Aspects of India's Development
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The fourth in a series of Lectures in memory of Jawaharlal Nehru.

I am greatly honoured by the invitation of the Governor of the Nehru Memorial Trust to give the fourth Nehru Lecture. In the first, Lord Butler told the fascinating story of the struggle of India to achieve independence from Britain. Then Lord Mountbatten described the actual process of the transfer of Power, in which he was deeply and decisively involved. Mr Krishna Menon gave brilliantly the Third Memorial Lecture entitled 'Personal Memories of Jawaharlal Nehru'. In my address I want to talk abut some economic aspects of independent India, which is now twenty-four years old and about the part played by Jawaharlal Nehru in these developments.

Nehru wrote three main books, all written while in prison. I think the last, *The Discovery of India,* is the most valuable for the understanding of India today. For it gives a very readable survey of the history of India from the earliest recorded civilisation up to 1945 when he was released from prison for the last time. No doubt some of the details of the history may now need refinement or correction - what book of this wide scope and written under such circumstances would not? What I found especially valuable about this book is that it gives us Jawaharlal Nehru's own view of the course of Indian history and so tells us something of his own way of thought and action, when in 1947 he became Prime Minister of the largest Parliamentary Democracy in the world, a position he held till his death in 1964.

Though Nehru had very warm feelings for many aspects of the British way of life and paid tribute in his writings to the many positive aspects of British rule, there were some long past events which clearly aroused his anger even after 200 years. Nehru quotes the British Governor General, Lord Bentinck's comment in 1834 on the situation in many parts of India. '... the misery hardly finds a parallel in the history of commerce. The bones of the cotton weavers are bleaching the plains of India'.[1] Nehru elaborates these tragic events and points out that 200 years ago, Bengal was a rich and prosperous province.

According to Nehru, Bengal was the first part of India to experience the full impact of British rule. This started in his view with outright plunder, and a land revenue system which extracted the uttermost farthing not only from the living but also from the dead cultivators. The historians Thompson and Garrett, quoted by Nehru tell us that 'a gold lust unequalled since the histeria that took hold of the Spaniards of Cortes' and 'Pizarro's age filled the English mind. Bengal in particular was not to know peace until she had been bled white'.[2]

In his book, Nehru lays much emphasis on the detrimental effect on the Indian economy of the British policy of discouraging the growth of Indian industry. This policy he tells us was in some degree maintained even as late as the Constitution Act of 1935. So successful were these British policies during the 19th century that India became increasingly ruralised. In almost every progressive country there has been, during the last century, a shift of population from agriculture to industry and village to town. With this shift went generally increased wealth. In India this process was reversed, due in part to the deliberate action of the British Government. In the middle of the 19th century about 55% of the population is said to have been dependent on agriculture; by the second decade of the 20th century this ratio was about 75%. In Nehru's view the appalling poverty

[1] Quoted by Nehru in *The Discovery of India, 1945*
[2] Thompson and Garrett, *Rise and fulfilment of British Rule in India, p.91.* (MacMillan, London, 1934).

of the Indian people is of rather recent origin and was due in part to the opposition of Britain to the industrialisation of India. Hence in part the magnitude of India's task to industrialise herself on coming to power in 1947. This major task is a main theme of my lecture tonight.

SCIENTIFIC ADVICE

One of the important events of my life was my meeting with Jawaharlal Nehru during the annual meeting of the Indian Association of Science in January 1947. This was eight months before Independence but he was already Acting Prime Minister. Having heard that I had had a Naval training, Nehru asked me how long I thought it would take India to Indianise her Armed Forces. He said that his British Commanders in Chief told him twenty years. Did I agree with this? I replied that this depended on what sort of war the armed forces were intended for. If for a war effort comparable, for instance, with the British effort in the 1939-1945 war, then I thought his advisors were right - for India would have first to become a strong industrial power and this would take a decade or two. If on the other hand, India planned its armed forces for the possibility of a war on her frontiers with a neighbour of comparable strength, then I thought that the Indian Armed Forces could be effectively Indianised within two years.

