Draft Memorandum On Human Nutrition Vis-a-vis Animal Nutrition in India

Publisher : Indian Council of Medical Research

Edition : 1952

PREFACE

The memorandum contains an integrated plan for human and animal nutrition in India. In preparing it the Joint Committee have taken into consideration the current practices in agriculture and animal feeding and human dietary habits in India. The plan as suggested in the memorandum has required certain modifications in all the three aspects mentioned above. The recommendations have been based primarily on the available statistics regarding human population, animal population, agricultural production and area under cultivation. The Joint Committee did realize that there may be some differences in the figures given if they had been obtained from other sources but they felt that the variations between the figures of different origin were not of such a magnitude as to materially affect the conclusions reached in the memorandum. In making their recommendations for the integrated plan, the Joint Committee have suggested certain modifications in the utilization of the arable acreage. In doing this, they have not suggested any revolutionary changes. They were guided by the practical considerations of utilization to the fullest possible extent of the available resources in the country. The Joint Committee did not dispute the fact that our food production and also the dietary habits of people may have to be changed substantially to reach the ideal of self-sufficiency commensurate with adequate nutrition, but they have kept in their minds the feasibility of putting the various suggestions into practice. They hope that the suggestions made by them, if given effect to, would result in relieving to a considerable extent the acute situation with regard to food in the country and would form the basis of more extensive plans which could be undertaken in the future.

The memorandum has been considered by the Indian Council of Medical Research and the Indian Council of Agricultural Research. It has been decided that the memorandum should be widely circulated with a view to obtaining suggestions and criticism from various sources. The comments received would be considered at a joint meeting of the Nutrition Advisory Committee of the Indian Council of Medical Research and the Animal Nutrition Committee of the Indian Council of Agricultural Research and the memorandum finalised for presentation to the parent bodies. The remarks made on the memorandum by the Advisory Board of the Indian Council of Agricultural Research at its meeting held in

December, 1951 are given below :—

"Tracing the history of the case Dr. Sen said that in 1949 the Animal Nutrition Committee recommended that the question of human feeding problem *vis-a-vis* animal feeding problem in India might be discussed at a joint meeting with the Nutrition Advisory Committee of the Indian Council of Medical Research which had been agreed to by the Board. As a result of this decision a joint meeting was held in June 1950 at Bangalore. They discussed the general question relating to the requirements of human folks and also the requirements of animals in relation to the possibility of the production of food for both in this country. It was decided to set up a sub-committee to prepare a memorandam which would again be considered by the joint committee. This work had taken six months and they had consulted a large number of specialists. The memorandum had then been adopted at another joint meeting. This memorandum had already been circulated to members about three months back for comments and views.

Detailing the recommendation of the memorandum Dr. Sen said that they had taken into account the minimum requirement of food for human beings, as accepted by medical workers and specialists. The Health people had several times impressed upon animal husbandry workers to increase the production of items of foodstuffs which were considered essential for human consumption. For instance, they had always been told that so much milk was required and that foodstuffs of biological value in the form of meat, ghee or other articles were also needed. But no one had bothered to ask the experts whether it was possible to increase production of such foodstuffs of animal origin. When they started discussing this question they immediately found that in order to meet the requirements of human folks in this country, especially of products of the type of milk or meat or eggs, it would be practically impossible within any reasonable period of time to fulfil the target programme as laid down by the medical authorities. Therefore it had been decided to revise the standard as recommended by the medical authorities. Here again it was found that there were certain inevitable difficulties for meeting the target requirements, with the result that the specialists had to suggest certain alternatives. They had to formulate certain tentative ideas as to how they could meet the requirements of the existing population of animals so that they could produce that much amount of milk, meat, etc.

Continuing Dr. Sen said that he wanted to take the members over the memorandum as circulated. The first few pages thereof dealt with the actual requirements of human beings in this country, based on certain assumptions. Those assumptions had been accepted by the human nutrition workers for a long time. The observations made in the memorandum were as follows :

They might have the total human population in this country of about 375 million by 1956. It was suggested in 1944 by the Indian Research Fund Association (now Indian Council of Medical Research) that there should be a certain minimum target of requirements for each person. Referring to page 3 of the memorandum Dr. Sen said that the target figures were about 14 oz. cereal ; but they were more interested in the milk target of 10 oz. and fish and meat target of about 3 oz. and one egg per head per day so that the total requirements on that basis came up to about 43 million

tons of cereals. So far as milk was concerned about 31 million tons, fish and meat about nine million tons and for eggs, there was a very huge number. That was roughly the target. Dr. Sen continued that they then set themselves to the task of trying to find out how many animals were needed in this country and whether they could at all produce that target figure of milk, meat and eggs.

Dr. Sen said that the next section in the memorandam referred to animals that were in the Union of India which roughly included about 60 millions of breeding cows and buffaloes, 56 million heads of bullocks and roughly about the same number of young stock, besides certain amount of sheep, goat and pig. They had then proceeded to calculate how much foodstuffs of ordinary type would be required to produce that 31 million tons of milk, nine million tons of meat, etc. He added that taking into account the present way of feeding of animals, as per Table 4 of the memorandum, it was impossible to produce that amount of milk or *ghee*. In that connection they had taken into consideration not only the foodstuffs of the type of bran, maize, barley, oilcakes, grass and rice straw that could be needed to maintain those animals but also to give the required production. They had also taken into consideration all the foodstuffs that they needed to maintain the young stock which would replace the old stock. Having found that it was impossible to produce that amount of extra milk, meat or eggs with any reasonable success, they had later on tried to find out what would be the land required and the position in regard to the rightful agricultural planning if they tried to produce all the material from the land. That was shown in Table 5 and they had found that if they expected to carry on some sort of statistics with all the figures that they had taken here it was quite possible that in some cases their figures might not be correct. At present they had 38 million tons of cereals produced in the country. The total area under crops of one type or another was 248 million acres and if they wanted to meet the target of human requirements, they would have to increase the area to about 391 million acres, *i.e.* an increase of 58 per cent. That was based on the current production and current acreage. After doing that they tried to find out that, assuming that they had produced that human food grain, there would be certain amount of other material and how much that would be sufficient to produce the required amount of milk or meat. It was found that it was impossible to produce 31 million tons of milk, and nine million tons of meat if they agreed to expect a target set by the human nutrition workers. They decided that they could not achieve any degree of success on the target set by the human nutrition workers. Therefore they anticipated a different target which was not so much different as far as the other crops were concerned, like cereals, but slightly different in the case of milk. They had suggested that 10 oz. of milk could certainly be supplied to 25 per cent of the total population in the country and 5 oz. (the present quantity available) to the rest of the population. That would be under the revised plan. They could also produce sufficient meat for the 55 per cent of the population to the extent of about 1-2 oz. a day. They could not however hope to bridge the entire gulf in the near future. Having come to that basis, they had tried to show how that could be achieved. The main point suggested in the programme was that they were going to produce certain amount of extra milk and extra meat and if it was proposed

to maintain the bullock efficiency to the present strength and to still increase their efficiency by better feeding, then they had to set apart about 11·5 acres of irrigated land for the fodder production in the country. Moreover another eight million acres of the so called rain-fed land was required where the *kharif* crop would be grown entirely for the feeding of the cattle. That was their suggestion so far as the immediate programme in regard to the animals was concerned. Incidentally quite a number of other problems had also been discussed here, *viz.*, question of oil seed production in the country, whether the oil could be taken out—at least some of that for human consumption and they felt that there was a possibility of getting certain amount of extra oil from oil cakes which was used as manure. If that oil could be extracted, assuming it to be about ten percent, it meant that they were losing about 80,000 to 100,000 tons of oil of the market value of Rs. 25 crores. That amount could be utilized for other purposes in this connection. Their suggestion was that it was possible to obtain certain amount of feeding material for cattle from outside at a much less cost compared to what they paid in this country. If that could be adhered to, they would achieve something. Another point was that their present system in regard to the use of certain foodstuffs even for human consumption was entirely wrong. For instance, they were now-a-days insisting on milling wheat to the extent of 98 percent in the country. Such milling deprived the country so far bran was concerned, which could easily be used for milch stock for producing more milk.

These were some of the facts brought out in the memorandum. So this memorandum had been in circulation in the Indian Council of Medical Research and it was also now before the members of this Board. He added that he had no resolution to move on the memorandum, but that if some criticism was offered on it to improve its utility, it might serve a more useful purpose and the sponsor of the memorandum would be prepared to accept the criticism. Unfortunately very few criticism had so far been received—only two in number and they did not know where they stood. If the memorandum could be circulated to more people and some useful criticism could be offered on it, this might be revised to be of more value.

