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A FOOD PLAN FOR INDIA

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A Food Plan for India

WITH A FOREWORD

by

Professor A. V. HILL, O.B.E., F.R.S.

Secretary, Royal Society

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Foreword

BETWEEN November 1943 and April 1944 I spent five months in India, invited by the Government to advise on scientific matters, particularly in connection with plans for future development. Very special opportunities were offered of seeing all one could, and access was freely given to every kind of information. My report, *Scientific Research in India*, was published recently by the Government of India and has been reprinted in England by the Royal Society.

Every branch of science breeds special peculiarities in its followers. One peculiarity of a physiologist was to regard a nation as a living organism, the healthy development of which could result only from the balanced growth and harmonious working of all its parts and functions. If the physiologist also knew a little mathematics he would tend not to think of national well-being simply as a function of a number of independent variables (industry, health, agriculture, transport, education and the like) but rather to regard each of these as closely connected with all the rest; not only with their values at the moment but with their past history and their rate of change. Yet three of those factors stood out beyond the rest for their intimate relationship and their stark importance to human welfare in India—health, food, and population: and when I returned to England I felt bound to urge[1] that disaster on a scale unknown even in India's history might occur before very long unless immediate steps were taken, with all the resources of science and technology and the fullest co-operation of all men of good will, to meet the need of a rapidly expanding population for more and better food.

A great historian recently said to me that he did not think of himself as a pessimist because whenever he prophesied evil the event was always much worse than the prophecy. Desiring to prove me a pessimist (which I hope events, and their efforts, will confirm) certain friends of mine got together and prepared the 'Food Plan for India' described in the following pages. They wish to remain anonymous, but asked me to introduce them and their Plan, which I am proud to do. The Plan is entirely theirs—my only part in it was the lamentation which provoked them. Of themselves I may say that they have a very

[1] 'The Indian People—Nutrition and Disease', *The Times*, 1 June 1944. 'India's real problem', *Spectator*, 9 June 1944. 'India—scientific development or disaster', (East India Association, 4 July 1944). 'Health, food and population in India, *International Affairs*, The Royal Institute of International Affairs, Vol. XXI, No. 1, January 1945.

special knowledge of the subject, excellent sources of information and wide experience of large-scale operations; that they have taken unlimited trouble by consultation and inquiry to arrive at practical proposals; and that their only object is to help. They claim that, although a critical situation might well arise in India in the next few years which could lead to a vast calamity, it is possible by the resolute application of existing knowledge and methods derived from agricultural experience to avert it: and so to increase food production within seven years that a margin of safety could be assured on the basis of which measures of agricultural improvement, resulting from organized research work and field trials, and employing the new resources of a progressive economy in India, would have time to mature.

This paper then is the outcome of their investigations and discussions, in which they have drawn on the advice and experience of many experts, both Indian and British, who have intimate knowledge of agricultural matters in India. Their approach has, in one sense, been novel in that they have treated the whole question as a strictly practical and administrative one: they have concentrated on working out possible machinery by which a few simple, practical measures, known from experience to be capable of giving substantial results, could be put into effect on such a scale as to increase the over-all food production in India by between one-quarter and one-half in seven years. They have treated the problem quantitatively and have even ventured to work out tentatively the financial implications of the programme proposed.

The chief importance of their Plan is that it outlines concrete proposals by which the extra 14 million annual tons of food can be obtained, which, with a 50 million increase in population and with rising standards, will be required by 1953. If this target is achieved within that period then India can hope to have the margin of safety which will avert disaster before planning of longer term becomes effective.

An essential part of such an emergency programme is to create the organization providing instruction, distribution, and collection in the villages. A village-group organization such as they suggest might lay down straightway a basis for permanent advisory education in agriculture which could be extended later on to other fields of rural education. From those 'million magnificent young men . . . unloaded into the villages of India' at the end of the war it should be easy to find 25,000 of the very best to be trained for the essential duties of organization and leadership

in the villages as required by the Plan. These young men 'have fought with conspicuous gallantry. They have been treated with respect and affection by their officers and by the people of many countries. They have acquired self-respect and a very high standard of living. They have become used to modern conditions of housing and sanitation.'[1] They provide, in fact, a unique instrument for bringing to Indian villages a new outlook, new standards and a new method. When the villager sees, as he would in a few years, the direct result of his own guided efforts, his old fatalism would tend to give way to a new hope. The number of men required for this purpose (25,000) is relatively so small that one could almost wish it were ten times greater; but there are other similar ways of employing some of the rest. At any rate, the highest quality of men should be available for selection: it would be worth while beginning to select them now.

The authors of this Plan realize very well how great is the concern in India about the problem of more and better and better-distributed food, and how actively the central Government and the governments of Provinces and States are concerting measures to solve it. They have been careful to integrate their proposals both with the immediate 'Grow More Food' drive now operating in India and with the proposals of longer term for agricultural improvement which have been set out by the Reconstruction Committee of the Viceroy's Council. They offer their contribution not as a unique solution but as one which, all their experience tells them, would work. Whether theirs is the best scheme or not, something essentially similar to it in form, scope, and boldness, is the *only* way of meeting the food difficulty in the next ten years and of providing the foundation on which measures of longer range can be built. Something of this kind must be done now, and done whole-heartedly, if any of the plans for the future welfare and prosperity of India are, for hundreds of millions of its people, to be more than a mockery.

A. V. HILL

THE ROYAL SOCIETY,
LONDON, W.1.
12 *February* 1945

[1] Brigadier F. L. Brayne, *Winning the Peace*. Oxford pamphlets on Indian Affairs. Oxford University Press 1944.

Preface

THE Council of Chatham House is glad to be associated with Professor A. V. Hill in presenting this study of the vital problem of India's food supply. The study is a timely contribution to a subject of equal concern to the peoples of Great Britain and of India. It was made by a private group of authorities and derives directly from Professor Hill's compelling analysis of the situation. It was undertaken in the belief that the subject required immediate examination as a preparation for a new and determined effort to deal with one of India's most fundamental problems.

Professor Hill's reports on his visit to India in 1943–44 included an address at Chatham House in the autumn of last year on 'Health, Food and Population in India', published in the January 1945 issue of *International Affairs*.

ASTOR
Chairman of the Council.

CHATHAM HOUSE,
10 ST. JAMES'S SQUARE,
LONDON, S.W.1,
June 1945

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Brigadier F. L. Brayne, C.S.I., C.I.E., M.C., Officer on Special Duty with the War Department, Government of India.

Sir David Chadwick, K.C.M.G., C.S.I., C.I.E., Secretary Imperial Economic Committee and Secretary Executive Council, Imperial Agricultural Bureaux.

Dr. E. M. Crowther, Rothamsted Experimental Station.

Sir Frank Engledow, C. M.G.,Professor of Agriculture, University of Cambridge.

Mr. J. C. F. Fryer, Secretary Agricultural Research Council.

Dr. R. M. Gorrie, Indian Forestry Service.

Sir John Hubback, K.C.S.I., Ex-Governor of Orissa and Adviser to the Secretary of State for India.

Dr. B. A. Keen, F.R.S., Rothamsted Experimental Station, now Scientific Adviser Middle East Supply Centre.

The late Dr. Stanley Kemp, F.R.S., Secretary Marine Biological Association of the United Kingdom.

Professor J. N. Mukherjee, C.B.E., F.N.I., University of Calcutta.

Dr. Watts Padwick, lately Imperial Mycologist, Imperial Agricultural Research Institute, New Delhi, and now Assistant Director of Agriculture with the Government of Bengal.

Dr. B. S. Platt, Director, Human Nutrition Research Unit, Medical Research Council.

Dr. Klaus Sunnanaa, Fisheries Adviser, Ministry of Supply and Reconstruction, Royal Norwegian Government.

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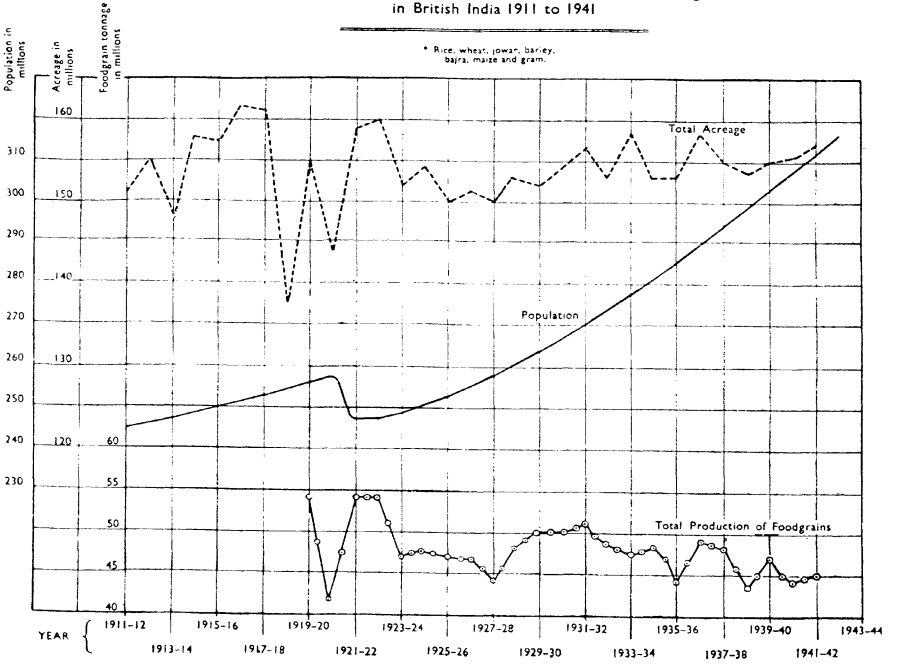
Population, total acreage and total production of major foodgrains* in British India 1911 to 1941
* Rice, wheat, jowar, barley, bajra, maize and gram.
Population in millions
Acreage in millions
Foodgrain tonnage in millions
160
150
140
130
120
310
300
290
280
270
260
250
240
230
60
55
50
45
40
Total Acreage
Population
Total Production of Foodgrains
YEAR
1911-12
1913-14
1915-16
1917-18
1919-20
1921-22
1923-24
1925-26
1927-28
1929-30
1931-32
1933-34
1935-36
1937-38
1939-40
1941-42
1943-44

Summary

PROFESSOR A. V. HILL has called attention to the danger implicit in India to-day from the present population and food production trends, and he has shown that the accelerating increase of India's population will inevitably lead to acute food shortage and so stultify all planning for a better way of life unless supreme effort is economically directed to the basic problem of food production. Our report should be regarded as a contribution which seeks to point out what could be done now on the basis of existing knowledge to avert the dangers which lie immediately ahead. We have taken account of the work which is already being put in hand on many of the subjects discussed, in Provinces and States, but we believe that our programme, which can be integrated with these, will enable a common pattern to be adopted.

The population of India is now about 400 millions. In eight years time it will be about 450 millions. How much more food will be required in 1953? The present production of rice, wheat, and other food grains is approximately 60 million tons per annum. The 1953 objective for food grains should therefore be:

For increased population	67.5	million tons
For 10 per cent increase in average diet	6.7	„ „
TOTAL ..	74.2	„ „

A further 14 million tons should therefore be produced in 1953.

We have analysed, as many other reports have done, the measures which can lead to increased production and have concentrated attention on five only, (*a*) use of fertilizers and manures, (*b*) improvement of water supplies and erosion control, (*c*) use of improved varieties of seed, (*d*) control of seed-borne disease and of stored grain pests, (*e*) malaria control. It is appreciated that water is the first essential and our proposals assume that work on the prevention of erosion and the improvement of water supplies will be on a high priority. Of the other methods for increased production, two stand out as likely to give the bulk of the additional 14 million tons of food grain required by 1953:

(1) The application of fertilizer at an average rate equivalent to about 1 maund of ammonium sulphate per acre, together with as much compost as the *ryot* can be taught to conserve—this in all areas of good rainfall or which are irrigated. These amount to 80–90 million acres, including the bulk of the rice

land where generally the pressure of population is the highest and the nutritional level lowest.

(2) The growing and distribution of improved seed treated against seed-borne disease.

If these two measures—and the others we have considered—are to succeed they will require an organization which reaches and provides in the village itself instruction, distribution, and collection. We have therefore suggested an organization based on 'groups' of villages with an official of the *havildar* or *naik* type (Army N.C.O.) for roughly each 5,000 of population (say ten villages). This man, recruited from the district in which he will serve, brought up on the land, and preferably with army service, would receive a year's training on very practical lines in the relatively simple functions which he would perform. About 25,000 such men would be required for the full programme, and its phasing over seven years would be somewhat as follows :

First Year. Selection of instructors, drafting of training schemes, selection and equipment of experimental farms, &c., to be used as training centres, training of instructors. Choice of first 5,000 men to be 'group' officials.

Second Year. Training of first 5,000 'group' officials, erection of 'group' stores, establishment of seed farms ; a second batch of 5,000 men selected for further training.

Concurrently with the above work during the first two preliminary years, the general planning for application of the scheme to the Provinces and States, the determination of areas to be organized each year, survey work for contour bunding and drainage, &c., would be carried through. The arrangements for the supply, storage, and distribution of fertilizers, seed, and other materials and for the collection of grain, would also be worked out for the whole scheme.

Third Year. First 5,000 trained 'group' officials commence duty and a further 5,000 men are trained.

Fourth Year. Second 5,000 'group' officials commence duty. Training schemes and location of schools are revised and a further 5,000 men trained.

Fifth to Seventh Years. Similar to fourth year, with 'refresher' courses for the 'group' officials, as necessary.

In the seventh year the programme would be in full operation. Approximately three million tons of sulphate of ammonia or equivalent quantities of other fertilizers, together with such ton-

nages of phosphate as may prove necessary, would be required during that year and the additional 14 million tons of food grain should then be obtainable concurrently with the release of some land for other crops.

Our report also discusses methods for improving Indian diets by increasing consumption of pulses, vegetables, fish, milk, &c.

The financial aspect of these proposals so far as they apply to rice has been considered. Control of prices is recommended so as to give the cultivator a minimum return of about Rs. 2 per maund of paddy on the field corresponding to a market price for cleaned rice of about Rs. 4.8 per maund. On this basis the cultivator should obtain even on the *minimum* expected increased yield of 3 maunds per acre sufficient to pay for the whole cost of the fertilizer and seed, and of the distribution organization. But it may be well to subsidize the cost of fertilizers.

The total cost of fertilizers, seed, &c., and of the distributing organization is estimated at Rs. 50 crores. The balance of this which is not covered by a subsidy on fertilizers could be paid for by the collection from the cultivators of grain required in aid of procurement. We have put this quantity at about 3 million tons of cleaned grain.

The *average* expected increased yield in the case of paddy is $7\frac{1}{2}$ maunds per acre, or 15 million tons of food grain from the 80 to 90 million acres considered. The value of this would be of the order of Rs. 200 crores (£150 millions) the greater proportion of which would remain with the cultivator for consumption or sale and would stimulate enormously the purchase of consumer goods and a rise in the general standard of living.

It is necessary to point out, however, that a drive to increase food production cannot have permanent results unless there is a similar drive to raise the standard of living in other respects. Without this, the incentive to increased agricultural efficiency cannot be sustained. In this respect, our proposals must be regarded as only a part of a wider scheme of economic development which will have its emphasis on the rural communities and which must be pursued concurrently with any efforts to increase food production. A rising standard of living can only be achieved by an all-round attack on a broad front, including the education of the women of the villages which will ensure their desiring a better way of life.

