FERTILIZER GUIDE

EXTENSION PAMPHLET No. 1.

सत्यमेव जयते

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This series of Extension pamphlets is being published by the Directorate of Extension and Training, Ministry of Food and Agriculture, Government of India, with the object of providing, in a handy form, detailed information on various subjects for the benefit of Extension workers. These pamphlets are written in simple, non-technical language and are based on the proven results of research.

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Introduction

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Land with its productive top soil is our greatest heritage. It represents the largest portion of the natural resources of India and the bulk of our people are engaged in farming, and therefore, ultimately in the correct exploitation of land. The well being of the Indian people and their cattle depends directly on the correct use of land. Nevertheless, the average crop yields in our country are extremely low.

2. The problem of increasing agricultural production is, therefore, the most urgent problem facing the country and it was for this reason that the first Five Year Plan concentrated its main attention on it. Of all the different facets that combine to create what is commonly called ''The Problem of Indian Poverty'', continued low productivity of land is the most glaring. As long as agriculture does not improve, the levels of production from land will remain low. As everything comes from land, whether it is food for the man or his animals or the raw materials of the various industries, there cannot be any lasting remedy for the grinding poverty of the people unless our planning provides for a programme of a spectacular rise in production from the soil. Our planners have, therefore, rightly emphasised that the problem of the poverty of the soil of this ancient land can only be solved by an integrated effort aimed at raising the fertility of our soils.

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3. In this effort the importance of proper manuring can hardly be over-estimated. The practice of manuring is very ancient, reference being made to it in the literature of some of the earliest civilisations. In China, the application of human and animal excrements to agricultural crops has been practised for centuries, while the beneficial effect of liming and green manuring was well-known to the Romans. With the progress of time, the use of various organic and inorganic materials as a means of improving soil fertility spread throughout the older agricultural countries, although it was not until the middle of the last century that a scientific explanation was found for this practice. The classical researches of Liebig in Germany and Lawes and Gilbert in England threw a completely new light upon the problem of plant nutrition, and at the same time laid the foundation of modern fertiliser practice, to which agriculture owes much of the revolutionary success achieved during the last century.

4. The value of bulky crganic manures has been appreciated by our farmers since the dawn of history. Artificial fertilisers, however, are a later introduction and are, therefore, relatively new to India and their use has not become as widespread and universal here as in other countries.

5. But when we look at the whole problem in perspective, it is clear that the need for the use of artificial fertilisers is even greater in a country like ours, where the lack of farmyard and other organic manure is acute and the search for supplement is, therefore, all the more urgent.

6. The remarkable success of the paddy and sugarcane campaigns, sponsored by the Ministry of Food and Agriculture, has been substantially due to the increased use of artificial fertilisers.

This small pamphlet has been written with the object of providing, in a handy form, detailed information on this subject for the benefit of Extension and Development workers.

I am confident that they will find it useful.

(P.N. Thapar)
Secretary,
Ministry of Food & Agriculture,
New Delhi.

Packing Fertilizer at the Sindri Factory.

THE LAND ...
our greatest natural resource

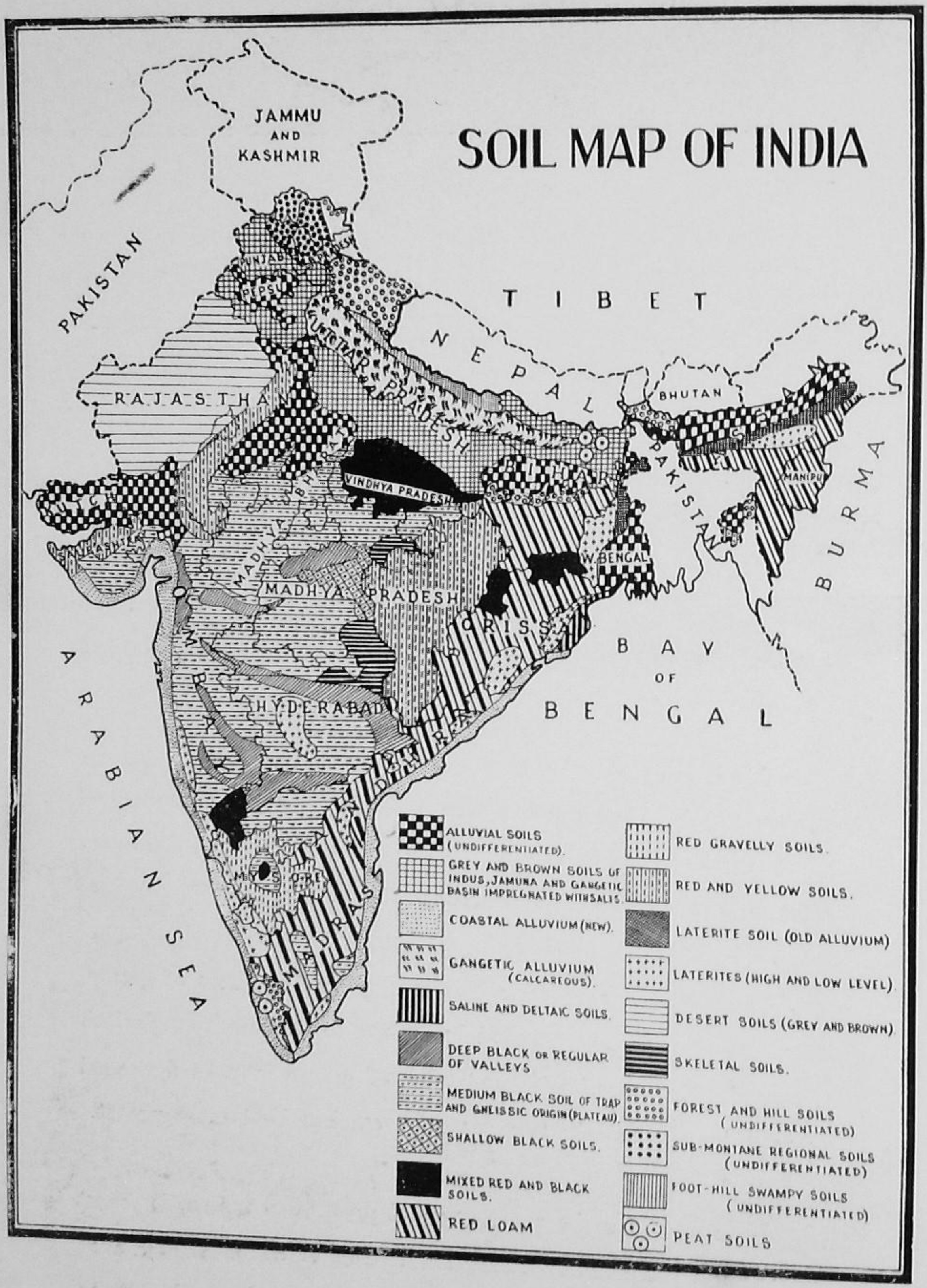
Our soil is our most important source of wealth. It is the foundation of our happiness, prosperity and progress.