Dr. Datta said that he had some discussion with the medical authorities on the statement made by some medical scientists in the country that sufficient quantity of vegetable protein could be produced in the country. According to his view, there was no such thing as a vegetable protein of a high biological value. As far as his little knowledge was concerned, that was a thing that needed little more information before it could be accepted and since the Committee had gone into the question from different angles with so many experts, he had no doubt that Dr. Sen would be able to enlighten the members on the subject.

Mr. Sivaraman said that since the Directors of Agriculture of all the States were here and having regard to the suggestion made out in this memorandum he suggested that oil cakes might not be used for manurial trials. In his view only such material should be used as manure which could not be used for feeding purposes. Some alternative methods should be found for manuring the land, if the oil cakes were to be used for *human* food by extracting oil from the cake.

Dr. Pal said that the whole account given by Dr. Sen was such which was essential in the nature of a long range scheme, although the idea was to tide over the present difficulty in food both for animals and men and the whole thing depended on the increase in food production in the country of which Dr. Sen had given us an idea. He was of opinion that if the recommendations, as enumerated by Dr. Sen, were to be put into practice they would have to correlate them with the land transformation plan which had also been drawn up by the Ministry of Agriculture and the Indian Council of Agricultural Research together. In his opinion this subject was out of the purview of the Board, but they would have to think about the agriculture side. However, there were one or two things which he would like to remark. The first was regarding the milling of wheat into flour and the wastage therein, as said by Dr. Sen, and the other was that unless the cattle were improved there would be no improvement in agriculture.

Anybody who was interested in the problem of production of food both for cattle and human being, was very well aware and for him the memorandum under circulation should not be the basis on which he could take any particular action. Therefore he thought it would be perfectly in order if they discussed and indicated the action in the matter. The first point in that connection was that they had to cast a very careful consideration whether in any of the land reclamation programmes and extension of the so called areas, how much land was being devoted towards pasture. That was a problem which required a careful consideration of an authoritative opinion. The other point was regarding the oil cakes. While it was a problem about which they had some experimental data and he would like to know what was more advantageous : oil cakes to the animal through the soil or feeding the soil through the animal.

Taking the problem as a whole, they should base their calculations in such a way that the minimum requirements of the people were met. After having arrived at minimum standards required for animal nutrition and human nutrition, there could be some increase gradually and then they might be in a better position to solve the problem. Secondly he did not feel confident about the importance of the vegetable protein or animal protein. He was of opinion that the memorandum being important, it might be circulated to other interested parties.

Shri Nanda said that the memorandum was circulated in July for criticism and only two replies had been received. The replies were with the Indian Council of Medical Research for publication in the form of a pamphlet and they would be circulated to members for criticism.

Dr. Vishwanath said that he would like to consider the encouraging part of the memorandum. He would also like the Board to explore the matter further and not only to record the proceedings.

Another member said that they had been seriously trying to think out a method of using the existing land in Madhya Pradesh for rearing the cattle and to get the maximum out of cattle, milk and manure. On a 7,000 acre land 50 heads of cattle were being maintained but after reading the memorandum and studying other data about 450-500 heads of cattle were being maintained. After paddy, it has been decided to start the growing of berseem on a very extensive scale. This was one of the instances

which was being quoted to show as to how important the memorandum was and how by giving better nutrition to the cattle, more return was possible and also bullocks for draught animals instead of the poor. Of-course tractors were also used but the cultivators in India had to fall back upon the cow and the bullock in many parts of the country in this modern age.

The Chairman said that the best course would be to reprint the memorandum and circulate it to different people for their criticism and opinion and the Committee may again discuss the matter.

The Board recommended that the memorandum should be printed for circulation with a view to obtaining suggestions and criticism from various sources. When all the comments have been received the Committee should meet again and then submit a final report".

INTRODUCTION

The acute shortage of foodstuffs for human beings over a number of years and the imperative need for self-sufficiency as early as possible have brought us to the unpleasant conclusion that all is not well with our production methods and allocation of the available food to different classes of consumers, both human as well as animal. The "grow more food" campaign organized by the Government is no doubt a move in the right direction, but as it is concerned mainly with increasing the cereal production, it is unlikely to prove of lasting benefit, because a balanced diet which alone can provide adequate nutrition requires other things beside cereals. One does not readily realize that the state of human nutrition depends not only upon the agricultural produce, but also on the supply of those foods which directly originate in animals. Besides, one cannot overlook the fact that almost all our agricultural production from land depends on animal labour. Hence the problem of maintaining the efficiency of animals by proper nutrition is of paramount importance, for ultimately the care taken of the animals will be reflected in the increased supply of different types of necessary foodstuffs required by man. Unfortunately, the recent tendency appears to be to consider the needs of the human population only, leaving the animal population entirely to fend for themselves on such materials as would be available as by-products of produce cultivated mainly for human consumption. It must, therefore, be emphasized that the final solution of the food problem in India will depend on the success achieved in the integration of the needs of the human and animal population in relation to the capacity of agricultural production.

A proper understanding of the problem of human nutrition *vis-a-vis* animal nutrition and a successful attempt to integrate our efforts towards improving the nutrition of both would be possible if a well considered account of the individual requirements of these two groups are taken into consideration. It is necessary to discuss this question from several aspects, some of which are of a long term nature, but one which is of immediate importance is the allocation of the present resources of food supply between the human beings and animals so as to make a full and judicious use of this supply. At present there appears to be a competition between human beings and animals not only for arable land, but also for certain types of foodstuffs, and men, being in a position to appropriate all the supplies, have gradually deprived the animals of their share so much so that an attempt at encroachment is now being made upon some foodstuffs which till now were considered natural food for animals. For instance, if the existing total output of work and milk is to be sustained on the basis of current system of stock feeding, the requirement of some of the feedingstuffs such as maize, barley, gram, bran, oilcakes and cottonseed are 4·9, 4·9, 2·8, 2·2, 5·8 and 1·4 million tons respectively. In view of the overwhelming human demand, maize, barley and gram have, however, become rare articles for cattle feeding. Besides, due to the restriction on milling of wheat, bran which is a desirable food for animals and can be much better utilized by them than human beings, has actually become a part of the human dietary without much physiological benefit. The total production of oilcakes is hardly 2·3 million tons as compared to 5·8 million tons required only to feed working and milch animals. Obviously, between the demand and the actual production, a

wide gap exists. Moreover, when the actual availability of oilcakes to animals is considered, one finds the gap becoming wider because almost 50 per cent of the production is diverted for use as manure. To crown the situation, there has recently developed an unmistakable tendency on the part of certain planners of food programmes to advocate the use of oilcakes for human consumption. It is even being advocated in some quarters to include a leguminous fodder in the dietary of man. These encroachments and tendencies portend sure and gradual deterioration of animal efficiency which will eventually upset the agricultural balance and thereby all hopes for future recovery in food production. There appears to be, therefore, considerable confusion in certain quarters regarding the direction in which our efforts should be canalized to achieve a reasonably lasting solution of our food problem.

The Joint Committee have tried to take an objective view of the problem in its manifold aspects and have tried in the present memorandum to bring out the various facets in their logical sequence. To start with, the basis of assessing the human food requirement on certain accepted principles has been described and the total annual requirement of individual items of food calculated. Since these items include articles which directly originate in animals, and because the production of the others depends largely on animal labour, an attempt has been made to estimate the quantitative demand of feedingstuffs which will uphold the necessary animal efficiency to achieve the target requirement of human foods. The existing supply of feedingstuffs having been found far too low to meet the requirement of full animal production, the possibility of meeting the target of plant foods for human consumption and the arable acreage involved has been explored next. A review of human nutrition *vis-a-vis* animal nutrition and of both in relation to the pressure on arable land has revealed an almost insurmountable difficulty in attaining the target if we continue to perpetuate the existing agricultural policy and practice. A modified plan for food production with its basis and scope has, therefore, been put forward indicating to what extent the target of human food requirement could be achieved. A rational method of livestock feeding which can be integrated in the general plan of food production has been elaborated in a separate section. Finally, to enable the reoriented food planning to be viewed through a clearer perspective and to indicate what should be our immediate attitude, references have been made in the concluding section of the possible effect of certain measures currently practised or contemplated in the near future in their bearing on human and animal nutrition.

In the preparation of this memorandum the Joint Committee had to keep in view the fact that all foods required for both human beings and animals must come from land and that animal husbandry is but a means to an end, the end being the improvement in the living standard of the people. The planning of animal husbandry is thus directed to the increased efficiency of our animals so that they would contribute directly or indirectly to the welfare of man.

Human food requirements—the target

In 1944, the Nutrition Advisory Committee of the Indian Council of Medical Research recommended a balanced diet for the Indian

population (Table I column II). In doing this the Committee had taken into consideration the current dietary practices and had aimed at formulating a diet on which optimum health was possible.

