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THE PROBLEM OF POPULATION AND FOOD SUPPLY IN INDIA

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PROFESSORS NOTESTEIN and Black gave you this morning a general picture of the problems of population and food supply. My object is more limited. It seeks to apply the same general principles to a particular country. But, I believe, it has also a general appeal in the sense that India is perhaps typical of some of the problem areas to which Professor Notestein referred this morning. In this sense my discourse would be supplementing what he and Professor Black have said and would also perhaps satisfy Mr. Barlowe who wanted someone to deal with the problems of population and food supply in an integrated manner. Now, one of the basic and most important facts of the Indian economy is the tremendous pressure of population on land. There was a time when this fact was not perhaps taken seriously enough by Indian economists, but today, especially after the publication of the results of the last two or three censuses, there is hardly anyone in India who questions the seriousness of the problem. The following table gives the trend during the last fifty years :

Year	Population* (in million)	Increase (+) or decrease (—) over the previous decade (in million)	Percentage increase (+) or decrease (—)
1901	235.50	..	..
1911	249.05	(+) 13.55	(+) 5.8
1921	248.18	(—) 0.87	(—) 0.35
1931	275.52	(+) 27.34	(+) 11.0
1941	314.88	(+) 39.36	(+) 14.3
1951	356.83	(+) 41.95	(+) 13.3

* Indian Union (excluding Jammu and Kashmir).

It may be noted that the fall in 1921 was a temporary phenomenon caused primarily by the influenza epidemic of 1918-19. Otherwise, the trend of growth has been quite high, especially in recent years. It is estimated that the population may very well reach the figure of 450 million in 20 years' time. Although I agree with Professor Notestein's warning against such forecasts, still it is perhaps useful to keep in view a rough estimate (or, if you prefer, 'guestimate') of this sort, provided, of course, we take care to bear in mind its limitations.

It is not the percentage increase which is alarming. It is, in fact,

quite close to the world's average. There have been comparable periods in recent British, American, and Japanese history when the growth of population was much faster. What is really disturbing is the huge absolute increment on the top of the very massive existing population. The addition of about 109 million mouths during the last thirty years and the prospect of even greater increments in the future cannot but cause most serious misgivings.

The reasons usually given for this tremendous growth are now well known and do not require any detailed discussion here. The latest authoritative summary would be found in the excellent monograph by Kingsley Davis, *Population of India and Pakistan*. Political stability, control of famines, and introduction of a modicum of modern public health services (however unsatisfactory and inadequate these may be compared with those of other countries) are supposed to be the main reasons. The absence of preventive checks may also have played some part. But during the last thirty years the birth-rate, although still very high, has shown a slight tendency towards decline. It is the relatively greater fall in the death-rate which is primarily responsible for the current increments of the population. In this connexion Appendix I which gives the available data regarding gross reproduction rates indicating fertility, and net reproduction rates showing the replacement tendency, in India and certain other countries may be of interest. The net reproduction rate in India is high, but not too high compared with other countries, but the fact that the gross rate is much higher than the net rate seems to indicate waste and a rather unhealthy state of affairs.

The growth of population, however, is by no means uniform in India and tends to vary widely from region to region as would appear from Appendix II. For instance, west India shows the maximum rate of increase (68.6 per cent.) and is followed closely by south India with an increase of 63.8 per cent. The smallest rate of increase (30.4 per cent.) is recorded in the north Indian zone. Even within each zone, again, the rates of increase vary considerably. Thus, in the south Indian zone the increases registered vary from 26.5 per cent. in the case of Coorg to 146.5 per cent. in the case of Travancore-Cochin. It would appear that in an area where the climate is tropical—hot and humid—the rate of increase tends to be high after a certain stage of economic development is reached.

The inevitable consequence of this prolific increase in population has worked itself out on the land economy of the country with relentless pressure. Land became increasingly chopped up into smaller and smaller fragments. The law of diminishing returns tended to manifest

itself more and more strongly and the class of landless labourers swelled in number. Density of population today amounts to as much as 281 persons a square mile, which may be lower than the density in some of the industrialized countries like Japan, but is certainly very high relative to the present state of Indian economic development (see Appendix III). The density varies considerably, however, from State to State. Thus while in Kutch it is as low as 34 persons a square mile, in West Bengal and Travancore-Cochin it is as high as 806 and 1,015 respectively. But the average density of population is not a good economic criterion; it is influenced by numerous factors, e.g. soil fertility, amount of rainfall, irrigation facilities, and the general development of agricultural and industrial resources. For example, even in a relatively highly populated State like West Bengal, where soil is fertile, rainfall abundant, and more than one crop can grow in an area, the standard of living is higher than in very sparsely populated States like Kutch, where rainfall is small and yield per acre very low.

An interesting study in this context would be the correlation of the density of farm population per acre of what may be called 'standard farm land' with agricultural productivity in different parts in India. Reliable data are not readily available, but a somewhat rough attempt has been made to do this in the chart at Appendix IV, and it reveals a number of interesting facts. Although agriculture is the main occupation in all the States, the distribution of farm population as related to the 'standard farm land' among the different States is very uneven. The density varies widely from State to State, the range of variation being from 35.91 persons a hundred acres of 'standard farm land' in P.E.P.S.U. to 98.95 persons a hundred acres of 'standard farm land' in Bihar. There seems to be also a definite inverse correlation between agricultural productivity and density of farm population an acre of 'standard farm land'.

Another interesting point in this connexion would be to study what has been the proportion of the population dependent on agriculture for a livelihood during the last few decades. Unfortunately, it is not possible to provide a straight answer, because the basis of classification adopted at different censuses has not been uniform. But during the first two decades, i.e. up to 1911 and 1921, the proportion of total workers dependent on agriculture increased from 70.82 per cent. to 71.67 per cent. The 1931 figures are not strictly comparable because of a different classification, while the 1941 census did not give occupational distribution of population. According to the 1951 census, 70 per cent. of the total population still depend upon agricul-

ture for their livelihood. This shows a rather alarming trend because although in 1951 the percentage may be almost the same as it was in 1901, the total number dependent on agriculture is now much larger. This only proves that all the industrialization and urbanization during the last fifty years have not been able to reduce the pressure on the land in the slightest degree, though the situation might have been worse but for the secondary and tertiary employment which was thus created. In fact, a study based on the comparable figures available for eight major States shows that net area sown *per capita* of population dependent on agriculture has declined from 1.1 acre in 1901 to 1 acre in 1951.

This increasing pressure of population on land has had two important economic and social consequences. Firstly, in the absence of organized institutions of farmers and owing to the technique of land-holding which prevailed and the apathy of the State, the position of the actual tiller of the soil steadily deteriorated as a result of the very keen competition for land, and by far the largest share of the income from land went to the hands of the hordes of middlemen, like landlords, merchants, and moneylenders. There was thus little improvement in the actual technique of production, the standard of cultivation, or even in the economic position of the agriculturist. Secondly, the settlement of land and the numerous gradations of rights in the soil which gradually grew up, produced a host of problems. The upper layers of society lost organic touch with actual production and contented themselves with collecting their share of the produce without performing corresponding services, while the actual tillers, mulcted of an increasingly larger share of the results of their labour, lost the will and the capacity and, what is equally important, the capital to improve the land.

