to provide the necessary additional nutrients to at least the animals in milk so as to secure the required additional production of milk. For the present it does not seem possible to extend the scope of improved feeding to young stock and working and breeding males, since as will be shown even increasing feed resources for breeding females involves considerable difficulty. The ultimate solution to the problem of meeting the shortage of cattle feed lies in the delimitation of the livestock population but this prospect is not in sight and cannot be counted upon in any realistic planning for the next 10 or 15 years.

Cattle feed requirements : The feed given to cattle consists of concentrates, dry roughages and greens apart from supplements such as salt. Concentrates themselves may be divided into oilcakes, brans, husks and grains. These ingredients of cattle feed provide different amounts of protein as measured by their digestible crude protein content (D.C.P.) and energy as measured by the total digestible nutrients (T.D.N.) which are required for maintenance and production. The D.C.P. and T.D.N. contents of different feedstuffs have been worked out on the basis of chemical analysis and digestibility trials and the values have been compiled by Sen (1957). Based largely on American studies, Sen also gives the amounts of D.C.P. and T.D.N. needed for maintenance, growth, work and milk production. Unfortunately standards based on Indian studies are not yet available. Studies undertaken for this purpose are meagre and their results have not been critically examined and consolidated. The Institute of Agricultural Research Statistics intends to assist the nutritionists in this task by consolidating the available experimental data in the same manner as it has built up the national index of field experiments in agriculture (1962). Pending such studies to build up technological production functions or yardsticks for response of milk yield to nutrients, we had to fall back on the figures given by Sen to work out the amounts of D.C.P. and T.D.N. needed to produce the additional milk required to meet the shortfall in the milk proteins.

Alternative solutions : It is possible to obtain a number of solutions in terms of the amounts of feed components such as oilcakes, bran, etc., needed to produce quantities of additional cow milk and buffalo milk for securing the desired increase in the total milk protein. These will differ in the cost of additional feed. A preliminary analysis was made with the target of milk protein for 1965-66 in view. A simple application of the linear programming technique was carried out, taking the amounts of D.C.P., T.D.N. and total dry matter required as constraints. The quantities of milk yield to be increased per cow and per buffalo were taken as unknown variables. (The small amount of milk available from goats has been assumed to remain constant throughout in this study). These quantities as well as the quantities of oilcake, bran, husk, straw and greens needed to produce the increases were so determined as to minimize the cost of additional production of milk protein. Grains which form a component of cattle feed according to present practice were omitted from this analysis for the obvious reason that with a shortfall of grains for human consumption it is not feasible to provide for additional amounts of grain as a constituent of cattle feed for increasing milk production. It

should be noted however that the conventional allowance for cattle feed is included along with that for seed and wastage in the additional production of foodgrains calculated earlier, as such an allowance is necessary in view of the increasing cattle population, and traditional feeding practices. For the purpose of the present study appropriately weighted average values of D.C.P., T.D.N. as well as the current price rates of oilcakes, etc., were taken, the weights used being the relative amounts of various constituent items consumed as estimated from the surveys conducted by the Institute on milk production and cost of production of milk. The alternative solutions obtained are indicated in Table XIII.

From these solutions it will be seen that any of the alternatives involves only one or two of the ingredients. This restriction on the nature of the solution arises because we have assumed only three inequalities of restriction corresponding to D.C.P., T.D.N. and dry matter intake. It was not considered appropriate to impose additional restrictive inequalities since they would make the solutions rather artificial and not as minimal as without them. The least cost solution suggests that additional feed of 231 grams of dry fodder and 1.70 kg. of greens per cow per day corresponding to an annual supply of 4.2 million metric tonnes of straw and 31.0 million tonnes of greens would produce the additional milk protein requirement of 1,483 tonnes per day by the end of the Third Plan. The corresponding additional cost would be about Rs. 950 million per year as against a cost of about Rs. 2,600 million if the same increase in milk were to be brought about by a supply of 7.1 million tonnes per year of oilcakes. It is interesting to note that an additional supply of greens alone at the rate of 2.58 kg. per day per cow in milk would also bring about the required increase in milk at the cost of about Rs. 1,040 million.

