OUR AGRICULTURE

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S. K. MUKERJI

National Council of Educational Research and Training

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Foreword

WE are living in an age of technology. Both science and technology are growing rapidly. Everything about science cannot possibly be told to a student at school or college. Consequently the investigatory approach when adopted is the only way to arouse the curiosity of the learner and enthuse him to acquire knowledge far beyond the rigid boundaries of a curriculum. To meet this requirement there is need to provide adequate supplementary reading material written in a manner intelligible to a student. Such material can arouse his curiosity and also quench his thirst for more knowledge.

The National Council of Educational Research and Training has undertaken the task of preparing supplementary reading material on topics which do not strictly fall within the school curriculum but which have a bearing on what the student learns at school. The present publication is one of such volumes. It is hoped that this publication will be found useful by both the students and teachers.

New Delhi
December, 1971

S.V.C. AIYA
Director
National Council of Educational
Research and Training

Preface

AGRICULTURE is still the largest industry sustaining our land and engaging the attention of the largest section of our population. The success of our nation, in all spheres, still depends basically on the quality and effective output of our agricultural efforts. It is, therefore, not only essential but very imperative that the young children of our land come to realize the vast dimensions and the many problems and achievements in the field of Agriculture.

The want of a comprehensive and detailed account of our agriculture, in lucid and simple style, as to interest the young children and also the public at large is genuine. We are very happy that we have been able to fill this gap in some measure, thanks to the efforts of Shri S.K. Mukerji, Assistant Director-General, Indian Council for Agricultural Research, New Delhi. At the time we thought of the present theme in this series, it was fortunate that Shri Mukerji was available and willing to undertake this task.

Shri Mukerji has had a distinguished academic record in this country and abroad and has held various positions concerned with agricultural development and education in India. It is a matter of considerable gratification to all of us that a person of his background could collaborate with us in this effort. The result is the present book on such a wide spectrum, on a topical subject.

The green revolution can be sustained only by continuous hard work and efforts all round and more so from the biologists in particular. It is hoped that this booklet on *Our Agriculture* will be received with interest by the children in our schools and make them aware of the progress we have so far made and make them realize the need for more concerted efforts towards agricultural development in the days ahead. Nature seldom yields her bounties to mankind, unless human society is prepared constantly to sustain and reap the rewards of nature by continuous hard work. We hope that this book will bring authentic first hand knowledge of absorbing interest to the public at large and parents of the children of the age group for whom Shri Mukerji has written this.

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1

Introduction

AGRICULTURE has been a very important factor in the progress of human civilization. Until man learnt how to grow food from the soil, he had no settled inhabitation. Early man, in India and elsewhere in the world, moved from place to place in search of food more or less like animals. He killed and ate other animals.

Then came the time when man discovered that instead of moving to places where food was available, he could grow food in places favoured with suitable climate, soils and supply of water. The earliest known human societies were those which practised agriculture. The Indo-Gangetic plains, the banks of the Nile in Egypt, the river valleys of China were all likely sites for the begin-

ning of agriculture in the ancient world. Later, these sites became famous centres of civilization. Not only did the rivers provide water; their floods spread silt in the fields. The fertility of the land was thus constantly renewed and crops could be grown repeatedly in the same area. People could therefore settle down permanently in such areas. This was the vital factor of civilization provided by agriculture—namely, that land should produce the food to support the people on this land.

The Ramayana and the Mahabharata give us the impression that India was a land of milk and honey during epic times. We have some proof now, as pieced together from ancient literature, accounts of foreign travellers and archaeological findings, that our present civilization goes back continuously for about 5000 years. The history and continuity of our agriculture is at least that long. We have discovered physical remains of an Indian civilization which flourished during the third millenium B.C. in the Indus Valley (now in Pakistan). These remains tell us of a highly developed urban life supported by abundant agriculture. Grains of wheat, barley, husk of rice, have been found at these sites along with remnants of cotton textiles, pottery vessels, metal implements and wheeled vehicles.

But this civilization suffered a setback between 2500 B.C. to 2000 B.C. by the invasion of nomadic tribes from Central Asia who spoke languages rather like Sanskrit and old Persian. They appear to have migrated from the Caspian Sea region. They had some knowledge of agriculture; they made use of bullocks in ploughing and took good care of their herds of cattle. Their chief crop was barley, which they made into a drink called *soma*. They were a warlike people. When they increased in number their original homeland could not support them. So group after group,

tribe after tribe, they migrated from their homeland and entered through the gaps in the Himalayas to attack the more civilized Dravidian people who were living peacefully in North India. The invaders came to be called the Aryans.

The Aryans generally remained in the North and spread along the Indo-Gangetic plain which they called Aryavarta. The Vindhya mountains of Central India proved a barrier for a long time to their spread to the South which therefore remained chiefly Dravidian and was called *Dakshinatya* by the Aryans. Later on, of course, enough contact developed between these two parts of the country for the people to share common customs. For example, the Aryans divided their society according to functions performed by groups of people. This system, which we have inherited in the form of India's unique caste system, spread all over the country in the course of time.

Nearly 80 per cent of Indians even today live in villages, within daily sight of agricultural activities. In those days, our villages had little contact with each other and almost none with the outside world. This lack of contact forced the villages to be self-sufficient in every possible way. They governed themselves through their own committees of elders, the panchayats, and were as good as independent republics.

These little republics were also the basic units of economy; for these were the villages of cultivators, and the produce of the land provided the subsistence for the community. A large variety of people had interest in land. The king had his share in the land revenue. The officials shared a part of this revenue. The peasant families who cleared the land and established the villages took their share in return for cultivating the land. The families had continuing rights in their separate strips. Village

chowkidars, weavers, blacksmiths, carpenters, got their portion too. In addition, the village as a whole might have had common lands for grazing and perhaps some woodlands for fuel.

It was so stable a system that it allowed the Indo-Gangetic plains, for example, to be cultivated fruitfully and continuously for several thousand years in spite of the succession of kings who ruled over large portions of northern India during the period. The same was true of southern India. Kings came and went, kingdoms rose and fell, but the farmer continued to till the land and raise the crops in the way his forefathers had done before him.

Before the arrival of the British, India had evolved a socio-economic structure which did not change much. Population growth was slow, hence the pressure on land was not felt. A traditional pattern of agriculture developed, which is about the same as practised now. The methods of cultivation had settled down to a pattern based on practical experience of generations of shrewd, though not educated farmers. The standard of living was never high by any means, but we managed to have a fairly balanced economy. Our cottage industries, at the same time, had developed to such an excellence that it was possible to export our handicrafts to foreign countries. We also exported certain unique products of Indian soil, e.g., spices like black pepper, cinnamon, cardamom, which were not grown much elsewhere in the world.

Once the British had gained control of large portions of the country they overhauled the rent collection system in an attempt to increase revenues from land. Two main forms of land tenure introduced in India were : *Zamindari* and *Ryotwari*, the former in Eastern India and the latter in the South and the West. Under the *Zamindari* system one or more persons owned the village and were responsible for the payment of land revenue to the Government. The landlords did not cultivate big estates themselves and

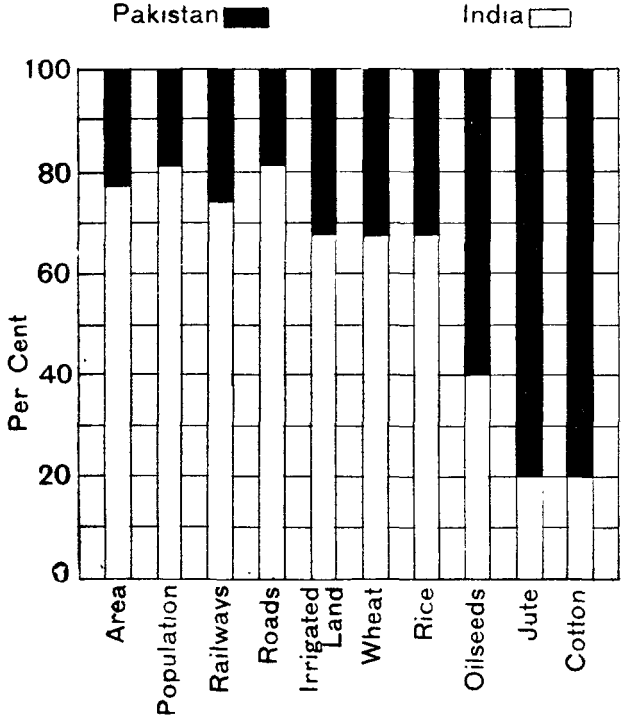
had tenants. Between them various intermediaries developed and the tenant farmer suffered. Under the *Ryotwari* system every registered holder of land was recognised as its owner and paid revenue direct to the Government. The revenue could be increased from time to time.

The impact of British rule led to the introduction of new commercial crops for export. Large tea and coffee plantations under their control were developed. Acreage under industrial and non-food crops like, cotton, jute and oilseeds were expanded to provide raw materials to British industries. This new phase of agricultural production resulted in specialisation of different regions in particular crops. Bengal specialised in jute, Maharashtra in cotton, Madhya Pradesh in oilseeds and Punjab in wheat.

The population of the country was fairly stable till 1921. But various famine and disease control measures began to reduce the death rate, thus increasing the rate of population growth since larger numbers of those who were born remained alive longer. Between 1921 and 1951 the average annual rate of increase was 1.3 and 1.4 per cent, adding more than 100 million to the population. Between 1957 and 1961, the annual rate of increase jumped to about two per cent, which was not matched by the rate of increase in agricultural production. This has become one of our most serious problems since independence.

After the separation of Burma from India in April 1937, the import of rice ranged between 1.5 to 2.0 million tonnes. This supply was suddenly cut off when Japan entered the Second World War, leaving no alternative source of supply. The food problem became acute during 1943 and the occurence of the Bengal famine focussed the attention of the country on the need for action on a national scale.

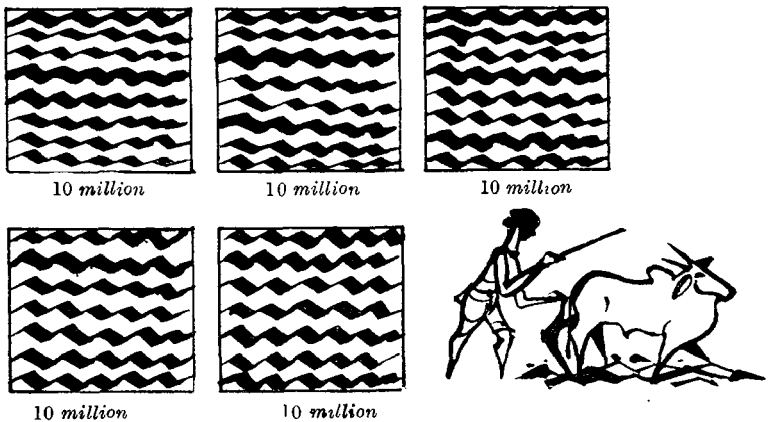
The vision of free India caught the imagination of our people under the inspiring leadership of Mahatma Gandhi. The Second World War left the country in a poor state. The industries were in a state of neglect and agriculture was stagnant. Therefore topmost priority was given by our leaders to the task of overcoming poverty by reconstructing the economic and social life of the country.