In order to meet the immediate critical food situation, moreover, it is essential to concentrate, in the agricultural field, on a few simple principles. Without such a simplification, both of the

technical principles and of an administrative organization for putting them into effect, we do not think that this problem, on the solution of which the prosperity and even the fate of India depends, will be capable of solution within the time limit imposed by the rate of increase of the population.

NOTE : 1 maund=82 lbs. (approximately).
3 maunds of paddy=2 maunds of clean rice (approximate).
1 crore of rupees=£750,000.

I

Introduction

1. THE PRESENT SITUATION IN INDIA

THE increasing seriousness of the Indian food situation has been recognized for some time, and the recent famine of 1942–3 has focused the attention of all those concerned with the production and distribution of food in India on the great urgency of the problem. It is, moreover, generally realized that the food problem in India is intimately connected with the whole level of agricultural production in relation to the population increase over the past twenty-five years.[1]

The 1943 famine was in fact symptomatic of the highly critical state of affairs which has now been reached in India. Malnutrition and under-feeding are estimated to be already prevalent in about 30 per cent of the population while, at the present rate of population increase (about 5–6 millions a year) there will be by 1950 30 million and by 1960, at least, 90 million more mouths to feed, that is, in fifteen years there will be a population about 20 per cent greater than that of to-day.[2]

India is predominantly and may be expected always to remain predominantly an agricultural country. At the time of the 1941 census six-sevenths of the population lived in towns or villages of less than 5,000 population, and a high proportion of these communities depended solely upon the land for their livelihood. The spearhead of attack on the economic development of India must therefore be the establishment of agriculture as the staple and prosperous industry without which any attempt at development in other fields, such as urban industrialization, will inevitably fail.[3] It will be an economic disaster if India cannot be made self-sufficient in food supply.

2. PLANS FOR FOOD PRODUCTION IN INDIA

In consequence of the recognition of this need for a co-ordinated attack to establish a progressive improvement in agricultural efficiency throughout the whole country sufficient to keep pace with the population increase, both Central and Provincial Governments are formulating plans for agricultural improvement. The Government of Bengal, for example, has already embarked on a scheme for the training of men for extension work in agri-

culture, while the Government of Mysore has formulated a five-year plan for agricultural improvement based on a few simple proved practical measures.[4]

These plans will give an excellent start to the practical work which will be needed to effect a permanent improvement. The food problem in India cannot be effectively solved by piece-meal schemes, since it is a function both of natural areas and of population density, neither of which is related to provincial boundaries. Plans for agricultural improvement must therefore be on an agreed all-India basis. At the centre, from whence the lead in a co-ordinated plan for all-India must come, the Government of India is considering two possible means of achieving an all-round improvement in the food situation. The first of these, the 'Grow More Food' campaign, is already launched and was designed principally to compensate for the loss of imports of rice from Burma, and the failure of a large proportion of the late rice crop in the Eastern Zone in 1942 due to the cyclone. Good results from this drive are already forthcoming.[5]

The second means which the Government of India are considering for improving the general food situation is a long-term programme,[6] proposals for which have been put forward by the Imperial Council for Agricultural Research.[7] These suggest the lines along which development should be effected over the next fifteen years and, in particular, point to the need for research, coupled with survey work, to ascertain how the best results can be achieved in each climatic tract, type of soil, etc., on the basis of which plans for practical action can be drawn up.

While the 'Grow More Food' campaign is a practical drive with limited objective, the long-term proposals of the Imperial Council for Agricultural Research cannot be expected to yield substantial results for some considerable time, particularly if extensive survey and research work is to be put in hand before a wide-scale extension service is built up. The urgency of the food problem, particularly as it will present itself in the next fifteen years, demands quicker results than can be obtained by such an approach[8] and the suggestions put forward below are made in the belief that there is a real need for a wide-scale adoption of immediate practical measures which will bridge the gap between the present 'Grow More Food' drive and the long-term schemes. They are based on the application of experience already available in India and the scheme set out is essentially a practical plan of action and has specifically avoided principles the application of which in India would call for major research programmes

before they could be put into effect. It aims at simplicity and practicability both from the administrative and from the technological aspects, but every effort has been made to integrate it as far as possible with the requirements for a long-term scheme based on research and survey work.

The plan is divided into two parts. The first covers methods for increasing food production as related both to agricultural efficiency in the production of food grains and to raising the nutritional level of the average diets in terms of quality. There is nothing here that is very novel. The technological principles advocated are those now familiar in improving agricultural efficiency, especially in sub-tropical countries, and they have been referred to in a number of official papers recently prepared in India.[9] They will be found, in many cases, to be in broad agreement with the principles which Provinces (States) already have in mind for their agricultural improvement schemes. Some importance, however, is attached to the order of priority in which they can be handled quantitatively in a scheme for the rapid increase in production, and they are, therefore, discussed in some detail.

The second part of the scheme which suggests a 'mechanics' to bring these technological principles into practical operation on a wide scale and to deal with the problems of distribution, is the more important and may be found of value as indicating on broad lines a possible common working pattern for application by Provinces (States). Although this will necessarily differ in detail according to local circumstances both between Provinces and possibly within a Province (State), it is believed to offer a means for effecting an increase in the over-all bulk supplies of food of about one-third within five years of its institution following two years of preparatory work and for achieving within that period a substantial improvement in the quality of Indian diets.[10] The financial implications of the scheme which we suggest, are discussed with reference to its application to paddy, a crop on which it may be expected to yield the most effective results.

II

Improvement in the Production of Food Grains

3. LOW CROP YIELDS IN INDIA

WHILE there have been substantial improvements in India in the yields of certain crops, for example in sugar cane and cotton, where scientific methods have been applied, there has been practically no increase during this century in the average yields of rice and wheat per acre, which remain about the lowest in the world in spite of the substantial areas under irrigation.[11] In addition there has, until this war, been only a very small increase in the area under food crops. Statistics for yields per acre are notoriously unreliable in countries such as India and China, where basic information is exceptionally difficult to acquire, but these statements are, broadly speaking, true. They are the more startling when a comparison is made between India and other countries. In China, where areas and population are of the same order, conditions and primary crops similar, and the bulk of the population live similarly on the produce of very small farms and holdings, the productions of rice and wheat per acre are about twice those of India, and its people are able to live on little more than half the cultivated area per head that is available in India. In other countries where modern scientific methods of farming have been applied, the differences are even more marked.[12] Even in India itself the crops obtained by the average cultivator are much less than those on Government farms and big estates. There is therefore considerable scope for increasing production by developing the resources and increasing the facilities and services available to the cultivator.

4. LONG-TERM MEASURES FOR INCREASING THE PRODUCTION OF STAPLE FOODCROPS

For short-term agricultural improvement in India little can be done in bringing to completion major irrigation works or large schemes to render suitable for cultivation any of the extensive areas now classified as cultivable waste.[13]

Projects for new gravity canal systems must take several years to prepare and can only then be brought into operation after several more years. Certain of the Provinces have schemes under investigation for an extension and improvement of the canal

systems,[14] but broadly speaking, these measures belong properly to a longer-term policy of agricultural improvement.

Similarly, the consolidation of holdings which, in many areas, is an essential part of a sound agricultural improvement policy, does not properly come within the framework of the scheme outlined here, since social customs often make it difficult to achieve results quickly. On the other hand, consolidation is being successfully carried through in some parts of India,[15] particularly in the Punjab, where the necessary legislative action has made it possible for villages to opt for it on a majority basis and the extension of such arrangements to enable the work to be pushed ahead concurrently with short-term measures along the lines outlined here is clearly desirable. The extension of co-operative societies stands in the same relation to our proposals for a short-term scheme of agricultural improvement, but with both this and with the extension of consolidation it may prove practicable to use the machinery suggested in Section V.

5. THE GOVERNMENT OF INDIA'S MEASURES TO REDUCE ACREAGES UNDER INDUSTRIAL CROPS AND TO BRING NEW LAND INTO USE

Under their 'Grow More Food' campaign, the Government of India have brought under temporary cultivation some three and a half million acres of marginal land for paddy and are bringing in further considerable acreages under cultivation for wheat, millets, and other cereals. It is believed that little more can be done in a short-term programme. In addition, there has been a considerable reduction in the areas under jute and cotton, particularly short staple cotton, the former for paddy, the latter principally for millet. In view of the importance of these cash crops for India's export trade, and the extreme difficulty in present circumstances of regulating the areas under food and non-food crops, it is not likely that these cash crop areas can be even maintained at the present reduced levels, and certainly no further reductions can be contemplated unless greatly increased yields of these crops per acre can be achieved.

6. SHORT-TERM MEASURES FOR IMPROVING THE PRODUCTION OF STAPLE FOODCROPS

For the purposes of this scheme we have considered only those technological principles which offer a prospect of increasing the yield per acre of already cultivated land.[16] If substantial results are to be achieved quickly it is essential to define a very limited

number of principles which from experience are known to be capable of giving big yield increases and to ensure that these are given exclusive attention in the extension scheme which is proposed for carrying them into effect. The following are, in our view, the factors which should be considered, and they are set out, broadly speaking, in the order in which they would be expected to be fruitful of results within a five-year extension period:

(i) the use of manures and fertilizers on lands where water supply is already adequate
(ii) improvements in water supply and drainage, including contour bunding of fields
(iii) the use of improved varieties of seed
(iv) the control of diseases in crops and of pests in stored grain
(v) the control of malaria and other parasitic diseases

Improvement in water supply has been put second on the list, although it is probably the most important single factor which can affect production as a whole in India. It is believed, however, that the results which can be achieved from this one measure in five years will not be as great as those from adequate manuring on land where water supply is already adequate and on the whole well distributed.[17] Manuring, water supply and the use of improved seed are, however, all interdependent and should be treated as parts of a single programme.

The above technological factors may be divided, for the purpose of the scheme set out here, into 'direct' and 'indirect' services, the former being those requiring the active collaboration of the cultivator on his own land, the latter being those which will have to be undertaken on a broader basis with the assistance of specialized teams. The 'direct' services will include manuring and fertilizing, the use of improved varieties of seed and the control of seed-borne diseases in crops. The purpose of this sub-division into 'direct' and 'indirect' services will be evident from the later section of this paper dealing with the extension organization of the scheme and its financial implications.

No reference is made here to the use of improved farm implements nor to improved methods of cultivation as such. The first of these will not have as marked an effect on improved yields as the other factors considered, and in any case the present unique opportunity for improvement of ploughs, water lifts and milling and grinding equipment to decrease time losses and increase efficiency, will obviously not be lost. The Government of India

have already recognized the need for the improvement of implements in their 'Grow More Food' campaign, and arrangements have already been made for the allocation of a special quota of standard iron and steel to Provinces and States.[18] Improved methods of cultivation, in so far as these are not covered by other technological principles such as the use of manures and fertilizers and of improved seed, are a matter for education of the cultivator, and it is difficult to envisage these being introduced into the present scheme in such a way as to give effective results in five years without overburdening the extension organization which we suggest. In this respect, improved methods of cultivation are regarded as a matter for longer-term developments to be integrated with the planning of research into methods for agricultural improvement.

In the following paragraphs the five particular technological factors on which our proposals rest are discussed.

7. THE USE OF FERTILIZERS AND MANURES

A comparison between the yields per acre of rice and other cereals for China and India has already been given, and the difference may be accounted for in large measure by the use in China of manures such as night soil, bean cake, and compost. In India, owing to the almost complete lack in rural areas of alternative fuel, about 40 per cent (65 million tons dry weight) of the total amount of cow dung produced is collected and burnt.[19] The balance is either lost because of difficulties of collection or is uneconomically applied chiefly through lack of compost. In consequence there is far too little use of animal manures. Green manuring has similarly not been used on any appreciable scale. The consumption of artificials, which in any case has been principally confined to plantation crops, has been very small in relation to the areas under cultivation. The maximum pre-war usage of sulphate of ammonia, the only widely-used artificial nitrogenous fertilizer, was only 20,000 tons in a year for all foodcrops except sugar.[20]

The economic use of a larger percentage of cow dung as manure is generally recognized as a vital need, but there is great difficulty in providing an alternative form of fuel which can be supplied sufficiently cheaply on the scale required and which would be acceptable to the peasant. This question of providing a cheap and acceptable form of fuel will no doubt receive the most careful examination in different provinces.[21] Meanwhile

measures for the collection and economical use of dung on a communal village basis are the most likely means of conserving supplies for the land and putting them to the best use.[22]

Further measures to increase the return of organic matter to the soil include the composting of vegetable waste and the collection of urine from cattle in loose, dry soil, particularly in cattle byres. Urine is as valuable a plant food as dung, and an extension of its use may offer substantial possibilities. Composting in towns for use in limited areas is already being extended by the Government of India at the present time under its 'Grow More Food' campaign, and results from the scheme of utilization of town refuse are already being obtained.[23] A vigorous campaign for increasing the return of organic matter to the soil on all the above lines, following wherever possible the methods which have already been established, should, however, enable a substantial increase in the utilization of natural manures to be achieved. There is no single way of securing this end, but methods applicable to different areas are in most cases known, and from experience in China it is quite practicable to ensure that full use is made of all available fertilizing material.

India's resources of oil cake are strictly limited, and more cannot be produced without additional production of oil seeds, which in turn interferes with the production of food grains.[24] Increased yields per acre of the latter will, however, enable more oil seeds to be grown for cattle food and manure. The policy adopted during the war of utilizing all oil cakes produced in India for these purposes should be maintained after the war in order to conserve all the plant food available.

The major soil deficiencies in India are nitrogen, and, less generally, phosphorus. The principal artificial nitrogenous fertilizers are sulphate of ammonia, nitrate of soda, ammonium nitrate, calcium nitrate, cyanamide, and urea, of which sulphate of ammonia is most commonly used. Ammonium phosphate might also be considered for those areas where both nitrogen and phosphate are required. From his observations, Sir John Russell stated that one maund (80 lbs.) of sulphate of ammonia used in addition to a light manuring with farmyard manure or compost produced increases of $4\frac{1}{2}$ maunds of paddy (say 3 maunds of clean rice), 3 maunds of wheat or 15 maunds of potatoes over untreated plots.[25] More recent experiments carried out in many parts of India have established that provided water is not a limiting factor the average rice or wheat crop can be increased by about 40 per cent by the judicious use of chemical fertilizers

with a good margin of profit to the grower on pre-war prices.[26] The Government of India have recognized that the use of sulphate of ammonia, which has proved itself very suitable for rice in India, provides the quickest means of increasing production of paddy, and have made proposals to use 240,000 tons per annum for securing 1–2 million tons of additional rice needed immediately.[27] This compares with a utilization of only some 15,500 tons per annum for paddy at the present time. In addition, consideration is being given to the manufacture in India of 350,000 tons of sulphate of ammonia per annum, but this will not yield results for two to three years.[28] These figures for the quantities of artificial fertilizers which the Government of India have before them for immediate consideration, may be compared with those for Japan and Russia. Before the war Japan was using nearly 4 million tons of chemical fertilizers, mainly sulphate of ammonia and superphosphate, almost wholly on her very small arable area (about 16 million acres) and her rice production per acre was more than three times that of India. In Russia the use of chemical fertilizers had increased in the ten years preceding this war from practically nil to 4 million tons for a population less than half that of India.