A recent study made by the Indian Council of Agricultural Research shows that, by and large, the yield per acre has tended to remain stationary during the last few decades. While in the case of cash crops there is clear evidence of general increase in yield rates, in the case of foodcrops the yields do not show any definite trend either way. The only valid conclusion is that, while the fertility of the soil or standard of husbandry has not perhaps gone down, it has not gone up either. All the attempts at agricultural improvement during the last few decades have been able merely to postpone the diminishing returns which inevitably follow increasing pressure of population on land.¹

¹ V. G. Panse, 'Trends in Area and Yield of Principal Crops in India', *Agricultural Situation in India*, June 1952, pp. 144-8.

The situation was already bad enough, but the partition of the country in 1947 made it worse. While the Indian Union received 82 per cent. of the total population of undivided India, it got only 75 per cent. of the total cereal production.

This was the dismal position which faced the country when it attained independence in 1947. The increase of population was so frighteningly high, the poverty of the people so endemic, and the production trends so discouraging that even to preserve the *status quo* from further deterioration was a colossal problem. The Government immediately put into effect a stop-gap plan for stimulating food production. This plan consisted of a series of short-term projects such as works schemes, like land reclamation, minor irrigation, &c., and supply schemes like distribution of improved seeds, manures, &c. It is estimated that the total 'production potential' created by these various schemes between 1947-8 and 1950-1 would be about 3.4 million tons. The total expenditure incurred by the Central Government on the campaign during this period of four years amounted to about Rs. 518 million or about Rs. 130 million per annum on the average compared to Rs. 39 million per annum spent by Government before Independence. Besides, the State Governments also initiated certain supplementary measures, e.g. tenancy reforms, consolidation of holdings, control of moneylending, provision of agricultural credit, strengthening of the co-operative movement, &c.

But all that this campaign has been able to do is to prevent the food position from becoming worse than it was. The main difficulty has been that the shortage of finance put a limit on the size of the plan, and the food-production schemes sponsored by Government have so far covered only a very small fraction of the cultivated area and their effect has naturally been too small to make a real impression on the total production. A single bad season in one part of the country was sometimes enough to undo all the additional production achieved elsewhere as a result of these schemes. Moreover, there was also considerable shortage of cotton and jute in the country, and land had to be diverted for the production of these very vital raw materials.

It was felt, therefore, that the problem of population and agricultural production in the country had to be tackled on a much more comprehensive and long-term basis. The Five Year Plan, which has recently been prepared by the Planning Commission appointed by the Government of India, therefore, gives top priority to the solution of this problem. This will be apparent from the following distribu-

tion of the outlay which has been tentatively proposed for the first part of the Plan.

	Outlay during 1951-56	
	Rs. million	per cent.
Agriculture and rural development	1,916.9	12.8
Irrigation and power	4,503.6	30.2
Transport and communications	3,881.2	26.1
Industry	1,009.9	6.7
Social services	2,542.2	17.0
Rehabilitation	790.0	5.3
Miscellaneous	285.4	1.9
	14,929.2	100.0

(Note.—Re. 1 = 21 U.S. cents.)

In short, the Plan seeks to intensify the original campaign and also to attack the problem simultaneously from several other directions. In the first place, sustained efforts to increase irrigation, to build up soil fertility, to improve the machinery through which the farmer is assisted and guided, and to bring about a better organization of agriculture, are considered to be the most essential factors. That is why it is proposed to spend during the five years as much as Rs. 4,504 million for irrigation and power and Rs. 1,917 million for agricultural and rural development out of a total budget of Rs. 14,929 million. A number of major irrigation projects are proposed to be undertaken which when completed are expected to bring under irrigation an additional 16.5 million acres of land, besides providing power for agriculture, rural industries, and factories. By 1955-6 it is expected that the projects completed till then would irrigate about 8.7 million acres, thus increasing production by 2.27 million tons. Another 4.93 million tons of food grains are sought to be produced through short-term measures as shown below :

Nature of scheme	Area ('000 acres)	Additional production ('000 tons)
Minor irrigation schemes	7,621	1,932
Land improvement and reclamation schemes	7,405	1,524
Manures and fertilizer schemes . . . . .	..	584
Seed distribution schemes . . . . .	..	370
Other schemes . . . . .	..	520
Total . . . . .	..	4,930

It is thus expected that by the end of 1955-6 an additional production of about 7.2 million tons of food grains would be achieved

directly by the various schemes included in the Five Year Plan. This would just ensure to the estimated population of about 383 millions in 1956 barely the same *per capita* availability from internal production alone as was enjoyed by the 1950 population from internal production and imports.

This is not a very high figure and is only 13.67 oz. per adult per day as against the minimum requirement of 14 oz. prescribed by the nutrition experts for a balanced diet. But a balanced diet presupposes an adequate supply of subsidiary and protective food of which again there is a very great deficiency in the country as will be seen from the following table:

	Composition of a balanced diet (per consumption unit)	Estimated availability for consumption in India (oz. per adult per day)		
		Pre-war average* (1934-8)	Post-war	
			1949-50	1950-1
Cereals	14	16.3	13.7	13.0
Pulses	3	1.9†	1.9†	1.9†
Leafy vegetables	4	3.7	2.0	1.6
Other vegetables	6			
Ghee and vegetable oil	2	0.25	0.35	0.36
Milk and milk products	10	7.3	4.9	4.8
Meat, fish, and eggs	4	0.6	0.4	0.4
Fruits and nuts	3	3.3	1.9	1.9
Sugar and Jaggery	2	1.6‡	1.4‡	1.5‡

* Undivided India. † Includes gram. ‡ In terms of gur.

Source: S. M. Roy, 'Food Consumption in India', *Agricultural Situation in India*, May 1952, p. 87.

There are, no doubt, provisions in the Plan for stepping up the production of protective food like fish, milk, fruits, &c. but it is unlikely that India would be able to make up fully her deficit in supplementary and protective food in the near future and in that event the nutritional requirement of cereals per adult per day will naturally be substantially higher than 14 oz. What the Plan proposes is, therefore, by no means the ideal, but it is all that is considered practicable during these five years.

This First Five Year Plan should, therefore, be considered primarily as a basic plan for clearing the decks and laying the foundation for more fruitful plans in the future. With the resources immediately available and with the enormous preparatory work that is necessary in all directions it is not considered feasible to launch a more ambitious plan immediately. It is, however, recognized that the various schemes mentioned above touch only the fringe of the problem, and