A relatively thin layer of the top soil, which covers land at an average plough depth of about seven inches, is the chief support of life on earth. The world's annual production of food and fibre products comes largely from this soil layer.

The soil that supports life is created by the forces of nature. Many, many years are required by nature to produce a single inch of topsoil. Yet, all of this good work of nature may be destroyed by man in a relatively few years by careless land management.

If India has to be a strong and prosperous nation, it must improve the productivity of her land. This is the most important and vital task, which faces our nation today and it is for this reason that the first Five Year Plan devoted its main attention to it.

SOIL MAP OF INDIA



How much land do we have

Since our land is our greatest and most valuable resource, it is well to consider how much we have.

The total geographical area of our country is 811 million acres but the cultivable area is no more than 324 million acres.

The remainder is used for cities, roads, homes, parks, forests or consists of mountains, deserts, marshes, usar, ravines and culturable wastes.

This means that for every man, woman and child in India we have less than one acre of arable land, on which to raise our food and fibre and to support our tremendous animal population.

This makes it imperative that we should take all possible steps to maintain and increase the fertility of our soils to meet the needs of our increasing population.

PRODUCTIVE SOILS—Abundant Harvests

How fertilizers improve soils

Manures and fertilizers are one of the chief means of improving soils and increasing their fertility. Plants, like human beings, must have food. Manures and fertilizers help to make good plant food losses and are one of the most effective means of improving soils and maintaining their fertility. Further, they greatly increase production. Numerous experiments have shown that the yields of wheat, cotton, rice, jowar and other crops in our country can be increased greatly by the proper application of manures and fertilizers.

Bulky organic manures

The value of bulky organic manures has been appreciated by our farmers since the dawn of history and can hardly be exaggerated. They supply valuable organic matter to the soil and organic matter improves the soil tilth, increases its water holding capacity, improves aeration, regulates soil temperature and has a beneficial effect on soil micro-organisms. It has been estimated that a ton of farmyard manure, on the average, contains about 10 lb of nitrogen, 5 lb of phosphoric acid, 10 lb of potash and significant quantities of other plant food elements. Further, certain organic constituents (hormones) are also present in it, which are valuable in promoting and stimulating plant growth.

But we do not have enough farmyard manure to satisfy all the needs of all our farmers. Therefore, we have to use commercial fertilizers also which supply the various plant foods in an easily available form. The role of these commercial fertilizers in increasing

crop yields has now been fully proved in all parts of the world and their importance too, therefore, is very great.

Food which plants need

For good growth plants need 14 nutrients. These are Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Iron, Manganeze, Boron, Copper, Zinc, Carbon, Oxygen and Hydrogen. The growing crop obtains these plant foods partly from air and water and partly from the soil. Air supplies mainly carbon and oxygen and in some cases nitrogen also. Water supplies hydrogen and oxygen, while the soil supplies the rest. Nitrogen, phosphorus and potassium are commonly known as the primary plant food elements in the soil as they are used in rather large quantities by crops. The other plant foods supplied by the soil are known as secondary and minor plant foods. Let us see what these plant foods are and how they help in improving soils and increasing crop yields.

Nitrogen

Nitrogen, in its pure state, is a colourless, odourless, inert gas and constitutes about 80 per cent of the air. Plants, other than legumes, cannot use pure nitrogen, nor can it be put into fertilizers in this form. Pure nitrogen must be combined with other elements before it can be put into fertilizers or used as a plant food.

Most of the nitrogen in soils is found in the organic matter which in turn is found largely in the topsoil. As the soils of the earth vary in their organic matter content so also do they vary in their nitrogen content.

Indian soils are highly deficient in nitrogen that is quickly exhausted by erosion, leaching, growing crops (and denitrification particularly during hot months) which require relatively large quantities of it. Therefore, nitrogen must be replaced frequently to maintain soil fertility.

Nitrogen

* Gives dark green colour to plants.
* Promotes leaf, stem and fruit or seed growth.
* Improves quality of leaf crops.
* Produces rapid growth.
* Increases protein content of food and feed crops.

Plant can use nitrogen when it is properly combined with oxygen

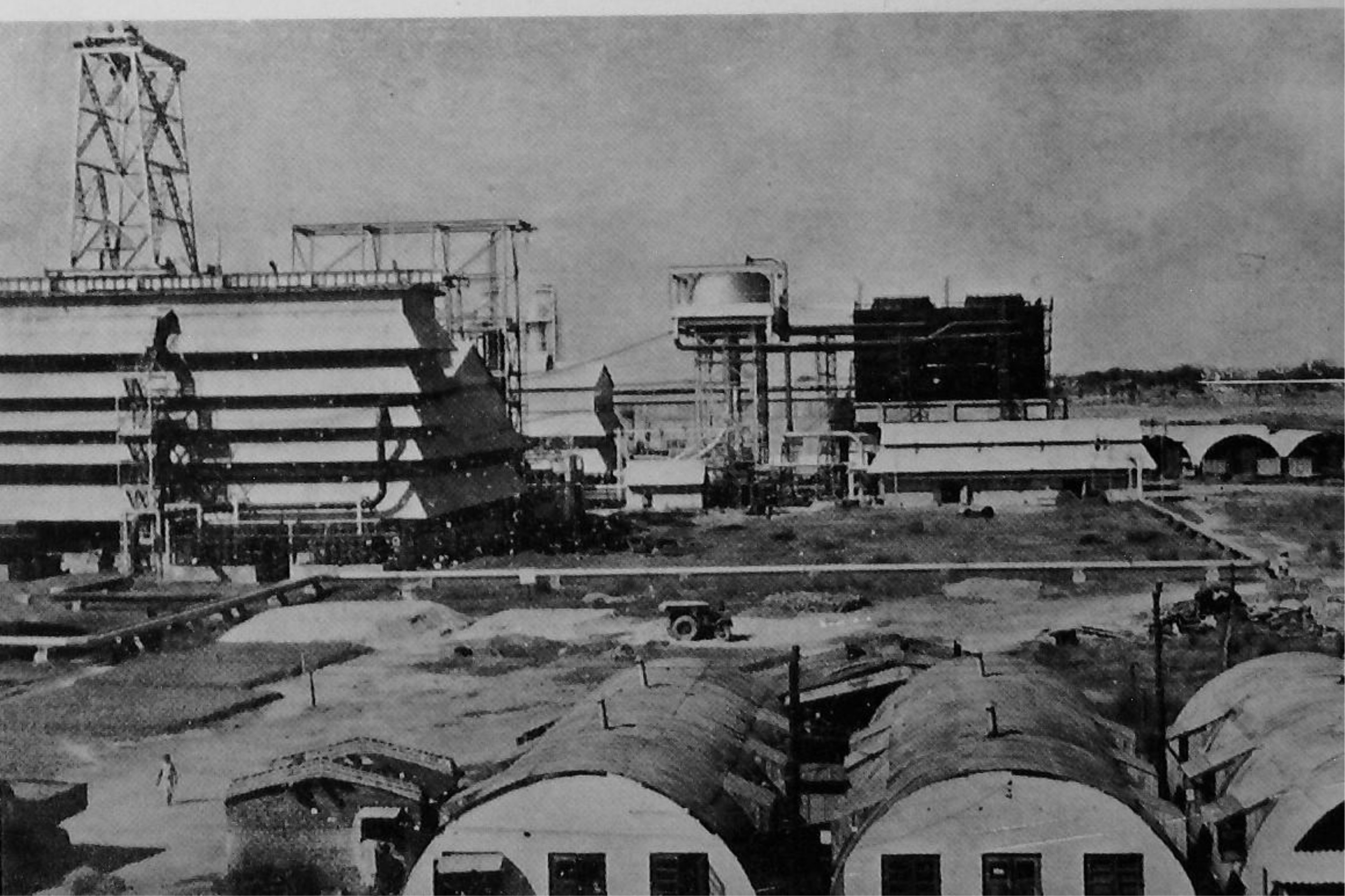
or hydrogen. In these properly combined forms it is useful to plants and is known as 'nitrate' or 'ammonia' respectively.