Distribution of natural wealth between India and Pakistan in 1947

In 1947 we at last gained independence but it was at the cost of partition of the country. It led to large-scale transfers of popu-

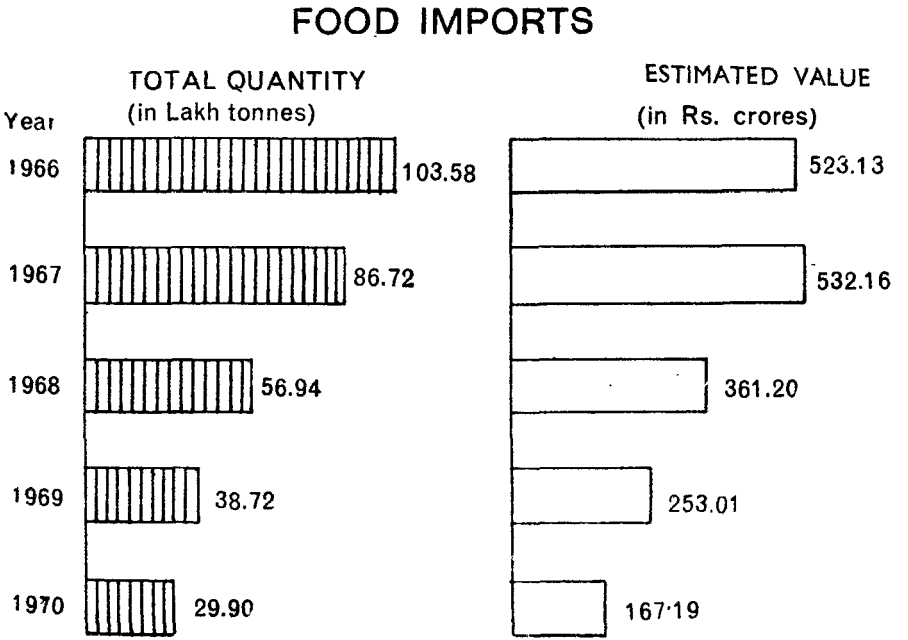
lation in the border states, affecting agricultural and industrial production . The food surplus areas of West Punjab and Sind went over to West Pakistan. While the Indian Union received 82 per cent of the total population of undivided India, it got only 75 per cent of the total cereal production , 65 per cent of wheat production and 68 per cent of the total rice production. Thirty-one per cent of the total irrigated area went to the share of Pakistan and 69 per cent remained with the Indian Union. While most of the cotton and jute stayed in Pakistan, the mills remained with us and we became importers of cotton and jute for our mills.



50 million hectares of additional land brought under the plough

Our constitution promises social, political and economic justice to every Indian and seeks to secure for him the right of a fair means of livelihood as far as practicable. A Planning Commission was set up in 1950 to have this objective achieved through series of Five Year Plans of development drawn up in consultation with the States. The increase in agricultural production during the First Plan period was encouraging. But most of the increase

was due to an increase of cropped area. The yield per acre did not increase. Cultivation extended even to marginal areas by clearing forest land. During the Second Plan our good record was maintained, but the production continued to be affected by vagaries of the monsoon. The Third Plan production targets could not be achieved due to successive unprecedented monsoon failures. The import of food grains which was continued after independence had to be stepped up to fight famine. A new strategy of intensive



agricultural production based on application of science in areas with assured irrigation was adopted by the end of the Third

Plan. It has so far withstood the test of unfavourable monsoon years.

Thus even in the seventies, the agricultural sector dominates the Indian economy. It provides half of the national income and employment to almost three-fourths of the population. Agricultural commodities comprise 80 per cent of the total consumer expenditure. The general level of prices in the country fluctuates with the rise and fall in agricultural prices. These in turn affect wage levels. In the export trade 45 per cent of the total is contributed by agricultural commodities like Jute, Tea, Spices, Tobacco, Hide and Wool. Inspite of our efforts to achieve the level of self-sufficiency, the share of imports for agriculture sector amounts to 20-25 per cent. Some of the important items are tractors, fertilizers, fine wool, vegetable oils, etc.

The story of the exciting progress of agriculture in India, in relation to our natural as well as acquired resources, is narrated in the chapters which follow. If we are to survive as a civilization, we must continue to grow more every year to feed our increasing population. This vital national objective, which used to seem hopelessly beyond our reach, is now much closer to our achievement than we realize.

2

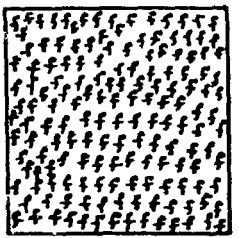
Resources of Our Agriculture

Land

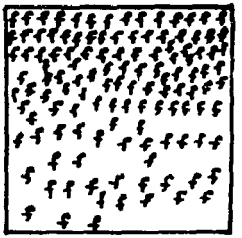
Usable Area

India is a vast country. If the North to South measurement is added to the East to West measurement, it will make one-tenth of the circumference of the earth. India covers an area of 3,274,000 sq. km., i.e., 326 million hectares approximately. The total cultivable area in 1966-67 was 137 million hectares. If this is divided on equal basis for the entire population of the country, approximately 500 million in 1967, then only 137/500 or 0.27 hectares per head is available. This is very low as compared to the world average of 4.5 hectares per head of population. Few people realize that one out of every seven persons in the world

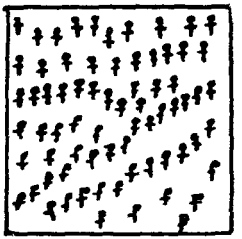
is an Indian. Our country has more people than USSR and USA put together. But in size we are smaller than either of them. So one of the basic problems of India is the shortage of agricultural land per head of population.



India : 162



Pakistan : 120



China : 70

Population per square kilometer

The way the available land is used indicates conditions of agriculture and peasantry. Land use suggests whether agriculture is a business proposition or a subsistence occupation, as a way of life. The broad categories of land use of some countries including India is given below :

Country	*Year*	*Arable Land*	*Pasture & Meadows*	*Irrigated Land*	*Forests*	*Irrigated to Arable Land*
		(In Million Hectares)				*(Percentage)*
India	1966	137.0	14.0	26.4	62.0	19.3
Japan	1960	6.0	0.95	3.1	25.4	52.0
U.S.A.	1959	185.1	256.2	11.2	302.0	6.0
Mexico	1960	23.8	79.0	3.5	43.6	14.8

Arable lands are the area under crops. Cultivation of arable crops pre-occupies the major part of the land resources and time of farmers in India, who form 70 per cent of the working population of the country.

You may not realize but about 30 per cent of the land remains uncultivated because of topography and relief and between 20 to 30 per cent because of scantiness of rainfall. Some land has to be set aside for roads, railways and buildings. Thus only about 40 per cent of total land area is available for cultivation. Taking into consideration that multiple cropping may be practised in a few favoured areas where the winter is mild and where water is available for a second crop, approximately 45 per cent of the total area, i.e., 144 million hectares in all, could be considered cultivable. Only 1.2 hectares of arable is available per agricultural worker, as compared to 40 acres in USA and four acres in Mexico. This is the basic problem of the country and one of the causes of its poverty. Thus we cannot banish poverty until we are able to reduce the number of people who demand land and provide more of them alternative employment in the industries and other non-agricultural occupations.

Genesis of Soil

In the animal structure we recognise two parts. The hard and durable skeleton that gives the frame, and the living but more easily perishable flesh and blood that largely make up the animal. Broadly this applies to soil also; its mineral part may be compared to the skeleton, and its organic matter and moisture component to the flesh and blood.

Solid rock provided the mineral particles. They were split from the parent rock by weather, vegetation and other agencies. Some remained located where they were formed and others were transported by water or ice masses to lower levels.

Our soils are formed of the coarse gritty particles—the coarse sand, fine sand and sand. They are chemically inert. In most Indian soils the sand fraction is almost all quartz but the silt contains some other minerals as well. These fractions have no part to play in providing plant food directly. But they have an important role in determining the physical properties of the soil and its behaviour in cultivation operations.

Soil Types

There are four major groups of soil in India, viz.,

1. Alluvial Soil,
2. Black Soil (*Regur*),
3. Red Soil,
4. Laterite and Lateritic soil.

In addition to the above, there are four other different soil groups :

1. Forest soil,
2. Desert soil,
3. Saline and Alkaline soil,
4. Peat.

Alluvial Soil

Alluvial soils are the most important and productive soil groups in India. They cover most of the populous regions of India because they produce enough food-crops to support large populations. They are derived from the deposits of silt laid by numerous river systems. They occur in all the States along rivers. In all alluvial soils, nitrogen deficiency is evident but they respond to phosphorus. Rice, sugarcane and wheat are the main crops on such soil.

Black Soil

Black soils are found mainly in Maharashtra, the Western part of Madhya Pradesh, parts of Mysore, Andhra Pradesh and Gujarat. They are also some times called "black cotton soils" since cotton is a common crop on such soils. They are mostly clay soils and therefore form deep cracks during the dry season. Black soils possess high capacity of conservation of soil moisture. Therefore conservation of soil moisture by contour bunding has been useful in increasing the production of Rabi crops like *Jowar*. They contain much iron and fairly high quantities of lime. They are poor in phosphorus, nitrogen and organic matter. Hence they respond well to application of nitrogenous and phosphatic fertilizers, and addition of farmyard manure and green manure crops.

Red Soil

Red soils cover large portions of Tamil Nadu, Mysore, Southeast Maharashtra, Orissa and Chotanagpur (S. Bihar), covering a total area of about 53,000 sq. kilometers. Most red soils are sandy loam or sandy clay in texture, low in lime and red in colour on the surface. They are usually deficient in nitrogen, phosphorous, lime and organic matter. But they respond well to good crop husbandry practices like irrigation, green manuring and fertilizer application.

Laterite and Lateritic Soil

Laterite soils are well developed on the tops of low hills in Western Andhra Pradesh, Mysore, Kerala, Southern Maharashtra, Madhya Pradesh, Orissa and Assam. In these areas the laterite soil is cut and used as building stone. The soils are porous but rocklike. The laterite soils are red in colour and poor in available

plant nutrients like nitrogen, phosphorous, potassium and calcium. Usually the soil is acidic and thus responds well to the application of lime.

Forest Soils

About 17 per cent of India is occupied by forest soils. They occur at high altitudes as well as low, where the rainfall is sufficient to support trees. They are usually too shallow, too steep, stony or unfertile to be utilized for arable crops. These soils support forests which supply us timber and fuel wood and protect the hillsides against erosion.

Desert Soils

Desert soils occur in the large part of the arid and semi-arid tracts of Rajasthan and Southern Punjab (annual rainfall 0—62.5 cm.) lying between the Indus and the Aravalli range. This part is covered under a thin layer of blown sand, which prevents soil growth. These soils are well supplied with soluble salts (sometimes in excess), and are low in organic matter. Some of the soils are low and some are high in lime. Desert soils are often quite productive when irrigated. The Rajasthan Canal Project will serve this area. In unirrigated areas often the soils are blown by wind and they cover roads, railway tracks, buildings, and standing crops.

Saline and Alkaline Soils

In many parts of the Indo-Gangetic plain without adequate drainage, salts accumulate in the surface layers of soil. During the summer months, as evaporation of moisture takes place from the soil, salts are brought upto the surface by capillary action to form a white crust. The semi-arid areas of Bihar, Uttar Pradesh,

Punjab and Rajasthan have such saline and alkaline soils where hardly any crop can be grown. It is, therefore, very important that when such soils are irrigated, they must be provided with adequate drainage so that productive lands do not go out of production due to the accumulation of salts.

Peat Soils

Such soils occur in the low lying areas in Bihar and Kerala which grow some vegetation but get submerged during the monsoon. The growing vegetation is killed on submergence but does not rot rapidly because of excess of water. After a long time, a layer of partly decayed organic matter accumulates on the surface. When properly drained and fertilised, these soils often record high yields of rice crop.

Soil Management

If the farmers in India are to become more prosperous and raise their standard of living, they must improve the soil fertility so as to produce more yield per acre. With the current advanced agricultural technology, this is possible.

We have very favourable climate for maximising crop yields. If all the inputs are made available and modern technology is correctly applied, the productivity per acre which is now so low can be raised multifold. Apart from the use of improved seeds, protection against crop diseases and pests, better prices as stimulant to farmers, the following soil management measures are equally important :

(a) Increased and timely supply of water for irrigation.
(b) Adequate supply to soil of organic matter either by green manuring or addition of Farm Yard manure or compost.
(c) Adoption of suitable crop rotation.