This reply must have satisfied Nehru, for a few months later he invited me to spend some weeks in 1948 in India advising him on the scientific research and development needs of the Armed Forces. A dozen or so more visits followed, at first mainly on defence matters but later on the problems of civil science and education. Like so many others, I fell under the spell of Nehru's charm, his illuminating intelligence and his total dedication to achieve world peace, to maintain the unity of India and to increase the wealth and prosperity of his country by the planned application of modern science and technology.

The more I learnt about India the more I felt an increasing commitment to attempt to help, in however small a way, this great and beautiful country emerge into a state of prosperity and happiness.

No friend of the Indian sub-continent could fail to be deeply distressed by the tragic events now taking place.[3] It may seem incongruous for me to talk, as I will, about the problem of increasing the material wealth of India at such a time. In fact this task is still more vital due to the drain of resources to the war situation: so I will leave substantially unchanged the text of my address.

After a hundred and fifty years of direct rule from London, at midnight on 14th August 1947, at the Red Fort in Delhi, Jawaharlal Nehru proclaimed India an independent nation. What was India then like?

India's population was then 450 million and its growth rate was 1.5%, that is 7 million extra people each year. Today in 1971 the population has risen to 540 million and the growth rate to 2.5%, that is 13 million extra people a year, mainly due to the reduction of the death rate. The income a head has remained about the same over these twenty-four years - and this was a great achievement - the population growth nearly cancelled out the growth in wealth, so leaving the wealth a head little changed.

This average income a head of $100 a year is about one-twentieth of the income a head in Britain and not far off one-fortieth of that in the U.S. All these extra 13 million people each year have to be provided with the necessities of life including places to work and tools to use. Thus a high population rate imposes a vast burden on the economic resources of the country.

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[3] Lord Blackett was referring to the Indian/Pakistan conflict of December 1971.

Quite early in his political life Nehru put his faith in the application of modern science and technology to cure the ills of his country and of the world. Not long after becoming Prime Minister, he expressed this faith in the oft quoted phrases:-

'...It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people ... Who indeed could afford to ignore science today? At every turn we have to seek its aid. The future belongs to science and to those who make friends with science ...'.

Then again Nehru wrote:-

'...I am convinced that the methods and approach of science have revolutionised human life more than anything else in history, and have opened doors and avenues of further and even more rapid change ...'.

Lord Mountbatten has told us that in his first interview he asked Mr Nehru what he thought the greatest problem confronting India. He replied 'the economic problem'. If Nehru had been here today I think he would have approved of my choice of the main subject of this address to be 'Aspects of the Development of India'. However, I must confess that to fulfil this intention it is inevitable that I discuss many highly complete and controversial subjects, mainly economic and technological in nature. Since I am no economist I may have made blunders. However, economists themselves are often divergent in their views so perhaps my amateurishness may not be too much in evidence, or in error! The three main aspects of Indian development, which I will discuss, are Industry, Agriculture and Population Control.

The increase of wealth a head of India depends mainly on the advance of agriculture and industry and on the decrease of the rise of population. For instance, in the circumstances of India a 1% reduction in the rate of population rise implies, other things being equal, a 1% rise in the rate of increase of income a head.

Some may think that it is impertinent of me, a British physicist, to discuss in detail, and sometimes criticise, India's achievements and problems. I do so because I feel that I might help some British friends of India to understand more clearly how India is developing. In studying Indian material for this lecture, I myself learnt much that was new to me, and I feel it might be useful to others.

My personal friendship with Jawaharlal Nehru opened many doors into the corridors of power in New Delhi and also to the possibility for me to have useful discussions of the problems of policy making.

I am indebted to the High Commissioner of India, Mr Apa Pant, and his staff for providing me with very useful Indian publications.

ECONOMIC INDICES

I will now give a few figures to indicate the growth of Indian Industry since independence.