Table I.

Target requirement for 300 *million adult units.*

Foodstuffs	Daily requirement ozs.	Annual requirement in million tons
Cereal	14	43
Pulses	3	9
Green leafy vegetables	4	12
Root vegetables	3	8
Other vegetables	3	9
Fruits	3	9
Milk	10	31
Sugar and jaggery	2	6
Vegetable oil, ghee	2	6
Fish and meat	3	9
Egg	1 No.	109,500 million eggs

The calculation of the annual requirement (column 3 in the Table I) has been based on the following considerations which provide a working basis for an approximate evaluation of our needs in the near future. The estimated mid-year population in 1950 is approximately 351 millions and at the rate of four millions increase per year, it will be approximately 375 millions in 1956. To this last figure has been applied corrections for age and sex. Children up to the age of ten years of both sexes have been uniformly considered as 0·5 of adult value. The calorie coefficients of various age groups below ten differ from 0·3 to 0·7. Assuming that there is equal distribution of children in each of the single year age groups the average coefficient for the whole group is equal to 0·5. Of the remaining population it has been assumed that the number of males and females is equal ; for the adult female population the coefficient of 0·8 has been applied. From the census figures reported in 1911, 1921, 1931 and sample for 1941 census the age distribution of the population in the various age groups has remained approximately unaltered. The same distribution has been assumed to have existed in the forties as well as fifties.

All the above considerations lead us to apply to the 375 million people computed above, a factor of 0·8 to reduce the total population in terms of adult units. The annual requirements have been calculated, therefore, on the basis of 300 million adults. One more factor which may have to be taken into consideration is that the whole of the population has been considered to consist of mixed eaters. There is an appreciable but as yet unestimated proportion of Indian population which has conscientious objection to flesh foods. Such groups are probably equally distributed in the various regions of India, although there is reason to believe that in Gujerat

there is a larger proportion of vegetarians. However, in the absence of any reliable data on the subject, it has been found impossible to make any correction in the figures calculated above. In 1944, the Nutrition Advisory Committee assumed that 30 per cent of the population was vegetarian, an estimate which was probably rather on the high side.

The calorie value of the diet composed as above is roughly 3,000 calorie gross. The net calories available from this diet would be less by ten per cent, that is about 2,700 calories. This nett calories intake has been considered to be adequate for an average Indian adult of moderate activity. When the value is applied to the whole population it is expected that it will cover the requirements of those groups in whom the calorie consumption is less as well as those other groups in which the calorie consumption might be higher than 2,700. In determining the calorie requirements the basis has been the work done in India on energy requirements, which has given values more or less similar to those recommended by the Health Organization of the League of Nations. Although there is need for further work to test the validity of the above assumption, for all practical purposes, the above figures could be considered as applicable to India on the whole.

Some facts about our animal population and their food requirements.

The classes of livestock involved in the supply of the human requirements together with their present-day numbers are shown in Table II.

TABLE II.

Class of animals and their numbers involved in the production of human foods.

Species	Class	Number in millions
Cow	Milch	41·1
	Breeding bulls	1·0
	Bullocks	51·0
	Young stock	41·1
	Useless cattle	3·8
	Total	138·0
Buffalo	Milch buffaloes	19·5
	Breeding bulls	0·5
	Bullocks	5·2
	Young stock	15·5
	Useless buffaloes	0·6
	Total	41·3
Goat	Milking goats	8·2
	Other goats	38·3
Sheep	Total number	37·0
Pig*	Total number	2·8
Poultry*	Total number	85·8

* Pre-partition All-India census 1940. For poultry census for U.P. and Orissa not included.

For many years past, the feeding of livestock in India has been decided by the nature of crop production practised. Consequently, their nutritional requirement is being met mainly from such by-products of crop processings as straw, oilcake, bran, pulse-husks and dal *chunni*, as also from cottonseed and, whenever available, from such grains as gram, maize, barley, etc. There has not been any organized grazing nor green fodder production in any significant quantity. The available nature and the type of feedingstuffs have given rise to a system of animal feeding where the nutritional requirements for production have to be met principally by the concentrate feeds, and for maintenance, largely by roughage with a small supplementation of concentrate.

In view of the situation described above, it is of interest firstly to examine the requirement of conventional feeds for the production of milk, egg and meat in quantities as laid down in the target. It will also be necessary to evaluate the food needs of work animals and follower stock consisting of young and breeding animals.

According to the target set, the annual requirements of milk is 31 million tons, of egg 109, 500 millions, and of fish and meat nine million tons. It is assumed for the purposes of this note that fish will form two-thirds of the meat and fish component. The development of fisheries, with a view to providing adequate quantities for human consumption, falls outside the scope of the present memorandum. In the following pages, therefore, the calculations are based on the assumption that three million tons of meat may have to be made available as human food.

Suitable concentrate mixture required for milk production may be composed of oilcake, 20 parts ; maize or barley, 35 parts ; gram or cottonseed 35 parts ; and wheat bran, ten parts. One pound of this mixture should be able to support $2\frac{1}{2}$ lbs. of milk production.

The production of eggs will entail $\frac{1}{2}$ ounce concentrate mixture per egg made up of oilcake, wheat bran, cereal grains and other feeds, such as, fish meal or meat offal in the ratio of 4 : 10 : 3 : 3.

Three million tons of meat will involve seven million tons (or 15,700 million pounds) of live weight. The daily dry matter requirement in the ration would be at 2 lb. per 100 lb. live weight. Of the total dry matter, 50 per cent can be obtained by grazing and the other 50 per cent by feeding of concentrate plus roughage in the proportion of 1 : 4. The actual amount of concentrate required will be about 5·5 million tons which may be made up of oilcakes, maize, barley and gram in the proportion of 2 : 4·5 : 9.

The requirement of feeds in relation to work production is of special significance to Indian agriculture owing to the fact that almost the entire agricultural operation as well as movement of agricultural produce within the rural zones of production are dependant on animal labour. Unfortunately, there are no precise data regarding food requirements for work. Based on the experience gained on organized farms in India the requirements can be calculated tentatively as 3 lb., 2 lb., 1 lb., and 0 lb., per head per day for successive quarters of a year depending on the intensity of work output. The mixture may be made of oilcake, maize or barley, gram and wheat bran in the proportion of 3 : 5 : 1 : 1. *There are about* 56 *million heads of working stock and it is felt that until a change is brought about by mechanization of our agricultural operation and road transport, this number must continue to*

remain. Even when by better feeding and breeding their efficiency increased the number cannot be reduced as one must reckon the additional work output which will be required for the significantly larger production target envisaged for human foods.

So far we have considered the requirement of feeds for the *production* of milk, egg, meat and work. The classes of stock involved in these will have to be maintained in health and in optimum condition for production. *The food requirement for maintenance* may be calculated on the basis of following considerations.

(a) Assuming that the contribution towards total milk production is half and half by cows and buffaloes, the present number of 41·0 million cows should provide a lactational yield of 1,700 lb. per cow as compared to the existing output of 700 lb. and 20·0 million buffaloes should produce a lactational yield of 3,600 lb. per animal as compared to 1,600 lb. at present. The maintenance requirement of these animals may be formulated in terms of (i) cultivated green fodder @ 30 lb. per head for cow, and 40 lb. per head for buffalo and (ii) dry roughage like straw or *kadbi* @ 5 lb. per head for cow, and @ 10 lb. per head for buffalo. About one-third of the total green fodder requirement may be assumed to be obtainable by grazing on monsoon grass.

(b) Assuming the egg laying capacity of a bird to be on an average 100 eggs per annum, the production of the total number of 109,500 million will involve about 1,000 million birds. The maintenance requirement of these birds, among other things, will necessitate the feeding of one ounce of the same mixture (prescribed for egg production) per head per day.

(c) Of the total dry matter required by meat producers, the maintenance requirement will be met partly from grazing and partly by 22 million tons of dry roughage like cereal straws.

(d) The maintenance requirement for working animals during the successive quarters of a year may be assumed as follows.

(i) Partly from 3 lb. conc. mix. plus 11 lb. straw or *kadbi.*
(ii) Partly from 2 lb. conc. mix. plus 12 lb. straw or *kadbi.*
(iii) Partly from 1 lb. conc. mix. plus 6 lb. straw or *kadbi* plus grazing for 3 hours.
(iv) 4 lb. of straw plus full grazing for 6 hours.

In addition to the producing stock, there are the supporting or follower animals and birds. The adequate feeding of the followers is as important as that of the producers since they either help in the current production (as is the case with the breeding males and meat producers) or in no distant date they themselves must commence to produce (as is the case with the young stock). The tentative requirement of feeds for animals and birds has been calculated on the assumption that the existing distribution of livestock population remains undisturbed and the number of followers brought *pari passu* with the number of producing stock.