In common with all plant nutrients, chemical fertilizers are of course only fully effective when the water supply is assured. In India, however, over 45 million acres of irrigated land are under food crops,[29] and if this area alone were to produce yields as large per acre as the average in Japan, a population more than half that of all India could be maintained. In addition, a further 45–50 million acres, counting about 10 million acres of double cropping areas twice, are under food crop cultivation in good rainfall areas where the availability of water is not the primary limiting factor. The use of artificials on these irrigated and good rainfall areas, coupled with the widest possible utilization of animal and vegetable manures and the improvement of water retention where necessary by contour terracing and water drainage, is believed to offer the most effective and reliable means of ensuring a rapid increase in India's food supply.[30] It is estimated that by the more general use of organic manures, coupled with the use of nitrogen fertilizers at an average rate of about 16 to 20 lbs. of nitrogen per acre, with some phosphate where necessary,[31] on the whole of that 40 per cent of the arable acreage where water supplies are or can readily be made satisfactory, there could be an increase in India's over-all food grain supply of not less than 20 per cent, say 12 to 15 million tons, per annum.[32]

For the purpose of the present scheme it is suggested therefore that about 600,000 tons of nitrogen in the form of artificial fertilizer,* and later the necessary tonnage of phosphate, as experience shows necessary, be brought into use. The distribution and utilization of this quantity would not call for any large soil survey programme, and it is principally a matter of demonstration and administration on the lines referred to in Section V of this report. The actual fertilizers and the quantities to be used will of course vary from district to district, but the necessary information is in almost every case already available with the Agricultural Departments of the Provinces and States.

The question of supply of fertilizers on this scale is, however, a difficult matter. The production of 350,000 tons of sulphate of ammonia per annum now being planned will grow only sufficient crops to feed about one year's increase of population. We judge from the report of the recent technical mission which has investigated this matter that a tenfold expansion of manufacture in India, on this initial production as a basis, within seven years would involve more difficult problems than could be solved within that time. For any scheme which involves the use of artificial nitrogenous fertilizers on the scale we have considered, the importation of substantial quantities of these must therefore be envisaged until such time as Indian production can meet requirements. At the present time it is impossible to say from where supplies on this scale could be obtained, but failing importation of fertilizer much greater tonnages of food grain will have to be brought in from abroad. Phosphatic fertilizers would not present the same difficulty in manufacture as do nitrogenous fertilizers. The technique is simple, although much of the raw material might have to be imported.[33] Both for nitrogenous and phosphatic fertilizers, however, the aim should be for India ultimately to produce all her requirements.

8. CONSERVATION OF WATER AND SOIL

It is recognized that the greatest single factor limiting agricultural production in India as a whole is the lack in most parts of the sub-continent of adequate and well-distributed supplies of water. In any short-term programme however large new irrigation works cannot be considered. Indeed, the Government of India believe that it is not now economically possible to embark on major programmes for developing the canal system

* Sulphate of ammonia contains 20 per cent nitrogen.

in India.[34] In a short-term scheme, however, much could be done to improve the existing facilities; for example, by de-silting 'tanks', minimizing seepage from tanks, clearing wells, etc., and by an extension of these simple means, it is possible that even over a short term of years the efficiency of the existing canal system can be substantially increased by a better distribution of water and by reducing percolation losses by lining channels.[35] In addition to these measures there is the drastic need for soil and water conservation in many parts of India by contour terracing. Run-off experiments in many parts of India have shown that even on gentle slopes there is the most serious loss of soil by sheet wash, and this applies in general on all types of field and with all types of crop except on rice land. Similarly, a short-term scheme can include the improvement of existing and the construction of new drainage schemes in areas such as the alluvial lands of Bengal, where heavy floods are prevalent and the soil tends to become waterlogged.[36]

For this work the use of mechanical equipment now widely employed both for military and civil purposes such as road construction and for soil moving should be planned. Such equipment will become available at the end of the war and will enable quite large schemes to be carried through quickly.[37] Preliminary surveying of a very simple kind only is necessary, and experience of this has been built up in the Punjab, in Bombay, and elsewhere. It is possible to use the equipment economically on fields lying fallow for at least eight months of the year, and uncultivated land can be included for terracing in each district. Its application to the de-silting of tanks and deepening of ditches and to the construction of new tanks and drainage ditches is immediately practicable in districts where the equipment is available. For new construction preliminary surveys for the location of tanks, etc., in relation to contouring and the trapping of water on a sound basis from small catchment areas, can be rapidly carried out by Provincial Soil Conservation Officers or Conservators of Forests where these exist. Even when mechanical equipment is not available much can be done by the extension of the supply and use of scoops pulled by plough bullocks for contour bunding.

Tube wells and pumping for an extension of irrigation facilities require other equipment which is only available at the present time on a strictly limited scale. With the end of the military campaign, however, materials and equipment for this type of irrigation work also may be expected to become available to a

go far to reducing losses from this cause while it is possible that prefabricated storage bins designed on lines which have proved satisfactory in various parts of India may enable adequate storage to be provided quickly.

II. THE CONTROL OF MALARIA AND OTHER PARASITIC DISEASES

Of all the factors indirectly affecting the cultivator's efficiency, malaria and other parasitic diseases are perhaps the most damaging, and for this reason we include their control as one of the principal factors which can achieve an improvement in agriculture in India. Between one and two hundred million people suffer annually from malaria, at least one million die every year, and many times that number are made weak and inefficient. On an average, every man on the land is unable to carry out his work for one month in the year on account of malaria. Next to this come hookworm and filarial infections, dysentery and cholera, and all have a profound reaction on agricultural efficiency. The wide-scale control of these diseases is, however, now possible. The malaria mosquito can be controlled both in its larval and adult stages, e.g. by the use of new insecticides, and methods have been worked out and experience in their application has been built up on the fighting fronts of the East. While it may be many years before a high degree of control of malaria can be achieved throughout the whole of India, there is sufficient evidence of the successes now being obtained to justify the assumption that the worst effects of malaria on agricultural efficiency in India can be combatted by a vigorous campaign in the villages using the nucleus of Indian Army personnel already trained or capable of being trained in the necessary measures.

Dysentery, which is largely spread by flies, will probably prove capable of control by similar methods, and investigations on this are already in hand. Methods of mass disinfestation of hookworm and similar infections have been worked out and again the institution of a campaign using Indian Army personnel as a nucleus may enable substantial results to be achieved within a few years.

III

Improvement in the Quality of Food Levels in India

12. THE NEED FOR SUPPLEMENTARY FOODS

WE have referred to the necessity for improving the food supply in India both from the bulk point of view as affecting the calorie value and from the quality point of view as affecting the protective principles—proteins, minerals and vitamins. The two aspects are not independent, since increased cereal consumption will contribute something towards the required quota of protective principles. There are deficiencies, however, which have to be made good from other sources even when the staples contribute as much as possible to the diet as, for example, with correctly treated rice.

13. SHORT-TERM MEANS FOR RAISING THE NUTRITIONAL LEVEL OF AVERAGE DIETS

First among these come pulses, vegetables, and related crops. From a nutritional point of view a combination of cereals and pulses, particularly legumes, is strongly to be recommended, since the latter are good sources of protein and vitamin B1[49] Although these are already consumed fairly extensively in India there is a need, particularly in the rice areas, for further production to bring the average consumption up to 3 or 4 ounces per day.[50] Similar remarks apply in general to vegetables. The particular importance of pulses and vegetables is that they offer immediate sources of supplementary foods to the rural communities. The value of ground nuts and soya bean as sources of protein and of fruit as a source of vitamins must also be borne in mind.

Second of the high-grade foodstuffs comes fish, a source of valuable proteins, vitamins A and D from the fish liver oils and, when the whole fish is consumed, of calcium and other essential elements. The resources in fish of the rivers, lakes, and off-shore waters of India are still largely undetermined, but there is no doubt that a great increase in fish catches could be accomplished within a few years given the necessary administrative measures to ensure a profitable market and the provision of the necessary equipment. The question of distribution involves *inter alia* considerations of processing which are dealt with later.

Thirdly come the animal products, so placed not because they are nutritionally of less value than fish or pulses, but because they will, it is believed, not offer such immediate results from efforts to increase supply. Any increased quantities that can be made available will however be a most desirable addition. Much can be done here even within a few years to improve the cattle of India with a view to raising both the quantity and quality of the milk. Attempts to utilize the Indian cattle to the best advantage as a source of high-grade food, even among those communities who will eat meat, would however not be practicable over a short term and would, in any case, involve a considerable loss of energy value in the conversion of cereals and other feeding-stuffs into animal products which is undesirable while the calorie intake of the average human diet is at its present low level. Such measures should, on general nutritional grounds, be reserved until supplies of feeding-stuffs in relation to human requirements are more satisfactory.

Finally, consideration must be given to the possibilities of producing and using concentrated foodstuffs from locally available raw materials such as yeast from molasses for the B vitamin complex and high-grade microbial protein. Similarly crude red palm oil which is obtained from the fruit of the oil palm, *Elaeis guineensis*, is equal to good cod liver oil in vitamin A content, and may be of value for areas where it can be introduced into the diet by mixing with the ordinary cooking fats in the proportion of one part in five. No reference is made here to synthetic vitamins, which are not likely to be readily available except in the cases of A, B1 and C, all of which are covered by the suggestions already put forward and by the use of high extraction wheat and parboiled rice.[51]

Of these four groups of commodities which will assist in raising the general quality of diets in India, fish must be treated as a specialized subject which does not readily fit into the general scheme for agricultural improvement set out in Section V. While its importance cannot be over-emphasized, development in this field will, in general, need to follow quite separate lines from that which applies to purely agricultural matters. It is therefore not referred to in detail here, but is dealt with in an appendix to this report. Similarly the production and distribution of food yeast is essentially an industrial problem which is already receiving the attention of the Government of India. The distribution problems, both for yeast and red palm oil, make it impracticable to consider these supplementary factors for rural areas in general, but from

a consideration of the availability of molasses in Northern India and the stage which the industrial production of food yeast from molasses has now reached, it should be possible to produce up to 25,000 tons of food yeast from some three to four times this quantity of molasses in five years. This would be sufficient at the required rate of intake of about one-third of an ounce per day for about five million people, and its use in urban areas and where there is control of feeding as in schools, hospitals, industrial canteens, &c., would provide a valuable supplement principally as a source of the B-vitamin complex, but secondarily as a source of high-grade microbial protein.[52]

14. PULSES, VEGETABLES, AND FRUIT

The Pattern Dietary Scales which have been worked out by the Medical Research Council for the Far East, estimate that for a moderate work scale at a 2,800 calorie level (which may be taken as approximately representative of the average level to be aimed at for a reasonable standard of nutrition in India) 3 ounces of pulses, rather less than 2 ounces of de-gutted fish or ½ ounce of dry fish meal and about 4 ounces of fresh vegetables or fruit are required per day. Variations in these figures can be made, provided the over-all nutritional value is unaltered.[53] On this basis a large increase in the consumption of pulses and of green vegetables or fruit is essential, and it can only be secured on the necessary scale and in the right places if substantial increases in the yields of cereals per acre release a proportion of the land for these crops. It is, moreover, precisely in the rice-growing areas (which, broadly speaking, will respond most readily to more intensive cultivation methods along the lines suggested in Section II) that the nutritional level of the diet is so dangerously low.

Of the pulses, ground nut and soya bean warrant special consideration, since both contain high-grade protein and a high proportion of fat. Ground nuts are already grown on a considerable scale and extension of their cultivation, and particularly of their use as food, would seem to offer immediate possibilities.[54] On the other hand, soya bean is not at present widely grown in India and is not an easy crop to establish. In addition, it requires education in methods of cooking before the best value can be got from it. Although, therefore, agricultural considerations must ultimately decide the choice between soya bean and ground nuts, the former does not recommend itself for a short-term

policy. Moreover, the need is largely for individual cultivators to grow more pulses for their own use, and it is essential to encourage the cultivation of the common legumes such as peas, lentils and beans as improved yields of cereals are obtained.[55] The importance of rotations and mixtures of pulses to maintain supplies throughout the year also warrants this aspect being carefully examined in any scheme for increased growing of pulses.

Of the vegetables, lettuce can be grown at almost all altitudes in the tropics,[56] and an extension of the cultivation of this and other greenstuffs and tomatoes by the *ryot** could be encouraged through the machinery which we propose. The problem of increasing the production and consumption of fruit in villages which are not near orchards is a difficult one. In general the only practical solution will be the establishment of fruit trees in the villages to meet the local requirements, and this can hardly be effected in a short-term scheme.[57] Even for urban communities it would appear that improvements in transport and marketing or a wide extension of processing will be essential before there can be big increases in fruit consumption.

15. IMPROVEMENT IN MILK SUPPLIES AND ANIMAL PRODUCTS

One-third of the world's bovine population, viz., 200 million head, is in India. The quality of these cattle is, however, very low, particularly in areas of heavy rainfall with poor soil, the average milk production being only 750 lbs. per annum.[58] They probably constitute the greatest single factor responsible for the wastage of foodstuffs and food-producing acreage in India.

Substantial improvements in the quality of India's cattle can, however, be achieved, for the main lines of improvement have already been established from work at cattle-breeding farms. Improving local types has proved more effective than crossing with imported bulls, and with the forty breeding farms in India as a nucleus for a breeding campaign, it should be possible to effect a steady upgrading of the cattle population of India.[59] This should start with the castration of existing bulls in as large a number of selected areas as is practicable, followed by re-breeding from the existing approved bulls at the cattle farms and the castration of all surplus male stock produced over a fifteen-year period. If breeding in these areas is to rely on the supply of bulls, it will prove an almost impossible task to introduce rapid improvement on any scale. The wider adoption of methods of artificial

* *Ryot*=cultivator.

insemination which have proved both practicable and efficacious in countries such as Russia, where distances are comparable with those in India, may, however, enable up-breeding to be greatly accelerated. Wartime experience in China has shown that artificial insemination is capable of immediate application from a few selected centres with only a small trained staff. Breeding improvements in experimental herds have given increases in the average milk production from 6 to 18 lbs. per head per day.[60]

Second only to the rearing of improved stock is the need for improved feeding and management, both of which may prove more practicable for extension on a wide scale within a few years. The possibility of growing more oil seeds and other fodder crops with increased cereal production has already been referred to,[61] while on bigger holdings and farms rotational grazing should also become possible. Immediate results have been shown to follow even in the worst areas from improvement in feeding alone, increases in milk production of up to 30 per cent having been recorded. It is believed that the principles of judicious management, particularly in relation to the reduction of the calving interval in the case of cows, can be demonstrated to the cultivator within the framework of the scheme which is outlined in Section V.

Milch goats should also prove to be valuable from a nutritional point of view. They are hardy and well suited to the peasant farmer and are not particular in their diet.[62] In this connection, control of the slaughter of goats which is proceeding at the present time at a high rate, especially in the Punjab and North-West Frontier Provinces to meet military demands, may call for immediate control. The maintenance of poultry by cultivators should also be encouraged, and with increased production of the staple foods it should become practicable on a much larger scale.[63]

The processing and marketing of any increased quantities of milk produced would certainly call for attention. The general indications are that those milk products should be produced for marketing which require the least equipment and are least perishable and which are suited to the tastes and requirements of the people. It would seem undesirable to attempt the development of a dairy industry on lines familiar in the United Kingdom. At the same time, it is necessary to ensure that full use is made of the nutritional value of the milk.[64]

IV

Distribution

16. TRANSPORT AND MARKETING ARRANGEMENTS

THREE important matters must be considered concurrently with the aspects of food production which have been discussed in detail—first, the need for improved transport; second, for improved marketing facilities; and third, the provision of essential consumer goods which the cultivator needs. All are of vital importance, since there can be no inducement to the cultivator to produce more food unless concrete benefit comes to him.[65] All three factors link up with the drive for industrialization to raise the standard of living in the towns.