(d) Application of fertilizers.
(e) Drainage and bunding, where necessary.
(f) Addition of soil amendments like lime or gypsum, etc., to saline, alkaline and acid soils wherever necessary.

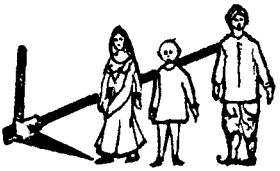
Land Tenancy

Before independence, the land tenure system in India was not helpful to the farmer. The landlords held half of the total land area even though they constituted only four per cent of the population. Three-fourths of the rural population of small farmers held only 16 per cent of the land. A large number of rural people had no land of their own and they worked as tenants or farm labourers.

All land belonged to Government which collected rent from those who tilled the land. The British Government found it difficult to collect rent regularly from tenants or farmers. So they appointed agents with wide powers to collect rent on their behalf and pay to the Government at fixed rates. This was known as the *Zamindari* system in U.P., Bihar, Bengal, Assam and Orissa.

There was also the *Ryotwari* system. Here the Government collected revenue directly from the farmers (*ryot*) who had settled on the land as in Punjab and other parts.

Under both the systems, sub-letting became common in course of time. Even though the Government collected land revenue at a fixed rate from the agents, they could increase the rent collected from time to time. Rents rose rapidly due to land hunger as population increased. The landlord grew richer but the tenant remained poor. The landlord could dispossess the tenant of his land, due to failure to pay the land rent. It is no wonder therefore that tenants had very little interest in the improvement of the land they tilled, hence production per acre did not increase.



5.71 million hectares of land distributed among the landless

In 1947, it was estimated that out of a population of 400 million there were 50 million landless labourers, who had farm employment hardly six months in a year.

Land reform legislation now has been adopted in most of the States from 1950 onwards. It stipulates that benefits of labour would go to the man who tilled the land so that he may have enough returns to improve the land and raise its productivity. Agents or intermediaries to collect rent have been abolished and the Government deals directly with the cultivators. The rents have been brought down to one-fourth of gross produce or even less. In some States recently land holdings of less than three acres have been exempted from land revenue. To settle landless labour on land, a ceiling on the area which any individual or family can hold has been fixed in all the States. The surplus land thus released is distributed among landless people.

3.62 million tenant farmers given ownership of 3.17 million hectares of land

Small and scattered holdings so common in the countryside lead to inefficient farming operations. In some States successful voluntary efforts have been made to consolidate scattered holdings to make compact farm units.

CLIMATE

One of the striking features of India's agriculture is the availability of abundant sunlight and prevalence of favourable temperature for crop growth throughout the year in most areas. This makes multiple or relay cropping feasible.

The rainfall, temperature, humidity and soil conditions are the chief factors affecting the growth of crops. Individual crops have their own optimum requirements of sunlight, humidity, temperature, nutrients and soil water relationship. If these specific requirements are met throughout the life history of the crop plants during the various stages of growth, they grow vigorously and produce best yields.

Rainfall

Rainfall varies widely from place to place ranging from 127 mm. per annum in the desert areas of Rajasthan to over 10,000 mm. in the Assam hills. Moreover, three-fourths of the total rain is received during the four monsoon months, i.e., June to September. During winter, only North-east monsoon provides additional rain to the Eastern coastal areas of Madras and Andhra Pradesh.

Approximately 11 per cent of land area in India receives more than 1900 mm. of rainfall in a year, 21 per cent receives 1200-1900 mm., 37 per cent receives 750-1200 mm., 24 per cent receives 375-750 mm. and seven per cent receives less than 375 mm.

The heavy rainfall areas are the Western Ghats, the hills of Assam and the foothills of the Himalayas. The Gangetic plain

and the Deccan are the areas of moderate rainfall. The North-west Punjab, Rajasthan and the neighbouring tracts represent areas of low rainfall.

Temperature

Temperature prevailing during a season influences the water condition inside the plant, soil and air. Thus it affects crop growth and its distribution. We find identification of crop seasons like *Rabi, Kharif* mainly based on temperature and rainfall, and the crops are associated with them. In North India rice is grown in *Kharif* and wheat in *Rabi* season. In South they grow two to three rices of different types during the whole year, since they do not have a cool winter season.

Sunshine

Sunshine is not a limiting factor in crop growth anywhere in India. But it is true that continuous cloudiness during the flowering season of crops may reduce the yields. It has been found that some high-yielding rice varieties like *IR*-8 do better as a summer crop than in the *Kharif* season when greater cloudiness prevails.

Agro-climatic regions

It is possible to divide India into well marked agro-climatic regions and sub-regions as follows :

Temperate Himalayan Region

This region has heavy rainfall, temperate or sub-humid climate. The terrain is hilly. It includes hill areas of Assam, West Bengal, U.P., Himachal Pradesh, Jammu and Kashmir. Tea and fruits are commonly grown. Paddy, maize, potato are the major field crops.

Dry Northern Region

This region is characterised by low rainfall (200-750 mm), alluvial soil, cool winters and dry hot summers. It covers North Gujarat, Western M.P., Punjab, Rajasthan, Western U.P. The chief crops are wheat, maize, bajra, barley, pea and cotton.

Eastern Region

The main features of this region are heavy rain (about 1500 mm.), high humidity, loamy soil and hot humid climate. It comprises of Assam, Bihar, Orissa, Eastern U.P., Eastern M.P., West Bengal, Manipur and Tripura. The major crops are rice, sugarcane, pulses, banana, mango and tea.

Southern Region

The main features are medium rainfall (1125 to 1500 mm.), mostly black cotton soil, some red loams. The summers are hot, followed by heavy monsoon showers, and the winter is mild. It includes the plains of Maharashtra, Gujarat, Mysore, Andhra Pradesh and Tamil Nadu. The major crops are paddy, jowar, millets, pulses, groundnut, castor, cotton and tobacco. The important fruit crops are banana, grape and mango.

Western Region

The rainfall is usually above 2250 mm. Soils are alluvial. The summer and rainy seasons are fairly long but the winter is mild. It comprises of two coastal strips of Southern India, i.e., parts of Andhra Pradesh, Tamil Nadu, Maharashtra, Mysore and Kerala. The major crops are paddy, coconut, arecanut, rubber, coffee, and spices, such as pepper, ginger, cardamom and fruits such as cashewnut, pineapple and jackfruit.

Irrigation

Plants require moisture during germination, growth and formation of fruits. Most annual crops like wheat or paddy cease to need much moisture towards the end of their life cycle when they ripen at harvest time. Perennial and tree crops like mango need moisture throughout their life.

The characteristic of Indian rainfall is that nine-tenth of it falls during the four months of the year, the monsoon season, i.e., June to September. But the total annual rainfall or its distribution in various months of the year is variable. Crops which need moisture regularly during their period of growth suffer from such erratic variations. In fact lack of moisture at certain critical periods of crop growth like tillering or flowering, leads to disastrous reduction in yields, or total crop failure. An early cessation of monsoon rainfall in Kharif season, may reduce the soil moisture so low that in large areas it may not be possible to sow the winter or subsequent crops.

The importance of irrigation to ensure production is therefore quite obvious. India could be divided into three parts on the basis of irrigation requirements.

(*i*) Those areas where annual rainfall is very scanty, i.e., less than 750 mm. Successful crop culture is possible only with irrigation. Parts of Rajasthan and Punjab are examples of such areas.

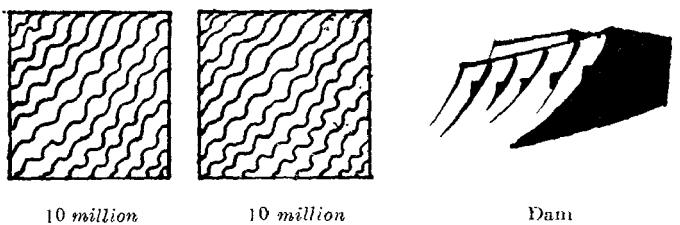
(*ii*) Those areas having normal annual rainfall between 750 mm. to 1149 mm. If the rainfall be well distributed most of upland crops can be grown with a total annual rain of 750 mm. or more. Rainfall being negligible during winter, winter crops in such areas need supplemental irrigation.

(*iii*) Those areas where the annual rainfall exceeds 1150 mm. Such areas are again divisible into two sub-groups :

(a) those which have negligible rainfall during winter;
(b) those having a precipitation even during winter, e.g., some Eastern areas in Andhra Pradesh and Tamil Nadu. In such tracts irrigation cannot be completely dispensed with because of high variability both in annual and monthly rainfall. For adopting new agricultural technology involving high yielding crops, assured moisture supply by irrigation is essential.

We are fast reaching the limits of land availability. Against an estimated ultimate net sown area of 142 million hectares, that may be made available for agriculture, we are now already sowing over 137 million hectares. But fortunately our water resources, which can stimulate available land for higher production, are relatively less utilised. They are, therefore, a ready means of intensifying production.

The annual rainfall over the country is just over 1110 million hectare meters of water. Of this about 370 million hectare meters is lost by evaporation and roughly 240 million hectare meters seeps into the soil, leaving about 500 million hectare meters to flow into the river system.



Additional 20 million hectares of land brought under assured irrigation

It has been estimated that out of 500 million hectare meters of our river flows, only about one-third can be utilised for irrigation because of limitations of topography, flow characteristics, climate and soil conditions. Most of this utilisable water, say, more than three-fourth, will be utilised by major (costing Rs. 5 crores each) and medium (costing between 15 lakhs to 5 crores) irrigation projects. The ultimate irrigation potential of these schemes is estimated at 45.3 million hectares. The balance will be utilised by another 12 million hectares which can be irrigated from minor surface water schemes. It is also estimated that 22 million hectare meters of underground water can be used to irrigate about 18.2 million hectares by minor groundwater schemes like surface wells and tubewells. The underground water potential is not yet fully known. As against known total irrigation potential of 76 million hectares, we have at present only about 34 million hectares (45 per cent) under irrigation from various sources of water from surface as well as underground. This actually amounts to one-fifth of the area under crops in the country. We have still a long way to reach the possible goal of maximum irrigable land.

Fertilizers

We know that India cannot grow enough food for her people because her crop yields per acre and production per animal are the lowest in the world. Except Oxygen, Hydrogen, Carbon and part of Nitrogen, which are furnished by water and the atmosphere, the remaining essential elements for plant growth—namely, Nitrogen, Phosphorus, Zinc, Boron, Manganese, Molybdenum and Sodium—are made available to the plant by the soil. Of these the big three—Nitrogen, Phosphorus and Potassium—are needed in much larger quantities than other elements listed here. A soil which has received judicious application of fertilizers and manure has a

higher capability to yield more per acre. But in India continuous cropping without returning sufficient plant food elements to it and lack of sound management practices have made Indian soils low in production.

It has been estimated that crops in India remove from the soil annually about 4.2 million tonnes of Nitrogen (N), 2.1 million tonnes of Phosphoric acid (P_2O_5), 7.3 million tonnes of Potash (K_2O) and 4.8 million tonnes of lime. A good part of all these elements has to be replenished through the application of manures and fertilizers.

In addition to application of organic manures like compost, etc., which are not available in large quantities, the only way to increase the fertility of large acreages of Indian soils substantially and rapidly is through the use of commercial fertilizers. In contrast to manures, the fertilizers are concentrated forms of plant nutrients.

Large number of experiments and demonstrations carried out in farmers' fields have shown that each kilogram of Nitrogen applied to a soil which has an adequate water supply increases on an average the yield of wheat or paddy by ten kilograms. At the current prices this is sufficient to pay for the cost of the fertilizers, leaving a substantial margin of profit to the farmer.