The requirements of feedingstuffs for (a) the production of milk, meat and eggs and for work; (b) maintenance and (c) feeding the follower stock, calculated according to the above considerations is given in Table III.

TABLE III.

The total requirement (in million tons) of different feedingstuffs for maximum animal production.

Feedingstuffs	Production				Maintenance				Followers		Total
	Milk	Egg	Meat	Work	Milk	Egg	Meat	Work	Animal	Bird	
Roughage											
Straw or *kadbi*	...	...	...	...	100	nil	22	75	40	nil	237
Green fooder	...	...	...	...	220	nil	nil	nil	25	nil	245
Grazing (as green grass)	...	...	...	...	110	50	102	110	60	25	457
Cancentrates											
Oilcakes	2·48	0·30	0·55	4·20	...	2·00	...	...	2·90	0·75	13·18
Maize	2·17	nil	1·24	3·50	...	...	...	...	2·90	nil	9·81
Barley	2·17	nil	1·24	3·50	...	...	...	...	2·90	nil	9·81
Gram	2·17	nil	2·41	1·40	...	...	...	...	2·90	nil	8·88
Cottonseed	2·17	nil	nil	nil	...	...	...	...	nil	nil	2·17
Bran	1·24	0·75	nil	1·40	...	5·00	...	...	2·90	2·00	13·29
Cereal grain	nil	0·22	nil	nil	...	1·50	...	...	nil	0·55	2·27
Fish meal or Meat offal	nil	0·23	nil	nil	...	1·50	...	...	nil	0·55	2·27

It would be of interest now to examine the extent to which the target of requirement can actually be met from the supply available today. In Table IV, the demand and supply of the various items has been shown.

TABLE IV.

Estimated requirements and present-day supply of the feedingstuffs.

Feedingstuffs	In million tons		
	Estimated requirement	Present supply	Deficit or surplus
Straw and *kadbi*	237	114	—123
Green fodder	245	100	—145
Grazing (as green grass) ..	457	525	+ 69
Oilcakes	13·18	2·31	—10·87
Maize	9·81	2·00	—7·81
Barley	9·81	2·00	—7·81
Gram	8·88	3·06	—5·82
Cottonseed	2·17	0·96	—1·21
Bran	13·29	1·52	—11·77

Table IV reveals large gaps between the requirements and available supplies. It is true that the gulf will be partly bridged if and when the increased production of plant foods for human being becomes a fact. It is also true that with respect to green fodder a very large increase in land devoted to its cultivation will have to be brought about. The grazing requirement could probably be adequately met by tapping all available grazing resources, *i.e.*, forests, land not available for cultivation, areas under cultivable waste and current fallow. On the other hand, with respect to gram, maize, barley and bran, the outlook is not at all bright. Even with regard to cottonseed the potential availability of future supplies dependent upon increased production is not expected to be more than 0·4 million tons. It should be clear, therefore, that it will not be possible properly to feed the animal population unless appropriate plans for increased food production are carefully laid and followed.

In planning for increased production the following points will also have to be borne in mind. In order that our milk target is achieved with the present number of milch animals, the productive capacity will have to be increased by 2½ times. A 50 per cent increase can immediately be secured by proper breeding alone. It will be necessary to supplement this by proper "breeding up" of the stock if the productivity is to be increased further.

The annual production of three million tons of meat will require seven million tons of live-weight. At present the total live-weight of the potential meet-producing animals (goat, other than milch, sheep, useless cows and buffaloes, pigs and poultry) would barely be three million tons. A moderate increase in the number of meat producing animals can possibly be brought about within a reasonable time, but the full realization of the target will be a fairly time-consuming process and will also raise newer problems, such as, enlargement of breeding stock and the provision of additional feed for these animals.

The number of egg-laying birds in the Indian Union will hardly be 50 million. To produce the number of eggs set out in the target, about 1,000 million birds will be necessary. Besides, it must be admitted that average egg-laying capacity of 100 per annum per bird does not exist today. The capacity of the present-day layers is about half this number. To improve upon it and at the same time increase their number by about 20 times will call forth organized effort on a large scale spread over quite a number of years.

In the final analysis, the important problem which will require the most careful consideration is the pressure on arable acreage which the increased animal production will exert for growing the requisite quantities of feedingstuffs in conformity with the current practice of livestock feeding in this country. Even if the practice is modified along a more rational line, the pressure on land will continue to exist although to a comparatively lesser degree.

The foregoing brief review of the serious gap between the demand and the existing supply of feedingstuffs as well as of other limiting factors, leads to the conclusion that it will not be practicable under the prevailing conditions to increase our animal production to such an extent as to meet the target of human requirement in the immediate future.

Possibility of meeting targets of plant foodstuffs for human requirement—Arable acreage involved.

In view of the fact that, under the existing conditions, the realization of the target requirement of foodstuffs of animal origin is almost impossible in the near future, it may be of interest to explore the possibilities of meeting the requirements of human foods other than those of animal origin. Incidentally, this will also give us an idea of the quantities of animal feeds which would be obtained as by-products once the target for human need is achieved.

In Table V are given figures which illustrate the present state of production of plant foods with regard to yields and acreage. The corresponding figures for increased production to meet human requirement targets are given in columns 3 and 4. The land area proposed to be under cultivation of cotton, jute, tea, tobacco, etc., is given at the end of the table.

TABLE V.

Crop production and acreage involved for the current supply and target requirement.

	Current production		Target production	
	Quantity mill. tons	Acreage mill.	Quantity mill. tons	Acreage mill.
Cereals ..	38	164	43	198
Gram & Pulses ..	6·7	35·2	9	53
Oilseeds ..	4·5	18·4	25	99
Copra ..		1·5		
Green leafy vegetables ..	—		12	1·2
Root vegetables ..	—	3	9	1·8
Other vegetables ..	—		9	3·7
Fruits ..	—		9	2·0
Sugar ..	5	3·5	7	5·0
				363·7
*Cotton, tobacco, tea, jute, etc. ..	..	22		27·3
		247·6		391·0

*About 22 million acres of land are annually devoted towards the production of cotton, non-edible oil seeds, condiments and spices, tobacco, tea, coffee, jute, etc. Normally, the question of any increase in acreage on these items need not be cosidered, but the economic situation which has lately arisen makes it incumbent on us to increase the acreage on cotton and jute so that their production may reach at least the level prevalent during the years before the country was partitioned. This increase will involve an additional acreage of 5 million and, therefore, the total will have to be raised from 22 to 27 million acres.

It will appear, therefore, that an increase by 58 per cent will have to be brought about if sufficient plant food has to be produced for human consumption alone. The total acreage in column 4 is dangerously near the potential capacity of the Indian Republic with regard to its total cultivable acreage. Even assuming that the above targets were capable of being achieved within the next few years, the by-products available for animal feeding will not be sufficient to meet the requirements with the possible exception of oilcakes.

The position so far reviewed of human nutrition *vis-a-vis* animal nutrition and of both in relation to pressure on arable land, suggests that our attitude towards the target of production requires certain modification, a modification not necessarily on a permanent basis but for such period as to tide over the formidable circumstances in which we find overselves now. We need also to overhaul the method of production in vogue.

A modified plan—Its basis and scope.

The capacity for crop production is determined, among other things, by (i) the area available for cultivation, (ii) the yield per acre and (iii) the availability of the *power* required for cultivation.

In the Indian Union the net sown area is about 228 million acres, of which roughly about 38 million acres are sown more than once. Thus, the acreage at present cultivated may be taken to be about 266 millions. If proper conditions are created, the potentiality of cultivable acreage can be increased by 60 per cent, or, a maximum of 400 million acres of total cultivable acreage can be mobilized by the following re-adjustment of the land.

(a) By increasing the net area sown, from about 228 to 273 million acres. This increase of about 20 per cent in the arable land can be effected by reclaiming 45 out of about 92 million acres classified as cultivable waste.

(b) By increasing the area to be sown more than once, from about 40 to 110 million acres. This augmentation is considered possible in view of the new irrigation projects which are already under way.

(c) By salvaging 17 out of 57 million acres of arable land which are currently kept fallow.

It is well known that the average outturn of principal crops in this country is poor. Agricultural experts, however, consider that through such means as using improved varieties of seed, the application of manure, irrigation and protection from pests and diseases, it should be possible to increase per acre production of rice by 30 per cent, other cereals and millets by 25 per cent, gram by 50 per cent, the edible oil seeds by 10 to 15 per cent and sugarcane by at least cent per cent. Once the technological possibilities in crop production are realized, there is no reason why the land available for cultivation would not bear the necessary crop burden demanded now as well as in the near future.