Nitrogen in the nitrate form is very quickly available to plants and also is subject to movement in the soil and to loss by leaching.

In the ammonia form, it is not so quickly available to plants and is more tightly held by the soil particles, thus being more resistant to leaching. Most plants grow best when they have available in the soil both of these forms of nitrogen.

Ammonium sulphate, ammonium nitrate and urea are the most common forms of commercial nitrogen available in India.

A view of Sindri Fertilizer Factory—the biggest producer of nitrogeneous fertilizers in India.



Phosphoric acid

Phosphorus, in its pure state, is a very reactive substance that bursts into flames when exposed to the air. Phosphorus must be combined with other elements to curb its violence before it can be put into fertilizers or used as a plant food.

The importance of phosphorus in crop production is emphasised by the fact that unsatisfactory plant growth is often due to a shortage of this element than of other plant foods. Phosphorus is intimately associated with all life processes and is a vital constituent of every living cell. Without phosphorus, there could be no life.

Phosphorus

* Stimulates early root formation and growth thereby helping to establish seedlings quickly.

* Gives rapid and vigorous start to plants.

* Hastens maturity.

* Stimulates blooming and aids in seed formation.

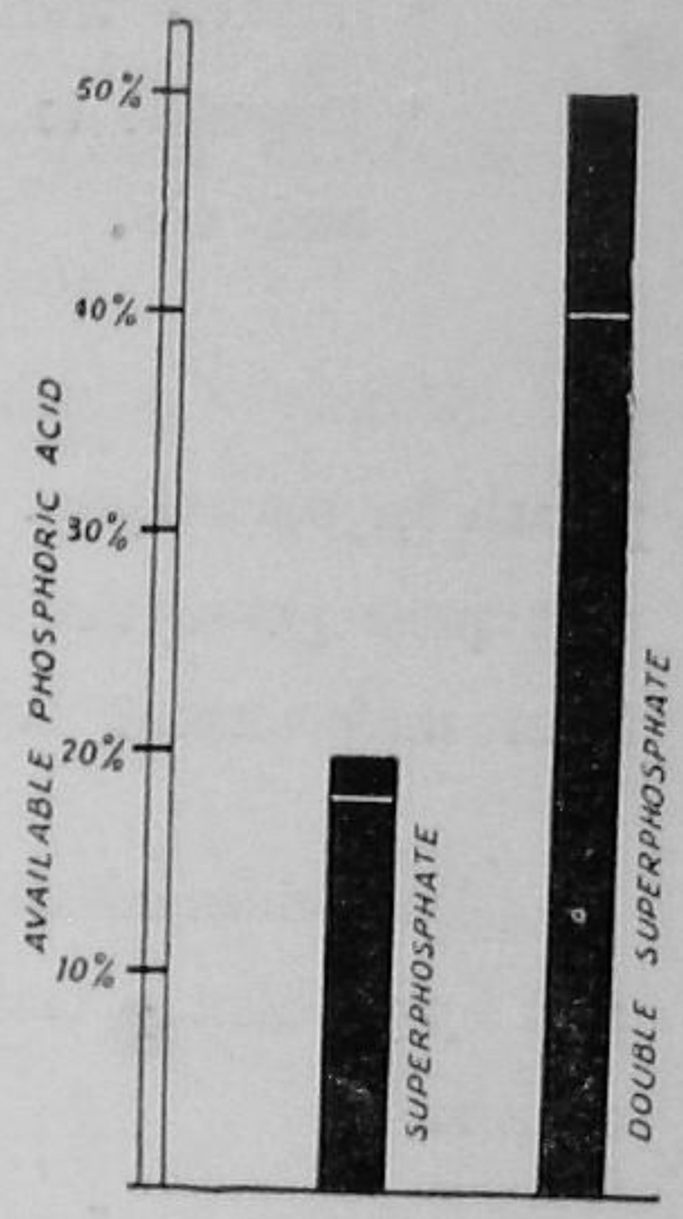
* Applied to legumes it activates soil bacteria and the formation of root nodules.

Superphosphate is the principal carrier of available phosphoric

acid. It is made by treating phosphate rock with sulphuric or phosphoric acid.

It has an available phosphoric acid content of 18 per cent to 20 per cent.

Double superphosphate (sometimes called triple or treble) contains 40 per cent to 50 per cent available phosphoric acid. The other materials commonly used in India for supplying phosphoric acid are rock phosphate and bonemeal.



Potash

In its pure state, potassium is highly reactive and dangerous to handle. It must be combined with other elements before it can be put into fertilizers or used as plant food.

Potash

* Is essential for Chlorophyll development.
* Imparts increased vigour and disease resistance to plants.

* **Produces strong, stiff stalks, thus reduces lodging.**
* **Increases plumpness of the grain and seed.**
* **Imparts winter hardiness to legumes and other crops.**
* **Essential to the formation and transfer of starches, sugar and oils.**

Muriate of potash is by far the most popular fertilizer supplying potash in agriculture. This highly refined material is over 98 per cent pure potassium chloride. It supplies potash in the cheapest form under most conditions.

Potassium nitrate, vegetable meals, tobacco stems, wood ash and by-product potash from the cement industry provide additional sources.

Secondary & minor plant foods

Until recent years, little attention was given to the importance of the secondary and minor elements—calcium, magnesium, sulphur, boron, manganese, copper, zinc, iron and molybdenum—in fertilizers. But it is known that poor yields often are due to deficiencies of these elements. Therefore, for most profitable crop production attention should also be given to these plant foods.

Secondary plant foods

CALCIUM : Calcium is found abundantly in various limestones, oyster shells, phosphate rock, superphosphate and gypsum.

CALCIUM.