It is important to see that in none of the solutions does buffalo milk figure. This is because although buffalo milk contains more protein per unit (.043) than cow milk (.033) it also contains more fat and other solids with the result that more D.C.P. and T.D.N. are required for producing a unit of buffalo milk protein than a unit of cow milk protein if the extra return by way of additional fat and solids other than protein are ignored. Since our object is to provide the deficient milk proteins with the least expenditure on extra feed resources, the solutions given in Table XIII would follow. We would, however, like to note that the position that each unit of buffalo milk protein costs more than a unit of cow milk protein is not in keeping with the indications of the livestock surveys carried out by the Institute. Even so we have preferred to base our present calculations on Sen's recommendations in the absence of firm yardsticks based on these surveys and other experimental data.

These solutions, however, cannot be considered satisfactory from the practical standpoint since they would imply increasing the average milk yield per milch cow from 450 grams to 1,350 grams, an increase of 200 per cent. This would impose an impossible strain on the cows, the majority of whom are non-descript and as such not possessing a potentiality for high milk yield. An increase as high as 200 per cent through feeding alone has consequently to be ruled out. A remedy for this difficulty would be to grade up the non-descript cows with good indigenous breeds and even carry out cross-breeding in suitable areas with a view to getting animals having a potentiality for high milk yield which would need for its expres-

sion adequate level of feeding. Such a measure would, however, be slow in realisation and even if a rapid increase in the rate of grading and cross-breeding programmes could be made immediately it is only towards the end of the Fourth Five-Year Plan that the improved progeny would begin to come into production.

The only practicable alternative, therefore, is to step up the production of buffalo milk as well as that of the cow. If we decide on the same relative increase in the milk yield of both species it can be worked out from the figures of milk protein availability and gap in Table XII that it will be necessary to increase the average yield of cow and buffalo by 68.7 per cent by 1965-66, by 70.3 per cent by 1970-71 and by 71.6 per cent by 1975-76 over the current levels of production. Such increases are definitely within the realm of practical achievement through feeding.

The alternative solutions corresponding to these increases in production levels of the cow and buffalo are set in Table XIV. As expected, solutions involving increases in concentrates are costly. Moreover, in the absence of any importation of oilcakes, bran and husks, which is not to be thought of, the amounts of these by-products of agricultural commodities are limited by the production of these commodities. The position with regard to production and consumption of bovine feeds was next examined and is discussed in the next section.

Production and consumption of bovine feeds : The targets for cereals and pulses for the years 1965-66, 1970-71, and 1975-76 are already given in Table III. From these the amounts of bran, husk and straw which would become available were worked out by assuming conversion factors of 5 per cent for rice bran, 15 per cent for wheat bran, 25 per cent for rice husk and 15 per cent for other husk, 2:1 ratio of straw to grain for paddy and wheat, 8:1 ratio for jowar and other millets and 3:1 ratio for gram. For estimating straw to grain ratio data pertaining to 'control' plots from the co-ordinated model agronomic experiments conducted at 34 centres all over the country during the period 1957-58 to 1961-62 were made use of (I.C.A.R., 1962) but conventional figures had to be taken for other conversion ratios. It was assumed that 90 per cent of the straw produced would be available for cattle feed, the remainder going for thatching and other uses. Also an allowance of one per cent of cereals and three per cent of pulses was made as direct feed to cattle and this was included in the margin of 12½ per cent to cover seed, feed, wastage and non-food manufacturing use. The results of the surveys carried out by the Institute indicate that at least for gram the conventional figure for cattle feed is low but the allowance at this lower conventional rate was made so that in calculating the additional feed requirement for cattle we might err on the safer side. The tentative projections of 7.00, 8.65 and 10.85 million bales[2] respectively of cotton prepared by the Indian Central Cotton Committee as production targets in 1965-66, 1970-71 and 1975-76 were taken to work out the availability of cottonseed cake. Seed to lint ratio was taken to be 2:1 and the extraction rate of cake from cottonseed was assumed to be 90 per cent. In the absence of any precise estimates, tentative figures of production of other oilseeds based on demand projections and estimates of supply potentialities were made use of and making allowance for export and use as seed, the production of edible oilcakes was worked out from the total production available for oil extraction, using ex-