Our farmers now use 35 times the quantity of chemical fertilizers they used in 1947-48

But India is lagging far behind other developing countries in fertilizer use as the undermentioned table will show :

FERTILIZER USE 1965-66
(*Figures in Kg. per hectare*)

Country	*Fertilizer use* 1955-56	*Fertilizer use* 1965-66	*Increase over the period of ten years*	*Percentage increase in ten years*
India	0.97	5.0	4.03	415.3
Japan	254.3	321.3	67.0	26.3
U.A R.	54.9	131.5	76.6	139.3
U.S.A.	21.3	59.7	38.4	180.3

It is no wonder therefore that we are far behind these countries in yields per hectare as the table below will indicate :

ANNUAL AVERAGE YIELDS OF SELECTED CROPS, 1965
(*Figures in Kg. per hectare*)

Country	*Wheat*	*Maize*	*Rice*	*Cotton*
India	9.1	9.9	13.1	1.1
Japan	27.0	25.0	49.5	1.0
U.A.R.	27.7	30.3	41.8	6.5
U.S.A.	17.9	46.3	47.7.	5.9

In the application of fertilizers, profitability is not the only consideration. Soil type and available facilities of water are also

important factors. Another important consideration is the purchasing power of the farmer with a small holding. This has recently been taken care of by liberal loans from nationalised banks.

These difficulties and the problem of the education of the farmer have so far hampered rapid expansion of the use of fertilizers. However, as a result of the farmer's training work during the first three plan periods and assured minimum price of farm produce, the farmers in India are fast learning the use of fertilizers. The earlier prejudice against chemical fertilizers is disappearing.

To achieve self-sufficiency in food, very ambitious targets of production and consumption have been set for the Fourth Plan. By the end of the Fourth Plan the anticipated requirement of chemical fertilizer will be 3.7 million tonnes of N, 1.8 million tonnes of $P_2 O_5$ and 1.1 million tonnes of K_2O. Most of the nitrogenous and phosphatic fertilizers are to be produced in the country. Apart from fertilizers, the other important tangible source of plant nutrient is the cow-dung turned into compost, farm yard manure, sludge, sewage, bonemeal and green manuring. No regular estimates of the consumption of cow-dung for manurial use are available. It has been estimated to be about 0.7 million tonnes of Nitrogen.

However, it must be admitted that our organic manurial sources are not being utilised to the fullest extent. A major part of the dung is burnt for fuel. The estimates vary between 40 to 50 per cent. Besides burning, a considerable portion of the plant nutrients available in the dung is wasted by careless handling. Cattle urine which is ten times richer than dung in Nitrogen is mostly wasted. Green manuring and green leaf manuring has not yet been widely adopted. Unlike Japan and China, there is

prejudice in India against the use of night soil as manure even after proper treatment.

The need for plant nutrients to achieve higher levels of production are so great that the production and use of both organic and inorganic fertilizers has to be developed to the fullest extent. The cultivator should now plan his farming practices to produce the maximum of farm yard manure and compost to reduce his need for fertilizers through a planning of crop-rotation, green manuring and then meet the remaining deficiency in plant nutrients by the use of balanced fertilizers.

Pesticides

We are in the midst of the Green Revolution and food production has crossed the hundred million tonnes mark. But there is a large number of factors that impose serious limits to human efforts and resources. Much of the crop losses ranging between 10-30 per cent are caused by a variety of pests (insects, nematodes, rodents, fungi, bacteria, viruses) and by weeds. These losses could be reduced by timely and adequate plant protection measures. It is no wonder that plant protection has now been accepted as one of the major factors in increasing agricultural production along with other inputs like better seeds, fertilizers and irrigation. But it is unfortunate that the pesticides are used actually by our farmers only in cases of emergency mostly as a fire-fighting measure.

A central organization for plant protection was set up as late as 1946 in the wake of recurrent locust cycles invading India. Similar organisations were set up in the States in the fifties. The progress of coverage of area under plant protection measure was rather slow. Only 2.4 and 6.4 million hectares were covered during the First and Second Plans.

Intensive efforts made during recent years to ensure adequate and timely supply of pesticides, dusters and sprayers to farmers, have borne fruit. The area covered under plant protection shot up from 6.4 million hectares in 1956-57 to 40 million hectares in 1968-69. But even then the quantity of pesticides used per acre is about one-tenth of the quantity used in the developed countries. For adequate protection we should use about 25-30 grams of pesticides for every kilogram of plant nutrient applied as fertilizer.

Our Government has realised the importance of the pesticide industry. Starting with one factory in 1951-52 we have now built up installed capacity of 40,000 tonnes and actual production of 26,000 tonnes. By the end of the Fourth Plan we should be self-sufficient in pesticides.

Power

Cattle are really the kingpin of our agriculture. The male progeny provides the source of power for drawing carts and ploughing. The buffalo costs the farmers relatively less, both in price and in upkeep, than bullocks. But they are more useful for work under slushy conditions as in rice cultivation than in other dryland crops. In recent years the contribution of bullocks and buffaloes in hauling transport vehicles is diminishing due to the competition of trucks.

Cattle however will continue to be the chief source of motive power for operation for a long time to come. This is due to the small and scattered nature of our holdings. But in certain operations like rice or wheat threshing mechanisation is coming in. Electricity and diesel pumps are coming more and more into use in lifting water for irrigation and household purposes. It is estimated that 1.25 million pumpsets and tubewells will be energised during the Fourth Plan period.

Power implements are becoming more common for stationary types of farm operations like cane crushing, chaff cutting, etc. There were 38.4 million wooden and nearly three million iron ploughs in India in 1961. There were 77 million working bovine population. They are often in short supply during peak periods of farming operations.

On an average there is one pair of working animal per ten acres of crop land in India. Crops areas per pair of animals are larger in case of better quality animals.

At present we are hardly producing 16,000 tractors per year. The estimated number of tractors required is 90,000 per year with the increase of mechanisation by the end of the Fourth Plan. But we are hopeful that with the increase of production by the existing manufacturers and newer ones, it may be possible to meet the farmers' demand for tractors.

Plant Wealth

Plants are nature's wonderful chemical laboratories in function. Nearly all crops begin their growth as seeds. A seed consists of a seed coat, an embryo or small plant and a supply of food. In fact the embryo of a seed is a miniature plant.

The embryo of the seed is able to pass safely through unfavourable periods like cold weather or drought which may kill mature plants. But with favourable conditions, the sleeping embryo inside the seed begins to grow and it emerges from the seed. This process is called germination.

When a seed germinates, it needs water most. The function of roots is to anchor the plant in the soil and to absorb water and nutrients. The water and nutrients absorbed by the roots are taken up by the stem of the plants to the leaves. Leaves are special food making structures which grow out from the stem. The

green colour of leaves is due to a substance called chlorophyll which is contained in the leaf cells. The energy of sunlight is absorbed by the chlorophyll which is able to change water and carbon dioxide into sugar. After the sugar has been formed, it may either be turned into starch or to oils or it may be combined with the nutrients absorbed from the soil to form proteins. It is important to realise that it is the leaves which manufacture food in a plant. Therefore if the leaf area is reduced by hail or storm, by disease or the leaf-eating insects, the plant will yield less food.

When plants like wheat are making seeds, at the milky stage the food which has been stored in the leaves and stems begins moving upwards towards the flowers. When this food has been stored in the seeds, the rest of the plant body is very poor in quality and is called straw.

Like other living beings, a plant needs supplies of energy to maintain its life. Now there is energy stored in the molecules of food and the plant supplies its cells with energy by breaking down some of the food molecules which it has made. Carbon dioxide and water are produced by this process of release of energy, which is called respiration. That is why the godowns containing viable seeds feel warmer as seeds continue to respire even at their resting phase.

When a plant matures, it usually makes flowers in order to produce seeds and so reproduce itself. Flowers are male or female as in the pumpkin or both sexes in one as in beans.

The life cycle of the plant can be divided into four stages and in each stage growth is either weak or strong. In the seedling stage, like a human being's, the growth is weak, and unless it has favourable conditions the plant may not survive. Once they have passed the seedling stage, the active growth stage begins in which plants are able to withstand hard conditions. Again, like

the pregnant stage of women, the plants at flowering stage are tender and are likely to be damaged by unfavourable conditions like frost, hail, hot winds which may damage flowers. Once they set seed they again reach the hardy stage.

India is very rich in plant wealth having over 10,000 species. With our favourable climate we are able to grow a large number of crop plants.

Crops may be classified in many ways. Thus we may group them according to the kind of product they produce or by the plant family to which they belong, or according to use which they serve on the farm. The following list shows how crops may be classified by the product obtained from them.

Cereal or Grain Crops

Wheat, Barley, Oats, Rice, Maize, Sorghum, Ragi, Bajra.

Legumes Grown for Seed

Groundnut, Peas, Lentil Gram, Cowpeas, Beans, Arhar (Tur), Kalai (Black gram), Mung (Green gram), Soybean.

Oilseeds

Linseed, Mustard, Groundnut, Sun flower, Safflower, Soybean, Castor, Cotton seed.

Root Crops

Carrot, Turnip, Sweet Potato, Sugarbeet.

Fibre Crops

Cotton, Ramie, Jute.

Tuber Crops

Potato, Tapioca.

Sugar Crop

Sugarcane, Sugarbeet.

Forage Crops

Sorghum (jowar), Berseem, Lucerne, Maize, Napier grass or other fodder grasses and legumes.

Drug Crops

Tobacco, Mint, Pyrethrum.

Plantation Crops

Tea, Coffee, Rubber.

Forest Wealth

India contains a large variety of forest vegetation. The forest areas are unevenly distributed. Apart from scenic beauty, forest timbers contribute to the natural wealth of the country and moderate the climate of the different areas. Forests situated on hill slopes protect the cultivated plains that lie below them from the devastating action of hill torrents. Forests are reservoirs of valuable timbers and thus have to be managed carefully as a source of income to the country. Forests that yield only inferior timber, fuelwood or fodder are used for grazing and managed mainly in the interest of the local population. The forests are continually threatened by encroachment from farmers and herdsman.

In some remote areas in forests shifting cultivation is practised by some tribals. For this purpose they clear a patch of forest by cutting the trees and shrubs and burn them to ashes.

Forest soil mixed with ashes gives bumper crops. When after a few years the productivity of the patch goes down, they clear another patch of the forest. With this practice water has flown down the Assam hills and with it most of the productive soil.

Most of the commercial forests are protected by Government as reserved forests. For the last 60 years forests in India have been continuously conserved by the Forest Department.

We have to take steps to make our people forest conscious and enlist their willing cooperation in protecting them. The late Shri K. M. Munshi, the then Minister for Agriculture, Government of India, introduced a nationwide celebration of an annual tree-planting festival of *Van Mahotsav.*

In spite of all these efforts only 69.5 million hectares of land or approximately 22 per cent of the country's area, is forested in comparison with the world average of about 30 per cent. Per capita forest is only 0.2 hectares as compared to 3.6 hectares in U.S.A. Thus the existing forests are inadequate to meet the domestic and industrial needs of the country.

During the Fourth Plan, large scale plantation of valuable quick growing trees and species of economic and industrial importance will be created to increase forest production. Quick growing species of trees will be planted on 3,90,600 hectares, economic plantation for industrial and commercial uses will be set up in 300,000 hectares, farm forestry and fuel wood plantations in 75,000 hectares. The major objective is to achieve self-sufficiency in forest products as early as possible, especially in major forest-based industries such as pulp, paper, newsprint, wood panel products and matches.