* **Promotes early root formation and growth.**
* **Improves general plant vigour and stiffness of straw.**
* **Influences intake of other plant foods.**
* **Neutralizes poisons produced in the plant.**
* **Encourages grain and seed production.**
* **Increase calcium content of food and feed crops.**

MAGNESIUM : Magnesium is found in dolomitic limestone, magnesium sulphate, sulphate of potash-magnesia and magnesium oxide.

MAGNESIUM

* **Aids in maintaining dark green colour of leaves.**
* **Regulates uptake of other plant foods.**
* **Acts as carrier of phosphoric acid in the plant.**
* **Promotes the formation of oils and fats.**
* **Plays a part in the translocation of starch.**

SULPHUR : The chief sources of sulphur for crop use are natural sulphur and sulphur obtained from fertilizer materials such as gypsum, ordinary superphosphate, sulphate of ammonia and sulphate of potash. Considerable sulphur liberated into the atmosphere in the burning of coal is returned to the soil in the rain-water.

SULPHUR

* **Gives increased root growth.**

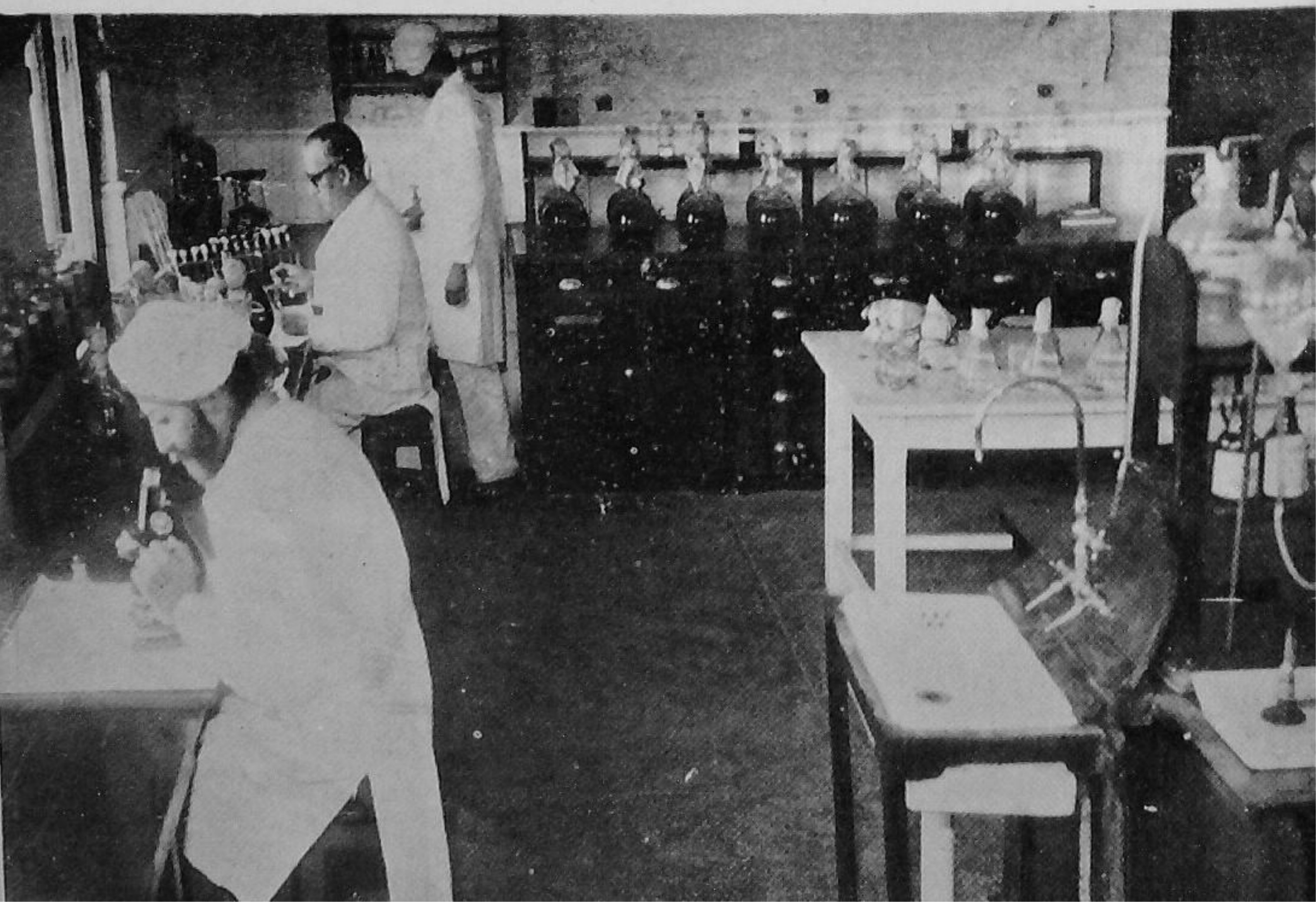
* Stimulates seed production.
* Encourages more vigorous plant growth.

Minor plant foods

The minor plant food elements, also called "trace elements", are boron, manganese, copper, zinc, iron and molybdenum. Although relatively small quantities are required, all are necessary for plant growth. But deficiencies of these minor elements in Indian soils are not so widespread as to warrant their general additions to all fertilizers.

With some of these elements the range between beneficial and detrimental amounts is very narrow, so they must be carefully used, for too much will cause injury.

Soil Tests being carried out inside a Laboratory.



Mixed Fertilizers

While all the 14 plant food elements have been described, it must be remembered that our soils are mostly deficient in the two major plant foods viz., nitrogen and phosphorus.

The Indian farmer, should, therefore, concentrate his attention mostly on correcting deficiencies of these elements.

Moreover, it is well-known that the growth of the plant is controlled by that nutrient which is in minimum supply. Soils vary widely in the natural supply of available plant foods and many crops have different plant food requirements. It is, therefore, always better to use mixed fertilizers particularly those in which nitrogen and phosphorus are available in proper combinations.

Further, when the deficiency of one plant food is satisfied, response may be secured from additions of a second plant food. Likewise the second plant food may not give a response unless deficiency of the first element is corrected.

For the most efficient and profitable use of fertilizers, therefore, you should do the following:—

1. Use mixed fertilizers in which the plant food elements, particularly nitrogen and phosphorus, are present in the right proportion to fit the needs of your soil.

2. Follow the fertilizer recommendations of your State Department of Agriculture.

3. Remember that fertilizers are used to supplement the natural plant food supplies of the soil and plant foods obtained from farm manure and crop residues.

4. Consider tbe requirements of the rotation as a whole, as well as the plant food needs of the particular crop.

5. Remember that fertilizers do not take the place of organic matter, good seed, proper cultivation or good crop rotations.

6. Try to be sure, as far as possible, which plant foods are most deficient in your soil.

7. Use adequate quantities of recommended fertilizers to obtain profitable yields.

8. Apply fertilizers at the right time and use an approved method of application to obtain the best results with each crop.

Determining & correcting plant food deficiencies

Agricultural workers long have sought dependable methods for determining plant food deficiencies in soils as an indication of the plant food needs of crops.