do not by themselves produce that dynamic effect which alone is capable of solving the tremendous problem that India faces today. Of course, there are certain basic difficulties. In the first place, as has been mentioned at the outset, the area available for cultivation per head is low. But this should not by itself constitute a major problem since we have the example of Japan which with less cultivated land per head of the population is in a much better position than India (see Appendix V). The main difficulty, however, is that the yield from the land is very much lower in India than in many countries with comparable climatic and soil conditions (see Appendix VI). The greatest single limiting factor which contributes to this low yield per acre is the uncertain availability of water supply. Of the total cultivated area of 266 million acres in the country only about 49 million acres are under controlled irrigation. Even the existing irrigational facilities are not timely, and delayed planting often results in much avoidable loss, amounting to 20 or 30 per cent. of normal yields. The soil by long successive cropping has become stabilized at a low level of fertility. The bulk of the cattle-dung produced in India, equivalent to about 200 million tons of farmyard manure is burnt as fuel. Experiments all over India have shown that applications of nitrogenous and phosphatic fertilizers either singly or in combination may increase yields by as much as from 20 to 100 per cent. Great possibilities also exist in the evolution and introduction on a mass scale of improved varieties. It is estimated that if available improved varieties of wheat and rice were fully introduced into cultivation, an over-all increase in the average yield by about 10 per cent. could easily be expected. Hope of substantial increase in production, therefore, seems to lie more in the application of intensive methods of cultivation than in the reclamation of new areas. Although the statistical tables of area under crops give large areas as cultivable waste lying uncultivated, it has been found on actual investigation that on account of the various difficulties, such as transport, water supply, nature of the soil, &c., not more than 10 million acres are capable of being brought under the plough in the near future. India must, therefore, grow much more food per acre of land than she is doing today if she wants to solve her problem. That this is not an impossible task is shown by the various crop competitions in the country itself where yields as high as 6,000 lb. of paddy and 4,800 lb. of wheat have been obtained by even ordinary farmers following indigenous methods on their small farms by making better use of seed, manure, and water.

It has been estimated that India's population is likely to be about 450 million persons in 1971 and this is likely to require about

63 million tons of cereals at the rate of 14 oz. per adult per day and about 72 million tons at the rate of 16 oz. per adult per day. It is certainly not an easy task to produce all that quantity when we remember that the present production is only 45 million tons on the average; but, not quite hopeless either, if the experience of the intensive cultivation efforts that I mentioned earlier can be a guide.

This can be done, however, only if adequate interest and enthusiasm can be created among the cultivators and harnessed to the task of food production. That is why the Planning Commission have put the greatest emphasis on the need for accelerating land reforms, building up an efficient agricultural extension service and establishing a system of co-operative village management. They want further to link up the development of agriculture with that of rural industries, health services, education, &c., in an integrated manner.

It is essential, [the Commission recommend] that every State should draw up a programme of work for bringing certain areas, one after another, under intensive development, while holding the rest of the State more thinly. . . . In the selected areas, the programme of agricultural development has to be a part of a wider programme covering every aspect of rural development. Measures for social education and improvement in the health of the population are vital to the success of an agricultural programme designed to lift the rural community to higher levels of organization and to arouse enthusiasm for new knowledge and new ways of life.

A novel and promising experiment in this direction is the one on Community Development Projects which has been recently sponsored in India under the joint auspices of the Governments of India and the U.S.A. Altogether 55 Community Projects are proposed to be started this year, each embracing roughly 300 villages with a population of about 200,000 and covering a cultivated area of approximately 150,000 acres of land. The project area will be divided into three development blocks, each comprising about 100 villages and a population of about 65,000 people. The 55 projects altogether cover about 16,500 villages and a population of 10 million. Forty-nine of these projects are of the rural development type, which include irrigation, fertilizer application, agricultural extension, health measures, and education and would each cost Rs. 5.2 million non-recurring and Rs. 1.3 million recurring. Six projects are of the composite type including, in addition to the foregoing, small and medium scale agro-industries, town planning and development, &c., and would each cost Rs. 9.4 million non-recurring and Rs. 1.7 million recurring. The general objective of these projects is to lift the rural communities to higher levels of economic organization and arouse enthusiasm in

them for new knowledge and improved ways of life. Experiments already carried out along these lines in certain areas in India, for example, in Etawah, have shown that it is not difficult in this way to increase agricultural production very considerably in a short time. A feature of special interest to agricultural economists in this context is that a continuous agro-economic evaluation of the actual working of the fifty-five experimental projects is proposed to be conducted under the joint auspices of the Planning Commission of the Government of India and the Ford Foundation of the U.S.A. If a majority of these first fifty-five experimental projects prove successful and if the country is able to take advantage of the lessons and to harness its resources and multiply these projects after suitable adjustment so as to cover the whole country during the next fifteen or twenty years, there is no reason why India should not be able to solve her present food problem in a satisfactory manner.

But the solution of the food problem alone is not the solution of the problem of India's population. There is already a pressing problem of surplus labour—and it is estimated that, even on the basis of the existing antiquated techniques of agriculture, there are between 15 and 20 million surplus agricultural workers in the country. If there is an improvement in the techniques of cultivation, there will be a further increase in this number. This problem has a very important bearing on what improved techniques of farming India can adopt without creating serious dislocation of her economy. In U.S.A. land and capital are relatively plentiful; it is labour which is the scarce factor. In Russia, land and labour are relatively plentiful; it is capital which is the scarce factor. But in India, it is only labour which is plentiful; both land and capital are very scarce. Therefore, the systems of farming and techniques of cultivation, which have been evolved in the U.S.A. or Russia would not suit India's requirements. India will have to develop her own systems and techniques to suit her conditions best. Her techniques will have necessarily to be of the labour-intensive type, at least for some time to come, and her optimum farms will also be of a much smaller size, and, in this, Japanese experience is likely to be of considerable value. Nevertheless, the problem of surplus labour will still be there and the successful absorption of this labour in alternative employment is essential for the success of any plan for the economic development of the country.

Organization of large-scale industries, no doubt, points one way of absorbing the surplus agricultural labour, but this has obvious limitations in a country like India which has a much higher mass density and increment of population than U.K. or even Japan had

when starting on the phase of industrialization. It is a significant fact that even today, after decades of industrial development, the total number of labourers employed in large-scale industries is only of the order of $2\frac{1}{2}$ million. This does not, of course, mean that industrialization has nothing to offer towards the solution of India's population problem. On the contrary, it is only rapid industrialization which by creating more capital and pumping a part of it into agriculture, creating markets for agricultural products, expanding secondary and, what is more important, tertiary sources of employment can ultimately reduce the pressure on land, increase the national income, and make increased investment in and higher productivity of agriculture possible. Besides, in an under-developed economy, the most important role that industrialization usually plays is to act as the catalytic agent for the development of agriculture itself. But, in order to achieve all these, the industrial development in the country will have to be planned in such a manner that there may develop an organic relation between the farm and the factory and, wherever feasible, technically and economically, a decentralization of all such industries as may be located in conveniently small units on a cottage or a village co-operative basis near the sources of raw material. It is well to remember in this context that in Japan, over 80 per cent. of the total number of establishments employ less than 30 workers each and that in spite of her striking advance in industrialization, Japan still remains a country of cottage industries and small workshops. It is, therefore, essential that in India a proper correlation should be established between agriculture, small agro-industries, and large-scale industries so that each would supplement and to some extent fit in with the other. Unless there is a parallel development in large-scale basic industries, small-scale agro-industries, and agriculture so that each sector generates the purchasing power which would help absorb the increased production of the other sector, there is bound to be introduced an element of economic instability which it would be very difficult for a country like India to solve. In fact, India will have to look largely to herself for solving her problems of unemployment and markets. She cannot, like nineteenth-century England, send out her surplus population to foreign countries. If she were to depend on the development of large-scale industries for export markets as Japan has done, she simply would not be able to find, under the present world conditions, the market for the very large industrial output which this would require. For her the problem is not merely one of finding employment for her population and producing more. It is important that she should herself be able to absorb most of her own production,

agricultural as well as industrial. The objective of India's Five Year Plan is precisely to ensure this balanced development.