The power to cultivate land in this country has devolved upon animal labour. Perhaps, for many years to come, animal labour will continue to be the main motive power for agricultural operation. Obviously, the area of cultivable acreage will depend upon the number and the capacity of working animals. As has already been mentioned the total number of

working animals is about 56 million. In the existing conditions of feeding and management, the average capacity of cultivation per pair of bullocks is about 10·6 acres, or 28 million pairs can cultivate about 296 million acres. By better feeding and management, the working capacity can be improved by about 20 per cent, so that the maximum total acreage that can be cultivated by animal power will approximately be 355 million. The rest of the potentially available acreage (45 million) can be worked by mechanical power.

On the basis of certain assumptions, which are mentioned later, the distribution of potentially available acreage for arable purpose may be proposed as follows :—

(a)	For the production of foods of plant origin	290 million acres
(b)	For the production of foods of animal origin	83 „ „
(c)	For growing commercial crops	27 „ „

The allocation of the acreage of 290 million for growing food crops, the stipulation for per acre yield, and the total available production may be as follows :—

(a) For cereals and millets, 164 million acres on the basis that present-day per acre yield is improved by 15 per cent. Total available production—43 million tons.

(b) For gram and pulses, 40 million acres on the basis that the present-day per acre yield is improved by 25 per cent. Total available production—9 million tons.

(c) For vegetables and fruits, 9 million acres on the basis already referred to earlier. Total available production for green leafy vegetables, 12 million tons ; for root vegetables, 9 million tons ; other vegetables, 9 million tons ; and fruits, 9 million tons.

(d) For sugar and jaggery (or, raw sugar)—4 million acres on the basis that the present-day production of sugarcane is improved by 40 per cent. Total available production 6 million tons.

*(e) For vegetable oil or edible oilseeds, 73 million acres on the basis that the present-day per acre yield is improved by ten per cent. Total available oil—4·25 million tons.

The production of food crops on the above scale will make available the following residues of crop and food processings for feeding the livestock :

Straw and *Kabdi*	.. ..	143·0 million tons
Oilcakes	.. .. ..	9·0 „ „
Bran	.. .. ..	2·1 „ „
Gram husk	.. .. ..	0·9 „ „
Dhal chunni	.. .. ..	0·9 „ „

The amount of oilcakes shown above is excluding the quantity lost in the export of uncrushed seed and including the quantity available at linseed and cocoanut cake.

The acreage of 27 million allocated to commercial crops will include, as has already been mentioned, the increased production of cotton and jute.

*If solvent process of oil extraction is introduced ; the acreage on oilseeds can be reduced from 73 to 63 million — *vide* P. 21

The cotton crop under this allocation will make available about 1·3 million tons of cottonseed.

As will be shown later, it will be possible to produce 23·4 million tons of milk and 1·7 million tons of meat. The quantities of residues obtainable from crop and food processings, cottonseed, and the feeds and fodder to be grown in the rest of the cultivable acreage together with the grazing on unappropriated areas of cultivable waste and fallow lands, as also on small fractions of forest and uncultivable areas will provide the necessary food.

In view of the almost unsurmountable difficulties which seem to be attached to egg production according to the target figure, no considered suggestion can be made in regard to the availability of eggs in this scheme of future plan. This does not necessarily mean that eggs have no place of importance in the human dietary. We feel there is considerable scope for egg production, partly on an organized basis, but mainly as individual household enterprise where a few birds can always be maintained on residues of family food, kitchen refuse, etc.

On the basis of utilizing the maximum potentiality of cultivable acreage, adoption of scientific methods for increased crop production, and taking into cognizance certain barriers which can be overcome only in due course, we can expect to achieve the following modified target of human requirement within a reasonable period.

TABLE VI.

A modified scale of human diet which can be achieved under the new plan.

Foodstuffs	*Daily requirement in ozs.*		
	Recommended	Attainable	
Cereals and Millets..	14	14	
Gram and Pulses ..	3	3	
Green leafy vegetables	4	4	
Root vegetables ..	3	3	
Other vegetables ..	3	3	
Fruits	3	3	
Milk	10	..	(a) 10 oz. + what exists today, for 20 per cent of the population (*i.e.*, the vulnerable group). (b) What exists to-day for the rest of the population.
Sugar and Jaggery ..	2	2	
Vegetable oil and Ghee ..	2	1½	
Meat	1	1	At present for 55 per cent of population only
Fish	Not considered in the present plan.		
Egg	1 No.	Not considered here.	

Meeting the nutritional demand of animals according to the new target.

In order of priority for animal feeding, our first concern will be to find ways and means of meeting the nutritional requirement of 56 million working animals from the food residues and other feeds that will have to be specially grown.

A sound basic diet for milch cattle should be built round a good quality roughage like pasture grass or a properly selected cultivated fodder. This fact has long been realized in countries where dairying has made the greatest advance. Apart from its nutritional soundness, such a system of feeding has also proved most economical for milk production, because the combination of bulk (to fill the capacious stomach of the ruminant), and the optimum as well as balanced distribution of nutrients in the green fodder greatly reduce the overhead cost of feeding. If the productive performance of the Indian milch cattle is to be rehabilitated (which should really be the first essential step) and then progressively improved upon by breeding up, it is necessary that the plan of their feeding should be laid on the same fundamentally sound system. In India, in view of the climatic conditions and other limitations, the possibility of developing organized pasturage will be difficult to achieve, but the cultivation of fodder crops in a small fraction of the arable acreage can be more easily introduced.

There are about 41 millions of breeding cows in the Indian Union. Their average body weight may be assumed to be 500 lb. The ration that can be prescribed is as follows :—

For maintenance	20 lb. mixed green fodder 4 lb. dry fodder (straw)
For production of 3·5 lb. milk	10 lb. mixed green fodder

The above ration is capable of increasing the present-day lactational yield of 700 lb. to 1,050 lb., or, of increasing the total milk production by 50 per cent. The existing total annual gross yield has been estimated at 9.7 million tons which can be augmented to 14·6 million tons. If 25 per cent of the gross yield is deducted for feeding calves, 10·9 million tons of net annual milk production becomes available. As the present net production is about 7·3 million tons, the suggested feeding plan should make available 3·4 million tons of extra milk.

There are about 19·6 million of breeding buffaloes in the Indian Union. Their average body weight may be assumed to be 800 lb. The ration that can be prescribed is as follows :—

For maintenance	30 lb. mixed green fodder 7 lb. dry fodder (*kadbi*)
For production of first 5·5 lb. milk	20 lb. mixed green fodder
For production of next 2·5 lb. milk	1 lb. conc. mix.

The above ration is capable of raising the present day lactational yield of 1,600 lb. to 2,400 lb. or increasing the total milk production by

50 per cent. The existing total gross yield has been estimated at 10·4 million tons which can be augmented to 15·6 million tons. If 20 per cent of the gross yield is deducted for feeding calves (assuming 50 per cent of the male calves are not raised), 12·5 million tons of net annual milk production becomes available. As the present net production is about 9·4 million tons, the suggested feeding plan should make available 3·1 million tons of extra milk.

The follower stock, whose important role in the particular context of Indian agriculture and animal husbandry has already been referred to, can be divided into (i) breeding bulls and (ii) young stock. The planning and estimating the requirement of feedingstuffs for these animals have been considered as follows :

The number of breeding bulls is approximately 1·5 million, and distributed in the ratio of 2 : 1 between the cow and the buffalo species. The average individual live-weight of this entire population can be assumed to be 9·0 lb. Since these animals should be kept on a plane of nutrition above that of the normal maintenance requirement and also with selected types of feed, the ration that can be prescribed for them is as follows :—

(i) Mixed green fodder @ 20 lb. per head per day
(ii) Straw or *kadbi* @ 12 lb. ,, ,, ,, ,,
(iii) Concentrate mixture @ 2 lb. ,, ,, ,, ,,

The concentrate mixture may be made up of oilcake 40 per cent, maize 40 per cent and bran 20 per cent.

The number of youngstock is approximately 56·0 million and distributed in the ratio 8 : 3 between the cow and the buffalo species. The average individual live-weight of this entire population can be assumed at 300 lb. After taking into account the quantitative as well as qualitative requirement of nutrients for the purpose of growth based on the weight at maturity reached by the Indian animals, the ration that can be prescribed to this class of stock is as follows :—

(i) Mixed green fodder @10 lb. per head per day
(ii) Straw or *kadbi* @ 2½ lb. ,, ,, ,, ,,
(iii) Concentrate mixture @ 1½ lb. ,, ,, ,, ,,

The concentrate mixture may be made up of oilcake 20 per cent, gram 40 per cent and maize 40 per cent.