2. One bale weighs 117.8 kg. (392 lbs.).

TABLE XIV—FEED REQUIREMENTS PER YEAR AND ITS COST WITH PROPORTIONATE INCREASE IN COW AND BUFFALO PRODUCTIVITY

Year	Alternative	Cakes	Brans	Straw	Greens	Cost	Average Yield per Day per Milch Animal (grams)	
							Cow	Buffalo
		(Million metric tonnes)				(Million Rs.)		
1965-66	1st	8.0	—	—	—	2,980	760	2,258
	2nd	0.4	8.5	—	—	1,451		
	3rd	—	7.6	—	7.6	1,343		
	4th	—	—	—	48.2	1,062		
	5th	—	—	5.0	29.1	972		
1970-71	1st	9.0	—	—	—	3,392	765	2,271
	2nd	0.4	9.6	—	—	1,647		
	3rd	—	8.7	—	8.7	1,528		
	4th	—	—	—	54.7	1,207		
	5th	—	—	5.7	33.1	1,105		
1975-76	1st	10.4	—	—	—	3,921	774	2,298
	2nd	0.5	11.1	—	—	1,906		
	3rd	—	10.0	—	10.0	1,769		
	4th	—	—	—	63.1	1,395		
	5th	—	—	6.6	38.1	1,276		

traction rates given in the F.A.O. Bulletin on Technical Conversion Factors (1960). It has been assumed in the present study that all edible oilcake would be available as feed to bovines and not used for manuring. Increased use of fertilizers and other manures should obviate the need of oilcakes for manurial use. This use in place of cattle feed is economically unsound and should be discouraged. Lastly, the amount of cultivated fodder was also projected on the assumption that the area under cultivated fodder crops would remain the same but that the irrigated area under fodder crops would increase slightly maintaining the present proportion of 4 per cent of the total irrigated area.

Next, the estimates of consumption of various feedstuffs by cattle and buffaloes of all categories at the current levels of feeding were worked out. For doing so the per head availability of feeds at current levels was worked out from the results of the livestock surveys carried out by the Institute of Agricultural Research Statistics. From these the feed requirements at the current level of feeding were estimated for the projected numbers of bovines at the end of Third, Fourth and Fifth Plans. In making this computation the per head consumption during the base period was worked out separately for rural and urban areas and for each class of bovine, *viz.*, adult male, breeding female and young stock of either species, cattle or buffalo, since the rates of increase of population were not quite the same for all the categories. For greens, it was observed in the surveys on bovine practices and cost of milk production that a large amount of uncultivated green fodder such as grass cut from bunds of fields and other grass lands, lopped tree leaves, etc., was fed to animals besides cultivated fodder. The requirement of greens was accordingly based on the per head consumption observed in the surveys. In projecting the production of greens a constant amount of uncultivated green fodder from these sources, estimated as the difference between the total consumption of greens and the total production of cultivated fodder, was added to the projection of cultivated green fodder in each year. This amount would certainly not increase in future years but may even decrease with increasing employment in the rural sector so that the amount of time and effort devoted today to cutting and fetching grass might not be available for this purpose. Lastly, some allowance has to be made for the amount of nutrients obtained by animals through grazing. This was done by adopting the assumption made by the Nutrition Advisory Committee (1952) that about 525 million tonnes of greens were available to animals in the form of cut grass and grazing together.

The estimates thus calculated of availability and requirement of feedstuffs at the current level of feeding by the increasing population of cattle and buffaloes are given in Table XV.