Each farm, and sometimes even each field, presents an individual problem owing to the heterogenous nature of the soil. In India, there is great need for accurate information so that fertilizers can be used most effectively and profitably.

Some methods now used to determine plant food deficiencies

* **External plant deficiency symptoms.**
* **Laboratory methods:**
  1. Chemical analysis of soils and plants.
  2. "Quick" soil and plant tissue tests.
  3. Biological tests of soil.
* **Greenhouse tests.**
* **Field plot experiments.**

Practical suggestions for correcting plant food deficiencies

* **Follow the fertilizer recommendations of your State Department of Agriculture.**
* **Consult the village worker.**
* **Local fertilizer dealers and agents can give you great help.**
* **Talk with successful neighbouring farmers and follow their fertilizers schedules.**

Taking Soil Sample.

Hunger signs in plants

Plants show hunger signs which can be detected by careful observation and study. While these signs are more or less definite, in many cases considerable experience is necessary for their recognition and proper treatment.

A disadvantage of this method of diagnosis lies in the fact that it may reveal deficiencies too late for effective treatment of current crops. This information can be used, however, in preparing for the following season. Some common hunger signs are as follows:—

Nitrogen deficiency

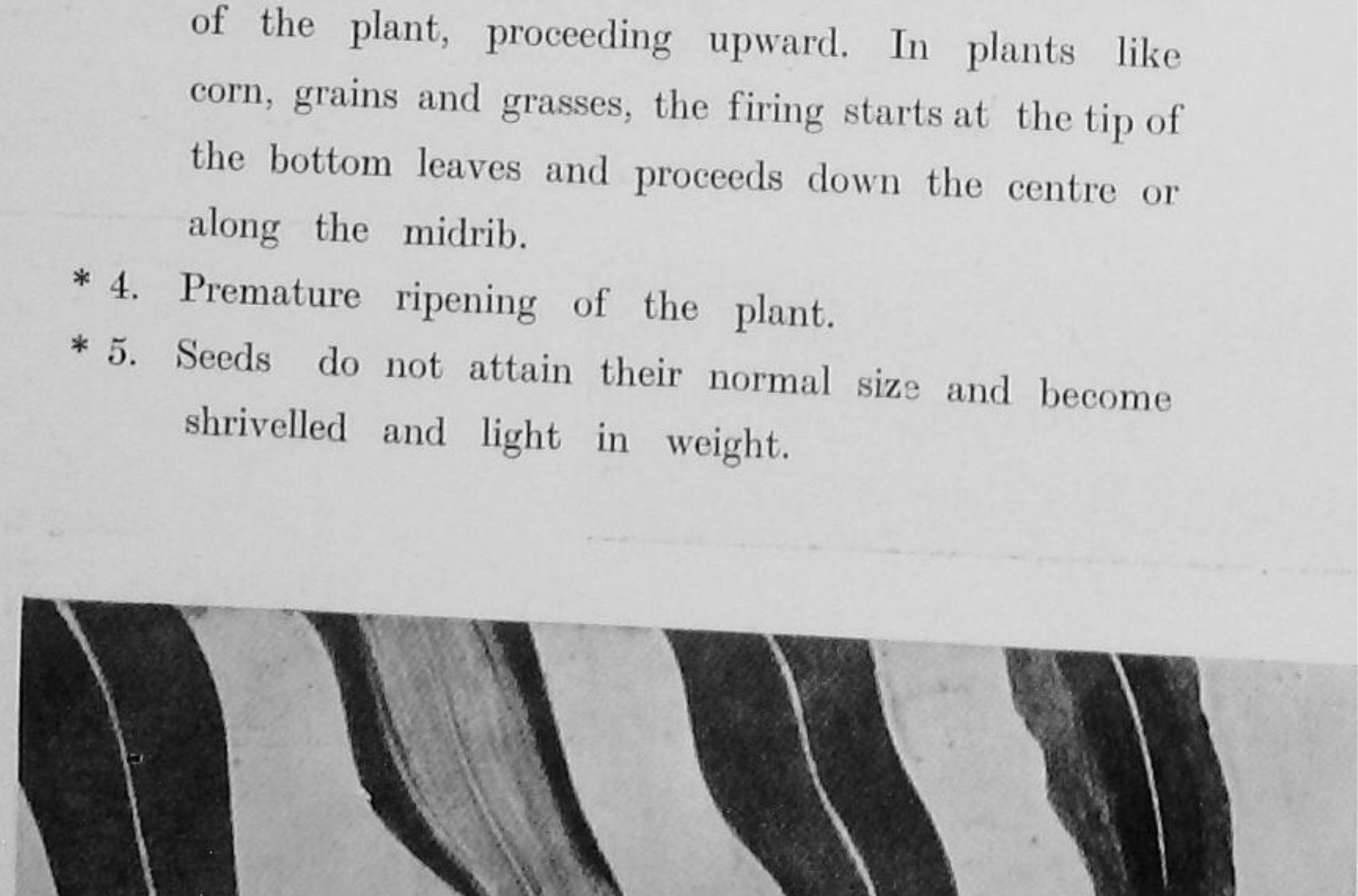
* 1. A sickly yellowish green colour.

* 2. A distinctly slow and dwarfed growth.

* 3. Drying up or "firing" of leaves which starts at the bottom of the plant, proceeding upward. In plants like corn, grains and grasses, the firing starts at the tip of the bottom leaves and proceeds down the centre or along the midrib.

* 4. Premature ripening of the plant.

* 5. Seeds do not attain their normal size and become shrivelled and light in weight.



Nitrogen, Phosphorus and Potash deficiencies on corn 1. Healthy green corn leaf. 2. Nitrogen starvation showing light yellow colour on the tip and centre of the leaf. 3. Phosphorus deficiency indicated by purplish colour on young corn plants. 4. Potash hunger showing scorched and ragged edges and tip.

Phosphorus deficiency

* 1. Leaves of cereals become dull greyish green in colour.
* 2. Slow growth and maturity.
* 3. Soft, weak stems with no strength and poor root growth.
* 4. Small slender stalk in case of corn. In small grains, lack of stooling.
* 5. Low yields of grain, fruit and seed.