Attention has been drawn to the fact that at the moment the available live-weight for meat production is about 2·0 million tons only. Since carcass production is relatively an easier process, it may be possible that in the near future the available live-weight of meat producers can be doubled to meet the daily requirement of one ounce of meat for 55 per cent of the total population. The production of meat at this rate will involve the maintenance of about 5·5 million tons of live-weight. As the meat production will mainly be of mutton type, the selection and planning of feedingstuffs for maintaining meat producing live-weight shall have to be decided accordingly. The basis of rationing for this class may be as follows :—

(i) The daily total dry matter requirement will be 2 lb. per 100 lb. live-weight.

(ii) The distribution of this dry matter may be recommended as grazing 50 parts, straw or *kadbi* 45 parts and concentrate mixture 5 parts. The concentrate mixture will be made up of oil cake, *dhal chunni* and gram husk in the proportion of 4 : 9 : 9.

In Table VII is summarized the requirement and surplus of feedingstuff which can be produced according to the proposed plan. The cultivable acreage specifically required for growing some of the feeds is shown in Table VIII.

TABLE VII.

Requirement and surplus of feedingstuffs (in million tons) according to the proposed plan.

Feedingstuffs	Work producers	Milk producers	Followers	Meat producers	Total for all classes	Surplus
Straw and *kadbi* ..	75	50	26	20	171	13·0
Green fodder ..	nil	316	64	nil	380	——
Grazing (as green grass) ..	110	nil	31	80	221	177·0
Oilcakes ..	4·2	0·4	3·0	0·4	8·0	1·0
Maize ..	7·0	0·7	5·8	nil	13·5	——
Gram ..	1·4	nil	5·6	nil	7·0	——
Cottonseed ..	nil	0·7	nil	nil	0·7	0·6
Bran ..	1·4	0·2	0·1	nil	1·7	0·4
Gram husk ..	nil	nil	nil	0·9	0·9	——
Dhal chunni ..	nil	nil	nil	0·9	0·9	——

TABLE VIII.

Acreage (in million) specially required for growing feedingstuffs.

Feedingstuffs	Work producers	Milk producers	Followers	Meat producers	Total
Irrigated fodder ..	nil	11·5	nil	nil	11·5
Barrani fodder ..	nil	nil	8·0	nil	8·0
Maize ..	15·0	1·5	12·0	nil	28·5
Gram ..	6·0	nil	24·0	nil	30·0
				Grand total ..	78·0

The data presented in Tables VII and VIII bring out the following points :

(a) Out of the total 83 million acres allocated, 78 millions should be immediately utilized leaving a reserve of 5 million acres.

(b) In addition to the feedingstuffs to be grown on cultivated land, the existing position regarding the grazing available from the forest area, area not available for cultivation and the area not appropriated in the present scheme from such heads as cultivable waste and fallow land will have to be maintained for the feeding of livestock.

Out of 83 millions of cultivated acreage allocated to animals, 25 per cent will have to be immediately devoted for the production of the requisite quantity of fodder. The choice of the green fodder may have to be decided by the regional character of the land and climatic environment. Seasonal excess of green fodders should be preserved by ensiling so that silage can take the place of green during the off-seasons.

(d) The selection of maize as the grain for the animals is dictated by the fact that it is not only rich in energy producing nutrient, but also obtainable at the highest rate per acre and can be grown in almost all parts of the country. Besides, as has been done in the U.S.A., its yield can be considerably increased by adopting the method of ' Hybrid Vigour'. Maize crop also leaves a valuable by-product in the form of *kadbi*. Amongst the leguminous seeds suitable for livestock feeding, gram has been found of proven merit owing to its richness in nutrients, its palatability to all classes of stock and also to its age-old extensive cultivation as a staple crop in this country. However, wherever possible, cultivation of gram (for animal requirement) can profitably be substituted by growing other leguminous crops like *guar* and *cowpea* which yield seeds of as high quality as gram and at the same time make available their hay which would be a very welcome supplementary roughage.

(e) The proposed plan allows a margin of surplus in straw and *kadbi*, in grazing (as green grass) and in concentrate feeds like oilcake, cottonseed and bran. The latter items mixed together should form an ideal ration for milk production, and 1·2 million tons of this concentrate mixture (made up of oilcake, cottonseed and bran in the proportion 1 : 3 : 2) will be capable of supporting about 3·0 million tons of milk. As the policy of " breeding up " progresses, this additional quantity of concentrate can be usefully employed in augmenting the milk supply. Even after meeting this possibility, there will yet remain another 0·8 million tons of oilcakes. This together with 1·2 million tons of maize which can be grown in half the surplus area of 5 million acres can meet the demand for a further increase in milk production to the tune of 4·6 million tons.

(f) The surplus of green grass could be converted into hay to the extent of about 44 million tons. This should be diverted to feeding of milch animals by replacing the straw and *kadbi*, especially wherever the straw happens to be rice straw (which recent research has proved to be deterimental to the animal unless suitably processed). The replacement of straw and *kadbi* by hay will have the added advantage in supporting yet another additional quantity of milk. In fact, not only this normal surplus, but also as much as possible of the glut of grass that appears in all the uncultivated areas following the seasonal monsoon should be conserved as hay to replace as much of the straw as possible in the diet of all classes of animals. The superior nutritive value of hay will enable substantial economy in feeding by the partial withdrawal of concentrates like maize and gram. This will incidentally bring some relief in the pressure on the arable acreage. In view of the potential benefit which hay may produce on

livestock feeding, it is desirable that (i) full scope should be sought in improving both the quantity and quality of grasses by scientific method of management, (ii) organized enterprise should be encouraged which will manage grass-land, harvest the surplus grass at the proper time to make hay as also to stack, bale and store the product before marketing and, (iii) as the hay producing areas are likely to be away from the consuming centres, communication and transport facilities for the movement of hay should be provided for.

(g) The gradual replacement of straw and *kadbi* will enable building up a stockpile of roughage which would prove useful at the time of scarcity.

It has been shown that by a rational plan of feeding, the lactational yield of cow and buffalo can be brought to 1,050 lb. and 2,400 lb. respectively. To reach the target of total production of 31 million tons, these yields must reach 1,700 lb. and 3,600 lb. respectively. In other words, it would be necessary by proper breeding technique to raise the lactational yield by 70 and 50 per cent respectively for the cow and the buffalo. It is realized that there are many bottlenecks in successfully carrying out the project, especially as the number of ' selected sires ' are so few. But since we have got at the moment the nucleus of an organization for the rapid propagation of animals by artificial insemination, the chance of realizing our objective can be greatly accelerated, presumably within the next 30 years, or once the requirement for adequate nutrition of the animals is fully safeguarded.

From what has been discussed above, it should be clear that the production of milk according to the original target, which on first consideration seemed a very distant cry, can be brought within reach. The pace at which the project will mature will depend entirely on how quickly and how effectively we reorient our agricultural policy according to the new plan. The fixation by the Nutrition Advisory Committee of ten ounces of milk per consumption unit as the daily requirement, it may be observed, has been rather on a modest scale. Perhaps, our endeavour should be directed to produce more, so that the minimum requirement could be more appropriately adjusted to 15 ounces a day. Considering the fact that in this country there are indigenous breeds of cows and buffaloes which have shown lactational performances of 3,000 lb. and 5,000 lb. respectively, the scope of the " breeding up " policy should not be considered to have been exhausted after the animals reach a performance stipulated for the present target. By the replacement of straw and *kadbi* by hay, by improving the quality of green fodder in the acreage already allotted, and by introducing a little more concentrate mixture, the ration of milch animals can be sufficiently enriched to uphold the maximum lactational yield that has been recorded so far.

Concluding remarks.

In view of the facts that the present-day acreage available for crop production, the crop yield per acre and the state of animal husbandry do not offer any immediate hope for the realization of the target of requirement for human foods as recommended by the Nutrition Advisory Committee of the Indian Council of Medical Research, it is necessary to revise our ideas in regard to the agricultural planning in our country.

By making available more land under the plough, by introducing improvement in the methods of cultivation and management of crop and by reorientating our crop planning as suggested in this memorandum, it may be possible to produce most of the requirement for foods of plant origin.