At the same time, it is also recognized that with all her attempts at increasing agricultural and industrial production and achieving a balanced economy, India will not be able to solve her problem of population and food supply in the long run unless she is able to put a curb to her increasing population. Every increase in her national wealth will soon be absorbed by the increase in population, putting her back where she originally was. The Five Year Plan of India says categorically that 'unless steps are taken deliberately to reduce the birth-rate, the upward trend of population will continue, since improvement in medical facilities and better control of epidemics, together with the measures taken to provide a certain minimum of food for the poorer sections of the community, should help to lower the death-rate further'. 'Family planning', is, therefore, prescribed as 'a vital step in economic and social planning'.

It must be recognized, however, that an alteration in population trends through family planning would take at least a few generations to materialize and that in the matter of family planning, the social, political, and economic problems are so very complicated that the State has naturally to proceed very cautiously. No short-term or quick solution of our population problem can, therefore, be expected from family planning. All that we can legitimately expect from any policy of family planning that may be adopted in India is that it would only slow down the increase of population so that it may be possible to stabilize it somewhere between 450 and 500 million by the end of this century.

In conclusion, I would like to touch briefly upon two points made by Professors Notestein and Black. There is considerable force in what Professor Notestein has said about the inability of colonial régimes, however well intentioned they may be, to bring about those social changes *pari passu* with technical changes which an efficient local leadership alone can effectively do. What Professor Black said about the future of international trade reminds me of the experience which I had while I was coming to this country. Thanks to modern science, I could fly from India to the States in only three days, but it took me over three weeks to get the passport and various documents which a traveller requires these days and which are considered today indispensable by all Governments to guard against cholera, yellow fever, and other unwelcome immigrants. It is true that science has given us techniques by which we may be able to produce enough to feed not only the existing but also a much larger population. But

trade barriers, foreign exchange difficulties, differences in relative purchasing power, &c. are again man-made factors which threaten to undo many of the good results which one might expect from modern science, and strangely enough are perhaps the corollary of modern technological development itself. These two points again have a bearing on the problem of India in the sense that the local leadership today can take risks which the former rulers could not afford to do, and that it is fully conscious that in the modern world India will have to depend largely upon her own economy to solve her problems of population and food supply.

APPENDIX I

*Reproduction Rates for India and Other Countries in Years around
1931 and 1941*

	Date	Gross rate	Net rate
India	1901	2.99	1.09
	1911	3.14	1.06
	1921	2.83	1.03
	1931	2.99	1.25
	1941	2.76	1.30
Egypt	1937	3.11	1.44
U.S.S.R.	1924, 26-7	2.64	1.72
Puerto Rico	1920-30	2.50	1.50
	1930-40	2.46	1.62
Japan	1930	2.37	1.57
	1937	2.14	1.44
Chile	1930-2	2.26	1.30
Romania	1930-1	2.16	1.40
Canada	1930-2	1.55	1.30
	1938	1.28	1.09
	1940-2	1.42	1.29
U.S.A. (white)	1930	1.22	1.08
	1942	1.27	1.19
England and Wales	1930-2	0.93	0.81
	1940	0.85	0.75

Source: Kingsley Davis, *The Population of India and Pakistan*, p. 87.

APPENDIX II

Percentage Increase in, and Density of, Population in Various States in India

Zone and State	Percentage increase in population between 1901 and 1951	Persons per sq. mile in 1951
I. North India	30.4	557
1. Uttar Pradesh	30.4	557
II. East India	52.9*	344
1. Bihar	41.7	572
2. Orissa	42.2	244
3. West Bengal	62.6†	806
4. Assam	140.2‡	106
5. Manipur	N.A.	67
6. Tripura	N.A.	158
7. Sikkim	133.9	50
III. South India	63.8	450
1. Madras	55.4	446
2. Mysore	63.8	308
3. Travancore-Cochin	146.5	1,015
4. Coorg	26.5	145
IV. West India	68.6	272
1. Bombay	71.5	323
2. Saurashtra	55.1	193
3. Cutch	16.4	34
V. Central India	57.8	181
1. Madhya Pradesh	57.7	163
2. Madhya Bharat	60.1	171
3. Hyderabad	67.4	227
4. Bhopal	23.1	122
5. Vindhya Pradesh	25.0	151
VI. North-West India	41.8	123
1. Rajasthan	57.0	117
2. Punjab	20.9	338
3. Pepsu	24.2	347
4. Ajmer	62.7	287
5. Delhi	329.6	3,017
6. Bilaspur	38.5	278
7. Himachal Pradesh	33.2	94
Andaman and Nicobar Islands	24.0	96
INDIAN UNION§	51.5	281

* The figures for Khasi States, Cooch-Bihar, Manipur, and Tripura have been taken into account while calculating the zonal average for east India.

† The 1901 population figure for West Bengal does not include Cooch-Bihar.

‡ The population figure for Assam does not include Khasi States for the year 1901 and tribal areas for the year 1951.

§ Excludes Jammu and Kashmir.

N.A. Figures for these States are not separately available for 1901.

APPENDIX III

Population Density per Square Mile in Selected Countries in 1947

	Country	Density per sq. mile
<i>Africa</i>		
	Egypt	51.8*
	Union of South Africa	24.6
<i>America, North</i>		
	Canada	3.4†
	United States	47.7
<i>America, South</i>		
	Argentina	15.0
	Brazil	14.5
	Chile	19.2
	Peru	16.3
<i>Asia</i>		
	Burma	64.8
	Ceylon	271.7
	China	123.3
	India	281.0‡
	Japan	343.9
	Korea	323.8
	Pakistan	199.9
	Philippines	168.9
	Siam	87.5
	Turkey	65.0
	Indo-China	99.2
	Indonesia	103.2
<i>Europe</i>		
	Czechoslovakia	246.6
	France	194.3
	Germany	489.3
	Italy	390.3
	Poland	197.6
	Rumania	180.3
	Spain	141.7
	United Kingdom	525.8
<i>Oceania</i>		
	Australia	3.9
	New Zealand	17.4
	U.S.S.R.	22.5

* Density per sq. mile of inhabited area 1426.3.