The consumption figures given in Table XV exclude small supplements such as salt and *gur*. (We have not concerned ourselves in the present study with the supply of these as their contribution to D.C.P. or T.D.N. is negligible). These consumption levels would permit the current production levels to be maintained resulting in the supply of milk protein to the extent shown in the last but one column of Table XII. It will be seen from Table XV that the feed requirements of cattle and buffaloes at the current level of feeding are generally met except for grains and greens according to the projections made for the last year of the Third, Fourth and Fifth Plans. This implies that the increases in production envisaged

TABLE XV—ESTIMATED AVAILABILITY AND REQUIREMENT AT CURRENT LEVELS OF FEEDING BOVINES IN THIRD, FOURTH AND FIFTH PLANS

(million metric tonnes)

Year	Item	Oil cakes	Brans	Husks	Grams	Straw	Greens including grazing
1959-60 to 1961-62	Availability	4.5	3.3	9.8	4.2	254.5	614.0
1965-66	Availability	6.2	4.1	12.5	1.4	323.7	631.7
	Requirement at current level of feeding	5.4	1.6	7.4	4.4	340.5	692.0
1970-71	Availability	7.6	4.6	14.2	1.6	363.3	653.0
	Requirement at current level of feeding	6.0	1.7	8.2	5.0	378.7	772.1
1975-76	Availability	9.5	5.2	15.9	1.8	411.6	673.3
	Requirement at current level of feeding	6.7	1.9	9.1	5.5	424.3	867.4

for cereals, cotton and oilseeds result in additional amount of by-products sufficient to meet the oilcake, bran, husk and straw requirements of cattle and buffaloes if the current level of per head milk production is to be maintained. As already indicated, the results of the surveys conducted by the Institute of Agricultural Research Statistics show the consumption of grains, especially pulses, to be much larger than the conventional allowances made in calculating production. This fact is reflected in the large deficit of grains available for cattle feed shown in Table XV. The increasing shortfall in green fodder including grazing shows that the small increase in cultivated fodder production brought about from the increase in irrigated area under fodder consequent upon a general increase in irrigated area under crops will not at all meet the situation. The deficits in grains and greens together with the additional nutrients required to bring about the increase in milk production to meet the minimum nutritional target for milk protein will have to be met only through systematic production of green fodder such as berseem. The availability and requirements of digestible crude protein and total digestible nutrients are given in Table XVI.

TABLE XVI—NUTRIENT REQUIREMENTS FOR CURRENT LEVEL OF FEEDING AND ADDITIONAL MILK PRODUCTION IN THIRD, FOURTH AND FIFTH PLANS

(million metric tonnes)

	1965-66		1970-71		1975-76	
	D. C. P.	T. D. N.	D. C. P.	T. D. N.	D. C. P.	T. D. N.
Availability	17.6	220.6	18.6	242.9	19.7	267.6
Requirement at current level of feeding ..	18.3	231.8	20.4	258.0	23.0	289.2
Requirement for additional milk	1.2	5.3	1.3	6.0	1.5	6.9
Shortfall	1.9	16.5	3.1	21.1	4.8	28.5
Additional area required under berseem to meet shortfall (million hectares)	1.6	3.0	2.6	3.8	4.0	5.2

It will be seen from Table XVI that during the last year of Third, Fourth and Fifth Plans, the shortfall in digestible crude protein is expected to amount to 1.9, 3.1 and 4.8 million metric tonnes. The corresponding shortfall in the total digestible nutrients would amount to 16.5, 21.1 and 28.5 million metric tonnes. Now berseem is known to have a D.C.P. content of about 2.5 per cent and T.D.N. content of about 12 per cent. Other fodders like lucerne, jowar, maize, etc., could be considered but these yield a lower return per acre in terms of nutrients available to livestock. For this reason berseem has been taken as the basis for our calculations. The available information from different organised farms growing fodder on a large scale gave 44.5 tonnes as a safe figure to take as the average yield of berseem per hectare.[3] Based on this information the area required to be put under systematic cultivation of berseem to meet the shortfall in D.C.P. and T.D.N. at the end of the Third, Fourth and Fifth Plan periods were worked out and are given in Table XVI. It will be seen from the table that in order to meet the requirements of cattle and buffaloes at the current level of feeding as well as the needs of nutrients for additional milk production required for meeting the minimum nutritional target for the human population, it will be necessary to divert 3.0, 3.8 and 5.2 million hectares respectively of irrigated area to grow berseem. Due allowance for these areas has been made in the earlier sections in considering the requirements of additional production of cereals. An allowance has also been made for fertilizer application to the berseem crop at the rate of 44.8 kg. of $P_2 O_5$ per hectare (40 lbs. per acre).