Potash deficiency

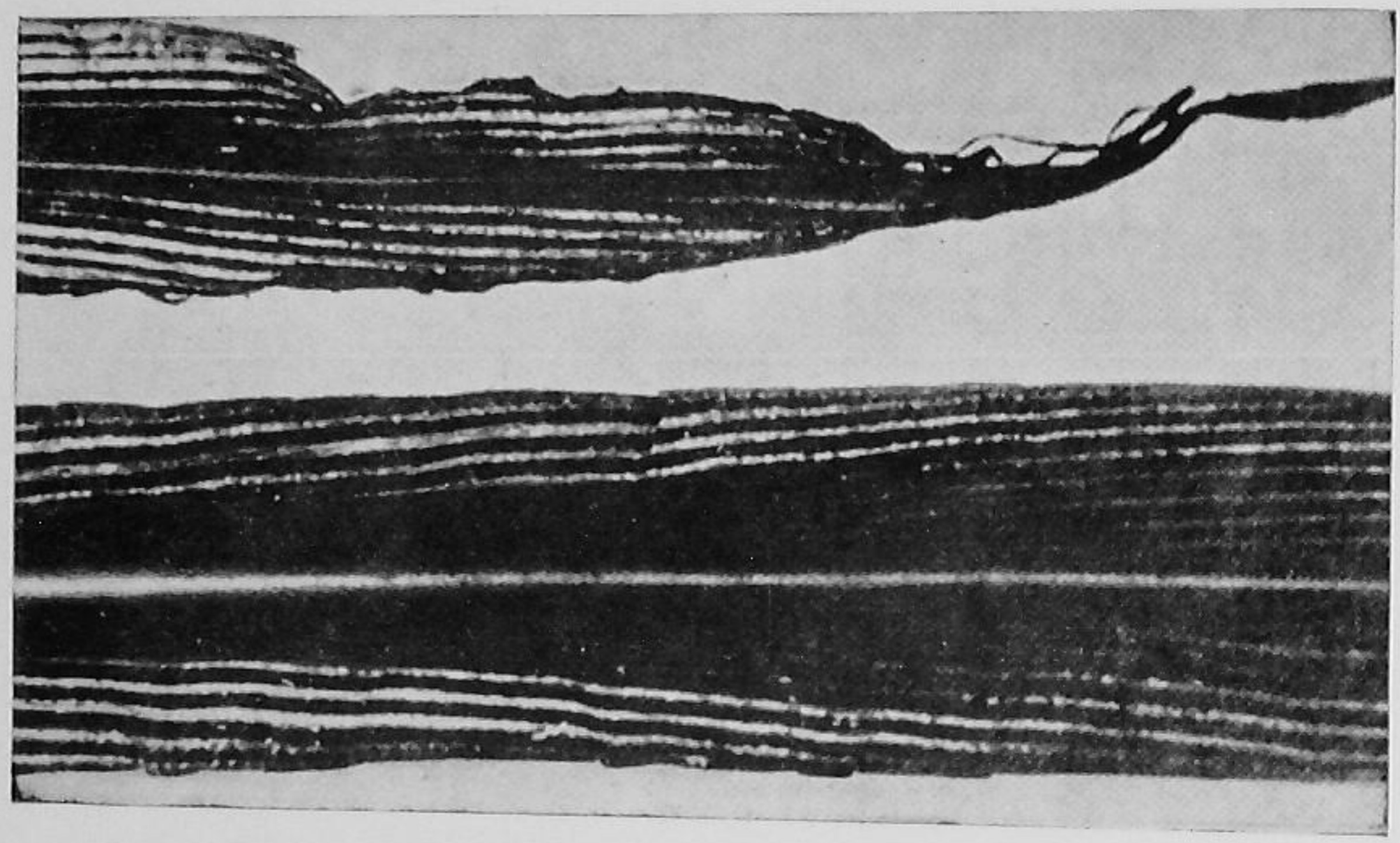
* 1. Mottling, spotting, streaking or curling of leaves, starting on the lower levels.
* 2. Lower leaves scorched or burnt on margins and tips. These dead areas may fall out, leaving ragged edges. In corn, grains and grasses firing starts at the tip of the leaf and proceeds down from the edge, usually leaving the midrib green.
* 3. Premature loss of leaves and small, knotty, poorly-opened bolls on plants like cotton.
* 4. Plants, like corn, falling down prior to maturity due to poor root development.

Calcium deficiency

* 1. Young leaves in terminal bud become "hooked" in appearance and die back at the tips and along the margins.
* 2. Leaves have wrinkled appearance.
* 3. In some cases, young leaves remain folded.
* 4. Short and much-branched roots.

Sulphur deficiency

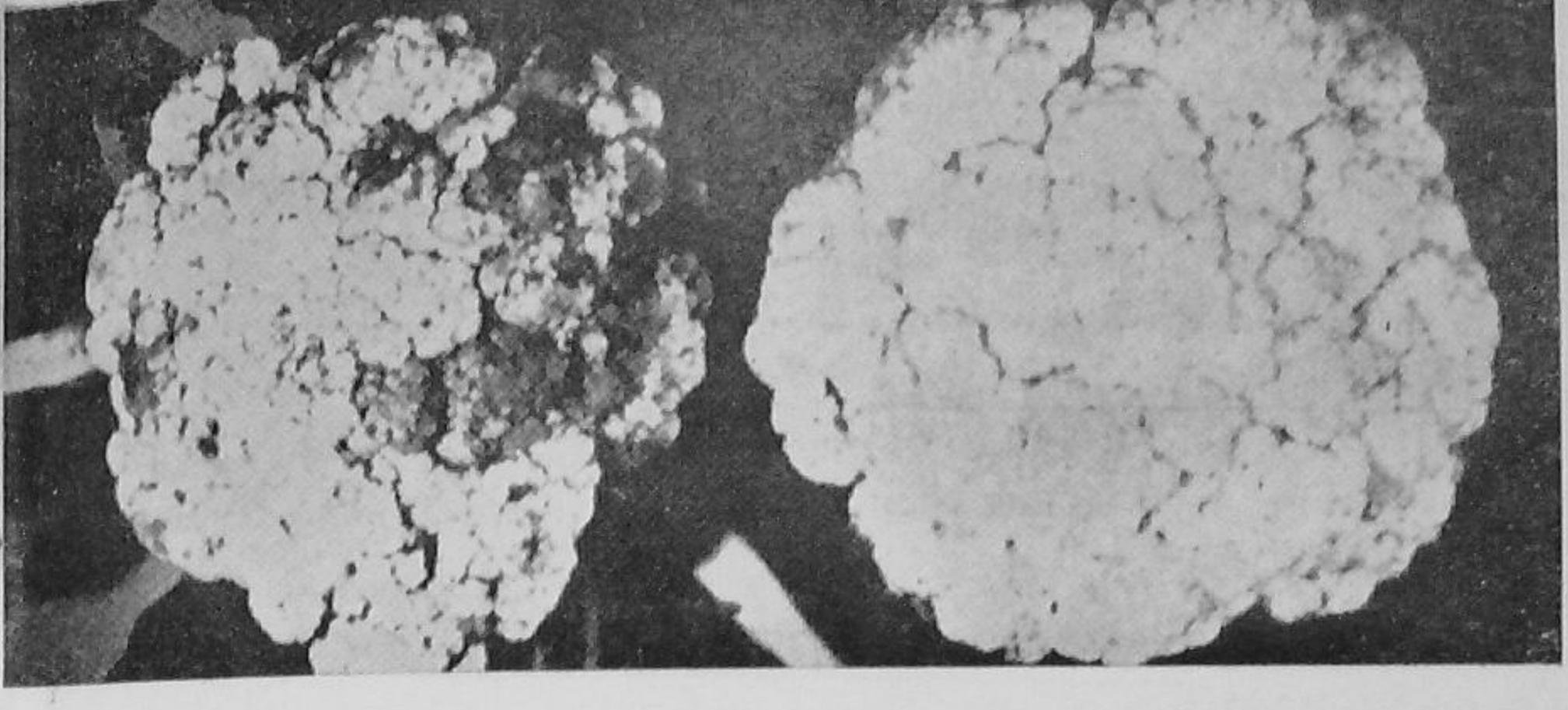
* 1. Young leaves light green in colour, have even lighter veins.
* 2. Short slender stalks.
* 3. Slow, stunted growth.
* 4. Spotting of leaves, as with potatoes.