17. THE INCENTIVE FOR INCREASED PRODUCTION

It is realised that the only means of ensuring sustained agricultural improvement is by creating and fostering the desire among the men, and particularly the women, of the villages, for a better way of living. This calls for a full programme of rural uplift, covering every phase of village life, improved health, housing, food, and amenities. Much of this work will no doubt be carried out through the media of broadcasting, village cinemas, exhibitions, &c., and it is anticipated that the development of the co-operative movement in the villages will play a big part in any broad schemes on these lines.

It will, however, probably be impracticable over the short term we are considering to establish new co-operative societies sufficiently extensively for these to play an important part in ensuring that the cultivator can benefit, through them, from the adoption of improved methods of cultivation. It is believed, however, that the necessary initial stimulus to increased production can be given if Provincial Governments will undertake to finance the supply of materials and services, if necessary wholly in the first year or two, with an arrangement whereby an agreed amount of the increased production raised is returned from the threshing floor by the cultivator and the landlord to the Government as part of its procurement schemes.[66] Given this initial stimulus, the cultivator may be expected gradually to take over an increasing proportion of the costs of further improvement provided there is ensured for him the opportunity of marketing his surplus and of benefiting directly from his increased produc-

tion. Clearly this will not apply equally in all parts of India. In the permanently settled areas, especially, it is essential to ensure that the absentee landlord is not the sole beneficiary from increased production, in which case there can be no stimulus to the cultivator to secure bigger yields. Similarly in heavily deficit areas the responsibility for financing improvements may have to be borne for a longer period by the responsible Provincial Government.

18. IMPROVEMENT IN TRANSPORT ARRANGEMENTS

Better transport arrangements are vital.[67] Apart from the increased movement of grain, which will follow from this programme, the distribution of materials on the scale considered in Section II will alone require assured communications with the villages. Better transport facilities may, moreover, prove an incentive to increased production in some areas by giving the cultivator the opportunity of farming for easy marketing instead of wholly for subsistence. Plans have already been considered for a great expansion of the road communications system in India over a twenty-year period, designed ultimately to connect every village indirectly through its district and provincial roads with the network of national highways.[68] Clearly in such a scheme the village and district roads can only be constructed quickly by using materials ready to hand. Methods of construction will therefore have to be based largely on soil stabilization, but they should be capable of withstanding the iron-treaded wheel of the bullock cart at least for a period until an all-out drive can ensure the replacement of iron-treaded by pneumatic-tyred wheels.[69] This adoption of pneumatic tyres generally for all bullock carts is essential to any satisfactory scheme of road construction which is to have any degree of permanency, since the bullock cart will almost certainly remain the principal means of rural transport for many years to come. Further, the cost of providing pneumatic tyres, if borne by governments, will ultimately be repaid in the economies which would follow both in the costs of construction and the maintenance of roads. Assuming, therefore, that soil stabilization can be widely adopted as a method for rural road construction, it is not impracticable to consider the construction within five years of 100,000 miles of village and minor district roads linking the villages, marketing centres, and provincial towns into a single network.

In considering the methods for improving transport, the possi-

bility of Army lorries being released for civil use after the war has not been overlooked. Apart from the numbers of these which will be required for constructional work, they should take their place in the system for the distribution of grain and other similar commodities between surplus and deficit areas, or *between collecting* centre and railroad or port.

19. MARKETING ARRANGEMENTS

In addition to improvements in transport facilities a strict control must be maintained on the marketing of food commodities. At the present time out of 60 to 70 million tons of grain produced annually in India some 20 million tons are brought to market, while for other crops such as fibres and oil seeds the proportion is still higher. In all about 35 million tons of agricultural produce are brought to market annually.[70] It is recognized that standard grades on the basis of which price quotations can be made, should be introduced and there must be insistence on quality standards and on standard contract terms. The licensing of weighmen and the provision of adequate facilities, particularly in relation to storage at all *mandis* (markets) or similar centres, are also vital to sound marketing arrangements. During the present emergency, stable prices are the basis of the whole marketing system, and each year there must be agreed throughout India a basis of fair prices for a given standard of quality which will be reasonably stable throughout the year and which can be enforced on all dealers and buyers who should in every case be licensed. Only in this way can the anomaly of one Province exporting grain from India while another imports it from other producer countries be controlled. These are matters which are being considered by Provincial and Central Governments. Their importance in relation to the rural economy of India cannot be over-emphasized.[71]

20. THE PROVISION OF CONSUMER GOODS

The provision through village stores of an adequate supply of consumer goods which the cultivator and his family need and will be prepared to buy, is a further essential factor in providing the stimulus to agricultural improvement. The range of essential consumer goods which are needed has already been reviewed by the Government of India in relation to its procurement machinery for obtaining the surplus grain from the rural areas.[72] In particular it is to the production and distribution of those goods which

will increase the standard of living of the peasant communities that urban and village industrial development, in so far as it is not concerned with the provision of the requisites for the production of food, the improvement in transport, or the improvement of the standard of health, should be directed.

V

The Plan of Operation

21. THE FUNDAMENTAL PRACTICAL PROBLEM

WE have discussed those factors which it is believed from experience already available could, over a five-year extension period, achieve a substantial improvement in the production of food supplies in India. To bring such a plan into effect requires a clear-cut extension scheme, a definition of the responsibilities of the various groups concerned and the recognition that the emergency calls for the co-operation of everyone in an agreed plan of campaign.[73] Great sums of capital will be expended for the provision of the necessary organization, plant, and materials: some of this should be provided by governments; other parts involve the organization or extension of commercial enterprise. But there is no cause to hesitate in the face of this expenditure since the great bulk of it *will* be carried out, sometimes indirectly, at a profit at least sufficiently great to give a satisfactory return on the capital laid down. The fundamental problem of putting the scheme into operation is one of organization and administration, of allocating responsibilities as between governments, industry, and the scientists, of drawing up a simple practical plan for each area and of training and sending out to these areas the executives who will carry the plan to the cultivator and who, at a higher level, will co-ordinate and provide the directing energy for the practical work in the field.

22. THE CONCEPTION OF 20,000 TO 30,000 VILLAGE GROUPS

In the extension work involved in bringing into practical operation the technological principles discussed in Section II, we propose that there should ultimately be set up throughout India some 20,000 to 30,000 'groups', each with a Centre, the groups being units of about ten villages or covering areas with a population of about 5,000. These groups should, in the first instance, be limited to those areas estimated at approximately 80 million acres, which from considerations of water supply (by irrigation or well-distributed rainfall) will give a maximum return over a five-year period. These areas will include practically the whole of

the rice-growing districts, together with parts of the Punjab, United Provinces, Sind, and to a lesser extent of other Provinces (States).

The group centres should, we believe, be financed by the Provinces and they should be suitably sited in relation to communications so as to give the best service. Each centre would consist of a store of 150 tons average capacity for carrying fertilizers, improved seed, new implements and tools, and anti-malarial insecticides, and for the storage of grain which will be brought in as part payment for materials supplied and services given to the cultivator. Each of these group stores would be under the direction of a trained official with cultivation or farming experience, preferably in the area where he will work, who commands the respect of the villagers and who from his practical experience and special training can instruct in the methods for improving production. He must work in turn with a small number of field men nominated by the villagers, who will be his assistants in carrying out demonstrations on cultivators' plots and in deciding on what issues of improved seed or fertilizers will be needed for each cultivator. These fieldmen will be responsible also for carrying out the routine treatment of villages and buildings against mosquitoes as directed by the official in charge of the centre or by the special squads who may be appointed to direct this work. In particular, these fieldmen will form the link between the official for the group of villages and the cultivator. It would be through the group official and his fieldmen, working with the village *Panchayat* or other local body, that communal arrangements would be made in the village for contour bunding, or for the collection of a portion of the increased production of grain resulting from improved methods of cultivation. The arrangements for the multiplication and distribution of improved seed would also be made through the 'group' centre. Our conception of fieldmen from the villages can readily be integrated with the Army project of training demobilized men as 'village guides'. It is, however, important to recognize that the Army may not be the only source of suitable men and that any scheme of this kind must provide for the training of men direct from the villages.[74] In addition each 'group' centre will need to call on the services of the *patwari* (local revenue official), who will be in a position to assess the requirements of the individual cultivators and to render accounts and estimate yields.

23. THE HIGHER UNITS OF THE ORGANIZATION

To serve these group centres there will need to be a larger store of some 1,000 to 2,000 tons capacity for every *tahsil* or circle, situated wherever conditions make it practicable, on the outskirts of a market town or at railhead, to facilitate communications and transport. This store, which might be considered as serving on an average every twenty groups, staffed by an agricultural supervisor and ancillary staff, would act as the direct distributing link for all the materials and equipment required by the villages, and would in addition provide the link between the existing experimental farms and those which will need to be established for a long-term scheme of agricultural improvement, and the village cultivator through the groups we have postulated. The agricultural supervisors in charge of these sub-district stores and farms would probably have to be responsible through the district superintendents to the Provincial Agricultural Department, and together with other specialist officers for the *tahsil* would organize and carry out surveys of the new work which has to be done in each year. It is believed also that through their group officials they would be in a position to find out the difficulties which cultivators are experiencing, and to put their problems to the experimental farms. Conversely they could be responsible to them for the introduction of new ideas to the villages. This hierarchy is based on that which has been suggested by the Imperial Council of Agricultural Research for a long-term scheme. It has been modified only to meet the needs of a short-term plan in relation to the requirements of trained men, and it could if necessary be adjusted or expanded as experience proved desirable and the availability of men made possible. It is important, particularly in the early phases of the scheme we suggest, that the issues dealt with by the whole organization—and especially from the group to the village—should be few in number and simple in essence. In the first instance it might be well to concentrate wholly on the use of fertilizers and the multiplication and distribution of improved and treated seed. Together with the collection and proper storage of grain stocks claimed in respect of services and materials supplied, this will probably prove quite enough to put over successfully.

24. RESPONSIBILITY OF PROVINCIAL AND CENTRAL GOVERNMENTS IN RELATION TO THIS PLAN

These suggestions for an extension organization do not, we

believe, cut across any existing agencies such as the network of farmers' clubs, co-operative societies, &c., which are associated in some areas with the propaganda or extension section of Provincial and State Agricultural Departments. A scheme such as that we have proposed would, on the contrary, knit these existing but fragmentary organizations together into a unified whole and would bring the work of the experimental farms both within reach and into touch with the cultivator.

The responsibility of the Provincial Governments for improvements on the lines we have proposed and for those longer-term improvement plans which will mature from the more extended schemes will, we assume, be vested with the Departments of Agriculture. Only they can determine what methods are most suited to their peculiar local conditions and make the necessary surveys on the basis of which detailed plans for the various areas can be worked out. The Central Government may be called upon to assist with specialized staff who can help in this work or with funds, especially for the preliminary work.

25. SUGGESTION FOR PROVINCIAL AGRICULTURAL IMPROVEMENT BUREAUX AND FOR A FEDERAL AGRICULTURAL IMPROVEMENT BUREAU

In order to co-ordinate the work in and between different Provinces, it is suggested that Provinces might set up Agricultural Improvement Bureaux staffed from the officials of the Government who are concerned with agricultural matters. These would draw on senior scientific staff working on experimental or government farms, and on the agricultural officers from districts who can report on local progress and difficulties, and advise on what methods, both technical and administrative, have proved most satisfactory in their own areas. Parallel with this a Federal Agricultural Improvement Bureau is suggested to undertake the practical development and extension functions of the Imperial Agricultural Research and Development Council in connection with both this plan and the longer-term plan which is finally adopted, thus welding them together. The Federal Agricultural Improvement Bureau could also co-ordinate the work in the Provinces with that of the Federal body, in connection with the allocation of priorities and the provision of assistance as necessary in personnel, education, materials, and funds.[75]

A typical problem which would be handled initially by a Federal Agricultural Improvement Bureau would be the procure-

ment and distribution to the Provinces of soil-moving machinery and the teams of skilled men to operate it for contour terracing and improvement in irrigation or drainage facilities. Such machinery is at present with the Army and arrangements for its use for civil purposes and for the purchase of additional machinery can only properly be made at the Centre. The allocation of available machinery to the Provinces would also be a matter for the Federal Agricultural Improvement Bureau to determine on the basis of the estimates submitted by individual Provinces. The responsibility for ensuring an economic utilization of the machinery would rest with the Provincial Agricultural Improvement Bureau who in turn could report progress and difficulties to the Federal Bureau.

26. THE SOURCES OF STAFF FOR THE ORGANIZATION SUGGESTED

Such an organization as that proposed here clearly cannot be built up in a year. We have suggested that some 20,000 to 30,000 'group' centres, each with a trained official in charge, should be the goal at the end of five years' extension work. The numbers of fieldmen, storemen, and, in higher ranks, agricultural supervisors for each *tahsil*, and other more senior staff will be in proportion to this figure, but we regard the 20,000 or 30,000 group officials as the key to the whole organization. The Army has under consideration a scheme for the training of demobilized men who were drawn from the rural communities as 'village guides', and we have indicated how our scheme could be integrated with this in regard to the requirements of fieldmen. The 'group' officials whom we require can, we believe, be similarly drawn in part from the ex-Army men, but it would be essential also to review the possibilities of drawing on the villages themselves or on personnel from large farms or estates. It is vital to the success of any such scheme as this that these men should know the country in which they are going to operate, should have a background of sound practical experience of cultivation, and should command the confidence and respect of the villagers.

27. THE PHASING OF THE PLAN

We envisage that the above scheme should be phased over a period of seven years in all, of which the first two would enable planning and preliminary training to be carried through, and the last five would be annual extension phases. We estimate that one

preliminary year would be required for the planning of the training schemes, for the allocation and equipment of the experimental farms, &c., which would have to be used, for the preparation of a training syllabus and for the training of the necessary teaching staff. It is believed that the teaching staff would have to come primarily from the large estates and government farms in each Province, since they must have a background of essentially practical and local experience. The details of the training syllabus would vary from Province to Province and even from area to area, and they would therefore need to be drawn up by the Agricultural Departments of the Province to suit local conditions.

A further year of the preliminary phase of two years would need to be devoted to the training of about 5,000 men who had been previously selected for duties as 'group' officials. They would need to be given intensive instruction in the few simple measures for improved cultivation which we have proposed, and their training should be on simple and practical lines, illustrated by demonstration, practice, and repetition. It is suggested that this training could best be carried out at existing experimental farms or government farms or by arrangement at large estates, by methods similar to those used at Army schools. Each of these selected farms or estates will have been equipped during the first year of the preliminary phase with a full-scale model 'group' centre serving the farm or, if possible, a group of villages in the vicinity of the farm on the pattern we have proposed above. This training of the first 5,000 'group' officials at experimental farms could then be made essentially practical and realistic in relation to the scheme as a whole, and it would fit in with the Army proposals for the training of men as village guides, or as we have called them, 'fieldmen'.