In a recent article, Strategy for Economic Growth, Mr Pitambar Pant, member of the Planning Commission, estimates that in spite of many difficulties, weak infrastructure, poor rate of saving and investment, lack of entrepreneurship, general apathy, India did succeed through planning to pull the country away from the old rut and stagnation. 'We have doubled our national income in

real terms in twenty years ... But guarding against an unwarranted sense of smugness, we are justified in saying that what has been achieved in twenty years after independence is far more than what the preceding fifty years of British rule had done. But this of course if not enough and can offer no satisfactory solution to our problems. Also we are now capable of doing much better'

Since 1951, India's Index of Industrial Production has increased by a factor 3.1, that is at an average of some 6% a year: agriculture only expanded by 80%.[4]. These figures do not include the small scale, or cottage, industries which have achieved a remarkable increase of output. If this is taken into account, then the rise of the Industrial Index will be still larger. It is interesting to note that there are now some 300,000 small-scale industrial units aided by Government finance employing some 3 million workers - giving an average of ten workers per unit. Many of these small-scale firms are presumably labour intensive and so fit in well with the national objective of creating as many work places consistent with a reasonable efficiency of production.

A crash programme for additional Rural Employment was announced this year by the Central Government to create new additional employment in every district of India.

Some interesting comments on India's economy as seen from outside have appeared in a trade journal *Far East Trade and Development*. This was a special number commemorating in 1917 the 21st Anniversary of India's Republic Day.

'India is one of the top ten national markets in terms of gross national expenditure with its infra-structure in good shape and with industry expanding, it is a market that is expected to sustain a good rate of growth'. 'In terms of industrial and technological capability India occupies a place between the highly industrialised nations and the developing countries'.

'A significant development on the export front is the continuous rise in exports of non-traditional items such as engineering products. From 1956 to 1969 Indian exports of engineering goods increased from $7 million to $140 million, that is a rise of eighteen fold in thirteen years'.

For instance,

'India ranks as the eleventh largest producer of machine tools in the world. Machine tools built in India range from simple lathes to special multipurpose machine tools for which there is a growing demand'.

'The output of machine tools is expected to rise at 10% a year compound. Machine tool exports in 1970 were $4 million: principal importers were Australia, UK, US and West Germany.

An experienced Economist and Consultant to the Indian Government wrote:

'There exists today in India the beginning of a great industrial state, and over the past twenty years a new generation of young engineers, technicians and scientists has grown up which is far more qualified to carry through the new round of development'.[5]

In the monthly News-Letter of the Indian Investment Centre (70.6.71) are the following official views:

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[4] Indian Investment Centre

[5] Austin Robinson, Cambridge, *Economic Progress in India*, p.14.

'The growth of Indian economy during the two years 1970-71 has been generally satisfactory and the overall rate of economic growth of about 5.5% p.a. which had been set in the Fourth Plan has been more or less attained. There was also an increase of about 5% in agricultural output.

Thus the per capita increase of national income in 1970-71 is 5.5% minus the population growth rate 2.5%, that is about 3% a year. This means real progress - if it can be maintained.

But such an advance may seem sadly slow and small. A higher goal could be achieved only by increasing the amount of investment or by getting a bigger return on what capital is available for investment. The best hope to increase the rate of growth substantially would be to attempt to raise the investment rate from the present 12%, to say 18% by about 1980. This would make possible a per capita growth rate of about 5%, which would lead to a doubling of the per capita income in some fifteen years. This I think would be acceptable politically. But it is very hard to achieve such a high investment rate in a very poor country. Generous external aid would help greatly to raise the investment ratio, and so the rate of growth of the economy.

COST OF DEVELOPMENT

It is curious to note that, though every one accepts that the vast wealth today of the developed countries is somehow due to science, it was by no means fully agreed as to how in detail it happened. In fact it has only been relatively recently that serious studies have been devoted to the mechanism by which science produces wealth. Unfortunately, science is no magic wand to wave over a poor country to transform it into a rich one. If Nehru's dream of a prosperous and happy India is to be fulfilled, it will need great wisdom, great dedication, and some sacrifice of present living standards for long-range economic health.