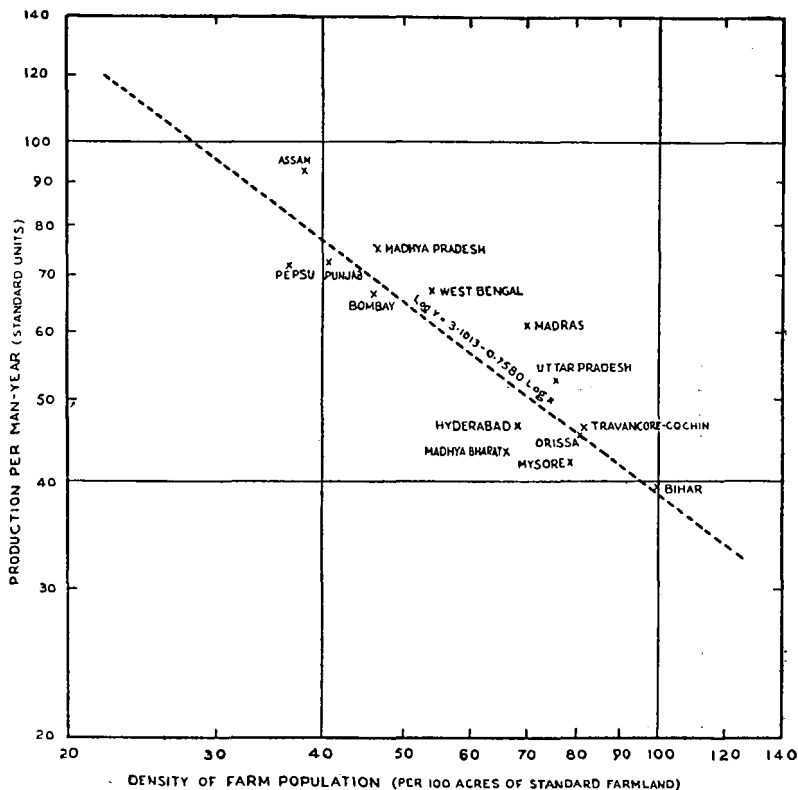
† Including Yukon and North West Territories.

‡ Relates to 1951.

Source: Adapted from Table I of *Statistical Year Book, 1948—United Nations*.

APPENDIX IV

RELATION BETWEEN DENSITY OF FARM POPULATION & PRODUCTION PER MAN-YEAR



APPENDIX V

Cultivated Land per capita in Different Countries

Country	Year	Per capita cultivated land (in acres)	Country	Year	Per capita cultivated land (in acres)
1. Burma . .	1947	1.16	8. Japan . .	1948	0.17
2. China . .	1947	0.49	9. Pakistan .	1948	0.69
3. India . .	1947	0.71	10. Turkey . .	1948	2.35
4. Indonesia .	1947	0.37	11. Venezuela	1944	10.65
5. Iran . .	1943	2.97	12. Ecuador .	1942	0.86
6. Iraq . .	1930	4.00	13. Colombia	1946	0.47
7. Israel . .	1951	0.50			

Source: Land Reforms; Defects in Agrarian Structure as Obstacles to Economic Development—U.N.

APPENDIX VI

Average Yield Per Acre of Certain Major Crops in the Principal Countries of the World—1949

Country	(lb. per acre)						
	Wheat	Rice (paddy)	Maize	Sugar-cane*	Cotton (ginned)	Tobacco	Groundnut (in shell)
Argentina . . .	1,008†	1,784†	910†	4,981	232	910†	722†
Australia . . .	1,044	4,220	1,472†	18,070	78‡	937†	919‡
Belgium . . .	3,470	..	2,917	..	..	2,070	..
Brazil . . .	678	1,436	1,160	7,889	125‡	606	965‡
Burma . . .	286‡	1,115	N.A.	..	98‡	N.A.	464‡
Canada . . .	803	..	2,810	..	..	1,285	..
China (22 Provinces) . . .	937†	2,141†	1,160†	2,210†	152†	999†	1,651†
Cuba . . .	..	1,106†	919	10,574‡	..	740†	722‡
Egypt . . .	1,748	3,533	1,775	10,411	491	..	1,133
France . . .	1,704	2,632	571	..	..	1,258	..
Germany (Fed. Republic) . . .	2,902	..	1,561	..	..	1,936	..
Greece . . .	982	3,366	883	..	241	544	..
Hawaii . . .	..	..	928	43,411	..	..	..
India . . .	§84	1,032§	560	3,052	85	688	770
Indo-China . . .	..	910†	N.A.	4,960‡	60‡	643‡	544‡
Indonesia (Bali & Lombok) . . .	..	2,105	1,088	N.A.	N.A.	..	1,061
Italy . . .	1,329	3,997	1,853	..	98	990	1,508
Japan . . .	1,534	3,462	1,133	20,944	107	1,517	999
Java and Madura . . .	..	1,454	731	..	..	964†	..
Mauritius . . .	..	1,552	1,436	15,035	..	..	1,017
Mexico . . .	758	1,526	625	7,799||	339	999	946
New Zealand . . .	2,150	..	2,801†	..	..	1,026†	..
Pakistan . . .	848	1,258	946	4,888	170	1,008||	..
Portugal . . .	526	3,301	392	..	..	..	..
Spain . . .	580†	4,372†	1,338†	N.A.	54	1,312†	1,543‡
Sweden . . .	2,025	..	..	..	..	910†	..
Turkey . . .	571	..	1,079	..	250	634	1,338
U.K. . . .	2,516	..	..	..	..	..	..
U.S.A. . . .	892	2,203	2,177	33,607	285	1,204	803
U.S.S.R. ¶ . . .	830	..	..	..	290	..	..

* Raw sugar. † Unofficial.

‡ 1948. || 1947.

§ 688 lb. cleaned rice and in terms of paddy the figure will be about 1,032 lb.

¶ Relate to 1934-8.

N.A. Information not available.

NOTE.—Figures of yield per acre of crops in foreign countries are not strictly comparable with those for India owing to the following reasons:

(i) The yield per acre in India is estimated on the basis of area sown to crops while those for foreign countries are based on area harvested.

(ii) In India more than one crop is raised in the same field while in other countries generally one crop is raised. As such the yield per acre in India in respect of individual crops in such areas is lowered to some extent.

Source: F.A.O. Year Book 1950, vol. iv, pt. i.

K. BRANDT, *Food Research Institute, Stanford University, California, U.S.A.*

At this morning's session several speakers stressed the necessity of dealing with population and food economics jointly—if possible by the same scholar. This desire has been fulfilled tonight by Dr. Sen's distinguished presentation on the problem of population and food supply in India. It is an illuminating and most concrete contribution to the discussion of this extraordinarily complex and intriguing area of scientific exploration—one for which I feel we may all be extremely grateful.

President Elmhirst observed last night that the discussion topic of this Conference over the years has been symptomatic of the shifting scenery of the pressing social problems of our time. In this tradition, which demonstrates the alertness and close touch of our international society with the rural people, it appears fitting that the first discussion of population and food problems of a specific nation should be contributed by one of our colleagues from India, the second most populous nation of the world—a nation most closely related to the West, which gained its independence only five years ago, and which, since then, has passed through most painful adjustments in its separation from Pakistan.

Dr. Sen's paper is most encouraging in many ways. First of all, it is impressive to hear a solid inventory of facts and a free and unprejudiced investigation of a highly dynamic situation that obviously defies all popular generalizations and, by the sheer size of the population involved, poses an appalling range of tasks. While appropriately pointing out the seriousness of the problems, Dr. Sen emancipates himself from the alarmist's interpretation of so-called 'trends' of population and food supplies. Nowhere does he subscribe to the notion that these problems are basically unmanageable. After demonstrating strong regional differences in population growth as well as in levels of living, he shows what initiative the Indian Government has taken to increase food production under a five-year plan and its various schemes. While measured by today's farm technology, India, like most other countries, has very large dormant food resources, Dr. Sen observes that in his judgement it would be more economical to increase production primarily by a more intensive use of land and cultivation than by large-scale reclamation of waste land. On the basis of research on what has happened during and after the war in various parts of the world, I find myself in agreement with this highly important observation, supported as it is by much evidence, particularly

from European countries. Superficially this may seem contradictory to the law of diminishing returns; in fact, it is not. In general, it stands to reason that we may expect the greatest profitability in increasing food production, i.e. the most favourable cost-price ratio, and therefore the greatest increase in food supplies, not from new areas but from land already in cultivation, from land with relatively high yields, and from the most efficient producers. If economy shall prevail—and it means the loss of millions of lives if it does not—then the moral from this situation must be heeded. Irrigation water, nitrogen, and pesticides can hardly be overrated as means for increasing crop yields. With these means available, intensification rather than expansion of cultivated areas is in general the least costly method of increasing the food supply in this country as well as in Europe and in India.