During these two preliminary years, the broad planning for the application of the scheme would be worked out by each of the Provinces or States to which it could be applied. It is thought that this should proceed on the lines of deciding what total areas could ultimately be brought into the plan to give satisfactory results, and dividing these up into five groups of areas which would constitute roughly the five annual phases for the extension of the scheme. The first group of areas should be determined so that each separate unit within this group is wherever possible near to the experimental or government farm or estate where training would be proceeding during the preliminary two-year phase. In this way the work of extending, for example, seed multiplication from the selected farms and growers to the culti-

vator will be greatly facilitated while in the first-phase extension areas the transference of the trainees to their operating areas would be readily effected without serious changes in agricultural conditions.

During the first year of extension the first 5,000 'inter-village' officials would be transferred from their training centres to the surveyed first-phase areas, and a further 5,000 men could then be absorbed for training.

For the second phase of the extension of the plan which should coincide with the completion of new roads in areas previously badly served, the first-phase areas would, wherever possible, be extended, and the training of the necessary staff could, it is suggested, be carried through conjointly on the farms and estates used for the first-phase training and on the areas brought under the scheme in the first phase. Simultaneously, new government farms could be established in the first- and second-phase areas which would serve both as training centres and as seed multiplication farms for those areas. Ultimately these new farms would be extended to carry out the experimental and research work which will be necessary for the solution of problems which present themselves in the light of the practical experience gained in the initial stages. They would in fact pass over from purely training and demonstration farms to the work of a longer-term character which is to be planned under the proposed Imperial Agricultural Research and Development Council. It is suggested, however, that they ought also to retain their function as seed multiplication farms until new varieties of seed are established in wide use. Subsequent extension in the third, fourth, and fifth phases would follow the same pattern.

It is believed that arrangements could be integrated with this scheme for the training of men—many of whom will be drawn from the Indian Army Medical Corps—in measures of public health and malaria control. These might be formed into units which could tour whole areas and instruct the group officials in the measures that should be taken. Similarly the work of improved cattle breeding could be carried out within the general framework suggested from the existing experimental State farms. The expansion of fisheries will, we believe, call for a separate organization, but the possibilities of keying this in on the extension side in so far as it includes fish farming and the breeding of fish in paddy fields should be carefully considered.

28. THE ALLOCATION OF RESPONSIBILITIES

If a scheme on the lines which have been suggested above were accepted, an analysis of the proposals put forward would need to be made regarding the responsibilities of the various bodies which will be concerned. Under the heading of industrial research, work could be put in hand to examine the possibility of producing a suitable phosphatic fertilizer on the scale required. The application of methods of soil stabilization which have been worked out in various parts of the world should be studied in relation to the peculiarities of Indian soils in various Provinces and areas, and the development of methods using locally available materials would need to be put in hand. Simple and economical methods for the processing of fish into forms which are nutritionally the most valuable and palatably the most acceptable, call for examination. There is still the need to evolve an economic and acceptable fuel and means of employing it which will release for the soil a proportion of cow dung now employed for heating purposes.

For applied field research and survey work such as is carried out under the direction of the Imperial Council of Agricultural Research and by irrigation authorities, an immediate start could be made on drawing up plans Province by Province, indicating the areas where the use of the various artificial fertilizers and artificial insemination will be most effective, surveying irrigation facilities to determine what improvement and extension work is required, determining the areas where aircraft spraying for control of mosquito larvae is likely to be effective, preparing preliminary surveys of areas to be contour bunded, and deciding on suitable sites for the establishment of fish farming. All this preliminary work could be integrated with the longer-term surveys which will be required for a more extensive and detailed improvement in agriculture.

For the industrialists, there would be the problems of organizing and carrying through into full-scale production and distribution the goods which are needed for the scheme we have outlined. These would include the provision of pneumatic-tyred wheels for the bullock cart, the supply of building materials for the store depots for grain and agricultural commodities, the production of fertilizers and the chemicals needed for such measures as pest control in foodstuffs and malaria control, the production of suitable forms of stoves for cooking, simple irrigation equipment, road-making machines of simple types (which can be

rapidly constructed and are commensurate on the one hand with the scale on which roads are to be constructed, and on the other hand with the availability of labour), the production of cement for road and other constructional purposes, and consumer goods. Industrialization on these lines would be no temporary measure. These commodities will be required increasingly as India develops economically, and the planning of industry to help in meeting immediate agricultural requirements will be an essential part of any longer-term plan of industrial development.

Finally, legislation may be required by governments to stabilize marketing and, if necessary, to facilitate industry to meet the requirements of a scheme of this kind. This could only be determined as experience was built up. It would be essential however that both Provincial and Central governments should co-operate in agreed spheres of responsibility and with clearly defined methods of procedure. In this connection we have assumed throughout that the ultimate responsibility for any improvement in agricultural production must rest with the Provinces, but because the problem as a whole transcends the boundaries of Provinces and individual Provincial responsibilities, it would need to be dealt with in terms of the natural areas involved, and cases of dispute arising out of details of administration as from one Province to another would in the last resort have to be settled by the Centre.

29. FINANCIAL IMPLICATIONS OF THIS SCHEME

For the purpose of discussing the financial implications of the scheme which has been outlined in the preceding paragraphs, it is proposed to confine attention to the paddy problem to which the scheme would be widely applicable. The financing of the work for the 'indirect' services of improving water supplies and malaria control, which would have to be carried out through teams employed by the Province, cannot be satisfactorily estimated in relation to the cultivator's balance sheet. We shall, therefore, examine only the costs of operating an organization such as we have suggested in relation to the 'direct' services which have been discussed, viz., the use of fertilizer and improved seed and control of disease and pests. The cost of the last of these will actually be negligible by comparison with the first two.

It will be convenient to deal with some unit less than the entire rice-growing area which, broadly speaking, this scheme would seek to bring under operation. Let us consider a tract of 5,000

square miles, of which 3,000 square miles or, roughly, 2 million acres, is rice land with adequate water. Let us suppose this to be divided up into 500 'groups', which will comprise about ten square miles and on the average, in the core of the rice-growing area, west Bengal and south Bihar, Orissa and north Madras, say ten villages with a population of some 5,000. The rice land will measure about 4,000 acres, which is a manageable charge for a man of the *havildar* or *naik* type who, as suggested on page 28, might be suitable for the work envisaged. The whole of the area will be within a couple of miles of his headquarters and he will have to deal with some 800 *ryots*. The scheme proposes that he should have four fieldmen chosen by the villagers to help him and should call on the services of the *patwari*. The 'group officer' as *havildar* or *naik*, has been getting from Rs. 24 to Rs. 38 a month, plus rations, billeting, and clothes.[76] To attract him he would probably need to get Rs. 50, rising to Rs. 75 when living in his own part of the world, with no allowances. The annual cost may be put at Rs. 700. The village *patwari*, who will have to make the necessary assessments of materials required, &c., should receive a higher rate of remuneration than is now general. It is suggested therefore that an allowance of one-half the group officer's pay should be set aside for him. The fieldmen, though not by any means whole time, will want some remuneration, say Rs. 10 a month, and thus four of them will cost Rs. 480 a year. To these items must be added the interest and upkeep charge on buildings, i.e. house for the group officer and a store capable of holding 150 tons of fertilizers, improved seed, implements, tools, &c., the rent of the land needed for growing improved seed and the cost of its cultivation. Putting this at Rs. 470 a year,[77] the total comes to Rs. 700 + Rs. 350 + Rs. 480 + Rs. 470 = Rs. 2,000 for each group.

The scheme contemplates a supervisory staff located at a market town or at railhead with a store of 1,000 tons capacity. One circle officer will be needed for every twenty groups with a total area of 200 square miles to look after. His pay should be about Rs. 100–Rs. 150 a month. Adding Rs. 80 a month for staff, the annual cost would be some Rs. 2,400. Interest and upkeep charges on buildings might bring this up to Rs. 5,000.

For superior supervision, a fairly senior officer of the Provincial Agricultural Service will be required, with a junior officer as his assistant, and clerks, situated at a convenient spot in the 5,000 square miles under operations. It will also be necessary to strengthen the office of the Provincial Director of Agriculture.

Another Rs. 10,000 annually will probably cover these charges.

Thus the cost of the organization for, say, 3 million acres (5,000 square miles) may be roughly estimated as follows :

Group officers and fieldmen	500 × Rs. 2,000 =	10,00,000 Rs.
Circle officers	25 × Rs. 5,000 =	1,25,000 Rs.
Superior staff	=	25,000 Rs.
Total recurrent costs ..		11,50,000 Rs.

It is probable then that with the scheme in full working order the cost of the organization would not be far short of Rs. 12 lakhs, which means on 2 million acres of suitable paddy land, 9½ annas an acre. It may be remarked in passing that this may be as much as ten times the present expenditure of a Provincial Agricultural Department on the same area.

For the purposes of this discussion we will consider the cost of fertilizing with sulphate of ammonia, for which recent cost figures in India are available.[78] The cost of producing sulphate of ammonia on a scale of 350,000 tons per annum at a single factory at Harduaganj (Nr. Aligahr) is given as Rs. 126 per ton, including primary distribution costs, i.e. cost at six depots throughout India. This does not include secondary distribution costs, i.e. the cost of distributing from the principal depot to the consumer. The *average* primary distributing cost from Harduaganj to the six widely separated depots is given as Rs. 12 per ton, or a little less than 8 annas a maund.

We assume that the cost of transport for secondary distribution to the 'groups' we have suggested would be on the average about half this, since it should be possible, under the scheme we have proposed, to rail the fertilizers direct from factory or port to the circle officer's stores, from where the 'lead' to the field should not average much more than five miles.

If this assumption is correct, the total cost per ton of the fertilizers on the field, including the cost of the staff of all grades, will be :

(*a*) Factory cost	Rs. 114
(*b*) Primary distribution cost	12
(*c*) Secondary distribution cost :	
(i) Transport	6
(ii) Staff and organization	16
Total cost per ton of fertilizers ..	Rs. 148

Rs. 147 a ton is equal to Rs. 5.6 a maund, and this figure may be taken as the probable cost of manufacturing and putting the fertilizer in the hands of the ryot under the scheme proposed. It should, however, be remembered that to a small extent existing subordinate staff of the Agricultural Departments would be available for absorption into the proposed organization ; and further, that the issuing of fertilizer would not be a whole-time occupation of that organisation. Both these facts indicate that the cost of staff should not be fully included in the price quoted above, but since it is only one-tenth of the total cost, any reduction will not be very significant. In any event, the above figure includes staff costs for the other 'direct' services, for which material costs will be negligible by comparison. The figure of Rs. 5.6 per acre (assuming an application of fertilizer at one maund per acre[79]) will therefore cover substantially the costs both of the organization proposed and of the materials required for all the three 'direct' services.

The next question is whether the *ryot* can pay Rs. 5.6 for these 'direct' services, including the provision of fertilizer. One way of looking at it is that he pays from Rs. 3 to Rs. 8 per acre as rent and, where canal irrigation is available, he has paid, sometimes rather reluctantly, rates varying with the price level in the last forty years from Rs. 1.8 to Rs. 4 per acre irrigated. For this the Irrigation Departments have somewhat optimistically estimated that he gets an extra 4 to 8 maunds of paddy. It should, however, be remembered that in the rice-growing area annual rainfall averages from 40 to 60 inches, and irrigation is of great value only when the monsoon is unusually short or is badly distributed over the growing season.

The benefit from the fertilizer should be much more certain, and, on the average, not less than that from irrigation. The present yield may be put at 16 maunds of paddy an acre (or, say, 10 maunds of rice) and the *ryot* may get from straw and a catch crop about a quarter more in value. The average benefit from the use of fertilizers at the rate advocated in this scheme is put at 4½ maunds of paddy per acre. It should be noted that this figure of 4½ maunds of paddy per acre is the *average* increase expected. Under adverse conditions, especially in certain areas, the cultivator may only get 2 maunds additional yield per acre from the use of fertilizer, while under good conditions the increase may be as high as 7 maunds. In addition, the use of improved seed and the contributions to increased yield from the other factors considered in this scheme may be expected to give

an average further increase of 3 maunds of paddy per acre, varying with conditions from 1 to 5. Thus the minimum total increase in yield may be taken as 3 maunds of paddy per acre, and it is on this *minimum* figure that a calculation of the lowest price for paddy to ensure a profit to the cultivator against the cost of materials and services, should be made.

The following table is an attempt to indicate the course of prices for a maund of paddy on the *ryot's* field over the present century:

	Rs.		*Rs.*
Average, 1901–10 ..	1.8	Average, 1921–30 ..	2.2
Lowest	1	Lowest, 1923 ..	1.11
Highest	2.8	Highest, 1927 ..	2.13
Average, 1911–20 ..	2	At beginning of the slump	
Lowest, 1911 ..	1.8	1930	1.11
Old Standard, 1913 ..	2	At worst of the slump..	1.2
Highest, 1920 ..	3.8	New Standard, 1939 ..	1.10
		1940 ..	2.8
		1943 ..	10
		October 1944 ..	5

It will be seen that if paddy prices recede to the lower levels experienced in the first forty years of the century, materials and 'direct' services for improved cultivation at Rs. 5.6 per acre will not be a very attractive propostion for the *ryot*, however essential it may be for the population as a whole to have more rice. To make the plan a universal success in all areas it would be necessary therefore either to maintain the price of paddy on the field at Rs. 2 a maund at least, or to subsidize the production and distribution of fertilizers.

The former alternative means that the consumer in district headquarters will have to buy rice at the rate of 9 seers (18 pounds) to the rupee or worse. The Reconstruction Committee of the Viceroy's Council include among general objectives 'stabilization of the prices of agricultural products at an economic level'.[80] A price of paddy on the field of Rs. 2 a maund would not compare unfavourably with figures since 1910, but it is not suggested that it would be essential to maintain prices at this level. It might be preferable, both for simplicity and for economy, for the State to pay some part of the cost of the fertilizers. In this connection, it will be noted that our calculations are based on the costs for sulphate of ammonia produced in India. Since it is contemplated, in the first instance, to produce only 350,000 tons (somewhat less

than 10 million maunds) of artificial fertilizers a year in India, the cost of imported fertilizers will clearly be of the highest importance in relation to this scheme. It is possible that, when the shipping position improves and external countries can resume large-scale production, the imported material may be markedly cheaper than that made in India. Immediately before the war, sulphate of ammonia was available, landed at ports in India, for about Rs. 103 a ton.

In any case, whether ultimately it was thought fit to charge the *ryot* with the full cost price of the fertilizer or not, it would be essential for the successful launching of the scheme to supply it at concession rates for the first year or two. In fact, it would probably be wise to give it free for the first year in any new area, and to charge only half the full rate for the second year. Subsequently it might simplify the collection from the *ryot* of what he has to pay if, instead of requiring him to pay in cash, arrangements were made for his crop to be divided on the threshing floor before the landlord takes his dues, a fixed amount of the whole crop going to the State. This plan would ensure a fair division between cultivator and landlord and greatly facilitate the 'procurement' of stocks, on which the State will continue, it is presumed, to depend for successful control of prices.