Animal Wealth

Do you know that India accounts for about 20 per cent of

cows of the world and 50 per cent of total world population of buffaloes? This amounts to almost one-fourth of the world's cattle population. But India has only 2.5 per cent of world land mass to support them. During 1966 we had a livestock population of 343 million consisting of 176 million cattle, 52 million buffaloes, 42 million sheep, 64 million goats and other livestock. According to the 1961 census, the average human population per sq. km. in India is 142 persons; in addition, there are 110 livestock including sheep, goats, etc. This is much more than the land can maintain. But India's livestock products form a small portion of the world output because production per animal is very low, as compared to cattle in the western countries. In European countries like Denmark a good cow produces as much as 36 litres of milk a day whereas 94 per cent of our dairy cattle yield less than one litre of milk a day and 29 per cent produce even less than a quarter litre a day. A pair of bullocks is hardly able to serve a ten acres farm. The position is not so depressing in buffaloes, where about 20 per cent of the population produce at least two litres of milk per day.

Animal Husbandry today accounts for 14 per cent of the national income from the agriculture sector. Its contribution to the total national income of the country does not exceed six per cent.

In large areas of the country, cows are bred and kept for male calves which are reared into working bullocks, e.g., *Amritmahal* breed in Mysore. Buffaloes are kept generally for milk as milk yield and fat content in buffalo milk is quite high as compared to cows. Therefore, it is no surprise, she is our main source of *Ghee*. The male buffaloes are used for drawing carts or ploughing particularly in rice fields.

Cattle are our chief source of motive power for farm operations. There were 77 million working bovine animals in 1961. The area

cropped per pair of working animal is highest in Rajasthan or Punjab and lowest in Assam or Himachal Pradesh. This is related to the type and size of animals available in these areas. Besides providing farm power, cattle supply one of the most valuable forms of plant nutrients in the form of cattle droppings as manure. It has been estimated that if all the cattle urine and dung are utilised as manure, the present livestock can provide more than 12 million tonnes of Nitrogen per year. This quantity is equivalent to the production of fertilizers from at least 160 fertilizers factories of the size of the Sindri Fertilizer Factory in Bihar.

Assuming that about two-thirds of the cattle dung is wasted and burnt as fuel, the farm soils still get about four million metric tonnes of Nitrogen from this source. Thus even with the increase of fertilizer use for maintenance of soil fertility, there would be sufficient need for the use of farm yard manure, which in addition to supplying plant food, improves the physical condition of the soil as well.

Essential animal proteins, needed for human diets for balanced nutrition, come from livestock products like milk, cheese, *dahi*, butter, meat, eggs, fish, etc. Milk and its products are particularly needed for children of vulnerable (pre-school) age for their growth. The average daily consumption of milk and milk products per person in India is only five ounces as against 45 ounces in Australia, 35 ounces in U.S.A. The minimum daily need per person of milk and milk products is prescribed at about 15 ounces per day. By the end of the Fourth Plan it is planned to achieve a daily consumption rate of 0.28 litres of milk per head. The poor performance of Indian cattle is due to the result of their poor feeding, low milk inheritence, lack of grazing areas, scarcity of pedigreed good bulls and ineffic ent control of diseases. Though

many of our cattle breeds like *Sahiwal, Tharparkar, Haryana* or *Gir* possess the production potential, they are hardly even able to produce to their full capacity because they are not maintained and fed properly.

About 30 per cent of our cattle are unproductive and uneconomic. They are left to graze and rear calves in nature. Perhaps the only useful thing they produce is dung for cowdung cakes. Owing to ban on cattle slaughter due to religious sentiments in the country, they cannot be eliminated. They cause a heavy drain on available feed and grazing resources of the country. It has been estimated that only two-thirds of the fodder and one-fourth of the concentrates required for proper feeding of cattle are produced in India. Thus it is no wonder that cattle in India remain semi-starved and suffer from general malnutrition. With a ban on slaughter no effective culling is possible, hence breed improvement programmes like cross-breeding are having slow impact. In case of buffaloes there is however no difficulty in eliminating unproductive animals. Recently a bold cattle breeding policy of using bulls from some exotic Western breeds like Jersey, etc., to improve milk production potentials of our breeds has been adopted. These imported animals are, however, susceptible to some tropical diseases and parasites to which Indian cattle are relatively resistant. The cross-bred progenies are showing better adaptability. In addition, a crash programme to protect cattle against important diseases has been taken up. Similarly, intensive programmes of fodder development have been introduced. The surplus growth of fodders and grasses during monsoon are being preserved as hay and silage. In some chronic scarcity areas like Rajasthan, Fodder Banks have been set up.

Sheep and Goats

Sheep and goat products contribute substantially to the national income and earn foreign exchange for the country. Sheep provide wool, skins and mutton while goats provide meat, milk, hair and skins. A large number of people are engaged in looking after these animals and others in handling their products as their profession.

Average annual production of wool per sheep in India works out to 0.8 kg. This is very low as compared to fleece weights of sheep in Australia and New Zealand, where it ranges between four to five kg. per year. Likewise we hardly get a crop of 60-70 lambs per 100 ewes whereas in improved sheep breeds abroad, the lamb crop ranges from 120 to 140.

The bulk of Indian wool is coarse and suitable only for carpet or rug making. They fetch low prices and are unfit for fine woollen clothes, for which high priced wool is required to be imported.

The improvement of quality and quantity of wool in Indian breeds has been taken up through cross-breeding with imported breeds and scientific husbandry practices. Problems in goat husbandry are similar.

Fish Wealth

Surface water consisting of 27,000 km. of rivers, 11,200 km. of canals and numerous reservoirs and ponds provide a huge potential for fresh water fish culture. Similarly, with a coastline of 5,000 km., the wide arms of Indian ocean and gulfs and bays along the coast form an enormous source of marine fisheries.

India has over 1,500 kinds of fishes. But only a few types are caught in appreciable quantities. So far we have utilised only five to six per cent of our entire fishable marine area. Lot of

wastage takes place in transporting the catch before marketing, due to lack of adequate refrigerated transport or supply of ice.

About a million adults are engaged in fishing. Average catch per man per year does not exceed 1,120 kg. Sea fishing centres are confined to the coastal waters extending from five to ten miles from the shores of Gujarat, Canara, Malabar, Madras and Coromandal. In fact three-fourth of the catch comes from the West Coast, which abounds in fishes like prawns, lobsters, sardines, mackarel, etc. We are earning over Rs. 20 crores by exporting fish, mostly prawn and shrimp, particularly to USA. We propose to double our export earning by modernising fishing techniques.

Inland fish farming is most popular in North-east India. According to a recent estimate only 0.6 million out of 1.6 million hectares of cultivable water area in the country are being utilised. Most commonly cultivated indigenous fresh water species are the India carps, i.e., *Catla, Rohu, Mrigal.* Some imported exotic fresh water fishes like common carps, Tilapia, etc., are thriving in India.

The Indian carps spawn during the monsoon in the flooded condition of the rivers. The collection from these natural sources is the main source of fish seed for stocking the ponds in the country with fishes.

For a balanced diet, 85 gm. fish per person has been recommended. If we take the country's current population at 550 millions and assume that 50 per cent of the population is fish eating, we would need for a balanced diet mentioned above about 8.5 million tonnes of fish per year as against the current rate of annual production of 1.4 million tonnes. This reveals a shortage of 7.1 million tonnes of fish per year. It is no wonder that fish prices have been high all over India since imports from East Pakistan ceased.

Although pond fish culture has been in vogue for over 2,000 years, the average production of fish remains as low as 600 kg. per hectare per year only against yields exceeding 5,000 kg. per hectare per year reported by fish culturists in some South-east Asian countries. By adopting improved methods of fish farming like adequate stocking, judicious combination of species, population manipulation, intensive feeding and timely manuring, it should be possible to increase fish catches multifold. In experiments, production of 4,000 kg. of fish per hectare per year has been achieved.

Poultry Farming

Poultry farming is the quickest way of producing rich animal proteins and creating employment opportunities for a large section of the people without heavy investment. Poultry production has made rapid strides in many parts of our country. Inspite of such progress, the availability of eggs in the country is far below the minimum requirements of the people. It is estimated that in 1966 the total production of eggs provided only 11 eggs per person per annum. In the Fourth Plan it has been proposed to provide 48 eggs per capita annually for the egg consuming population which is approximately half of the total population. This will be achieved by evolving more productive poultry strains, by doubling the number of layer birds from 90 to 180 million, and by encouraging better feeding practices.

Piggery

Pigs are prolific breeders producing 8 to 12 piglets per farrowing. They are most efficient converter of feed as meat. They can be easily multiplied to provide animal protein. In addition to

lard (fat), pig bristles also fetch a good price and earn the much needed foreign exchange.

Improved foreign breeds have been introduced to replace the uneconomic native breeds. Pig breeding farms have been set up to multiply them. To process the produce, bacon factories are being set up in different regions. The non-vegetarians are being educated by extension workers about the advantages of the consumption of pig products.

Grassland and Fodder

Where trees and crops cannot grow, grasses can. Grasses improve soil structure and prevent soil erosion. The earthen dams, roads, embankments and dykes get added strength through a grass cover. Grasses are the most natural and nutritious feed for our cattle.

A living blanket of grass originally covered the virgin soils of the world and protected them against nature's powerful destructive agents—fire, air and water.

All domestic animals live on plants directly or indirectly. There is a nutritional chain—from plant to animals, and animals to man. Hence fodder production and pasture management receive a great deal of attention in other agriculturally advanced countries of the world. Unfortunately in India we do not pay adequate attention to these. Since the cattle are not provided with even the bare maintenance ration, the milch and draught cattle now have low milk production and working efficiency.

How serious the problem is can be realised from the fact that only three per cent of the cultivated area in India is under fodders. The grazing lands which constitute less than five per cent of the total geographical area are overgrazed and denuded. Their grass yields are low and that too of poor quality.

Out of the total area of 62.3 million hectares under forests, only 14 million are open to grazing. But only a small percentage of this area is utilised for grazing. Most of the cattle get some bite while grazing during the few months of monsoon. But for the remaining part of the year, due to inadequate grazing, they have to survive on such poor feed as rice straw or dried stalks of jowar, Bajra or Bhusa of Wheat, Barley and other crop residues.

Our agricultural pattern is changing fast. New cropping systems are being evolved. A harmoniously blended crop and livestock farming programme would involve introduction of rich nutritious fodder crop in the new relay cropping pattern.

High protein fodder crops which are also highly nourishing ones are berseem, lucerne, cowpea, and several other such leguminous plants. Of the non-legumes, the popular ones are maize, jowar bajra in Kharif and Oats and Peas in Rabi Season.

Apart from the above, some of the recently introduced fodder grasses suitable for Indian conditions are Elephant grass, Giant Napier, Guinea, Para, Rhodes and Dinanath.

Apart from the cultivated grasses, highly palatable grass species occur in natural grasslands. But due to overgrazing their density becomes low in the grasslands and unpalatable coarse grasses of low nutritive value predominate. Regeneration of such useful grasses in the natural grasslands can be brought about by controlled grazing and reseeding with suitable species. Fencing alone brings about quick regeneration of superior grasses which can support a larger animal population.

The supplies of green fodders and pasture grasses are abundant during and immediately after the rainy season. They are scarce or unobtainable in the dry months except in the irrigated tracts. The failure of monsoon rains even for one year causes

fodder famine. It has happened recently during the last two years in Rajasthan. A regular and steady supply of forage for animals can be ensured if the seasonal surplus fodders and grasses are conserved for later use. There are two ways of conserving green forage crops, namely, making them into silage or drying them into hay.

In silage-making green fodder is compressed and packed into air-tight pits or towers. Preservation takes place by the process of controlled fermentation of carbohydrates in the ensiled crop. That is why farmers call silage *Achar*, i.e., a pickled feed for cattle.

While silage is the succulent form of green fodder preserved for a scarcity period, hay is the dehydrated form in which the green matter is preserved and stored without much loss of nutritive value. Now a-days in many States surplus green grass in the forests is being converted into hay and compressed into smaller bales for transport to dairy farms. The quality aspect of hay making needs to be widely known among people. Most of them do not realise the difference between hay and straw from the nutrition point of view.