Since foreign aid already provides a substantial fraction of the available net investment in many developing countries, the amount of aid can be an important factor in the use of modern science and technology to increase the wealth of the poor countries. Thus scientists and technologists, who want to see their achievements applied for the benefit of humanity, must concern themselves with social economic and financial matters - including the problem of investment and the flow of resources from the rich to the poor countries.

As has been said very clearly and pointedly, 'Applied research and development is simply a form of investment, and in many cases a form of investment which cannot yield an economic return unless it is followed by a much larger investment in plant and equipment and marketing. It also makes claims on scarce scientific and engineering manpower which can be used in a variety of employments. It is quite possible to hinder economic growth by employing too high a proportion of scientists and engineers in research and development. Finding the right deployment of scientific manpower is part of the economic problem'.[6]

Industrialisation implies the use of production machinery and plant to increase wealth by producing better or cheaper goods. Now the cost of modern production equipment such as machine tools and other production goods, steel and fertilizer plants, power stations, transport vehicles, process plants, communication equipment, etc., may cost about the same in a poor developing country as in a rich developed one, or even more. So, in terms of *per capita* income modern production goods may cost twenty times as much in a poor as in a rich one. It is such goods which incorporate much science and technology. Unless a country can find the investment capital to buy or manufacture these advanced production goods it cannot make use of much modern science and technology.

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[6] Williams, B R, *Technology, Investment and Growth.* (Chapman & Hall, London,1967)

In recent years the world problem of unemployment in the poor developing countries has come to the fore. This was of course fully expected as increased industrialisation is generally accompanied by higher productivity per man and by lower employment. What is worrying is the scale of the unemployment. It has been estimated that unemployment in the poor developing countries as a whole is expected to rise to a total of 300 million or so by 1980. This prospect has led to the view that a poor developing country needs two goals, that is to maximise both the rates of rise of national income and of employment. How in detail this should best be attained must be spread over a very wide spectrum of production goods ranging from capital intensive and highly technological power plants, etc., on the one hand, and to labour intensive and generally less technological small scale industries, including village industries and crafts, on the other. The cost per workplace for the heavy industries may be around $20,000 a year or more and for the light industries the cost may be a few hundred dollars. Ideal investments are at the same time labour intensive and highly advanced technologically.

Due to the realisation of the vital importance of keeping down the number of unemployed to an acceptable level, many studies have been made by economists of the nature of the problem and of practical methods of dealing with it.

This is where the concept of intermediate or appropriate technology comes in. These words indicate a technology which is markedly cheaper in capital than a full modern technology and yet gives a markedly greater output per man than the craftsman or artisan working with no modern aids at all. Such intermediate technologies are likely to have a cost for a workplace somewhere between the very high cost of a workplace in heavy industry and the quite small cost of a workplace in handicraft industries. A national investment plan will involve a spectrum of investment goods from the very heavy to the very light. The prosperity of a country will depend on the wise choice of types of investment goods. Valuable lessons can be learnt from Japan. Her great economic advance since the second World War has been due in part to a clever mix of different types of industry, from heavy to light and from conventional to science based: and on a highly developed educational system.

Here lies a task for scientists and engineers of the rich and the poor countries: this is to help create production goods suitable for the economic and social conditions of a poor developing country.

INDIA'S SCIENTIFIC RESEARCH EFFORT

A major part of India's scientific strength now lies in a large number of government financed research establishments. The figures I am going to give you are taken from a Report on Science and Technology 1969, issued by the Committee on Science and Technology (COST) of the Cabinet.

Today the list of government research institutions is a formidable one. The Council of Scientific and Industrial Research controls thirty-four Research and Development Establishments and eleven Research Associations. The Ministry of Defence has thirty-four Establishments, the Indian Council of Agricultural Research twenty-six, the Indian Council of Medical Research six, and the Department of Atomic Energy eight. Finally there are about fifty institutions controlled by other Ministries. In all there are thus over 150 government financed research institutions of various kinds, apart from the seventy-six selected universities.

The total annual cost of these stations (1969) is about $200 million, which is about 0.4% of the national income of $40 billion. This is near the Research and Development target laid down by some United Nations Agencies.