Corn Leaves Showing Magnesium Deficiency

Magnesium deficiency

* 1. A general loss of green colour which starts in the bottom leaves and later moves up the stalk. The veins of the leaf remain green.
* 2. Cotton leaves often turn a purplish-red colour between the green veins.
* 3. Weak stalks with long branched roots.
* 4. Definite and sharply defined series of yellowish-green, light yellow, or even white streaks throughout entire leaf as with corn.
* 5. Leaves curve upward along the margins.



Boron Deficiency in Cauliflower (left) compared with Healthy Head.

Minor plant food deficiency

*1. Boron need is indicated by cracked stem of celery, brown rot of cauliflower, dry rot of sugar beets, heart rot of turnips, corky core of apples and black heart of table beets.

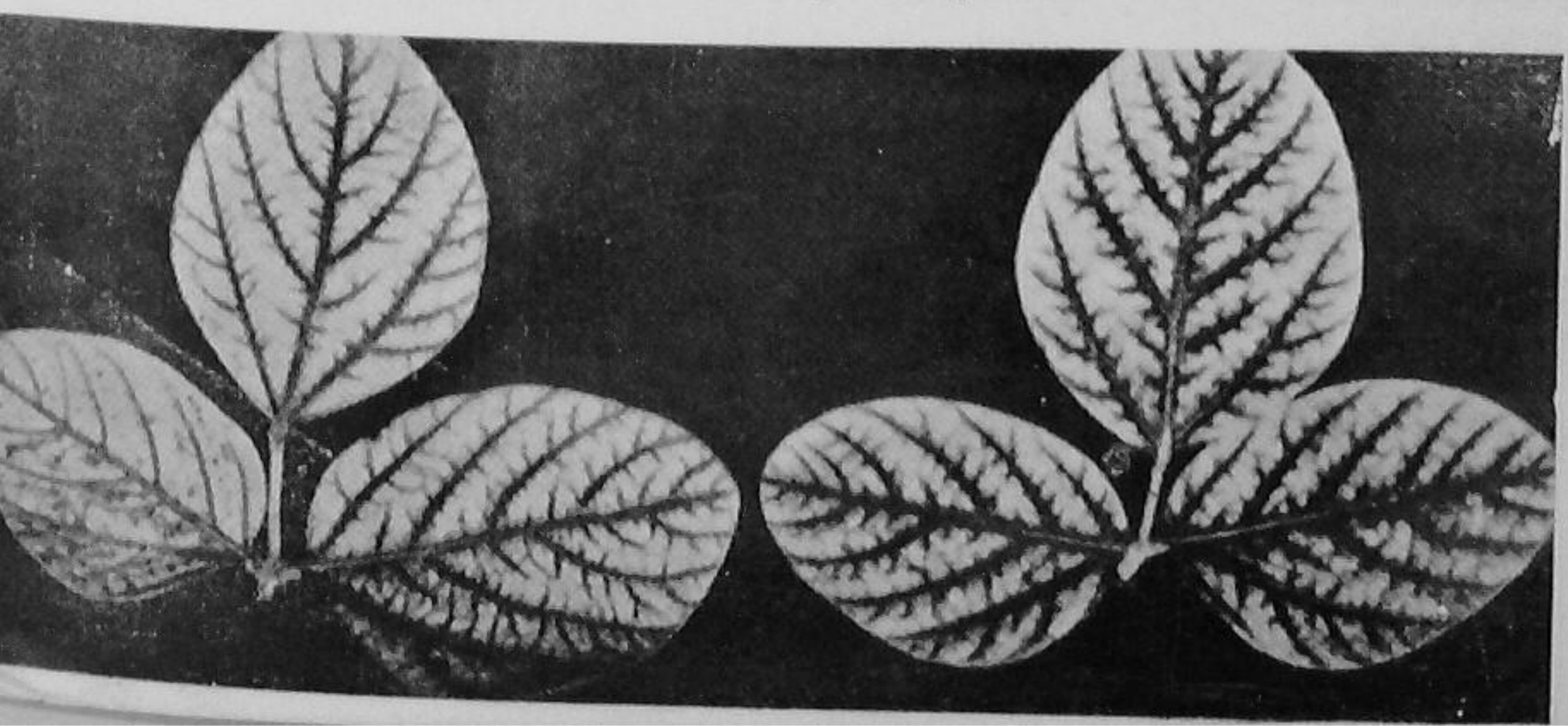
*2. Manganese deficiency is shown by pale green to yellow and red colours between green veins of leaves of tomatoes and beets, resinous spots on leaves of citrus, chlorisis of crops such as spinach and soybeans on overlimed soil, and "gray speck" on oats.

*3. Copper deficiency causes die-back in citrus, and blasting of onions and truck crops.

*4. Zinc deficiency is indicated by white bud of corn, and little leaf of fruit trees.

*5. Iron need is shown by pale-yellowish colour foliage, in the presence of adequate amounts of nitrogen and on soils that are high in lime or manganese.