3

Crop Culture

LIKE all other living organisms the crops have the power of reproduction. They are propagated sexually, i.e., through seeds, or vegetatively, i.e., through some part of the parent like cuttings in grapes, tuber in potato or suckers in banana. Vegetative propagation ensures that the characters of the parent pass on to the progeny. That is why we find that mango grafts are planted instead of seeds of the fruit.

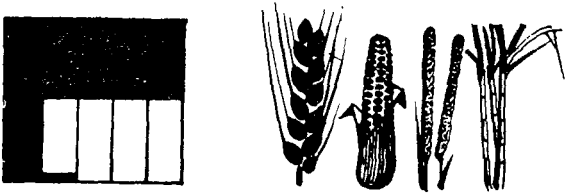
Our cultivated crops differ from their wild ancestors. The crop fields of older days used to have a mixed population. But only the types adapted to the environment survived. From antiquity this process has been helped by our forefathers by the custom of saving outstanding ears of crops or fruits for seeds for next year's sowing. Our modern plant breeders even now follow

in some ways the same age old method of plant selection. In self-fertilized crops like wheat or paddy, single plant selection gives uniform seed stocks.

The second important method of crop improvement is hybridisation or cross-breeding. A plant otherwise acceptable but lacking some desirable quality (character) is mated to another possessing that quality by transferring pollen from one flower to the stigma of the other flower. The first generation does not breed true but in later generation as per laws of inheritance the characters get sorted out for varieties having the desirable qualities. That is why it takes several generations to evolve a new crop variety.

Our plant breeders are even using X'rays or nuclear energy for bringing about quick change in genes, i.e., units of plant inheritance. The most recent example is *Sherbati Sonora*, the amber coloured wheat variety produced by atomic radiation from high-yielding red wheat of Mexican parentage, at the Indian Agricultural Research Institute, New Delhi.

In every State we now have a large number of plant breeding stations. Research work in the States is being linked through All India Coordinated Research Projects financed by the Indian Council of Agricultural Research at the Centre.



Additional 6.07 million hectares of land brought under multiple crops

High Yielding Crop Varieties

We have learnt earlier that the unique asset of tropical and sub-tropical agriculture in a country like India is her abundant sunlight throughout the year. This makes it possible for irrigated areas to take up multiple cropping, i.e., growing two or more crops per year. For achieving the aim to produce maximum grain per hectare a radical reconstruction in the morphology and physiology of our crop varieties is necessary. Fortunately our scientists have been able to evolve recently high-yielding varieties of crops in Wheat, Rice, Jowar and Bajra. They possess a dwarf, non-lodging habit, high photosynthetic ability, high response to fertilizers and resistance to diseases.

In India 73.6 per cent of the cropped area is under foodgrains, 19.6 per cent under oilseeds and 5.5 per cent under fibre crops. About 80 per cent of the cropped area is unirrigated and mainly dependent on the rain, hence it is no wonder that Indian agriculture is called a gamble with the monsoon. The fact that about 22.5 per cent of the total cropped area in India is under rice, but of which hardly 38 per cent is irrigated, makes Indian agriculture all the more unstable.

The national demonstrations conducted in farmers' fields in 100 districts of India have shown that with the use of new technology, fertilizer responsive seeds, balanced use of fertilizers and proper plant protection measures, farmers can increase production by six to eight tonnes per hectare.

Let us review the position of our important crops.

Rice

Rice is the staple food of more than half the population of the country. Though the yields per acre are low, India covers

about one-third of world acreage. One of the main reasons for this situation is that rice is grown under diverse conditions, spreading from Tamil Nadu to Kashmir and Maharashtra to Assam. The States of Bihar, West Bengal, Uttar Pradesh and Assam account for about three-fourths of the country's acreage. The major portion of this area is either rainfed or subject to flooding. India should be able to increase her rice production substantially by intensifying efforts in the cultivation of high-yielding dwarf and fertilizer responsive varieties which are amenable to better water management practices. They are usually of short duration and may be planted in any season in warmer rice growing areas. A procession of such varieties suitable for different areas have been released by scientists during the last few years. Some of the notable ones are *IR*-8, *Padma, Jaya, Jagannath, Pankaj* and *Sabarmati.*

Jowar

Not many people are aware that area wise jowar comes next to rice but in production its position is next to wheat. It is an important crop of the drier parts of the country. Its yield per acre is low because most of it grows under unirrigated conditions. Jowar is consumed by the poorer section of our people. In recent years varieties of hybrid jowar like *CSH* 1, *CSH* 2 and *Swarna* have been given to the farmers. They produce very high yields even in dry farming areas.

Wheat

Wheat is an important crop in the northern states of Uttar Pradesh, Punjab, Haryana, Rajasthan and Madhya Pradesh. After the release of the stiff straw, dwarf disease resistant and ferti-

lizer responsive varieties, the country has really witnessed a 'Wheat Revolution'. Total wheat production in the country shot up from seven million to nearly 20 million tonnes in three or four years. The scientists feel that with the wider application of new farming techniques by the farmers, the total production of wheat can be further increased. The latest high yielding varieties in the field in most of the States are *Hira, Kalyansona, UP* 301, *Sonalika, Sherbati Sonora* and others.

Bajra

Bajra is an important crop in the States of Rajasthan, Haryana, Gujarat, Maharashtra and Uttar Pradesh. The crop is grown in the driest parts of the country. It is grown in areas having the least rainfall. The first hybrid of bajra *HB* 1 with high yield potential was given recently to the farmers. Fortunately it grows well both under irrigated and unirrigated conditions. Recent varieties are *HB* 3 and *HB* 4.

Maize

Maize crop acreage is spread over the States of Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Bihar and Himachal Pradesh. The introduction of hybrids and composite varieties of maize has ushered in a new era in the cultivation of the crop in the country. The reputed hybrids in the field are *Ganga* 3, *Ganga* 5, *Hi starch, Ranjit* and *Deccan.*

Pulses

For a large population of the country, pulse crops are the main source of proteins. Being leguminous crops, they are largely grown in the unirrigated areas. They are rarely manured. The yields are poor. To meet the general protein malnutrition in the

country, these crops are receiving attention as a source of vegetable protein. But as yet our scientists have not been able to achieve a breakthrough in crop yields, hence production potential is low.

Oilseed Crops

India produces large number of oilseed crops. In fact it occupies the first place in the world both in total production and in acreage. Oilseeds cover ten per cent of the total cropped area, but only three per cent of the entire area under oilseeds is irrigated. In our country they are grown in mixture with other crops. Oilseeds production is not keeping up with our requirement or for home consumption, industry and export trade. Intensive search programmes have been taken up by our scientists to produce high-yielding varieties of oilseed crops.

Fibre Crops

Cotton and jute are two most important fibre crops which supply raw materials to our cotton textile and jute industry. In the case of cotton, 80 per cent of the crop is still grown under rainfed conditions. Three-fourths of the crop consist of short staple varieties mostly suitable for coarser textiles. Attention of scientists is focussed on developing long staple varieties which we have to import for our mills. Some of the new such varieties like *Sujata*, suitable for superfine cloth spin 120 counts. Cotton Hybrid No. 4, developed in Gujarat has very high yield potential.

Two most important types of Jute are *Olitorious* and *Capsuralis.* They are grown mostly under rainfed conditions in West Bengal, Assam, and Bihar. Intensive research for jute and cotton is in progress and efforts are being made to develop high-yielding fertilizer responsive varieties.

Sugarcane and other Sugar Crops

The area under sugarcane has been changing year after year depending on the comparative prices of cereals and sugarcane. This crop supports our second industry based on raw-material from agriculture. The major area is in the States of U.P., Bihar and Maharashtra. As yet real breakthrough in yield potential has not been achieved, but this is one of the greatest fertilizer consuming crops in the country. Our yield per acre is low, hence, the cost of sugar is high as compared to the world market.

Tobacco

The tobacco crop occupies an area of 0.4 million hectares in the States of Andhra Pradesh and Gujarat. Good quality of artificially cured cigarette varieties are grown under rainfed conditions. It is an important foreign exchange earner.

Seed Production and Seed Certification

Every farmer wants good seeds for sowing his crops. The superior varieties of foundation seeds are initially produced by the agricultural scientists in small quantities at the research stations. Till recently we did not have reliable agencies who could multiply these seeds and supply them to the farmers.

Now the Government of India has set up a National Seed Corporation with branches in all the States to supply seeds to the farmers. This organisation has taken up multiplication of seeds produced by the breeders. They also test and certify the seeds. The certified seed label on sealed seed bags ensure the farmer of the purity of the variety and germination capacity. In this respect the interest of the farmer is safeguarded by the recent Seed Act passed by the Parliament. It requires that all seeds sold through the commercial channels must bear labels of seed certification given by the seed laboratories in the States.

4

Crop Protection

Most of us are aware that our crop plants have many types of enemies which limit production. With the liberal use of fertilizers, multiple and relay cropping, etc., insects, diseases and weeds tend to multiply quickly. The continuous growing of high yielding *Taichung Native I* rice in large area, led to the appearance of bacterial blight and other diseases in large tracts.

It is hardly possible to grow hybrid jowar without adequate plant protection measure against shoot fly. Chemical methods have proved most effective. Seed treatment before planting is also advisable. The farmers are now adopting full seasonal control schedules from sowing till harvesting.

We know that harmful insects not only compete with man for

food but also transmit diseases to man, animals and crop plants. Likewise crop diseases reduce crop growth and may kill the plants altogether. Therefore it is very important to keep the multiplication of insects and plant diseases under control by various crop protection measures. Insect control methods could be broadly classified as natural or artificial.

Some of the natural control agencies are climatic factors, predators, and parasites. Man applies poisonous chemical compounds called "Insecticides" for artificial control practices.

Earlier, for insects with biting mouth parts like cockroaches and caterpillars, dangerous stomach poisons like lead arsenate were used. Similarly for insects with sucking mouth parts attacking crops like aphids or other bugs, spraying of tobacco decoction was common. For stored grain pests of cereals like weavils or *Khapra* beetle, fumigation with hydrocyanide gas was practised. This was also used for fumigating burrows of field rats infesting standing crop plants. A mixture of lime and copper sulphate in water known as Bordeaux mixture was the common prescription earlier against plant diseases.

During the second world war , the discovery of DDT made insect control easier. It could control a wide range of harmful insects. It first proved most effective in controlling malarial mosquitoes, which carried malarial parasites to the human population.

During recent years, new insecticides which are more effective have come in the market. Some of the common ones known to the farmers are Endrin, Parathion, Malathion, Sevin, etc. Similarly newer fungicides like Agrosan, Captan, Blitox, Dithane, Fytolan , etc., have come in the market. They are applied by small hand or mechanically operated machines called sprayers

or dusters. The dosage and time of application is ascertained by the farmers from the extension workers posted in the blocks.

The insecticides are harmful not only for insects but also for human beings and animals. They also kill some beneficial parasites and predators, which keep natural multiplication of pests under check, and also the useful insects like honeybees. Therefore, great care is to be exercised in the application of insecticides to safeguard against some of these dangers. A combination of different control measures is the best solution in this respect.

Biological control measures using the natural enemies of crop pests appear to be the safest method of control. Under this method, the natural enemies are multiplied in large numbers and under controlled conditions and released in large numbers in the fields. They parasitise either on the egg or caterpillar of the host insect and gradually kill them by sharing the food. Some of the predators hunt them for prey as in the case of ladybird bettles feeding on aphids.

One of the famous examples of biological control of a crop pest is the use of *Trichogramma* wasp which feed on the borers of sugarcane.

Some of the notorious perennial weeds have been successfully controlled by employing biological control techniques. The best local example is of prickly pear, a thorny succulent cactus type of weed which was spreading over cultivable land and was becoming difficult to control. A plant lice called cotton cushion scale was introduced from abroad. It multiplied fast and sucked the plants continuously. As a result prickly pear weed has disappeared from many areas in India.