The annual allocation of funds to the major recipients as a percentage of the total is as follows: Atomic Energy 24%, Council of Scientific and Industrial Research 14%, Defence 13%, Agriculture 14%, medicine 1.4%.

These facts and figures show that India has built up since Independence a massive and wide reaching Research and Development infra structure, capable, in principle, of bringing great social benefits, and so contributing to making a reality of Nehru's vision.

At the Indian National Science Academy-Royal Society Conference in New Delhi in March 1971, the President of INSA, Professor B R Seshachar said, speaking of India's progress in science: 'The fact that we had, at the critical period of our history, Jawaharlal Nehru at the helm of affairs was an important circumstance. His commitment to science was total, and his zeal for the development of science and technology was unremitting. Had we had at that time anyone else, whose appreciation of science was not as sympathetic and comprehensive, it would have been difficult if not impossible to lay the firm foundation of science that got laid at that time'. Prime Minister Indira Gandhi is actively continuing her father's support for science and technology. If the statistics were available I would not be surprised to find that Nehru either opened or at leasT visited the majority of these hundred or so Government Stations.

A key question is: Does India get a reasonable social return on the heavy expenditure on these Government Research and Development Establishments?

At the opening of the Conference, the President of India, Sri Giri, went further and put the forthright question: 'To what extent have all these efforts improved the lot of the common man? We must see that our industry and agriculture are benefited by the work done in our research bodies and higher technological institutions.'

In respect of Qualified Scientists and Engineers (QSE) in India, the immediate problem today in my view is not so much a shortage of numbers but the efficient deployment of those available; in particular the fraction in industry is very small. Out of 80,000 scientific/technical personnel employed in 1969-70 in Research and Development establishments and in the Universities, only 3,000, that is only 3.5%, are in private sector.

It is clear that more Qualified Scientists and Engineers are needed in Indian industry. In the UK there are more QSE's in industry than in government stations, but still there are too few.

These figures pinpoint the scientific backwardness of many private firms in India today: the situation in the state firms seems not to be always much better. But in both public and private industrial sectors the situation has begun to improve rapidly.

In more detail a main criticism of the present set up is that some of the stations, particularly those which are concerned with the physical and engineering subjects, seem not to have succeeded in working closely enough with the manufacturing industries which they are intended to help. Some of the government stations in the UK have suffered from the same failings.

Some changes in the organisation of the interface between station and firm are clearly needed. Already the Council for Scientific and Industrial Research has made a detailed study of twenty-three Pilot Plants in its stations and has published a forthright report recommending much closer contact between a station and a firm or firms, from the very beginning of all projects. At present the commercial return on these pilot plants seems to be very low. (The Pilot Plant Committee, CSIR New Delhi, 1970)

NEED FOR FOREIGN CAPITAL

One of the essential difficulties is due to the now well recognised fact that the total cost to a firm of innovating a new product, for instance a machine tool or a process plant, may be ten times as much, compared with the cost to the station of the initial research. Now at present the whole cost for the research in the station is generally paid by the government, while the ten times greater cost for the industrial stages of the innovation process are expected to be paid for by the firm. In many cases however the firm is unable to provide the requisite finance. So the project may collapse and much government money will be wasted.

There are several possible solutions. One is to treat each project as a joint one of station and firm from the very beginning. Perhaps at the start some of the station's personnel could work in the firm. Suitable financial arrangement would be required. The main object must always be to strengthen industrial firms both at the managerial and the technological levels. For it is in general the firms, both state and private, and not the stations, which manufacture and sell a product and so create wealth. The establishments themselves cost a lot of government money - they must earn this money mainly by the help they give to industry or to well-defined social needs.

If one now again considers industrial development one realises that even a giant power, such as the US or the USSR, cannot be self-sufficient in technology. the UK produces perhaps not more than 10% of new world technology; India probably much less than 1%.