DISCUSSION

The present nutritional status of India's population is among the lowest in the world. This is well brought out in a recent F.A.O. publication (1963) summarizing food balance sheet data for the latest available three-year period, 1957-59, for 43 countries, which form a representative cross-section of the countries of the world. According to present per capita availability of calories and total proteins, India stands 3rd and 8th in rank from the bottom among these countries, while in the availability of animal proteins it has the lowest position. With the nutritional aims that we have adopted for our calculations of the targets for production, the per capita nutritional status of the country will only be raised to the 13th position in calories, 12th in total proteins and 3rd in animal protein from the bottom of the scale. The nutritional improvement we aim at is thus the barest minimum and the great urgency of bringing it about in order to improve by a small degree the health and general well-being of the population and the efficiency of the working force needs no further emphasis. To underline this urgency, we have outlined a plan for the production of three key items of food, cereals, pulses and milk, over a relatively short period upto the end of the Fifth Plan, and have further shown its break-up for the individual plan periods, *viz.*, the Third, Fourth and Fifth Plans, although we are already in the middle of the Third Plan. These targets of production are summarized in Table XVII.

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3. The information on the production of different types of fodders and grasses was kindly supplied by Dr. A. K. Ghosh, Institute of Agriculture, Allahabad, Dr. K. K. Iya, Director, National Dairy Research Institute, Karnal, Shri I. D. Mantramurti, Director, Animal Husbandry, Madras, Dr. M. D. Patel, Director, Institute of Agriculture, Anand, Dr. S. C. Ray, Director of Dairy Development and Animal Husbandry, West Bengal, Shri Y. V. Salpekar, Director, Greater Bombay Milk Scheme, Maharashtra and Dr. K. S. Shetty, Director of Animal Husbandry, Mysore.

TABLE XVII—TARGETS OF PRODUCTION OF CEREALS, PULSES AND BERSEEM IN THE THIRD, FOURTH AND FIFTH PLANS

(million tonnes)

Year	Item	Additional Production due to					Total Additional Production	Loss due to Diversion of Additional Area to Berseem	Target for Production	Target for area under Berseem (million hectares)
		Irrigation	Fertilizers	Improved seed	Soil conservation	Double-cropping				
Current * Production	Cereals						66.9			
	Pulses						12.0			
	Foodgrains						78.9			
1965-66	Cereals	2.77	14.22	0.33	0.27	—	17.6	1.8	82.7	3.0
	Pulses	0.50	3.15	—	0.11	5.58	9.4	—	21.4	—
	Foodgrains	3.27	17.37	0.33	0.38	5.58	27.0	1.8	104.1	3.0
1970-71	Cereals	4.69	5.53	0.33	0.51	—	11.1	0.5	93.3	3.8
	Pulses	0.55	0.30	—	0.22	1.66	2.7	—	24.1	—
	Foodgrains	5.24	5.83	0.33	0.73	1.66	13.8	0.5	117.4	3.8
1975-76	Cereals	4.04	7.21	0.33	1.01	—	12.6	0.8	105.1	5.2
	Pulses	0.53	0.31	—	0.44	1.75	3.0	—	27.1	—
	Foodgrains	4.57	7.52	0.33	1.45	1.75	15.6	0.8	132.2	5.2
Total additional production by 1975-76	Cereals	11.50	26.96	0.99	1.79	—	41.3			
	Pulses	1.58	3.76	—	0.77	8.99	15.1			
	Foodgrains	13.08	30.72	0.99	2.56	8.99	56.4			

* Average annual production for three years 1959-60 to 1961-62.