Having just returned from several weeks of travel in Europe, I would like to mention two avenues of economic policy for getting more cultivated land irrigated. In Europe's richest area of irrigated farming, the Po Valley, the Empress Marie Thérèse of Austro-Hungary established during her reign a law that anyone who wanted to bring irrigation water to his land could trespass and cut ditches across other people's property. This law has proved to be more beneficial than some of the largest modern irrigation projects. Today, in Germany and Switzerland, supplementary sprinkler irrigation with aluminium-pipe and small motor-pump units is proceeding more rapidly than anywhere else, fostered by the high depreciation allowed under the income-tax rules. Indirect approaches such as these promise the largest stimulus towards the decentralized efforts of millions of producers.

Dr. Sen has stressed how appallingly large is the task of lifting productivity, and has shown how much has been started in large-scale community development projects. He concludes that in spite of the large reserve capacity for food production and for industrialization, India would not be able to solve her problem 'unless she is able to put a curb on her increasing population,' and further cites the Five-Year Plan of India, which aims at deliberate steps to reduce the birth-rate. Dr. Sen ends on the note that an alteration in population by family planning would take generations to materialize, and that we can therefore legitimately expect no more than the stabilization of the population of India by the end of the century at around 450 or 500 million. Since this subject has come into international focus for several years and will be present in international relations for years to come, I beg your indulgence to listen for a few moments to a

conservative rebellious meditation, voiced aloud in the presence of this austere gathering.

Regarding these thoughts, I claim that they are legitimate and constructive comments, and cannot easily be shunted aside. Nowhere in our deliberations do we come so close to the boundary of man's most intimate sphere of inalienable individual rights, and nowhere so close to that little intersection at which the road splits between democracy and totalitarianism, between respect for human dignity and its denial, as we do in the discussion of public planning and action to curb population growth. There can be no disagreement about the need for thorough and highly sophisticated exploration of this vast area of population by the social sciences, with due consideration for the framework of their moral philosophies and moral codes—philosophies and codes by which all civilized people of the various nations live. We need all the assistance in understanding the problems involved that social science can offer, just as do the people themselves. Professor Notestein's paper is an outstanding example of what can be offered toward this end. However, in a democratic society social scientists should be on tap, but not on top. The ken of social scientists is finite, like that of other people. If agricultural economists and population-research scholars had a monopoly of knowledge and wisdom, if they alone had power to rule the people, then I should personally prefer to emigrate from such a State. In spite of the assumed omniscience of such rulers, I would prefer, simply because of my queer inclinations as a private citizen, a society in which farmers, workers, soldiers, merchants, housewives, and retired people also have their say.

To our friends from India I should like to speak a word of dissent from some of our contemporaries who are often too sure of themselves and of everything. I for one would emancipate myself from any recommendations addressed by Americans to other nations in Europe or Asia to tackle their food problems by beginning as nations with a deliberate reduction of their people's birth-rate. I consider such advice the opposite of humility and obligatory tact implicit in good international relations—particularly so because nowhere in Western countries, including the United States, has anyone ever tried to do this. Any American whom you would approach with such advice would simply tell you to mind your own business. As public policy, all public efforts ever made worked in the opposite direction, and whenever a reduction in the birth-rate occurred in Western countries, it came about by individual adaptation to changing conditions in the social environment and changes in the wants

and the thoughts of free people. In fact, at this time, our people, as individuals and as teams of husbands and wives—an institution still going strong in this country—have perhaps changed their ideas about the number of children wanted, for the birth-rate is expanding.

How far one can go astray in the honest pursuit of solutions to the world's food problem, to land directly in the devil's pit of the police State, may be illustrated by two remarks. A California judge earnestly advocates that we save our American democracy from certain deterioration by rationing the number of children permitted to a couple according to well-administered intelligence and medical tests. If this sounds to you like a pathetically grim joke, is it a much sadder case than the proposal of certain scientists a few years ago to one of the great foundations that it grant several hundreds of thousands of dollars for medical and chemical research on contraceptives that can be taken by mouth? Technically it does not matter very much that this proposal was made, because if such a discovery were possible it would be made anyway. A much more serious aspect of the possibility is that such chemicals could be added to drinking water without the consent of those concerned. All that this appallingly naïve—to put it mildly—proposal demonstrates, however, is how easily scientists, too, can go astray when they become frightened. In parenthesis I should like to say that none of my critical comments is aroused by Professor Notestein's able paper, but concerns books of worldwide distribution by authors such as William Vogt and Fairfield Osborne. Balanced birth-rates are a sensible achievement for a good, dynamic society, but can come about only as the aggregate effect of all-round social progress on the broadest scale. Those who toy with the idea of starting development policies by limiting population growth by deliberately direct measures, incidentally, would have said the same thing of India 200 years ago or 100 years ago, because the circumstances they refer to were worse then; they would have said the same thing to the Japanese or to the Javanese in 1860 or 1880. Would their advice have been correct then? To my way of thinking, population pressure is the great force that has induced man, the *zoon politicon*, to develop his individual and social ingenuity and inventiveness. Without it, it is doubtful if he would have developed his civilization as he did.

The question is neither whether to try or not to try to achieve a balance between population growth and the development of food resources, nor whether to try or not to try to achieve a balance between population growth and the constantly changing standards of

happiness that people choose for themselves within the framework of the ethical values and moral code of the society in which they live, with their own conscience their sole judge. The only sensible question is this: how may this be achieved? Dr. de Vries has mentioned that changing the age of marriage from 14 to 20 might be one of the important moves that could achieve this; but at the same time we have heard Professor Ashby say that one cannot quickly change the desires and the *mores* of people. Moreover, if an attempt is made by force, the purpose of this free society will be defeated. In this international community of agricultural economists, practical common sense and scholarly wisdom alike seem to call for by-passing all over-simplified short cuts, and instead, for putting all the emphasis on the all-round adjustments of a developing society and an expanding economy. In this, I feel certain, there is unity among the speakers of this morning and Dr. Sen.

J. P. BHATTACHARJEE, *India, and University of Illinois, U.S.A.*

In commenting on some of the points raised by Dr. Sen, I would like first to emphasize the inadequacy of the approach that is usually adopted in discussions of population and food supply. More often than not, the approach is in physical terms, that is, in terms of the physical quantity of agricultural products produced in a country, and the quantity needed by its people. We usually think of the actual difference between these two, calculate this deficit, and then plan measures to meet it, either through a reallocation of the existing resources or by imports from other countries. The measures planned on the basis of such an analysis are usually technological, that is, agronomic and/or engineering, biological and/or mechanical. The approach is in physical, as distinguished from economic, terms. Perhaps, I should state at the outset that the two approaches by no means conflict. In fact, the economic approach is complementary to the other and is the only one that would enable us to select from among the various technological measures the ones which would specifically serve the ends in view. The economic analysis has to be carried on in terms of the supply of and the demand for food products, both expressed in monetary terms. Naturally, demand and supply are macro-economic concepts here, and the analysis has to be carried on in terms of income and expenditure.