It is the high cost of the innovation process which makes it necessary for all countries to buy many foreign patents and much know-how. This is especially so in the developing countries. It is generally a sensible policy never to re-invent unless it is essential. An adverse balance of royalty payment is often a sign of sensible national management.

The importance of foreign firms setting up manufacturing plants in a developing country must be stressed. It can be a very efficient way of transferring managerial skills, technological know-how and advanced training to a developing country. Political and financial difficulties may arise but can often be overcome given understanding on both sides.

India has made very wide use of foreign collaboration to speed up the use of modern technology in Indian industry. Figures have been published recently. Between 1957 and 1970 over 3,000 cases of such collaborations have been authorised by the Appropriate Ministries.

However, care must be taken that reliance on foreign technology is not excessive. A simple slogan might be 'Buy your way to the front line of technological advice and then use your own resources to make further advances'. This is what the Japanese have done so effectively

In this connection the Indian Government has wisely laid it down that when an Indian firm makes an agreement with a foreign firm for technological collaboration, then the Indian firm must set up its own R & D unit so as to be able to use properly, and later improve, the imported technology.

These considerations make it important not to think of science as being only, or even mainly, identified with basic research. For science has a big practical role to play other than by adding to knowledge: in fact, most science in the world is essentially concerned with the application of existing knowledge to useful ends. Trained scientists and engineers are essential, along with other professional colleagues, in all the steps that lie between some new scientific result and the eventual practically useful material object or process. So, even if no new basic scientific knowledge were being created in the world, the main wealth creating sectors of the economy of a poor country,

industry, agriculture and mining, would all demand an adequate number of trained scientists and engineers. Moreover, they would be needed for all kinds of jobs, adaptive research, administration, management, design, production, sales, operating industrial plants, extension work, etc., in fact throughout the economy.

GREEN REVOLUTION

Until a few years ago it seemed that hopes for rapid economic progress in many of the poorest countries were doomed by very slow growth of the huge agricultural sectors. For instance, the developing countries in South East Asia, which had exported annually 14 million tonnes of cereals in the 1930s, became net importers of 10 million tonnes a year in the 1960s.

Then came the Green Revolution: a triumph of biological science and technology. A good part of the developing world, particularly South East Asia, is experiencing a major breakthrough in food production; rates of increase of food production in South East Asia are over 7% per annum and some of these countries are likely to become net exporters again in a few years. All the world over there has been world wide acclaim at the award of a Nobel Prize for Peace to Dr Borlang for his outstanding contributions to this success.

This advance has been due to the breeding of dwarf varieties of wheat and rice in Mexico and the Philippines under the sponsorship of the Ford and the Rockefeller Foundations working closely with local research institutes, such as the Indian Agricultural Research Institute in New Delhi. These new strains permit the use of three or four times as much fertilizer, and, when combined with adequate water control and pesticides, give double or triple yields. A farmer may find his net income rising from $15 to $60 an acre a year. From 1965 to 1969, 34 million acres have been sown with the new wheats, perhaps 10% of the total grain acreage of these areas.

An expert in this field has written: ‘The collision between population growth and food production has been averted temporarily. The new seeds have bought time to seek a breakthrough in contraception’. ‘While man breeds new wheat, nature breeds new rusts. Thus plant breeding is a never ending process’. ‘... the course of the Green Revolution will depend importantly on what the rich countries do. Their aid policies will quite directly determine the speed with which the drive towards self-sufficiency in food proceeds’.[7]

The importance of intensive and continuous applied agricultural research tailored to specific local problems needs stressing: when and how to irrigate, when to plant, when and how to fertilize, pest control practices, etc.

At first sight the Green revolution now in progress, due to the introduction of new high-yielding wheats and other food crops should allow a rapid increase in the speed of general economic advance at a very low cost in investment. However, this is only partially so, because of the need for water, tube wells, fertilizers, pesticides, electric power, transport, storage facilities, credit, agricultural advisory services, etc., which also must be provided.

So the agricultural revolution demands an industrial one as well, including sometimes profound social changes and the provision of much investment capital. Even the Green Revolution does not provide instant development.