We can now carry the analyses of costs for the scheme proposed one stage further. The cost of the organization has been estimated at Rs. 12 lakhs for an area of 5,000 square miles (say 3 million acres), of which 3,000 square miles, or, say, 2 million acres are land where conditions are favourable to give a good return. For the 80 million acres of suitable land which the scheme would seek to bring under operation, this gives Rs. 5 crores. Taking account of the cost of materials, of which fertilizer is the only significant one, at say Rs. 4.13 per maund including transport, this will involve an expenditure on 90 million acres, allowing 10 million acres for double cropping, of Rs. 44 crores. To this must be added, say, a further Rs. 6 crores for indirect services, making Rs. 50 crores in all. The return in increased crops, principally rice, from all the factors considered by the scheme, can be estimated at up to 15 million tons, or say, up to 400 million maunds of grain, assuming that none of the land is diverted to increased production of pulses, vegetables or fodder crops. For the purpose of this discussion we may take the figure of Rs. 2 per maund for paddy on the field, which may be valued at an average of Rs. 4.8 for cleaned grain of all kinds (principally rice) at market, as indicative of the return which may be expected.[81]

It is not clear how much of the increased production could be taken by Provincial and Central Governments as a part of their procurement schemes, since much of the increase would have to remain with the cultivator for his own use and would be required in urban areas and to meet the requirements of the increased population. Further, the production of much more rice in some of the present principal deficit Provinces might well alter the whole balance of procurement as between the present surplus and deficit Provinces (States). If, however, we assume for our purpose that one-fifth of the increased production, viz., 3 million tons of grain, is taken in aid of procurement[82] and in lieu of services and materials, this would be valued at about Rs. 37 crores, leaving a maximum of Rs. 13 crores to be met from Central Revenues. A subsidy of Rs. 1½ per maund on fertilizer used at a maund per acre on 90 million acres would fully cover this. No account is taken in this analysis of the over-all favourable effect which increased production of food grains would be expected to have on the purchasing power of the cultivator and, therefore, on indirect sources of revenue.

This figure may be compared with that suggested in the draft proposals of the Imperial Council for Agricultural Research, viz., 15 crores a year for British India for plant husbandry, which covers the cost of extension staff only and does not include either cost of materials or the maintenance of buildings, &c. We believe, therefore, that the scheme we have outlined could be largely supported from the increased marketable return resulting and that the balance which might have to be met from Central Revenues would not compare unfavourably with the costs of those schemes which have already been put forward. As the principal object of this or any other such scheme for agricultural improvement is to ensure that the people of India as a whole are adequately fed and the country is self-supporting in food, it would seem to be in every way proper that a substantial proportion of the cost should be met by the Centre.

The tentative calculations which have been made in this section in order to indicate the financial implications of our programme for agricultural improvement have been based on estimated minimum and average increased yield figures. The actual effect which would be achieved from the programme as a whole when in full operation at the end of seven years can, however, only be measured in terms of the extent to which it would meet the needs of the population at that time. It is estimated by agricultural experts that India's *present* population of 400 millions requires a

10 per cent increase in cereal production,[83] i.e. 6 million tons to provide the basic ingredient of a balanced diet. In eight years from now there will be some 50 millions more to feed, requiring a further eight million tons of food grain (at 1.1 lbs.) per capita per day. Thus to meet the cereal need alone for a balanced diet, 14 million tons of additional food grains will be required in 1953. The programme we have outlined would meet this minimum requirement and would enable some already cultivated land and any new land brought under cultivation to be utilized for production of pulses, vegetables, fodder, &c., to raise the quality of the diet.

Appendix

THE DEVELOPMENT OF FISHERIES

THE development of fisheries is believed to offer a most promising means of raising on a wide scale the nutritional level of Indian diets, both by the provision of high-grade protein and some of the deficient vitamins.[84] About 40 per cent of the peoples of India will eat fish, but hitherto, despite sporadic efforts, the development of fisheries has never been very successful due to lack of organization, and particularly the lack of any central direction, since the Government of India Act of 1919, when fisheries became a transferred subject in the Provinces.[85]

Of the three broad types of fisheries, viz., (1) inland, i.e. river, lake, and artificial pond fisheries, (2) inshore and estuarine fisheries and (3) deep-sea fisheries, the first two probably offer the most promising lines for development over a short period. In these fields there is sufficient empirical knowledge and a sufficient amount of training already available in India to enable an extension of established practices to be made with assurance[86] and with only relatively little capital outlay and equipment. The resources of deep-sea fisheries on the other hand could probably best be exploited by a large commercial organization with the necessary experience and facilities.

For an average consumption of half a pound of fresh fish per week per capita for the 150 millions in India who will eat fish, some two million tons would be required per year. This figure should be regarded as a minimum since the half pound per week basis is low, but it compares with an estimated present annual catch in India of 650,000 tons, of which two-thirds are from marine and the balance from inland fisheries. The figure of two million is rather less than half that of the Japanese fishing industry immediately before the war, a high proportion of which was used either as human food or for the preparation of manures for a population of less than 100 millions.

Although there is relatively little basic information on the availability of fish in the different Provinces and in the waters around India, experts are agreed that a rapid increase in production, particularly in and around Bengal and off the shores of Madras Presidency could be achieved by vigorous administrative measures. It has, for example, been estimated that administrative measures alone could double the annual tonnage from these areas within three years. These measures should include the

provision of greatly extended facilities for landing fish—piers, jetties, boats, and gear, and improved refrigerated transport arrangements. It is reliably stated, that in Bengal, owing to heavy military demands for ice, quite one-third of the total catch is wasted. In particular it is essential to introduce a revised system of marketing which will suppress the price rings formed in the major fishing ports, as at Calcutta, and will ensure, for example, by the organization of co-operative societies, something more than a bare subsistence to the actual fisherman. It is only by administrative measures such as these that the fishing industry can even be satisfactorily rehabilitated in areas where it has suffered from the death of many fishermen, the desertion of many others to more lucrative war-time occupations and the destruction or loss of equipment. The training of new men cannot be satisfactorily embarked on until this has been accomplished.

Fish farming, already conducted in some parts of India, including Bengal, is a source of supply of fresh fish for rural communities which can be greatly extended on the basis of existing empirical knowledge and training.[87] In areas which are suited to its use it probably offers the greatest hope of regional self-sufficiency and proper nourishment for all classes of people.[88] Similarly, fish culture in paddy fields has definite possibilities and is now being tried in Sunderband Abads. Notable progress in fish farming has been made recently in Palestine and although the technique best suited to Bengal and other Provinces would have to be worked out, this could be done quickly and efficiently by bringing existing fish farms under competent scientific control. In this connection also the use of inorganic fertilizers to increase the phytoplankton content of the water has proved a most valuable means of increasing the rate of growth and density of the fish population.[89] The extension of tried and successful fish farming practice can only be accomplished through a network of demonstration centres or fish farms, where the improved methods of culture can be brought to the notice of the fishing and rural communities.[90] Such a scheme could, however, probably be integrated readily into the pattern suggested in Section V for the extension of sound agricultural practices.

The offshore grounds in many areas around India are a rich potential source of marine fish, but they have never been properly exploited and, except in a few places, are largely unexplored. It is noteworthy, however, that Japanese trawlers were working successfully before the war in the Bay of Bengal and that the steam trawlers *Golden Crown* and *Lady Goschen* demonstrated that

large quantities of fish were to be had in the Bay of Bengal in offshore areas such as off the mouth of the Hugli. The outstanding difficulty in initiating steam trawling is that ships and the crews needed to man them will probably be unobtainable for some years unless ships can be taken over from the Japanese at the end of hostilities and use made of men from the Royal Indian Navy when this is reduced to peace-time establishment. Moreover, the economics of steam trawling as compared with indigenous methods of procurement will require examination.[91]. Many of the offshore grounds between the 15 and 50 fathom depths may, however, be suited to the Danish seine[92] and this may offer a more satisfactory immediate means of developing marine fisheries : these are matters which should properly be the concern of a Central Fisheries Research Institute. In whatever direction development is pursued, however, it will be essential to broaden the whole basis of scientific and administrative staff associated with fisheries and to recognize the vital importance of this branch of food production.

The processing of fish is a matter of particular importance for marine and estuarine fish which are not for local consumption, and available methods must receive careful examination from the economic point of view. Some methods such as sun-drying, curing, smoking, &c., are already practised in certain parts of India and may be capable of extension without any basic alteration in the existing practices. Artificial drying should, however, also receive attention, although it is probable that the more refined methods cannot be widely introduced owing to their relatively high cost. The production of a fish meal, made by processing the whole fish with degutting and with the bones included, is strongly to be recommended because of its great nutritional value ; but in the first instance it would be necessary to ascertain whether, as is the case in many of the colonies, fish in this form will prove acceptable. Blocking or granulation of the meal gives a more acceptable appearance and renders it better for use in Indian diets. Transport refrigeration and refrigerated stores will be required to balance drying plants for the higher grades of fish, and for the distribution of fresh fish to principal urban areas, and refrigeration arrangements on sea-going fishing vessels will be essential. Systems of refrigeration for such purposes which are self-contained without requiring external sources of refrigerant and which are rapidly erected and extremely compact and economical, have been worked out on the basis of American experience.

No mention has been made of the possibilities of processing fish into fish manures, since it is believed that for the first few years of the development of a fisheries industry every effort should be directed to increasing the consumption of fish as a human food. If supply exceeds demand, and this should ultimately be possible with the exploitation of deep-sea fisheries, the production of fish manure would naturally be considered.

References

(1) The Hon. Sir M. Azizul Huque, as Member for Food to the Government of India, speaking before the Central Legislative Assembly on 9 August 1943, said: 'The food problem [in India] to-day is much deeper than it appears on the surface. If statistics are correct, rice production in India during 1911–12 to 1942–3 has remained nearly constant between the figures of 25 million tons and 27 million tons. . . . As compared with the three pre-war years the combined acreage for our basic food crops, rice and wheat, is almost constant, viz., 107.5 to 109 million acres. . . . In the meantime, the population has increased from about 311 millions in 1910–11 to 388 millions in 1941, with the corresponding increase in rice-eating population. The main food grains production of India has remained almost constant between 50–51 million tons with small variations from year to year. . . . Did we realize, however, ourselves that the very basis of our economy is so made that it is hardly enough to meet our immediate needs and certainly lacks the strength to stand the pressure of any abnormal circumstances or conditions of strain?'

(2) The acreage per person under food crops, including food grains, sugar cane, vegetables, fruits, condiments and spices, has declined from 0.83 in 1911 to 0.67 in 1941 (estimated from the 1941 Census figure by Burns). The figures for 1921 and 1931 were 0.86 and 0.79 respectively. *Population Problem of India*, P. K. Wattal, R.I.I.A.

(3) Sir Frederick Whyte, in his short book on India (Second Edition, 1944), refers to this matter in the following terms: 'The central economic problem of rural India, and therefore of the whole country, is to raise the purchasing power of the peasant to the point where he can be assured of adequate nutrition and something more . . . the establishment of home industry, village workshops and local processing factories for peasant products.'

(4) Details of the Government of Mysore's proposals for agricultural improvement are given in its post-war development plan (1944).

(5) From information in the summary prepared in July 1943 by the Department of Education, Health and Lands of the Government of India, the total increased production in 1942–3 over the previous year from the 'Grow More Food' Campaign has been estimated at 3,856,000 tons for the five principal food grains (Burns). It is not, however, clear how much of this increase was due to a favourable monsoon and rainfall generally throughout the greater part of India during that period.

(6) See, for example, the 2nd report of the Reconstruction Committee of the Viceroy's Council 1944, Part II, Section 17.

(7) Summary of the draft proposals set out by the Imperial Council for Agricultural Research for increased food production and

improving agriculture in India, put before the Agricultural Policy Committee of the Reconstruction Committee in Council, March 1944.

(8) Referring to requirements for increased production of primary foodstuffs, the 2nd report of the Reconstruction Committee in Council reads as follows: 'It cannot, however, be sufficiently emphasised that positive executive measures are required to increase production on the scale referred to. It may be possible to achieve this by enlisting the co-operation of the cultivator and by giving him the assistance that he needs. It is necessary to recognise, however, that the problem is urgent and that if these measures do not succeed, others will have to be tried.'

(9) See, for example, the 2nd report of the Reconstruction Committee in Council, Part II, Sec. 17, and *The Technological Possibilities of Agricultural Development in India* (Burns), 1944.

(10) The approximate yields of rice in the producing countries of the world up to 1939 may be quoted as indicating the general trend of production yields in India compared with other countries. The figures, which are in lbs. per acre, are quoted from Burns's *Technological Possibilities of Agricultural Development in India*, 1944:

APPROXIMATE YIELDS OF RICE IN PRODUCING COUNTRIES OF THE WORLD. (LBS. PER ACRE)

	Aver. 1909–13	*Aver.* 1926–7 *to* 1930–1	*Aver.* 1931–2 *to* 1935–6	*Aver.* 1936–7	*Aver.* 1937–8	*Aver.* 1938–9
India (including Burma)	982[1]	851	829	861	826	728
Burma	—	887	845	833	813	959
Indo-China	928[2]	661	637	—	—	—
Siam	—	1017	961	863	829	943
United States of America	1000	1333	1413	1505	1471	1469
Italy	1952	2797	2963	2839	3258	2903
Spain	2969	3749	3709	—	—	—
Egypt	2119	1845	1799	2083	2001	2153
Japan	1827	2124	2053	2339	2305	2276

[1] 1914–15 to 1918–19. [2] 1912–13 to 1913–14.

Average wheat figures in certain countries are as follows, the figures for India being taken as the mean of those for both irrigated areas and areas where wheat is dependent only on rainfall. They are quoted from the Report on *The Marketing of Wheat in India*. 1937.

	Aver. 1924–33	*Aver.* 1909–13
United States	846	852
*Canada	*972*	*1188*

	Aver. 1924–33	Aver. 1909–13
Australia	714	708
Argentina	780	596
Europe	1146	1110
Russia	636	612
India	636	724
Great Britain	1970	1985

(11) The standard yields for India as given in *Agricultural Statistics for India* and elsewhere are based on crop cutting experiments in the different Provinces. Experience has proved that the figures provided by these experiments are very unreliable. As regards areas, while these are known to be fairly accurate in India, where settlements are temporary, it is far from the case in the permanently settled Provinces, where figures for areas are often largely conjectural (Burns). Moreover, it is not clear in the statistics that sufficient allowance is made for the large areas under marginal cultivation.

(12) It is not clear here that like is being compared with like since the methods of computing the statistical data vary. The general conclusion is, however, unaltered.

(13) 'Cultivable Waste' is the residual category in the Revenue statistics which includes everything except manifestly uncultivable land on the one hand and cultivable land and fallows on the other. From experience it is, broadly speaking, not a potential asset from the agricultural point of view. If it had been readily possible to bring any of these areas under cultivation to yield an economic return, the pressure of population and land hunger would have led to this long ago.

(14) Address by Sir William Stampe, Irrigation Adviser to the Government of India, on *Planning and Plenty* to the Institute of Engineers (India) at New Delhi, November 10, 1944.

(15) Sir Ardeshir Dalal, Member for Planning and Development, presiding at the Fifth Meeting of the Consultative Committee of Economists on January 3, 1945, said, in replying to criticisms on the Second Report on Reconstruction Planning of the Reconstruction Committee of Council, 'Fragmentation . . . of course, is the greatest curse of Indian agriculture but . . . various Provinces are taking measures. The C.P. Government have made very good advance with regard to the consolidation of holdings and the Punjab Government has been proceeding along the same lines mainly by the co-operative method. The Bombay Government have recently been considering legislation based on the C.P. model. All these things involve a great deal of interference with the established habits and customs of the people. It has got to be done very cautiously and we have got to carry the people along with us.'

(16) The various technological factors which would result in improved yields in India are given, *inter alia*, in the following publications :

(i) *Report on Crop Production in India*, Sir John Russell, 1937.
(ii) *Report of the Royal Commission on Agriculture in India*, 1928.
(iii) *Technological Possibilities of Agricultural Development in India.* Dr. W. Burns, 1944.
(iv) Summary of the draft proposals of the Imperial Institute for Agricultural Research placed before the Reconstruction Committee in Council, March 1944.