It will be noticed that the greatest leeway in increasing production, calling for the heaviest effort, will have to be made in the Third Plan itself. This is because of the very poor level of per capita availability of essential items of food at the present time. Once this large shortfall is made up, the gaps in the subsequent plans resulting from increase in population will be relatively smaller and easier to bridge. It also follows that unless the initial deficit in essential food supplies can be removed speedily through an intensive drive, it will prove extremely difficult to cope with the mounting shortage as years pass and the possibility of ever raising the nutrition of the Indian population to any desirable level will become dim.

To meet the serious deficiency in the Indian diet of total proteins and animal proteins it will be necessary to raise the production of pulses specially and provide adequate feed to milch animals for increasing milk production. It will be seen from Table XVII that against the present situation that pulses form 15 per cent of the total production of foodgrains, their proportion will be raised to 20 per cent in each of the three plans. Secondly, an increasing amount of irrigated land rising upto 5.2 million hectares at the end of the Fifth Plan will have to be diverted from cereals to the cultivation of berseem for augmenting milk production for attaining the target. The Third Plan as prepared by the Planning Commission suffers from lack of proper emphasis on the production of proteins, pulses providing 17 per cent of the foodgrains, and there is no concrete provision for the augmentation of milk production by production of additional cattle feed. These two aspects of food production must receive adequate consideration in subsequent plans.

As is to be expected, fertilizers and irrigation are the chief sources for increasing the production of foodgrains. This is particularly true of cereals and most of their additional production will be derived from these two sources. Phosphatic fertilizers are important for increasing the production of pulses and berseem also. There can be no finality in the recommendations on the kinds and rates of application of fertilizers to different crops under different conditions. Our recommendations are based on the technical knowledge available at present and the progress made in the use of fertilizers by farmers as ascertained from results of sample surveys on fertilizer use carried out by the Institute and other similar information. Today the farmer is more familiar with nitrogenous fertilizers which also show a universal response on various crops. For speedy results we have recommended larger doses of nitrogen on irrigated cereals in the Third and Fourth Plans and have confined phosphatic fertilizers to leguminous crops like pulses and berseem to which they are specially suited, and to unirrigated cereals in conjunction with nitrogen. As fertilizer use becomes more general and as crop production is raised to a higher level, a greater balance will have to be achieved in the use of nitrogenous and phosphatic fertilizers. As the latter is also cheaper, economy would demand that the more costly nitrogen should be replaced to the maximum possible extent by phosphatic fertilizers. With this in view we have recommended the application of both, nitrogen and phosphate, to irrigated cereals also in the Fifth Plan. The immediate problem would be to persuade farmers to use more phosphate and among other measures its price needs to be reduced to make it more attractive. In the final phase of the development of fertilizer use in India, as elsewhere, all three fertilizer elements, nitrogen, phosphate and potash,

will have to be provided in appropriate proportions according to the needs of various crops.

It is clear that availability of fertilizers is the key to the achievement of the targets of food production we have aimed at. Fertilizer requirements for foodgrains and for all crops are given in Tables X and XI. It will be seen that during the Third Plan itself the requirements for foodgrains are approximately 1.5 million tonnes of nitrogen and 0.6 million tonnes of phosphate according to our estimate against a total target of 1.0 million tonnes of nitrogen and 0.4 million tonnes of phosphate for all crops laid down by the Planning Commission. We would repeat that immediate action to arrange for the import of requisite amounts of fertilizers and for setting up additional factories to manufacture fertilizers in order to replace imports progressively is necessary, as without this action there does not seem any hope of improving the nutritional level of India's population. It is interesting to note that our estimates of total requirement of nitrogen at 4 million tonnes and of phosphate at 2 million tonnes by the end of the Fifth Plan agrees with the long term estimates of the requirements of these fertilizers made by the Planning Commission.