Insect resistance in crop plants is the answer to the problem of crop protection. The plant breeders are now trying to evolve

crop plants with crop pest resistance. This is a task not easy to accomplish. We have now sugarcane plants relatively resistant to borers, and cotton plants with hairy leaves resistant to leaf hoppers.

In the case of plant diseases also similar crop protection measures have to be adopted. Our specialists have prescribed different fungicidal dusts or sprays against different crop diseases as a preventive or protective measure. One biological control method now used in disease control is the application of antibiotics like streptocycline against bacterial blight disease in paddy.

Some insects serve as carriers of virus diseases of plants. The spread of the disease can be prevented if the multiplication of carriers like aphids or other bugs is controlled by timely insecticide spraying.

The plant breeders have now introduced disease resistance in most of the crops as one of the essential objectives in their plant breeding programmes of improved varieties.

5

Economics of Agricultural Production

It is not difficult to identify the link between the biological nature of agriculture and economics. Directly the growth of a plant may not have much to do with economics but the process of agricultural production is repeated a number of times and mainly to satisfy certain needs of the producer.

First comes the need for food and there are a large number of other needs which cannot be satisfied by the crops he grows. He has to sell a part of his produce to obtain cash to pay for his other needs. Thus, while the physical process of agriculture has nothing to do with economics, the purpose behind undertaking this process in more often than not economic in nature. It is because of this relationship that economics is concerned with all areas of our agriculture, be it production, consumption, marketing or any other field.

The farmer is required to decide what crops he will grow on the farm and how much area he will put under each crop; what inputs he will use in the raising of these crops and wherefrom he will get them and how he will sell his produce. For answers to such every day questions Agricultural economics helps him in making decisions. It guides the farmer to get the maximum possible income.

Agricultural economics does not deal with farmers alone. Its one aspect of study is at the farm level since agriculture contributes almost half of the national income. An agricultural economist in India also studies the problems like the relationship between agriculture and industry, trade in agricultural commodities, government policies and programmes related to agriculture.

In short, we see that at the farm level, Agricultural economics indicates how the farmers can obtain the maximum returns; at the national level, it studies the problems of international trade and impact of government policies and programmes on agriculture. It also shows how the national production can best be increased and how best the resources of the country as a whole can be utilised.

We chose the path of democracy in order to achieve the economic well-being by mobilising, through persuasion and consent, the maximum possible resources for nation building. While laying down the broad social and economic goals before the country, our constitution desires these goals to be achieved through democratic planning. Soon after independence the national government headed by Pandit Jawaharlal Nehru decided that the nation should have a plan of work. The Planning Commission thus came into being in 1950, with the Prime Minister as Chairman. This body of experts has so far drawn up four Five Year Plans to put our men and resources to the best use. The total plan outlay from

the first to the fourth plan increased from about Rupees 2,000 crores to 24,000 crores.

It is no surprise that in the early days of the Green Revolution, the Deputy Chairman of Planning Commission was Dr. D. R. Gadgil, an eminent agricultural economist. Realising the importance of ensuring fair price of farm produce, an Agricultural Prices Commission, consisting of economists, has been set up to advise the Government in the matter.

6

Extension Service to Farmers

THE Indian farmer was using primitive methods of cultivation till recently. This was not much different from the farming practised in the Vedic times. Some tribal people in the Assam hills even now follow the practice of what is known as *Jhoom* or shifting cultivation. They cut down the trees in the forest and burn the bushes to clear a piece of land and sow seeds of a crop. Later, as crop production diminish, they shift elsewhere and clear a fresh piece of forest land for cultivation. For centuries our farmers have faced floods and droughts. Their crops suffered from diseases and pests. They did not know well the use of chemical fertilizers or pesticides.

It was therefore necessary to train the farmers in modern methods of farming. About 20 years back an agency called

National Extension Service was set up for the purpose on Gandhi-ji's birthday in 1951. The unit was a block serving about 100 villages. There are over 5,000 blocks in 313 districts in India. In each block there is a Block Development Officer assisted by a cadre of Extension Supervisors and ten multipurpose village level workers. In intensively farmed areas their numbers are doubled. They help the farmers to procure the agricultural inputs and arrange a number of field demonstrations to enable the farmers to learn quickly improved farm practices. The *gramsevak* seeks guidance from agricultural extension supervisors when he is unable to solve the problems of the farmer himself.

All the blocks in the districts are linked to the District Agricultural Officer. He is fed with the latest technological information by the Agricultural Information Units at the State Headquarters. They in their turn are guided by the State level specialists in different fields. Most of them are located in the Agricultural Colleges or Research Institutes to work out solutions to the farmer's field problem.

The situation is rapidly changing with the establishment of at least one agricultural university per state. They are taking over the statewide research work and extension education functions. The State Departments of Agriculture and Animal Husbandry look after the supply of inputs to the farmers. Commercial agencies like Fertilizer or Seed Corporations serving farmers are increasingly coming into these areas.

A bridge has been established for outflow of knowledge and inflow of farmers' problems by posting three or four university specialists in each district to help the District Agricultural Officer. The matriculate *gramsevaks* need to be replaced by more technically competent agricultural graduates.

7

New Agricultural Strategy

OUR agriculture had remained stagnant not because the 350 million Indians who work on land are lazy or backward, but because they lack the means to work more effectively.

After independence we started the first Five Year Plan of development in 1951 and had two more plans completed by 1966. The average food production recorded during the three plan periods were 65, 75 and 80 million tonnes respectively. Production of commercial crops like jute, sugarcane and cotton also increased considerably.

The above figures show that the rate of growth slowed down during the third Five Year Plan, partly reflecting two years of drought. The steady rise in the import of foodgrains during the 15 years of the three Five Year Plans confirmed the fears that

increase of food production did not keep up with the demand due to faster rise of population.

The agricultural scientists working with foreign germ plasm of crops claimed in the sixties that undreamt of yields per acre could be obtained in food crops in India with the proper application of science and technology. At some research centres it was demonstrated that more than ten tonnes of foodgrains could be produced per hectare per year from the same land using methods which were within the reach of an average farmer. Currently the average yields hardly exceeded a tonne.

To face the food sufficiency problem, Shri C. Subramaniam, the then Union Minister for Food and Agriculture, developed a new strategy for agriculture in 1966. The goal set to attain the objective was 1971.

The newly evolved high-yielding dwarf varieties of cereals are the chief items in the production programme. They attracted the farmer with their capabilities to produce even 100 per cent more yield than the existing varieties of crops. The earlier evolved improved varieties with capacity for yielding 10 to 20 per cent more than the local ones did not impress the farmer.

The key point of the new strategy was to concentrate the valuable seeds of high-yielding varieties of cereal crops and the still inadequate supplies of fertilizers and plant protection materials on 13 million hectares of our land with assured irrigation. This represented only one-twelfth of India's total cultivated area and no more than a third of even the total irrigated land.

Moreover, these crops were grown with the full complement of package practices in respect of fertilizers, pesticides, irrigation schedules, etc.

Growing of more than one crop of high-yielding crop per year

in the areas of assured irrigation was also encouraged. The farmers were provided with easy credit facilities to purchase the required inputs.

To ensure that the farmer gets fair price of his produce, the Government set up an Agricultural Prices Commission to determine the minimum fair price for his crop to be harvested. A Food Corporation was set up by the Government to take up marketing of the agricultural produce. They rushed into the market to purchase from farmers whenever the market price fell below the minimum price announced earlier. This organisation safeguarded the interest of farmers and protected them against unfair trading practices.

8

Recent Breakthrough in Agriculture

We have coined the popular term 'Green Revolution' to publicise the recent technological leap forward in agriculture. Indian farmers are now increasingly adopting the most modern and scientific techniques for stepping up productivity.

The production of total foodgrains has crossed the 100 million tonnes mark as against only 72 million tonnes five years ago. There has been a steady rise in total production during the last five years inspite of two unfavourable crop seasons. One of the chief contributors to this increase has been wheat.

The production of rice has risen during the same period from 30 to 40 million tonnes and of wheat from 10 to 20 million tonnes. Though once in a very favourable year in 1964-65 we had touched

total food production of 89 million tonnes with rice contributing 39 million hence, a stable rice revolution has yet to come.

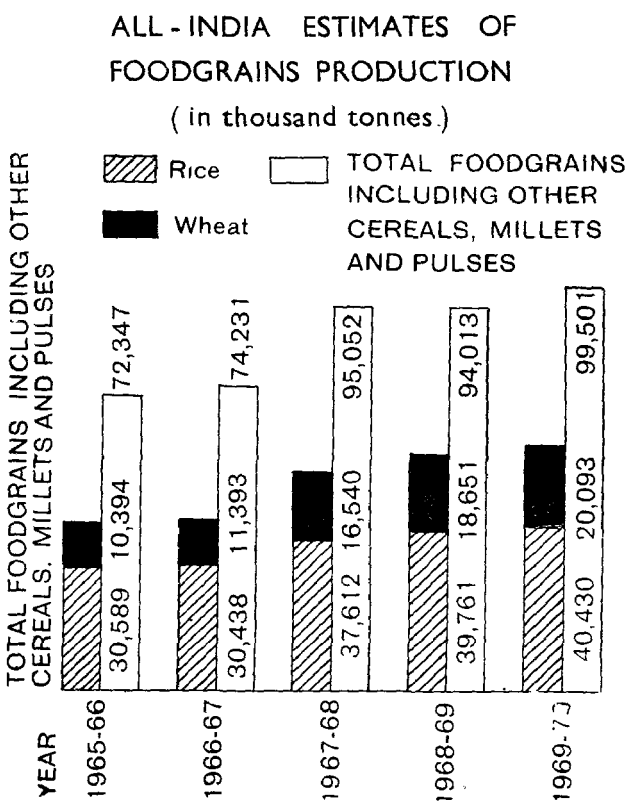
The dramatic story of the wheat revolution may be told in greater detail. Some American scientists discovered the famous *Norin* dwarf genes in Japan. Dr. Norman Borlaug, Nobel Prize Winner, used these dwarf units of heredity in wheat to produce high-yielding Mexican wheats. The results were spectacular in Mexico. They soon became a wheat exporting nation.

Dr. Borlaug on his visit to India in 1963 felt that the northern parts of India had similar climate as Mexico, hence Mexican wheats could perhaps fare well in India. Mexican wheats were tried in India for two seasons with great success. A bold decision was taken by the Union Government to import 18,000 tonnes of Mexican wheat seeds in 1967. As a result, we had nearly 0.4 million hectares under such high-yielding wheats in 1967 and 20 million hectares in 1968. Perhaps there is no parallel for such rapid spread of new varieties of a crop in the world and breakthrough in production.

In rice also dwarf stiff straw high-yielding varieties obtained from Taiwan first and then Philippines repeated the story of wheat. They could utilise high fertilizer doses and be sown any time of the year provided the temperature and moisture conditions were favourable. They recorded undreamt of yields per hectare.

In *Bajra* and *Jowar* also similar high-yielding varieties were produced by our scientists in India with some male sterile parents obtained from USA. They proved immensely popular with farmers in areas without adequate irrigation facilities or low rainfall.

The main moving force in the new strategy is the message of scientific agriculture. The link between the agricultural scientists and the farmer had to be found. The new agriculture universities, one in every state, have taken up farmer's education, research and



teaching. After a good deal of thought, the national demonstration scheme was introduced. This demonstration is being conducted by a group of agricultural scientists in one or two hectares of a farmer's field in 100 districts.

It is no wonder that there has been a dramatic rise in the use of agricultural inputs by the farmers. The consumption of nous and phosphatic fertilizers have increased five-fold

during the last five years. The area under high-yielding varieties increased six-fold during the same period. The area under multiple cropping trebled.

There has been some complaints about the taste of wheat and rice of high-yielding varieties. The scientists are quickly remedying the defects and varieties with better consumer preference are being released to farmers every year.