(17) The report of the Food Grains Policy Committee 1943 comments as follows on the requirements for intensified cultivation : 'Intensified cultivation needs intensified manuring. Intensified manuring can only be successful if there is an assured water supply. The Committee is satisfied that in the existing circumstances the only sure ways of increasing production quickly are by the extension of irrigation facilities and manuring, the two essential requisites of intensified cultivation.'

(18) Summary of measures taken by Government of India to implement the recommendations of the report of the Food Grains Policy Committee. Department of Education, Health and Lands 1943.

(19) The Imperial Agricultural Research Council give a figure of eight hundred million tons green weight per annum or 160 million tons dry weight for the production of farmyard manure, and quote rough estimates for expenditure as follows : 40 per cent used as fuel, 40 per cent used as manure, 20 per cent lost due to difficulties of collection.

(20) The following statement by the Department of Education, Health and Lands, refers to the position as regards availability and use of sulphate of ammonia in 1943 :

'Present imports are 65,000 tons, which, together with 15,000 tons from indigenous production, are required as follows to maintain the production of tea, sugar-cane, vegetables, coffee, and rubber to meet urgent demands :

Tea	28,000 tons
Sugar-cane	24,680 „
Potatoes and vegetables ..	11,200 „
Coffee and rubber	1,120 „

Only approximately 15,500 tons was allocated to paddy.'

(21) No detailed information is available on what measures are being considered to provide alternative forms of fuel. Experience in the Punjab shows that charcoal, although it is slow burning and can be employed in the simplest possible types of stove, is not a

fuel which the peasant will use. In any case, the establishment of a charcoal-burning industry to provide the quantities required at a cheap rate (in the Punjab charcoal was costing about Rs. 8 per maund in 1944) would be almost impossible over a short period, even with the planting of quick-growing trees round the villages. Oil is not a suitable fuel in relation to the present level of rural economy, since, in addition to its cost, it calls for the provision of relatively elaborate stoves, education in the use of which would require a quite impracticable organization. Some success has been reported from the Punjab using 'hot boxes', and this may offer a possible line of investigation. The requirements will, however, vary in different parts of India.

(22) The Imperial Council for Agricultural Research in their proposals set before the Agricultural Policy Committee of the Reconstruction Committee of Council (1944) consider that the only direction in which progress is feasible is to ensure that dung used for fuel is properly conserved in order to release as much as possible for use on the land.

(23) According to Dr. C. N. Acharya, of the Indian Institute of Science, Bangalore, it is possible to prepare about 5 to 6 million tons of good quality compost manure every year from the waste from towns and cities of above 5,000 population. In addition to these bigger towns, there are a large number of medium-sized towns between 2,000 and 5,000 population, managed by municipalities or village *panchayats*, which possess sanitary staff for the collection of urban refuse. This category is estimated to account for an aggregate compost-producing capacity of a further 5 to 6 million tons annually. It should, therefore, be possible to supply ultimately for agricultural purposes about 10 million tons of compost manure annually by the proper utilization of the urban wastes in India. At 0.58 per cent nitrogen, this would, however, only be equivalent to 50,000 tons of nitrogen per annum, and this could, of course, only be used in the neighbourhood of the towns where it was prepared.

(24) The average nitrogen content of oil cake is about 5 per cent, and although the amount of oil cakes produced in India is not known accurately, the Food Grains Policy Committee quote a figure of about 1½ million tons, equivalent to, say, 75,000 tons of nitrogen per year. Of this, it is estimated that half is required for feeding cattle, the remaining half being insufficient for manuring the intensively grown crops, such as sugar cane, potatoes, tea, &c., and that hardly anything is left for manuring food grains.

(25) *Report on crop production in India*, 1937. Sir John Russell.

(26) Dr. Burns, in his *Technological Possibilities of Agricultural Development in India*, takes 20 per cent as a conservative figure for the probable increase in rice yield per acre from manuring alone, but he states that at the rate of 20 lbs. of nitrogen per acre, at least a 40 per cent

increase is to be expected. The results of experiments on the fertilizing and manuring of wheat are more erratic than those with rice, particularly on account of variable water supply. Irrigated wheat, however, which in India covers about 12½ million acres, responds satisfactorily to both compost, artificials and green manures.

Dr. Burns gives estimates as follows for the quantities of nitrogen fertilizer which can on an average be used with various crops to give optimum results when other factors, such as inadequate or badly distributed water supply, do not seriously interfere :

Crop	*Suggested manuring in lbs. per acre*	*Acreage in million acres*
Rice	20 ..	76
Wheat	40 ..	33
Barley	20 ..	6
Jowar	20 ..	33
Bajra	20 ..	17
Maize	20 ..	6
Ragi	20 ..	6
Sugar-cane	100 ..	4
Cotton	40 ..	23
Coffee	40 ..	0.20
Tea	40 ..	0.80
Vegetables	40 ..	0.75
Fruits	40 ..	2.5

(27) Statement by the Department of Education, Health and Lands (1944) on the requirements for sulphate of ammonia to meet the immediate rice deficiency. The usage of sulphate of ammonia on paddy even in pre-war years did not exceed about 15,000 ts. p.a.

(28) Report of the technical mission to advise on production of artificial fertilizers in India (1944).

(29) The corresponding figure for irrigated land under rice is 18 million acres out of the total of about 75 million acres.

(30) Compare, for example, with the following quotation from Section 17 on agriculture of Part 2 of the 2nd Report on Reconstruction Planning of the Reconstruction Committee of Council (1944).

> 'The requirements of Indian soils in nitrogenous manures are enormous. The object should be to provide adequate manures at least for all lands commanded by irrigation ; it is in these that manuring gives the highest result,'

and with the quotation at reference 17 from the Report of the Food Grains Policy Committee, 1943.

(31) The results of experiments with phosphatic fertilizers are not in general conclusive ; although large areas are known to be deficient in phosphate, no final recommendations can be made

without a careful survey of the evidence of all experiments to date, and it is probable that further experiments would be necessary. Generally, on Russell's evidence, there is no response to phosphate on rice unless nitrogen is also added and a general guide might be obtained in the case of rice by envisaging in the preliminary stages the possible use of phosphate up to an equal weight with that of the nitrogen employed. Phosphate deficiencies would be expected, however, to show up more prominently after a few years using nitrogen alone.

(32) The figure 12 to 15 million tons represents the minimum additional amount of food grain which it should be possible to produce by manuring alone at the end of the seven-year period considered in this scheme, if none of the land were diverted to increased cultivation of pulses, vegetables and fodder crops or to grazing. We believe, however, that such diversion from food grains is both possible and desirable. The Government of India (2nd Report of the Reconstruction Committee of Council, 1944) has accepted the following figures as a guide to the all-India targets of production likely to be required to provide the ingredients of a balanced diet for India's *present* population :

Cereals	..	10 per cent increase over present production				
Pulses	..	20	,,	,,	,,	,,	,,
Fruits	..	50	,,	,,	,,	,,	,,
Vegetables	..	100	,,	,,	,,	,,	,,
Fats and oil	..	250	,,	,,	,,	,,	,,
Milk	..	300	,,	,,	,,	,,	,,
Fish and eggs		300	,,	,,	,,	,,	,,

This implies an increase in available food grains of about 6 million tons for India's present population. At the present rate of population increase there will be about 45 millions more to feed in 1953, i.e., in seven years from 1946, the period envisaged as necessary to bring this scheme to full operation. These will require at least 7.3 millions of tons of additional food grains, even at the low per capita consumption of 1 lb. per day, or 8.0 millions of tons at the above rate of 1.1 lbs. per capita per day as recognized by the Reconstruction Committee. It will be seen, therefore, that the scheme we outline will not result in over-production and that if increased production at the rate of even 16 millions of tons of food grains on 90 million acres were to be attained under this programme, this would release only about 4½ million acres of land for other crops at the end of 1953.

(33) There are deposits of rock phosphate nodules in Travancore, but these occur embedded in clay and the working of the deposits would probably be uneconomical. It has been estimated that India's total reserve of phosphate rock is of the order of 10 million tons.

(34) Summary prepared in July, 1943, by the Department of Education, Health and Lands, on measures for effecting an immediate increase in the food-grain production.

(35) Address by Sir William Stampe, Irrigation Adviser to the Government of India, on *Planning and Plenty*, to the Institution of Engineers (India), at New Delhi, November 10th, 1944. Sir William said that in his view improvement in existing canal systems on the lines indicated could secure an increase of 15 per cent on the existing canal irrigated areas, and that an increase of some 2 million acres could be effected within three years by tube well feeders.

(36) A certain number of limited irrigation and drainage schemes have already been initiated in Provinces and States with financial assistance from the centre and the Cotton Fund, but the Food Grains Policy Committee felt that much more could be done.

(37) *The Place of Mechanical Equipment in Indian Soil Conservation*, by Dr. R. Maclagan Gorrie, I.F.S., Royal Society of Arts, November 16, 1944.

(38) *Report on crop production in India*, 1937. Sir John Russell.

(39) Social Service in India, 1938. R. Allen.

(40) Summary prepared in 1943 by the Department of Education, Health and Lands on measures for effecting an increase in food-grain production. As immediate results were required to meet the loss of rice from Burma, no specific measures were taken by the Government of India to ensure an expansion in the use of improved seed, but it was urged that it should be pressed on as part of a 'longer term' policy (longer term in this context is to be taken as relating to the plans which were being made to meet the immediate emergency by 1944. It was stated in the Summary that three to four years would be required to effect widescale use of improved seed).

(41) Proposals by the Imperial Council of Agricultural Research set before the Agricultural Policy Committee, of the Reconstruction Committee in Council (1944).

(42) Experiments have shown that in certain instances the use of improved varieties with their higher fertility requirements on a soil which normally only supports a low-yielding variety may result in a poorer ultimate yield than would have been obtained using a low-yielding variety only.

(43) Dr. Burns (*Technological Possibilities of Agricultural Development in India*, 1944), in speaking of rice only, estimates that improved varieties could give a 10 per cent increase, and he takes the conservative figure of 5 per cent as the probable increase from this factor.

(44) 'Helminthosporum, the leaf spot of rice, presents an immense problem. Similarly, grain smut of Jowar (sorghum) is very widespread, a conservative estimate of the overall loss from this disease being 5 per cent, or about 325,000 tons per annum. In

upper Baluchistan common bunt of wheat usually varies from 5 to 20 per cent; it is rarely free from infection, and up to 40 per cent is sometimes seen. Similarly, in Kashmir, 40 per cent infection is not uncommon.' (Private communication, Imperial Agricultural Research College, New Delhi, dated November 28, 1944.)

(45) It is calculated that the cost of treating jowar with ground crude Baluchistan sulphur is 10 annas (11d.) per ton of increased yield of grain when applied to the whole of the Jowar acreage. Similarly, a figure of 5.12 annas (6d.) per maund (80 lbs.) is quoted as the cost of increased yields of wheat in Kashmir on an area of 20,000 acres only by treating the seed with a mercurial or copper carbonate. The pre-war prices for these commodities are taken as a basis for these calculations.

(46) Referring to weevil damage in wheat, the *Report on the Marketing of Wheat in India* (1937) states:

> 'In the Punjab, the weevil loss is estimated as being between 2 and 5 per cent for an average period of six months' storage. Where stocks are held up to the end of the season a loss of about 8 per cent is apparently not considered unusual. The Provincial Marketing Office of the United Provinces places the loss due to weevils between 1 and 6 per cent, depending upon the period and method of storage. At Karachi, after six months' storage, the loss due to this agency alone may amount to from 3 to 5 per cent in the case of soft wheat and from 2 to 3 per cent for the hard types.'

Estimated losses for rice and paddy are given as about 1 per cent over all in the Report on the Marketing of Rice in India and Burma, 1942.

(47) *Stored grain pests and their control*, by Dr. H. S. Pruthi, 2nd edition, 1943. *Miscellaneous Bulletin*, No. 37, of the Imperial Council for Agricultural Research (India).
A 3 per cent overall loss from insect and vermin attack of all major food grains represents on present production a total annual loss of some $1\frac{3}{4}$ tons of grain.

(48) In general, serious losses from grain pests in the villages are confined to stocks held by the *Zamindars* and village traders. The cultivator generally takes better care of his supplies, and the quantity he retains is not carried over long periods. In addition, paddy has better keeping qualities than clean rice.

(49) First Report—Part I of the Committee on *Nutrition in the Colonial Empire* (Economic Advisory Council) 1939, Chapter 8. The Report states: 'It should be a principle of policy that the energy requirements should be met out of the most varied possible supply of foodstuffs . . . the greater the variety of foodstuffs consumed the smaller the chance of there being a serious deficiency in any essential requirements.'

(50) The principal pulses grown in India are gram, peas and beans, lentils and ground nuts, of which gram is responsible for, by far, the largest tonnage. The estimated production of gram for 1943–4 was 3,200,000 tons, which was on the low side compared with the average for recent years. It is not however well distributed and rural communities in areas where it is not grown have to rely principally on their own products from other pulses. The present average consumption of pulses in India, as a whole, is somewhat below 2 oz. per capita per day.

(51) While synthetic vitamins have proved successful in combating the consequences of deficiencies when administered therapeutically (as under strict medical control) it is a fundamentally unsound approach to the problem of vitamin deficiency to introduce them as a nutritional measure for peoples who are living on an unbalanced diet.

(52) Nutritional data for food yeast, compared with other standard high-grade foods, are given in a pamphlet *Food Yeast—a Venture in Practical Nutrition*, 1944, published by the Colonial Food Yeast Company.

(53) The Pattern Dietary Scales for the Far East were prepared by Dr. B. S. Platt, Director of the Human Nutrition Research Unit of the Medical Research Council and Mrs. G. M. Culwick. They may be considered as broadly applicable to India and have, in fact, been used by the Young Committee working on Far-East Relief requirements for Burma. They cover three scales, emergency (1,700 calories), moderate work of 8 hours per day at an expenditure of 100 calories per hour (2,800 calories), and heavy work of 8 or 10 hours a day at an expenditure of 200 or 160 calories per hour respectively. These scales are averages for the whole year, and take account of seasonal variations in energy expenditure and other variable factors. Priority allowances are necessary in addition to the standards quoted for such classes as mothers, infants, children, and hospital patients. The following table sets out the basic requirements for each of the above three scales :

DAILY RATIONS IN OUNCES PER CAPITA

Type Foodstuff	*Emergency Scale* 1,700 *Cals.*[1]	*Heavy Work Scale* 3,600 *Cals.*	*Moderate Work Scale* 2,800 *Cals.*
Rice[2]	12	24	20
Pulses[3]	3	6	3
Fresh Meat and Fish (edible portion) ..	—	$2\frac{4}{7}$	$1\frac{2}{7}$
Food Yeast[4] ..	$\frac{1}{8}$)	—	—
Fish Meal[4]	$\frac{1}{4}$)		
Oil[5]	$\frac{1}{2}$	1	1

Type Foodstuff	*Emergency Scale* 1,700 *Cals.*[1]	*Heavy Work Scale* 3,600 *Cals.*	*Moderate Work Scale* 2,800 *Cals.*
Fresh Vegetables or Fruit (gross weight)	$\frac{32}{7}$ (6)	$\frac{32}{7}$	$\frac{32}{7}$
Salt[7]	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$
Lime[8]	$\frac{1}{4}$ gm.	$\frac{1}{4}$ gm.	$\frac{1}{4}$ gm.
Sugar	$\frac{1}{2}$	1	1
Soya Sauce	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$
Currystuffs	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$

(1) Excluding allowances for priority classes.
(2) The rice should be lightly milled, i.e. to a 75 per cent extraction of the paddy (corresponding to 80 per cent for wheat), or alternatively expressed, to a bran yield not exceeding 5 per cent. If highly milled rice is issued, it should form not more than half the ration, the remainder being lightly milled or parboiled.
(3) For instance, 1 part soya beans, 1 part groundnuts, 2 parts other pulses.
(4) Only required where supplies of fresh meat and/or fish are insufficient to provide 9½ oz. per week, edible portion.
(5) One-fifth should be red palm oil, unless vitamin A requirements are covered from other sources (e.g., green leaves and red and yellow fruits).
(6) 'Iron Ration' equivalent is ½ oz. daily of green leaf meal.
(7) *In making final* estimate, an additional allowance should be made for curing and pickling.
(8) Normally used in preparing various foods; simplest and most economical way of introducing essential calcium.