Dr. Sen mentioned, and Dr. Brandt supported him, that it would be more desirable to rely on intensification of farming on the already cultivated lands for obtaining additional supplies of food needed to

meet the deficit that India has been facing for the last few years, than to try to get them, or the major portion of them, from an extension of cultivation to waste or unused lands. Technology offers these two as more or less alternative measures. The question arises, therefore, which one to adopt, and the answer can be obtained only from an economic analysis.

There are always quite a few underlying assumptions when we speak of, or calculate the food needs of the people of a country. First of all, the estimates are made at the existing or at an historic rate or average level of consumption, however low that rate may be. The possibility that it changes and continues to change is often not taken into account. Consequently, the whole analysis is *ex post* and static in nature. Secondly, the physical need is thought of as more or less synonymous with demand. But demand is an economic concept, which means not only the desire and need but also the ability to obtain from the market and consume. This ability does not arise simultaneously with the need, nor is it necessarily equal to it. The market mechanism equates with the current supplies, not the need of the consumers, but their ability to buy. If we are to equate supplies with needs, we have, first of all, to equate ability with needs. This can be done only by ensuring that the formation of additional income takes place in those segments of the economy where there is unsatisfied need.

Now, if additional lands are brought into cultivation through various processes of reclamation, the supply of food and agricultural products on the market will obviously increase. Additional income to the extent of the additional supply will be generated and will accrue, in the first instance, to those who will be engaged in farming and associated occupations on the new land. The impact of this income on the aggregate demand will depend on the nature of settlement on the new land and the methods of farming adopted. If the new lands are settled so as to give rise to commercial, as distinguished from subsistence, farming (as is likely to happen, even though the farms are all of the family type), then the average volume of business and the average size of farm will be larger than in the rest of the economy. The units, in that case, will be so planned and laid out as to make the easiest and most economical use of technology, either separately on each farm or jointly on all of them. The result will be a higher rate of output per person employed and a lower density of population than in the older settled areas of the country. Consequently, the number of persons who would be economically dependent on the area will be smaller than on an equal area in any other

part of the agricultural economy. Thus, if the newly reclaimed areas were to add 10 per cent. to the existing output of food and agriculture and thereby solve, for the time being, the deficit in the national production, the percentage of the total rural population that would be removed from the older to the new areas would be much smaller than ten. The relief to the pressure of population would be too small to create any appreciable income effect directly in the rest of the agricultural economy of the country. Nor would there be any direct income effect on wages and earnings in the industrial sector.

The only way incomes can be affected, therefore, is indirectly through prices. The important question here is, what the effect of this new output would be on prices in the agricultural and the industrial sectors of the economy. So far as food and agricultural prices are concerned, the additional output would undoubtedly ease the supply situation and lead to a lowering of prices—by how much, it is difficult to say. We have already seen that the productivity of the rest of the agricultural economy would not be significantly increased as a result of the new production. The lowering of food and agricultural prices would therefore lead to a smaller money income in the agricultural sector, which might in turn lead to a lowering of agricultural wages. In general, we may say that while the real income in the rest of the rural economy would remain the same, the money income would go down. If, on top of this, the industrial prices did not fall as much as agricultural prices or refused to fall at all, then both the money and the real income of the rural population would decrease. Their economic condition would worsen beyond doubt. In circumstances such as these the demand for agricultural products in the rural economy of India would decrease. The effect on the industrial sector would be different, however, and the demand there would be likely to remain the same or even increase. But it must be remembered that in India 70 per cent. of the population depend on agriculture and the percentage of rural population to total is higher even than this figure.

If, on the other hand, measures to increase the yield on the already cultivated lands were adopted as a solution to the food problem, both productivity and real income of the agricultural sector of the economy would increase. And this would happen in spite of the price effect which would be the same for both sets of measures. Obviously, the advantage gained from the saving of foreign exchange would be the same in both cases.

The upshot of the whole analysis is that attempts to solve the food problem by means of extensive cultivation, such as reclamation of

waste lands, may produce the physical supply needed to meet the deficit, but in the absence of other measures, would not necessarily ensure the demand necessary for its consumption. The multiplier effect on income in this case is much smaller than it would be if reliance were placed on measures to intensify farming and raise the yield per acre of the already cultivated lands. It must be emphasized here that the rise in yield per acre in the latter case must be achieved by methods which will also raise the output per man employed in agriculture. Yield per acre is a measure of the efficiency of the capacity of an economy like India's, while output *per capita* can be used as an index of the demand. Unless these two move in line, there cannot be economic progress or growth.

For illustrations to support my analysis we can look to any country of the world. A simple and clear case would be found in the problems of the south-eastern region of the United States of America. In spite of great extension of the frontiers of cultivation and farming, and tremendous development in the agriculture and food supply of other regions of the country, the standards of consumption and living in the south are even now much lower than in the north or west. The basic problem of the south is low productivity and lack of purchasing power; in other words, the existence of a level of productivity not high enough to support the level of demand of the other regions. Similar problems of poverty in agriculture exist in all countries and cannot be solved unless the productivity in those regions is increased. It is on the same line that India should try to solve her food problem.

The second point I would like to comment on relates to industrial development. It is well known that in order to maintain economic progress or growth, industrial development has to proceed hand in hand with agricultural improvement. The difficulties in the way of industrial development in India are, of course, formidable, as Dr. Sen has already pointed out. From the point of view of planning, the most important difficulty is to find industries which would give employment to the vast number of people who have become surplus to the economic needs of the rural areas. Not even in the United States are so many people employed by the industries. One solution would be to direct technology to labour-embodiment and capital-saving channels.

It seems to me, however, that in our approach to the whole question of industrialization we are slightly glamour-minded. By industrialization we always mean the setting up of the heavy chemical and metallurgical industries. By their very nature these are capital intensive industries, employing a comparatively small number of people.

They have not solved the problem of employment of the surplus population in any of the industrialized countries of the West. In fact, if we look at the history of the industrial development of the U.S., we see that the most significant shift in the occupational distribution of the population came about as a result of the development of the food industries. At present, the food industries responsible for functions like processing, preservation, and canning employ by far the largest number of people of all the industries of the country. Here also the connexion between agriculture and industry is obvious. India cannot build up a good-sized food industry until she has improved her agricultural production and marketing systems.

Finally, it is dangerous, I think, to talk of population and food supply solely from an economic angle. I agree with Dr. Notestein in his thesis about the inter-dependence of the social sciences and the need for an integrated approach to social and economic problems. We can see this relationship very clearly if we analyse the difficulties in the way of building up a food industry in India. Many of the functions performed by the food industry in the U.S. are, in India, within the domain of the family. Consequently, unless the structure, composition, and functions of the family in India are changed, a large enough food industry cannot be built up. Incidentally, it is because of the wide range of functions performed by the family in underdeveloped countries, which are normally done outside the family in the advanced countries, that no estimate is made of the value added by these functions, nor is any allowance made on that account in the computation of the gross national product. Anyway, when we come to the family and its role, we naturally enter the domain of sociology. Hence, we cannot solve the problem from the point of view of economics only.