9

Future Prospects of Our Agriculture

THE new strategy of intensive farming in areas of assured rainfall has been responsible for the recent rapid food production increases. As a result India has been able to attain a level of output at which 100 million tonnes production may be regarded as quite an easy performance. India may now consider building a buffer stock of a few million tonnes against future bad weather. Some people talk of exporting grain within the near future even after allowing for the additional 13 million mouths we have to feed each year.

Beset by droughts but encouraged by its own successes, agriculture has become a genuine top priority item with the Union and State Governments.

The output effects of the Green Revolution have been amply

demonstrated. The first year of good weather after the droughts in 1967-68 brought in a bountiful grain harvest of nearly 100 million tonnes, ten per cent higher than any previous best production. During 1968-69, the weather was below average yet the total production equalled the previous year. It provided the confirmation that a corner has been turned and production is no longer a gamble of monsoons. All data indicate that now Indian agricultural production is capable of a rate of growth of five per cent compared to 2½ per cent per annum during the period of 1950 to 1965.

With the Green Revolution marching through the countryside, the hunger and starvation deaths are rare, i.e., the calorie gap has been bridged. But it has not really minimised the dangers of malnutrition, i.e., imbalanced feeding. Therefore, during the next plans we have to tackle the problem of malnutrition and protein hunger in this country on a war footing. Fortunately in India, pulses constitute the most widely used component of the Indian diets. They contain 20 to 30 per cent on protein dry basis which is nearly three times the value found in the cereals. The proteins present in cereals and pulses differ in aminoacid composition and make good each other's deficiency.

India has the largest area in the world under pulse crop but in recent years the development of remunerative high-yielding grain crops is said to have resulted in a shrinkage of the area under pulses which account for about 11 per cent of the total grain production.

Intensification of pulse production to meet the protein deficiency in the country is part of the next phase of agricultural development. Time is ripe for initiating a high and quick-yielding pulse varieties programme on the model of high-yielding varieties

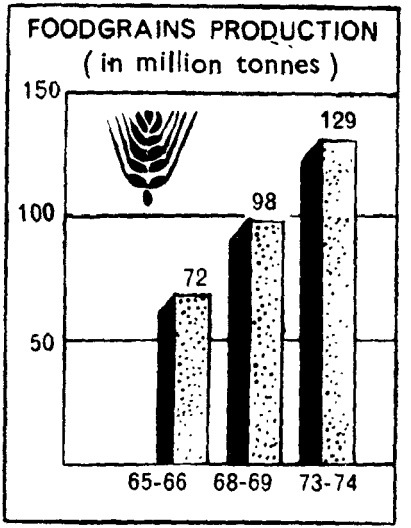
of cereals. Soybean, a leguminous oilseed crop containing very high protein percentage shows promise in a few States of providing a cheap protein source of high quality for vegetarians in addition to its oil. The animal products would provide additional protein for non-vegetarians.

With this background, we may review the current plan and the future plans to come in agriculture. In agriculture, the Fourth Plan has two main objectives. The first is to provide the funds necessary for a sustained increase in production of about five per cent per annum over the next decade. The second is to involve as large a section of rural population, including the small cultivator and the farmer in dry areas, to participate in development and share its benefits.

We envisage the following targets of crop production (in million tonnes) :

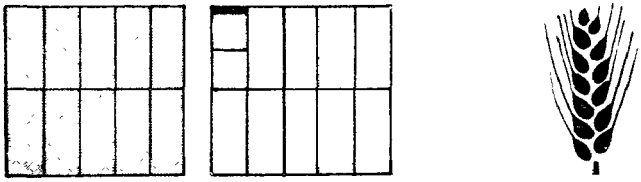
	Base Level (1968-69)	*Fourth Plan Targets* (1973-74)
Foodgrains	98	129
Jute	6.2	7.4
Cotton	6	8
Oilseeds	8.5	10.5
Sugarcane (Gur)	12	15

An important consideration in determining this target is the objective of eliminating foodgrain imports by 1971. Except in the case of long stapled cotton, imports of all agricultural commodities will be stopped as soon as possible.



The main strategy in achieving the production targets is based on intensive scientific agriculture. The five key elements are :

1. Full exploitation of high-yielding varieties of cereals with greater attention to qualitative aspects.
2. Intensive effort in selected areas to raise yield levels of major commercial crops.
3. Continued expansion of irrigation facilities and reorientation of current irrigation practices.
4. Expansion in the supply of fertilizers, plant protection materials, farm machinery and credit.
5. Improvement in the agricultural marketing system in the interests of the producer and assurance of minimum prices for major agricultural commodities.



High-yielding variety of seeds introduced on 10.5 million hectares of land

Success in the achievement of food production targets is mainly linked with the success of the high-yielding variety programmes. About two-thirds out of the additional 31 million tonnes of foodgrain production envisaged will be contributed by this item.

Schemes of irrigation, supply of fertilizers, seeds, pesticides, farm machineries, and strengthening of technical services in the villages will support these production programmes.

To enable the small farmers to adopt techniques of the Green Revolution and share its benefits, the general loaning policies of banks, and similar agencies will be reoriented in their favour.

Research will play a significant role in the Fourth Plan agricultural programmes by providing the latest knowledge for profitable farming. The Indian Council of Agricultural Research, the apex organisation in agricultural research and education, will be further strengthened and provided with adequate funds to continue work on all important food and commercial crops.

In agricultural education, already a dozen agricultural universities are functioning in the States to serve the farming communities. By the end of the Fourth Plan every State will have at least one agricultural university.

Agricultural scientists are being brought in direct contact with farmers through national demonstrations conducted in their

fields and other farmer's training programmes. The All India Radio Farmer's Forum programmes are playing an important role in this sector. Rural television agricultural programmes through satellites are being planned to teach new agricultural techniques.

Adequate production of high quality seeds will be ensured by the National Seeds Corporation, who are operating large mechanised seed farms.

Almost three-fold expansion is visualised in the consumption of chemical fertilizers. Indigenous industries would be able to supply most of it by the end of the Plan. The story is similar in the case of plant protection programmes where 80 million hectares are proposed to be covered.

In the Animal Husbandry sector systematic cross-breeding of Indian with foreign breeds and improvement in production of feeds and protection of animal health are the main planks of the programme. The real break-through in animal production has yet to be achieved, as in crops. Some of the Fourth Plan targets are, increase of milk production from 21 to 25 million tonnes, egg production from 5300 to 8000 million and wool production from 35 to 38 million kilogrammes.

Even if we achieve this it would work out to be 0.28 litres milk per head per day and 48 eggs per head per year. Thus we would still be far behind our normal requirements for proper nutrition. It is no wonder that a large percentage of our pot-bellied children without such essential food show signs of malnutrition.

The agricultural outlook beyond the Fourth Plan, i.e., upto 1980-81, appears to be hopeful. The objective of long-term plans is expected to be the same as Fourth Plan, i.e., growth with stability. The demand for farm product is estimated to rise at the rate of 4.7 per cent a year.

The agricultural production will have to increase a little faster than demand during the Fourth Plan, so that the dependence on imported foodgrains may be eliminated altogether. Thereafter, over the period as a whole agricultural production will have to increase by five per cent a year.

The provisional projection of the area yield and production of major crops in 1980-81 and comparative figures of 1968-69 are given below :

	1968-69			1980-81		
	Area in million hectares	*Yield Kg./Hc.*	*Production inmillion tonnes*	*Area in million hectares*	*Yield Kg./Hc.*	*Production in million tonnes*
Cereals	99.2	843	83.6	107.00	1389	148.6
Pulses	21.3	488	10.4	25.0	44	18.6
Oilseeds	14.6	473	6.9	20.0	760	15.2
Sugarcane (Gur equivalent)	2.5	4878	12.0	3.2	6875	22.0
Cotton (Lint)	7.7	124	0.85	11.5	172	1.98

As compared to gross cropped area of 156 million hectares in 1966-67, it is projected to reach 188 million hectares by 1980-81. The rate of increase expected is 1.3 per cent per annum. This is approximately the same as for the first three plan periods.

The major part of additions to cropped area as during the Fourth Plan will have to come from increase of area under multiple cropping. The gross irrigated area is expected to touch 58 million hectares by 1980-81. The cropping intensity in irrigated area would reach 150 per cent, i.e., about one and a half crop per year.

The projected growth of crop area in 1980-81 as compared to 1966-67 is :

	1966-67	1980-81
	(In million hectares)	
Net sown area	137	151
Gross sown area	156	188
Gross irrigated area	32	58
Gross unirrigated area	123	130

The cropped area will increase hardly 1.2 per cent per annum; therefore, steep rise in yield per acre with newer technology will be required to achieve the target of production.

The current progress in agriculture based on research results will be sustained. The Indian Council of Agricultural Research will be further strengthened and provided with adequate funds. The Council's research projects would cover all important food and commercial crops and most of animal products.

In agricultural education, the 14 agricultural universities already set up in 13 States to support agricultural production will be strengthened. Three more such universities will be set up and developed to full stature so that every major State has at least one agricultural university.

10

Our Outstanding Agricultural Scientists

We have had a galaxy of agricultural scientists who have contributed to the development of scientific agriculture in India. Sir T. S. Venkatraman is known as the saviour of the Sugar Industry in India. He produced new sugarcane varieties at Coimbatore with high yield and greater sugar content. He used the wild *kans* (*Sachharum*) grass as one of the parents for breeding varieties which matured early and could grow without irrigation in the northern sugar belts of the country. His varieties have spread in most sugarcane growing countries in the world. With his contribution he made India self-sufficient in sugar production in the early thirties.

Dr. K. Ramiah is now a member of Rajya Sabha representing the scientists. He made a major contributions in rice breeding.

He was a pioneer in producing a variety of rice (*C.*0.25) in Madras which was resistant to the dreaded blast disease in South India. He initiated the crossing of Japanese and Indian rice to incorporate high-yields in our varieties. This led to the evolution of the famous high-yielding variety *ADT* 27 in Tamil Nadu. This has made double or triple cropping of rice easy in that area.

Our University Professors have not lagged behind in their contribution to agriculture. Professor Karam Chand Mehta at Agra College worked out how the rust disease cycle in wheat and barley operated in India. Unlike as in other countries, these disease organisms in India spend their summer life cycle through the summer wheat and barley crops grown in the hills. He proved that winds from the hill carry infection to the Gangetic plains. Then there was summer exodus of the disease in the spring from the plains to the summer crop in the hills. The stoppage of cultivation of such crops in summer in the hills could break the rust disease cycle.

Dr. B. P. Pal, at present Director General of Indian Council of Agricultural Research, is known internationally for breeding high quality disease resistant wheats. He also initiated the potato breeding work in India. In addition he has done outstanding work in rose breeding. He has been awarded Padma Vibhushan by Government of India and made a member of the Academy of Agricultural Sciences in Russia and Japan in recognition of his outstanding contribution in agricultural research.

Prof. D. S. Atwal of Punjab Agricultural University developed Hybrid Bajra No. 1. It yielded about 100 per cent more than the existing best variety in the country. One remarkable feature of this variety is its wide adaptability from Madras to Punjab. He was also responsible for selecting *PV* 18 Mexican dwarf wheat variety for Punjab in the early sixties.

The massive importation of suitable dwarf Mexican wheat varieties in 1965-66 brought about the wheat revolution in the country. But they had one serious defect, that the grains were red and did not make good *chapaties*. Hence they fetched lower price in the market. This was solved by Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, and his fellow workers by exposing Mexican seed *Sonara* 64 to atomic radiation, to produce mutation. An amber coloured wheat called *Sherbati Sonora*, having all the other qualities of the present Mexican wheat, was evolved. This wheat also was qualitatively superior with higher protein and excellent bread-making quality. This is a distinct advance in our scientific progress in the field of plant breeding. This is an outstanding example of peaceful use of atomic energy in the service of Agriculture.

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