Some figures have been given in a recent report by the Indian Agricultural Research Institute (IARI) of the percentage increase of yield between 1960-1961 (the pre-package period) and 1967-

[7] Brown, Lester, R., *Seeds of Change*. (Praeger Publishers, New York, 1970)

1969 (when the High Yielding varieties were grown). Rice 12%, Wheat 80%, Maize 72%. Further big increases in yields are being obtained by multiple cropping. An extreme form of this is Relay Cropping where four different crops are grown each year.

The following remarks are taken from a recent report by the India Agricultural Research Institute :

'It is rather painfully true that the Green Revolution has been experienced by the irrigated areas alone and the lot of the farmers of the unirrigated areas remains more or less unameliorated. The High-Yielding varieties were launched in areas with assured rainfall and/or assured irrigation. However, these programmes only served to accentuate the already wide socio-economic gap that existed between the farmers of the more fortunate regions and those of areas largely dependent on the vagaries of a notoriously fickle monsoon. The neglect of the unirrigated areas can be continued only at grave risk to our agricultural economy since they constitute nearly 80% of the total cropped area and contribute as much as 40% of the total food output'.

'Research on dry farming has been in progress for the last 30 years or so and certain useful practices for moisture and soil conservation have been developed: also studies have been made into the selection of varieties suitable for low rainfall areas. However, no concerted effort has so far been made to apply an integrated package of technology involving the simultaneous application of all the results of research. Consequently the individual practices developed by scientists working in different disciplines have not found wide adoption because of their marginal impact on productivity and income. A significant yield and income jump in the unirrigated areas can only be achieved by such an integrated approach'.

Some of the main scientific and technological problems are as follows: Land consolidation and soil conservation: Improvement in tillage leading to better soil structure and root penetration: Use of plant residues to improve soil structure: Adoption of water harvesting: More efficient application of fertilizers e.g. deep placement and foliar application: Improvement of biological fixation of nitrogen through efficient strains especially those tolerant to salt. Photo-sensitive and quick maturing varieties least affected by drought: Mixed crop rotations: Popularisation of soybean, high protein maize, etc.

This brief survey by the IARI of the problem of the unirrigated areas shows the intricacy of the problem compared with that of the irrigated areas. Intensive training programmes for extension-personnel will have to precede the introduction of he new technology. The only way to bring about a significant advance is to launch a broad scientific approach dealing with all the variables. Only when a farmer can expect big improvements is it worth his while to change his practice.

Close collaboration between the agricultural research institutes of other less developed countries which face the same intricate problems of dry farming would seem sensible, and is now being planned.

CONTROLLING POPULATION

I now want to say something more about the population problem. The basic figures for the world as a whole are well known. The present number of people is about 3.5 billion and is increasing at about 2.0% a year. By the end of the century, i.e. by 2000AD, the number will be about 7 billion and nothing which we can do now will alter this substantially. However, if nothing is done during the next decades, by 2030 AD the number will be around 14 billion: and so on, doubling every 30 years. At some period in the future world catastrophe would ensue due to the inevitable scramble for food, land, raw materials and space.

Let us now look at the situation in India. The present population of 547 millions has been growing at the rate of 2.5%, that is 13 million extra people a year.

Calculation have shown that the cost to India today of providing one workplace, that is housing, tools of trade, etc., is around $110[8]. So the cost of providing for 13 million extra people is somewhat over a billion dollars a year. This amounts to about 3% of the national income, but may now be growing at a rate of nearer 9.0%.

If the present 13 million extra births could be reduced to say one-half, then the cost of providing the requisite places would be also reduced by one-half. The resulting 'saving' of rather less than a billion dollars could then be used for other investments or to increase the consumption of the people.

In a recent Indian Government pamphlet rough figures have been given in some detail of the additional resources required for an extra 13 million persons. These include 130,000 schools, 2.6 million houses, 37,000 schoolteachers, 200 million metres of cloth, 12 million quintals of food and 4 million jobs, etc. every year.