Increasing the production of pulses is a problem which cannot be solved through greater use of fertilizers on existing acreage alone. Most of the pulses are grown in rainfed areas, have a rather low yield and a limited response to fertilizers. On some of the area use of fertilizers cannot be recommended because of poor soil and low rainfall and we have been forced to the conclusion that extension of area under pulses is essential for increasing their production. The extent of double-cropped area is small today and there would appear considerable scope for growing pulses as a second crop after rice or as a monsoon crop in land reserved for wheat in the *rabi* season. This extension is possible in irrigated areas where a light irrigation, which is all that a pulse crop would need, can be made available for growing it or where the soil is retentive of moisture and the pulse crop can be grown on the residual moisture in both irrigated and rainfed areas. The other possibility which should be explored as being equally important is that of growing pulses in a mixture with cereals and other crops. There is already a considerable practice of growing pulses mixed with various millets and this practice can be extended to a larger area without detriment to the yield of the associated cereals and other crops. Although our calculations are in terms of additional area under pulses through double-cropping, we visualize growing of pulses in mixture with other crops as a part of the solution. Selection of suitable areas for double-cropping and for growing pulses mixed with other crops and promotion of cultivation of suitable pulses is an urgent task to be undertaken by agricultural research and extension agencies, since this forms the most important item in the programme for increasing the production of pulses.

In relation to additional milk production growing of berseem on an area ranging from 3.0 million hectares in the Third Plan to 5.2 million hectares in the Fifth Plan and application of phosphate at the rate of 44.8 kg. per hectare (40 lbs. per acre) to this crop is suggested. Being a leguminous crop, incorporation of berseem in the crop rotation on irrigated land will be beneficial to other crops which will also profit from the residual value of phosphate applied to berseem. Here again selection of suitable areas for growing berseem with a suitable crop rotation and propagation of this crop with the help of bacterial cultures for pro-

moting its growth in new land where necessary is a measure that has to be taken up by agricultural extension agencies in different States. We have recommended berseem as giving the highest return per acre of T.D.N. and D.C.P.; but other suitable fodders may be substituted where required keeping in view their nutrient value. The essential consideration is that for augmenting milk production a certain minimum area must be allocated in any plan to the cultivation of green fodder, which as we have shown, is the cheapest method of providing nutrients to milch animals for producing additional milk.

The targets of production of cereals, pulses and milk presented in this paper have been based on technological considerations. We consider them eminently practicable, because we have fitted them within the framework of the overall agricultural development. Whatever the inputs, irrigation, fertilizers, soil conservation, etc., we have appropriated only a proportionate share of these for increasing the production of these three commodities, leaving the rest for other agricultural items. Also for some measures that we have found necessary to increase, *viz* fertilizers, increase of area under pulses and allocation of a limited area for the cultivation of berseem, the magnitude of increase recommended is well within the scope available for this purpose. As we have stated, for fertilizers our estimates for overall requirement at the end of Fifth Plan agree closely with long term estimates made by the Planning Commission. We have not taken into consideration the strictly economic aspects of the present Plan. The targets set can be attained only if the producer considers it worthwhile and is able to produce according to plan. This involves questions like prices, credit, supplies, marketing facilities and other incentives. The question of economic incentives to the producers has been discussed by Panse (1962). Again, the increased production is intended primarily to improve the nutrition of the economically weaker sections of the population. Conditions will have to be created through price regulation and other measures under which these sections can afford to utilize the greater availability of nutritional food in their normal dietary. These are wider issues which are common to the entire plan for agricultural development and are outside the scope of our present study.

Lastly, even with the limited objective we have set for ourselves, we have touched only the fringe of the problem of planning. Planning only begins with the setting up of national targets. These targets have to be broken down through States, districts, and blocks to the level of each farming community, and must be acceptable to them in order to win their enthusiastic co-operation in the task of achieving the planned production. This involves a process of mutual consultation and adjustment at various stages on the background of local potentialities, limitations and needs. We do not propose to enlarge on this subject as Panse (1961, 1962) has discussed already this and other aspects of planning and the weaknesses of our Five-Year Plans, in considerable detail. All the three Five-Year Plans for agriculture so far have been merely sets of development schemes empirically agreed upon between the States and the Central Government. The process of detailed planning which would ensure the attainment of our objectives through a far more efficient direction of our efforts is overdue and a beginning could be made from the Fourth Plan with detailed planning at least for the three commodities which have been the subject of our paper.