While in our opinion there is no insuperable difficulty in reaching self-sufficiency in cereals, we do not suggest that this self-sufficiency should be reached at the cost of 'quality' items, such as, milk, meat, fruits, vegetables, etc., nor at the cost of commercial crops which play an important role in balancing our external trade. In fact, if we have a flourishing cash crop or a cash crop industry, a part of our requirement for cereals can perhaps be more easily procured from international market. Such, however, cannot be the case with fluid milk, vegetables and fruits. As is done in the United Kingdom (where population pressure is much more pronounced than ours), we must give a high preference to fluid milk production because of the obvious reason that fluid milk can not be imported from outside and without this essential food, the question of nutritional improvement of the people loses all its significance. In the present plan, therefore, we have tried to emphasize the fundamental requirements on which adequate milk production can be based. The main feature of this approach is that the milch animal must receive in her ration a reasonable quantity of green fodder which has to be specially cultivated in land compulsorily appropriated from the irrigable acreage, so that the continuous supply of green fodder throughout the year can be guaranteed.

The backbone of Indian agriculture is cattle ; animal labour is the sole motive power to keep it going, while animal manure is perhaps the main source to sustain it by maintaining the fertility of the land. It is, therefore, natural that if our agriculture is to maintain the nation in health, the efficiency of our cattle population must be high. The single factor which will require particular attention in this respect is their adequate and balanced feeding. This can be done provided we realize that the cattle have a justifiable demand on a part of our arable acreage. In the present scheme we have tried to show what proportion of our arable acreage should be allocated for animal nutrition.

Some people seem to believe that a sizable portion of our animal population is useless and should, therefore, be destroyed. From Table II of this memorandum, it may be seen that the number of useless cattle is about four millions. Even on a conservative estimate of 5 lbs. per head per day no less than three and a quarter million tons of feedingstuff are consumed annually by these unproductive animals. These animals should, therefore, be eliminated by planned slaughter. The meat of the slaughtered cattle will provide for the essential protein element in the diet of that section of the population which has no prejudice to beef.

There is, however, another point which deserves consideration in this connection. In view of the low performance of both milch cattle and draught animals it becomes imperative that more animals are provided to bear the additional burden for the type of production which the target of human requirements has imposed. It is, therefore, felt that there is a very cogent reason for the replacement of stock and for the improvement of the present cattle population by better and more generous feeding. Because a planned slaughter of useless cattle is suggested in this memorandum it is

not implied that we have surplus cattle in the country. *Pari passu* with planned elimination of unproductive cattle indiscriminate slaughter of healthy animals between the ages of 3-12 years must be stopped. After all the useless cattle have been slaughtered, it may be necessary to raise bovine stock to provide meat to that section of the Indian population which have no religious objection to its use.

In the present memorandum the nutritional requirement of animals has been considered on the basis of total bovine and ovine population of about 262·8 million. In addition, we have in this country a relatively small population of about 2·6 million equines and about 0·6 million camels. These animals play an important part in the transport of men and goods in both rural and urban areas. Although, their food requirement has not been specifically considered here, we feel that when the reorientated policy is implemented, the feeding of this small number can easily be adjusted within the larger plan. Similarly, we have not made any specific reference to the feeding of pigs whose number (of about 2·0 million) is not inconsiderable. At the moment, pig raising is confined to poorer section of our population. Obviously no particular care is taken to feed them. There should, however, be a fair prospect of pork industry in this country when pig husbandry is developed on a more scientific line and under cleaner surroundings than heretofore.

It should be evident from the new feeding plan for adequate nutrition of animals that oilcake features as one of the major items among the concentrate feeds. Oilcake appears in the schedule of ration for practically all classes of stock. At the moment on a rough estimate the average annual production of edible oilcakes in this country can be taken to be about 2·00 million tons (excluding the contribution from groundnut and copra exported uncrushed). A good portion of these oilcakes, verging to almost 50 per cent of the annual production, is used as manure in the cultivation of cash crops like sugarcane, tea, coffee, etc. For the feeding of livestock, one may, therefore, assume that the present availability of oilcakes is about one million tons only. It has been shown earlier that even under a rational plan of feeding with utmost economy in concentrate feeds, at least eight million tons of oilcakes will be required to sustain the animal labour and the animal production for milk and meat. Obviously, from quantitative standpoint, there is a huge gap between the supply and demand of oilcakes for animal feeding, and the existing practice of using large quantity of edible oilcakes for manurial purpose will adversely affect the maximum potentiality for animal production. It is, therefore, suggested that if oilcakes must be used for manurial purpose, the possibility of utilizing the cakes from non-edible seeds should be fully exploited. The cake from castorseed is at present used as a fertilizer though there are also others, namely, oilcakes from mohua, neem, pongamia, etc. which can be used for the same purpose. If these are made available in fairly large quantities, the pressure on edible cakes for use as manure will be eased to that particular extent.

Owing to acute shortage in edible oils, attention has recently been focussed on the possibility of recovering larger part of oil in the present-day oilcakes by taking recourse to solvent process of oil extraction. Since the oil is a total waste when the present-day cakes are used as manure, solvent extraction of oil from half of the existing production of edible cakes can

readily be suggested. The consideration of various *pros* and *cons* of solvent extraction of oil *vis-a-vis* animal nutrition seems to suggest that oil cakes arising out of solvent process can be used for feeding all classes of stock except milch animals. The loss of oil in the cake can be made up by supplementing the ration containing solvent extracted cake with isodynamic proportion of a cereal grain like maize. The necessity of this supplementation is specially emphasized because oilcakes are fed mostly to working bullocks, and since agricultural production in this country almost entirely depends on this class of stock, no risk can be taken through any dietetic deficiency to minimize their efficiency. If and when the solvent process is introduced to extract oil from the edible seeds, the different heads from which additional oil could be salvaged are as follows :—

(a) From 1·00 million tons of oilcake used as manure, the quantity of oil recoverable is 80,000 tons;

(b) From 0·75 million tons of oilcake fed to animals other than milch stock, the quantity of oil recoverable is 60,000 tons.

The total quantity of oil that can be salvaged is about 1,40,000 tons, the assessable monetary value of which is about 25 crores of rupees. Since a fairly wide margin seems to exist between the assessable value of extra oil (rupees twentyfive crores) and the cost of supplementation with maize or barley (rupees six crores), and since a reasonably large part of the oilcake at present utilized for stock feeding is given to a class of animals which seem to have no demand for a specific level of fat in their ration, there may not be any cogent reason, purely from the standpoint of animal nutrition, against the introduction of solvent process of extracting oil from the edible seeds provided (a) a suitable measure is taken to set apart a portion of the total production of oilseeds to be crushed by improved methods the resulting oilcake being earmarked for feeding the milch animals, and (b) the solvent extraction process to be introduced does not leave a cake which would be unpalatable or suffer in nutritive quality or in any way toxic for stock feeding. It is possible that a certain proportion of solvent extracted oil may not be fit for human consumption, in which case the unconsumable quota can be diverted for industrial use, thereby releasing an equivalent quantity of edible oil now used in the industry for human consumption. It may be of interest here to inquire what effect solvent process may produce in the long term planning of nutrition for our human and livestock population. According to figures given in Table VII, except in 0·4 million tons for milch animals, about 80 per cent of the oil in the entire balance of 7·6 million tons can be recovered. This recovery of about 0·61 million tons of oil will entail supplementation of the ration of the first three classes of stock by about 1·53 million tons of maize. The total arable acreage required for the production of target requirement of 4·25 million tons of vegetable oil for the human population has been estimated to be 73 million. The solvent process seems to be able to supply about 14 per cent of the total requirement of oil. It may, therefore, be possible to reduce the estimated acreage under edible oilseeds to the same extent, or 63 instead of 73 million acres should be able to produce the total requirement of oil. The quantity of maize (1·53 million tons) which will make up for the loss of oil in the solvent extracted cake can be grown in about 3·0 million acres. Thus even when the acreage required for raising the supplementary grain is taken into consideration, there still remains a balance of 7·0 million acres which

can be usefully switched over to other essential crops. It appears, therefore, that even in long term planning, the solvent extraction not only promises a substantial economic return, but also a welcome release in the land resources which is barely sufficient for the increasing population pressure.

The oil of cottonseed can be used after processing for human consumption. So far no large scale attempt has been made to tap this source. Lately, however, in connection with the solvent process, the question of extracting oil from cottonseed has come for consideration. The seed at present, however, is much prized as a concentrate feed for milk production. In actual practice, it is largely fed to milch buffaloes. Experimental evidence is available which show that under proper condition of feeding 70-80 per cent of the oil in the seed is converted into milk fat by buffaloes. As a matter of fact high percentage of fat is a characteristic of the milk produced by buffaloes in the cotton tract of this country. It is, therefore, apprehended that if the relatively high oil content in the production mixture (constituted mainly of cottonseed) of these animals is reduced, it may act adversely on the large butterfat production now obtained. In view of this, there may be no logical scope for extracting oil from cottonseed to the extent carried out by solvent process. Since, however, cottonseed contains about 20 per cent oil, instead of extracting major portion of it by solvent process, only a part of it can be taken out by the existing methods of crushing oilseeds. The resulting cake containing approximately ten per cent oil may provide sufficient fat in the ration of milch buffaloes to maintain the existing high level of fat secretion in their milk. If this proves to be true, about 100,000 tons of cottonseed oil can be made available by the current methods of oil extraction. In so far as animal nutrition is concerned, the loss of this amount of oil from cottonseed will have to be compensated by iso-dynamic proportion of maize or barley. It has been roughly estimated that the gross monetary value of the above quantity of cottonseed oil is about 14 crores of rupees, and the cost of supplementation (with any of the cereal grains) to make up the loss of the oil is about nine crore of rupees.