The Indian Planning Commission has made several forward planning projections of the population, ranging from uncontrolled to very strongly controlled. The 'medium projection' is the one used by the Planning Commission. This medium plan involves about halving the fertility rate by 1985. Even with this reduction, there is the prospect of India's population increasing by 320 million in the next 30 years over and above the estimated 550 in 1970, giving a total of 870 million in 2000 AD

India in 1956 initiated a government programme for the control of population and was the first country to do so. The budget of the Family Planning Organisation has risen very rapidly lately and the annual budget provision for the period 1968-74 is about $80 million.

There are now some 5,000 rural planning centres and 30,000 subcentres. More than half of the Indian population are covered from these centres.

The number of trained personnel employed by the Family Planning Organisations are as follows: 4,000 medical officers; 6,000 extension educators; 14,000 health assistants; 40,000 auxiliaries of various type; the total trained personnel is around 60,000.

Some states have passed laws to encourage the limiting the size of families as to make small families the norm. A Bill has recently been passed to legalise abortion in India.

From these facts and figures it is clear that the Indian Government has built up a massive planning organisation, probably the largest Family Planning Organisation in the Western World. The main methods used were sterilisation, IUD and conventional contraception.

The question one must put is whether the programme is big enough to enable the national targets to be met. These targets are to reduce the birth rate from 37 to 25 per 1,000 and to reduce the population growth from 2.5% to 1.5% by about 1980.

As a result of the work done so far, the birth rate for India as a whole has been estimated to have come down from 41 per 1,000 in 1961 to 37 per 1,000 in 1970. The birth rate has declined less

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[8] Robert Nield, *India at Midhassase*, 1964, p. 26. Overseas Development Institute.
Goran Ohlin, *Population Control and Economic Development*, OECD, Paris, p. 116.

slowly in States where the Family Planning Organisation has made good progress: for instance in five such States the birth rate is 34, and in the tea estates, where medical services are good, the birth rate is as low as 31.

The Family Planning Organisation holds that the target of 25 births per 1,000 for India as a whole should be achievable within seven years or so, given a fast enough growth of the infrastructure and organisation.

Recently the use of oral pills has come under detailed study in India by the Department of Family Planning and the Indian Council of Medical Research. It will no doubt soon be established if oral contraceptives are as successful in India as they have been in many developed countries.

The present target of 25 per 1,000 must surely be taken as a first step, to be reached as soon as possible, but to be replaced by a target birth rate of under 20 per 1,000 as in Europe.

I believe that the only long range target for all countries must be a stabilised population.

In this talk I have outlined, mainly for a British audience, a few facts about the three main aspects of present day India which dominate its economic future and so are deeply relevant to realising the dream of Jawaharlal Nehru of a prosperous, happy and united India. In discussing these three aspects, industry, agriculture and population, some may think that I have spoken too much of the problems of increasing the wealth of India and too little of the quality of the life of individual Indians. My reason is of course that almost everything which improves the way of living costs money, and this must come out of the proceeds of industry and agriculture. Population control is perhaps the major factor in preventing the worsening quality of life in India by overcrowding. It must be remembered that the Planning Commission, presided over by the Prime Minister, is inevitably concerned with population trends over the next few decades. Without adequate population control, long and indeed medium range forward planning is impossible.

I will now end this address by quoting an apt passage by Jawaharlal Nehru in a lecture given in 1959. Today, twelve years later, the theme seems to me to have still more relevance.

‘Tomorrow’s India will be what we make it by today’s labours. I have no doubt that India will progress industrially and otherwise; that she will advance in science and technology; that our people’s standard will rise, that education will spread and that health conditions will be better, and that art and culture will enrich people’s lives ... What I am concerned with is not merely our material progress, but the quality and depth of our people. Gaining power through industrial processes will they lose themselves in the quest for individual wealth and soft living? That would be a tragedy, for that would be a negation of what India has stood for in the past, and I think in the present time also as exemplified by Gandhi. Power is necessary, but wisdom is essential. It is only power with wisdom that is good ... Can we combine the progress of science and technology with this progress of the mind and spirit also?’