We would like to touch briefly on one point made by Panse in the course of his discussion on planning as being of pressing importance. It is that detailed

planning requires detailed knowledge such as can be obtained only through a wide variety of reliable statistics, some of them reaching down to the ultimate producer. Even in our present modest exercise, we have been seriously handicapped for lack of data. In the field of agriculture, improvement of agricultural statistics, so that their reliability, coverage and depth are increased to the maximum attainable limit, must be treated as an integral part of planning and funds needed for this purpose should be forthcoming as leading to greater efficiency of planning and implementation of the programmes planned. Unfortunately, this principle has not been recognized unreservedly in India yet and no systematic steps have been taken through all the three Plans to fill up the lacunae in the statistics required for agricultural planning. An agricultural census of holdings by complete enumeration recommended by F. A. O. as the foundation for regional planning by providing data for small administrative units was not carried out, although this opportunity occurred twice, in 1950 and 1960, in conjunction with the world programme sponsored by F. A. O. Even the efforts made to strengthen the primary reporting agency in the States have not borne any result so far. There is an unavoidable time lag between the field collection of data, their analysis and the actual utilization of the results of this analysis in planning and in the execution of programmes. Setting up and expansion of the appropriate organizations for collection of detailed primary data relating to agriculture all over the country and for their competent analysis for the purpose of planning is, therefore, an urgent pre-requisite for the Fourth and subsequent Five-Year Plans.

SUMMARY

The paper makes an assessment of the gap between the availability and requirement of three key food items, *viz.*, cereals, pulses and milk, for the Indian population at the end of the Third, Fourth, and Fifth Five-Year Plans in order to raise the nutritional status to a minimum desirable level and discusses the specific means for increasing production of these items to meet the shortfall. The minimum nutritional target of 2,370 calories and 66.6 grams of proteins including 10 grams of animal proteins per head per day, suggested by Sukhatme is taken as the basis and the least cost combination of items of food worked out by him which includes 403 grams of cereals, 104 grams of pulses and 7.4 grams of milk protein per head per day has been taken as the starting point for the calculations. With the help of the population projections made by the Central Statistical Organisation and allowing for the non-food use of cereals and pulses, the production targets for cereals and pulses have been worked out. From a careful study of the available information on targets envisaged for the different plans in respect of various improvement measures, *viz.*, extension of irrigation, soil conservation measures and introduction of improved seed, the additional production expected from these sources has been estimated. The balance of the shortfall is sought to be made up by the judicious use of fertilizers. The specific manner in which this can be done is shown by utilizing yardsticks for increase in the yield of cereals and pulses from the application of fertilizers. In the case of pulses, since the gap cannot be fully bridged through these measures an additional area at present under single-cropping has to be brought under pulses as a second crop. As regards milk production the study is aimed at only meeting the feed needs of milch cows and buffaloes for additional milk production, since it seems well-nigh impossible to meet the overall nutritional requirements of the entire bovine population for

maintenance, growth and production with the levels of agricultural production likely to obtain in the near future. The least costly method of providing cattle feeds needed for additional milk production is shown to be to grow berseem on irrigated area of 3.0, 3.8 and 5.2 million hectares by the end of the Third, Fourth and Fifth Plans. Due allowance has been made for this diversion in considering the production of cereals and pulses. Although the study has been confined to three important items of food a proportionate margin has been allowed all through this study for the development of other agricultural commodities, such as in the allocation of area under irrigation and soil conservation measures and in the gross requirements of fertilizers. The gross requirement of fertilizers is expected to amount to about 4.0 million tonnes of nitrogen and 2.0 million tonnes of P_2O_5 at the end of the Fifth Plan.

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