In regard to the grains to be fed to livestock, owing to the shortage in pulses for human feeding, we hesitate to recommend any significant portion of present-day gram production for cattle feeding. The procurement of this commodity by import is not possible as it is not grown in any larger quantity outside India except in Pakistan. Gram, however, can be replaced by a relatively small quantity of edible oilcake plus a larger proportion of maize or barley. Unfortunately, the situation with regard to maize and barley is none too easy. Both, maize and barley are, however, grown in very large quantities in certain other countries of the world. The question of importing these for livestock may have to be seriously considered. It may be suggested that extra amount of oil obtainable as discussed earlier and which need not immediately be used within the country can be exported and the amount of foreign exchange realized can be used to pay for the import of maize and barley.

The position of bran among the concentrate feeds used in stock feeding is important. Apart from supplying fairly large amount of nutrients, bran has additional virtues. It is a mild laxative and is reputed to stimulate milk production in all lactating animals. Some years ago, wheat was being milled and flour of about 70-75 extraction was obtained. When the food shortage began, the milling of wheat was banned, only atta being

allowed to be prepared. Whereas the pre-war product left a large proportion of bran the present day atta leaves behind ordinarily not more than five per cent, in many cases not even two per cent. The bran which was available to the cattle before the war now goes in for human consumption. It is possible that the ban on milling of wheat has made a larger amount of wheat available to man. But the scientific considerations show that the existing wheat made available for man is not properly utilized. The digestibility of whole wheat is considerably lower than the digestibility of milled wheat. It is thus wasting the amount of bran on human beings which could be used by milch animals and young stock with greater benefit. The milling of wheat, therefore, should be permitted and the bran thus obtained should be entirely reserved for the use of productive cattle. In our calculation in the previous section, the requirement of bran for stock feeding has been based on the average supply of 15 per cent from the total production of the grain. It is not possible to be equally definite about rice. For, although it is known that non-milled rice is less digestible than milled rice, it is extremely difficult to set a standard to which rice should be milled. It is understood that the Government of India have been advised that 3-4 per cent milling of rice should be permitted. In our calculation we have assumed it at five per cent.

As a result of control by Government on milling of rice the practice of adulteration of rice bran with finely ground husk has crept into the trade. It is well known that feeding of husk has deliterious effect on the livestock of the country. Sufficient percentage of rice should, therefore, be permitted for milling so as to prohibit the use of husk for adulteration of rice bran.

In recent years we have often heard of short-cut solutions to either the milk problem or to meet the other requirements for food and fodder *e.g.*, soya bean extract is supposed to remove our difficulties in regard to the shortage of milk, oilcakes are expected to meet the protein requirement of human beings, while millions of tons of feedingstuffs are supposed to be obtained from 'hitherto unrecognized sources'. The so-called unrecognized sources are not really unknown. If these could truly serve as food for cattle, people would have naturally adopted them. We see no particular point in focussing attention on these so-called short-cuts even if we feel that these sources can at least provide relief at the time of scarcity. While we recognize the importance of exploiting every available source of food and realize that the utilization of unusual and less known foods for human beings and animals is likely to relieve a little the acute food shortage, we apprehend that too much emphasis on this aspect may result in diverting our attention from the essential requirements to make-shift arrangements and instead of making a well-planned and all out effort to achieve self-sufficiency in food, our energy will be frittered away in the pursuit of ideas which can never yield results of lasting importance. The uninitiated are likely to imagine in these "short-cut" suggestions the permanent solution for the problem of human and animal nutrition.

The all-round food shortage in our country is no doubt due to the fact that our food production has not kept pace with the increase in human population. There is undoubtedly a scope for increased production of food which should meet the demand for the existing population provided

the population figure can be stabilized within the next few years. Although the cultivated area in the Indian Union at present is 0·78 acres per capita, we feel that by suitable development and reclamation, we can get a figure of a little over 1·0 acre per capita. With this amount of land, we may be able to provide a reasonable standard of diet to our people if modern technical knowledge is fully utilized for food production.

At present a somewhat undue emphasis is being laid on the ten per cent shortage in cereal production and on attempts to wipe out the deficit. We wish to point out that the present deficit in cereals is accentuated on account of the unavailability of other foodstuffs which not only provide energy but also help balance the diet. It should be clear that an overall increase in quality food production as envisaged in this memorandum is bound to reduce the present pressure on cereal consumption. This is an aspect which has been borne in mind in assessing the extent of total food shortage and the suggestions made in this memorandum to overcome it.

Finally, mention may be made of one aspect of our animal feeding problem. The requirement of our milch cattle for the production of even the target amount of milk is really not much as may be seen from Tables VII and VIII. About 11·5 million acres of suitable land *plus* a small portion of the available by-products should suffice to produce enough milk for a not-too-high target. But the requirement of 56 million work animals together with about 28 million followers (*i.e.* the young stock which will grow into working bullocks) upsets our agricultural balance, but we do not foresee any immediate relief in this direction. Large-scale mechanization of agriculture does not appear probable. Apart from the socio-political and economic question involved in the large scale mechanization of our small holdings, it would be unwise to depend on other countries to supply us with agricultural machinery, implements and fuel. Mechanization will proceed slowly and it is expected that this will continue along with our industrial progress. Meanwhile, our best hope lies in the utilization of our technical knowledge for the greater production of foodstuffs by a proper planning of our agricultural system.

APPENDIX

1. In the preparation of this Memorandum, the data in regard to the classification of land areas and their acreage, the acreage under principal crops and the production of principal crops have been collected from :—

(a) *Estimates of Area and Yield of Principal. Crops in India* (1936-46). Issued by the Economic and Statistical Adviser, Ministry of Agriculture, Government of India.

(b) *Technological possibilities of Agricultural Development in India* by W. Burns. Published by the late Department of Education, Health and Lands, Government of India, 1944.

2. The data on the classification of animals and their numbers and quantitative milk production in the Indian Union have been taken from :

(a) *The Role of Livestock in the Economy of India.* Issued by the All-India Cattle Show Committee, 1949.

(b) *A brief review of the progress and present position regarding the productivity of livestock in India,* issued by the Ministry of Agriculture, Government of India, for submission to the F. A. O. Conference on Livestock Breeding at Lucknow, 1950.

(c) *Brochure on the marketing of milk in the Indian Union.*—Issued by the Marketing Adviser to the Government of India, Ministry of Agriculture, 1949.

The data on the quantitative availability of by products, such as, straw and *kadbi* gram husk, *dhal-chunni,* bran, oilcake etc. have been estimated by multiplying the respective crop yield with commonly agreed factors. In some instances, however, certain assumptions based on the personal experience of some members of the Committee have been made. The factors are mentioned below :—

(i) Straw from cereal grains :—In the ratio of straw : grain as 3 : 1;

(ii) *Kadbi* from *Jowar, bajra,* and maize :—In the ratio of *kadbi* ; grain as 3·5 : 1 ;

(iii) Mixed green fodder grown under perennial irrigation @ 50,000 lbs. per acre;

(iv) Mixed green fodder grown under barrani condition @ 20,000 lbs. per acre ;

(v) Production of grass from forests, uncultivated areas, etc. @ 9,000 lbs. green per acre ;

(vi) Production of *dhal-chunni* including the husk @ 15 per cent of the weight of the whole grain ;

(vii) Production of bran : Wheat bran @ 15 per cent of the grain ; Rice bran @ 5 per cent of the grain ;

(viii) Production of oilcakes :—

Groundnut cake @ 55 per cent of the kernal
Mustard and rape cake @ 66 per cent of the seed
Linseed cake @ 68 per cent of the seed
Sesamum cake @ 57 per cent of the seed
Coconut cake @ 74 per cent of the copra.

NOTE (a) Estimates of items (iii) & (iv) have been kept intentionally low to include all conditions of growth as also the variable types of fodder crops.

(b) The estimate of item (v) has been taken from Williamson, Kartha and Ram Sarup (1947) *Indian J. Vet. Sci.* Vol. 17, p. 23.