Thus, even if we do not like it, we are forced to think in terms of a jointly determined or inter-dependent system. In this system of simultaneous relations or simultaneous equations, there are variables from all fields, economics, sociology, psychology, and the rest. This makes the task of prediction almost an impossible one for economists or, for the matter of that, for all social scientists. That is why I do not see any point in Dr. Sen's attempts to forecast the future population of India. He thinks it is likely to be stabilized somewhere between 450 and 500 million at the end of this century. I guess he arrives at this figure on the basis of projection of the present trend. But here again we run into the fallacy of speaking in terms of a trend, while what we have in mind is a system of simultaneous equations. Obviously, if we are to get an answer from a study of the system, we

have to study the variables in the system and its parameters—what they are and how they change. But here our limitations are obvious. Our lack of knowledge is much greater than what we actually know. Many of the well-known social variables have not so far been quantified. Nobody knows what they actually are or how to measure them. Hence nobody knows or can tell what the population of India will be in the year 2000. In fact, until these variables have been quantified, our approach to socio-economic problems is bound to be rather piecemeal and more deductive than inductive. This gives us a great scope for imagination, with the result that our predictions and forecasts are likely to prove erroneous, as indeed they have so many times in the past. History is replete with instances in which we, economists and social scientists, have blundered ourselves into wrong policies.

E. M. H. LLOYD, *Ministry of Food, London*

May I add my tribute to Dr. Sen for his statesmanlike and comprehensive review of the problem of food supply and population in India. I only wish he had been able to go on further and deal with all those other interconnected problems in the social sciences on which I know that many of us would like to ask him questions. May I raise just one or two brief points by way of question?

First of all I was struck with the footnote to his first table. It is noted there that the fall of population in the ten years from 1911 to 1921 was a temporary phenomenon caused primarily by the influenza epidemic of 1918-19 when tens of millions of people lost their lives. I would like to have heard some inhuman economist discuss the implications of periodical influenza epidemics as one of the remedies for over-population; but we are not a medical society nor are we concerned with problems of world health. I would only draw attention to the profound economic significance of rendering these influenza epidemics and similar pestilences less frequent.

The second point that struck me was the very interesting but rather casual reference to farmyard manure, amounting to 200 million tons; and I wanted to ask how many cattle does Dr. Sen estimate were responsible for producing that sizable amount of farmyard manure. I made a calculation once that there might be something of the order of 200 million head of cattle, including buffaloes, in India and the question that I would like to ask is, 'How many of those cattle are really earning their keep? Are not there a lot of scrub-bulls and half-fed cows which would be better dead?' And this is a plea that I would like to make to the people of Princeton who are studying problems

of human population. What about the animal population of some of these countries? Is it not time that we considered measures of controlling animal population in addition to, if not instead of, proposing social control of the human population? Incidentally, it may be argued that these 200 million head of cattle are required to produce the dung to produce the fuel for which it is used. But would it not be more economical to use kerosene rather than burn the manure? Then it may be argued, why not put the manure on the land? When I was in Cairo we had an interesting discussion about the use of organic manures on tropical soils and I heard the astonishing heretical view, as it was to me at that time, propounded by Dr. Keen of Rothamsted, that the peasant was probably perfectly right in burning animal manure, because it would oxidize so quickly in a tropical soil that he might as well burn it himself; and that the sole benefit from the animal manure was precisely those minerals, such as nitrogen and phosphates, which you might get in a more economic way than producing an animal to give it as a by-product.

I would like to put to Dr. Sen whether there is not scope for studying the sociological approach to this problem of surplus population, not only human but animal. I was interested in discussing this once with a psychiatrist who had turned sociologist. Having visited India and been fascinated by the problems facing the Government of India, I asked him what would he do? The sort of idea that I derived from him (I won't say that I attribute it all to him) was that it might be possible to enlist the co-operation of the religious leaders of India, the priests, and the temples. When U.N.R.R.A. first went to Greece and decided to introduce artificial insemination and they brought a prize bull to Athens, they were very wise to get the Archbishop of Athens to bless the bull at a public ceremony to show that it had the backing of the Church (Laughter). Is anything analogous possible in India? Is it impossible to get the temple priests to recognize the desirability of reducing the number of sacred bulls by having sacred slaughter houses (Laughter). I put these suggestions not as provocative criticisms but only in the hope of eliciting something more from Dr. Sen.

S. R. SEN (*in reply*)

I am very grateful for the kindness you have shown me. Professor Brandt has emphasized that India's food problem could be better solved by intensive cultivation rather than by extension of cultivation. Mr. Bhattacharjee has sought to support this from what he calls the economic point of view. I am glad that there is no difference of

opinion between us. But even if there were any, and there were strong theoretical reasons in favour of extension of cultivation, the hard fact of the situation is that there is really not much scope for it. As I have already pointed out, there are only ten million acres of waste land which we can expect to bring under cultivation in the near future, so that it is of sheer necessity that we turn to intensive cultivation. As regards the estimates of population twenty years hence, I think I have already made it clear that I am in agreement with Professor Notestein in that they are subject to a number of qualifications. But when you are preparing a plan or when you have to take a policy decision you have to work upon some such estimate, however unsatisfactory it may be. As regards the points made by Mr. Lloyd, I think when he mentions 1918-19 he really wants to know whether there may not be similar epidemics in future which may yet retard the growth of our population. I would not completely rule out the possibility, but with the development of modern public health measures I doubt if that would really be the case in practice. Chances of epidemics decimating the population in future are much less now than they were in the past. As regards the question of cattle slaughter a government has to work in a certain social, political, and religious atmosphere and take into consideration not only what is ideal but what is practical. In fact, if it tries to push through some measure which the people are not prepared to accept, sometimes the reactions may be very unexpected and unfortunate. The point is that the religious prejudice in India against the slaughter of cattle is much greater than the prejudice against artificial insemination in Greece. In fact, there is very little prejudice against artificial insemination in India. But if there were as much prejudice in Greece against artificial insemination as there is in India against cattle slaughter, I doubt if the Archbishop of Greece could ever be persuaded to give his blessing, or if his blessing would have produced any effect. Then there is the difficulty that there is no single archbishop in India whose authority is acknowledged all over the country. There are millions of priests and if one supports cattle slaughter, thousands will oppose it. This does not mean that we are not conscious of the gravity of the problem or that we are not taking any action in the matter. In fact, if you read our Five-Year Plan carefully you will find that there is a fairly comprehensive scheme for the improvement of our cattle and for gradually reducing the number of useless cattle. Actually there is a proposal for concentration camps of some sort for useless cattle. But we have to proceed very cautiously because, whatever we may do, the fact stands that the cattle population will remain more or less

at the present level for the next five or ten years. As in the case of family planning, similarly in the case of cattle slaughter, it is not what may happen in the distant future but what is likely to happen during the next five or ten years that is our main concern today, and has to be accepted as a basis of our plan whether we like it or not. You cannot use force in these matters and voluntary effort takes time.