NOTE: (1) Food yeast and dried green stuffs may be made up in compound preparations as developed in the United States for relief feeding. Dried greenstuffs will only be necessary when fresh vegetables are not available locally. Food yeast may possibly be combined with soya sauce and currystuffs.
(2) The above scales assume a sufficiency of potable water.

It will be appreciated, of course, that the types of foodstuffs listed are not to be regarded as rigid, but are interchangeable with other foodstuffs of equivalent nutritional value. Thus, 1½ lbs. rice (or any grain except maize) may be replaced by 1¾ lbs. of maize or 1½ lbs. of wholemeal flour from any grain, &c., while 1 lb. of fresh meat or fish may be replaced by ½ lb. of dried meat or dried fish or ¼ lb. of dried meat powder or fish meal or 4 pints of milk or 10 eggs. 1 oz. of food yeast replaces 3 ozs. of fresh meat or fish.

(54) The area under groundnuts has risen rapidly since 1920, and for the years 1933–7 production averaged about 2,800,000 tons from about 7 million acres. A considerable proportion of the crop was marketed for export or for oil extraction. (Report on *Marketing of Groundnuts in India and Burma*, 1942.)

(55) The value of leguminous crops for the maintenance of soil fertility is also, of course, an important factor.

(56) There is practically no reliable information at present available in accessible form on the production of vegetables in India. Except for field vegetables (peas, greenstuffs, and beans) and potatoes, cultivation is usually carried out in the neighbourhood

of large centres of population by a gardening class with some hereditary skill, as a profitable occupation (Burns). A report on the marketing of vegetables in India is to be issued shortly by the Central Agricultural Marketing Dept. of the Government of India.

(57) One of the best examples of the organization of widely dispersed fruit growing may be found in Java, where great pains were taken to select out a series of all the best kinds of tropical and sub-tropical fruits and to propagate and redistribute these from Government nurseries. In almost every native compound a complete succession of good fruits could be found. The most fundamental problems of suitable root stocks, nutrition, &c., were studied at Central Institutes. The Report on the *Marketing of Citrus Fruits in India*, 1943, calls attention to the very low per capita consumption of citrus fruits in India and to the high losses which are sustained at the present time during transport from lack of cold-storage facilities.

(58) Summary of draft proposals for increasing food production and improving agriculture placed by the Imperial Council for Agricultural Research before the Reconstruction Committee of Council, 1944. Section IV Animal Products.

Dr. W. Burns, *Technological Possibilities of Agricultural Development in India*, 1944, gives full statistics for livestock populations and milk produced in various parts of India. He points out that India is divided, for the purpose of statistics relating to milk products, into three regions based on climate, this being the main factor of the environment which affects livestock production. The first of these, or the wet region, has a rainfall of 70 to over 100 ins. per annum, and comprises the West Coast of India, Bengal, and Assam. The second region has a rainfall of 30–60 ins. per annum and forms the middle of India. The dry region with rainfall of less than 30 ins. per annum is made up of North and North-west India. Broadly speaking, these three regions represent a gradation of the general conditions which influence the efficiency of live-stock production. On this basis, Dr. Burns quotes the following figures :

Region	*No. of Milch Cows*	*Milking capacity lbs. per head per annum*	*Total annual milk production of the region*	*Number of male cattle*
(*a*) CATTLE				
I	11,030,000	370.6	4,090,000	12,680,000
II	20,450,000	463	9,470,000	28,000,000
III	5,800,000	773.7	4,480,000	8,200,000
British India ..	37,280,000	484	18,040,000	48,880,000
(*b*) BUFFALOES				
I ..	740,000	732.6	542,000	
II ..	9,460,000	1,049.6	9,930,000	
III ..	4,850,000	1,615	7,830,000	
British India	15,050,000	1,216	18,302,000	

Region	No of Milch Cows	Milking capacity lbs. per head per annum	Total annual milk production of the region	Number of male cattle
(c) GOATS[1]				
I	6,640,000	73·9	74,000	—
II	21,000,000	191.1	602,000	—
III	10,030,000	297.0	458,000	—
British India ..	37,670,000	200	1,134,000	—

[1] Only 15 per cent of the goats produce milk, the rest are males or young stock or are not milked at all.

(59) The annual reports of the Department of Agriculture, Bombay, from 1939–41, refer to a scheme of supplying 'Premium' bulls to selected agents in the villages from the livestock section of the Department. In many tracts of the Provinces the influence of these selected breeding bulls on the raising of the standard of village cattle, is spoken of as most noticeable.

(60) Dr. Burns, *Technological Possibilities of Agricultural Development*, refers to data available on grading up work with large numbers of village animals such as in the Anamalai Hills (South India) and Bhadri Raj (U.P.), indicating a minimum of 100 per cent increase being obtained in first cross progeny of imported bulls from local cattle, but he takes the average potentiality for improvement in the first generation from village animals generally in India as only 15 per cent.

(61) The requirements of oil cake concentrates are variously estimated at from four to eight times the quantities at present available.

(62) The first report of the Committee on *Nutrition in the Colonial Empire* (1939) expresses the view that the tethered milch goat may assist considerably in remedying the deficiencies in first-class protein in certain areas. It is estimated, however, that in India only 15 per cent of the total of 38 million goats in British India are milked, the yield varying from 75 lbs. to 300 lbs. per annum average in various parts of the country.

(63) Details of production and distribution of eggs in India are given in the Report on *Marketing of Eggs in India and Burma*, 1938, issued by Central Agricultural Marketing Department.

(64) The extension, for example, of the practice of making and marketing curds may warrant examination. Curds play an important part in nutrition in several parts of India and they contain practically all the fat of whole milk with its attendant Vitamins A and D, the bulk of the protein, much of the calcium and phosphorus and appreciable quantities of most of the other constituents of whole milk. It possesses the important advantage over liquid milk that it can be kept longer and is less liable to contamination. Cheese, although particularly valuable as a very rich source of first-class protein, is not widely acceptable in India. Ghee ensures the consumption of fats and some part of the other constituents of milk, but is wasteful unless the skimmed milk which remains is also used.

(65) It has been observed that even where facilities for improved cultivation have existed, as, for example, in parts of the Punjab, in the form of availability of fertilizers and staff, these have almost invariably been used by the cultivator on his money crops, provided he could grow enough grain by his existing methods to feed himself and his family.

(66) The method of advances in kind and return at harvest time is very well understood in India and is used for many agricultural loans. It is essential however if a scheme similar to that we propose is to have any success, for some oversight to be maintained on the use of the materials and services employed to ensure that these are genuinely used on food crops.

(67) Addressing the Transport Advisory Council in January, 1945, the Viceroy, speaking of the improvement of communications in relation to development in India, said :

> 'It seems to me that the first step in all schemes for the social progress of which India is in such desperate need, must be an improvement in means of communication, not only of main roads, but minor district and village roads.'

The Food Grains Policy Committee (1943) recognized the importance of transport facilities in relation to distribution problems, even as they now present themselves in terms of present production, by urging the utmost possible use of all forms of transport and their proper co-ordination.

(68) The Nagpur Conference of December, 1943, of the Chief Engineers of Provinces and States set out a twenty-year programme for the construction of 400,000 miles of new roads. Of this new construction, village roads were scheduled to account for 150,000 miles, secondary district roads 100,000 miles and major district roads 60,000 miles. The balance was made up of provincial highways and national highways and trails. Schemes of a similar magnitude are referred to in the *Bombay Plan of Economic Development* and in M. N. Roy's *Peoples' Plan.* Provincial Governments are now formulating their plans for road development on a scale commensurate with these all-India schemes. Details of the proposals of the Sind and Bombay Governments have already been published.

(69) Considerable experience in methods of soil stabilization for road construction has been obtained in America and the Middle East and from airfield construction in all operational theatres. The application of this to Indian soils will require some study at soil laboratories, which will need to be established in various provinces, but the general principles of construction by this method are now established.

(70) Summary of draft proposals by the Imperial Council for Agricultural Research for increasing food supplies and improving agriculture, 1944.

(71) This matter of price control was extensively examined by the Food Grains Policy Committee in 1943. Price Control is considered to be implicit in any measure, direct or indirect, which operates against a state of affairs in which, so far as India is concerned, India is a free-trade area. Thus, the fixing of priority on movements of food grain or the rationing of consumption by Government influences prices and therefore constitutes a measure of price control. The question, therefore, is whether such control as exists should be rationalized and improved and whether the process of control should be pushed further and statutory price control generalized. The committee suggested that regional prices reached through co-operation between the Provinces and States of a particular region should be the aim, the Centre having the right to suggest changes of prices either upwards or downwards. It would appear that some such system must be maintained during any period of rapidly expanding production, although it will call for constant review in the light of changing circumstances.

(72) Summary of measures taken by the Government of India to implement the recommendations of the Food Grains Policy Committee issued by the Department of Food, 1943.

(73) The achievement of British agriculture during the present war in successfully meeting a similar emergency to that which faces India, has been largely due to the willing co-operation of farmers, scientists and the Executive in formulating and putting into operation a single plan of campaign.

(74) The question of the resettlement and re-employment of ex-Service men is discussed in paragraph 2, Section II of the 2nd Report of the Reconstruction Committee of Council, 1944. It is pointed out that the main line of division is between those who will look to the countryside for their future livelihood and those who will look to industrial or other employment in towns, either from their pre-war work or from the special training which they will have acquired while in the Army.

(75) The general pattern of provincial agricultural improvement bureau suggested here is based on the technical development committees and Agricultural Improvement Councils set up in the United Kingdom during the war. These have proved very successful in effecting extension work in agriculture, both by pointing out the scientific needs of the situation and also the practical implications of research.

(76) The actual present rates of pay (1944–5) of Indian non-Commissioned Officers and other ranks are as follows :

Rank	*Basic pay Rs. per month*	*Highest possible pay Rs. per month*
Havildar	27	38
Naik	24	33
Lance Naik	20	28
Sepoy	18	26

The highest possible rates are calculated by adding proficiency and special proficiency pay and other special allowances. It is exceptional for a havildar to receive more than Rs. 35 or Rs. 36 per month. Indian Army non-commissioned officers and sepoys receive their uniform, food, and billeting free.

(77) A recent report, *Principles of Cereal Storage*, by Dr. F. P. Coyne, Director of Storage, Department of Food Government, published February 1945, by the Government of India Press, New Delhi, gives cost of constructing permanent brick grain stores with concrete floors and suitable roofing, as Rs. 1.6 per maund of grain capacity. We have taken a somewhat higher figure of Rs. 2 per maund which is reported as being nearer the achieved cost under present-day conditions. Interest charges have been calculated at 5 per cent per annum.

(78) Report of the Technical Mission on Artificial Fertilizers, 1944.

(79) We conclude from a survey of available evidence that on an average 16 to 20 lbs. of nitrogen in addition to a light manuring with farmyard or compost will make up the soil deficiency in this respect in the areas we are considering for all major food grains. See, for example, reference 26 above.

(80) Second Report of Reconstruction Committee in Council, 1944.

(81) This figure is substantially in line with recent ceiling prices for the major food grains in various areas.

(82) The total amount of food grains brought to market in India is about 18 to 20 million tons per annum. Under the procurement schemes 3,700,000 tons of food grains, exclusive of imports, were received under monopoly of the Government of India between July 5th, 1943, and November 9th, 1944. This included requirements for the Defence Services, which may be estimated over this period at 850,000 tons, so that approximately 2,850,000 tons may be considered as having been procured to meet civil requirements. On the basis of this figure, it is not considered that our suggested figure of 3 million tons will be seriously amiss at the end of seven years when allowance is made for (*a*) relief from increased production in some deficit areas coming under our scheme and (*b*) increasing deficits due to population increase in some areas not coming under our scheme.

(83) Second Report of the Reconstruction Committee of Council, 1944, p. 36.

(84) In the recent famine there was a quite clear-cut distinction between the people living along the coastal strip in the Malabar Coast area who were able to obtain fish and who regularly consumed it as a part of their diet, and those further inland who could not obtain it. Both groups received approximately the same quantities of cereal foods, but while the latter showed the whole range of stages of malnutrition, the former remained healthy, with bright clean

skins, &c. (private communication from Director-General, Indian Medical Service).

(85) In his memorandum on the *Post-War Development of Indian Fisheries* (August 1943) Dr. Baini Prashad suggests that the lack of a Central Department of Fisheries is the main reason for the development of Indian fisheries, whether fresh water, estuarine or marine, not taking place along proper lines.

(86) This is particularly true of tank fisheries, where a programme of increased production is being put in hand by the Government of Bengal without recourse to any further pure scientific research (private communication, September 1944, from the Director of Fisheries, Government of Bengal).

As regards estuarine and offshore fisheries Dr. Prashad writes: 'From the nature of the coasts of India and the drainage of the country, the best fishing grounds are likely to be concentrated at certain centres only, such as the estuarine regions of the Ganges and the Brahmaputra, the head of the Bay of Bengal, the East Coast of India in fan-shaped areas of the sea opposite the estuaries of the Mahanadi, Godavari and Kistna and Culvery rivers, in Palk Bay and the Gulf of Manaar and on the West Coast of India generally between Travancore and the Gulf of Cambay, with concentrations at Trivandrum, Cochin, Calicut, Tellicherry, Mangalore, Karwar, Honnavar, Ratnagiri, Bombay, and Broach, and in the Gulf of Cutch, the estuarine region of the Indus and the Baluchistan coast between Karachi and Gwadar.'

(87) 'Inland fisheries as a source of food have unlimited possibilities of development provided sound cultural practices more or less akin to agricultural practices . . . are adopted.' Dr. Baini Prashad, *Post-War Development of Indian Fisheries.*

(88) Private communication from the Director of Fisheries, Government of Bengal.

(89) See, for example, United States Department of the Interior—Fish and Wildlife Service Fishery leaflet No. 12, Chicago, Ill., January 1943.

(90) *Post-War Development of Indian Fisheries.* Dr. Baini Prashad.

(91) Dr. Jenkins is of the opinion that trawlers cannot compete with indigenous methods of production. *Current Science*, Vol. VI, No. 8, p. 376 (1938).

(92) Summary of draft proposals for increasing food production and improving agriculture placed before the Agricultural Policy Committee of the Viceroy's Council by the Imperial Council of Agricultural Research. March 1944.

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