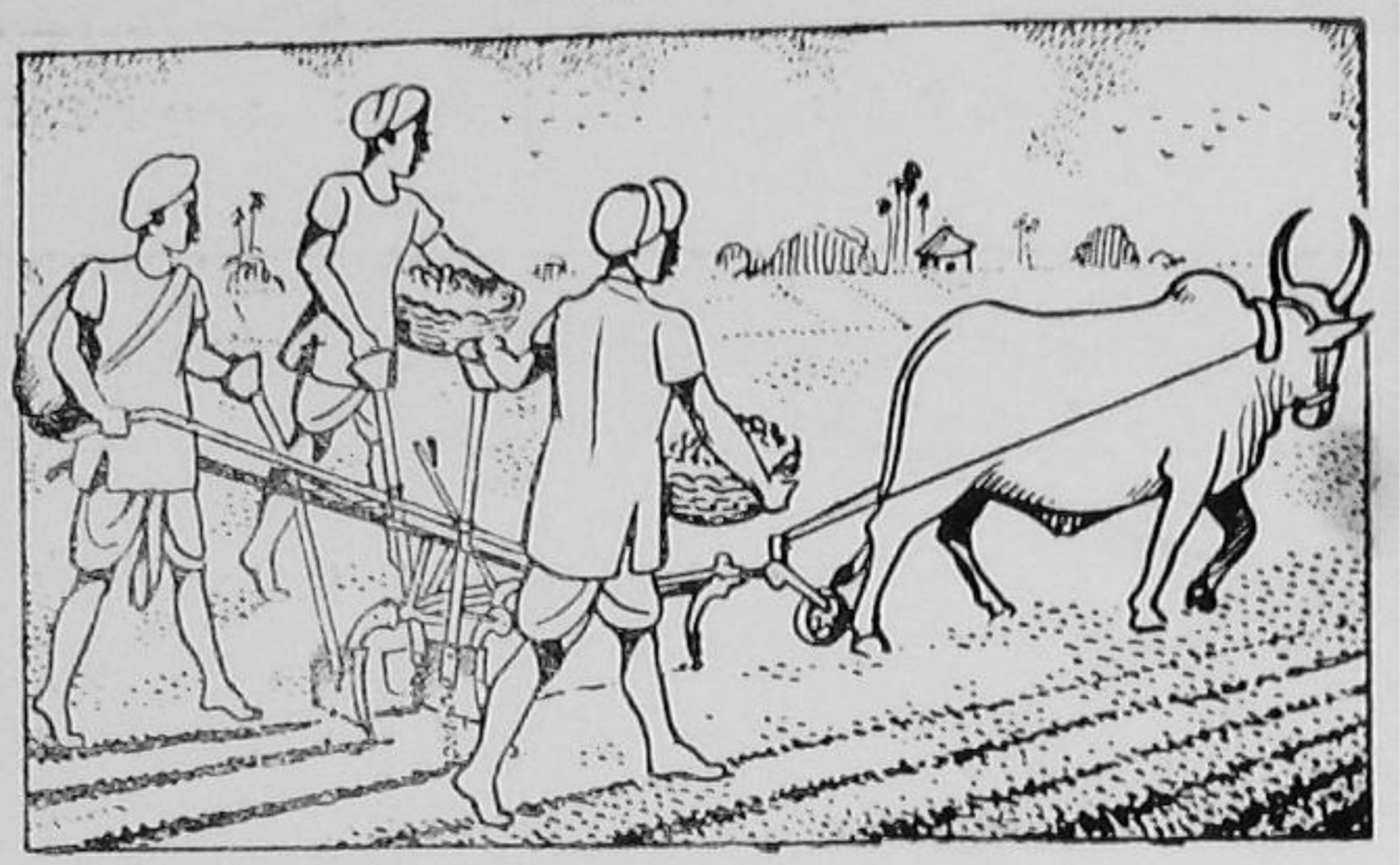
Manganese Deficiency in Soybeans.



Methods of applying fertilizers

There are many ways of applying fertilizers, each of which has its advantages. The method to be used depends upon the crop, soil, climate and various other factors. The aim should be to get the fertilizer in the soil, where it will do the most good.

Drilling with Seed



Some common methods of applying fertilizer are :

BANDING ALONG THE ROW

Distributing the fertilizer in bands one or more inches wide on either or both sides of the row while planting, usually at or below seed level.

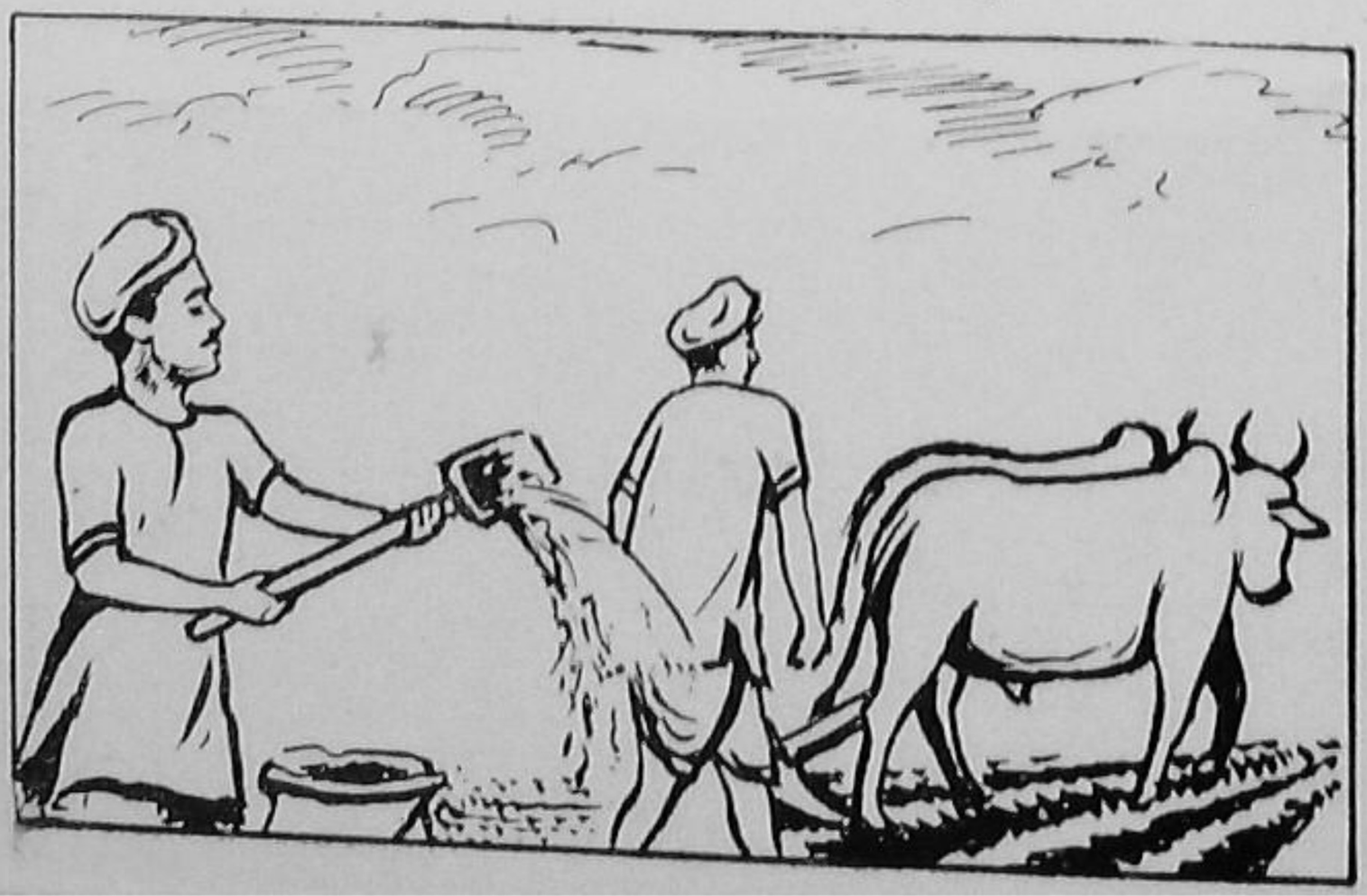
DRILLING WITH SEED

Applying fertilizer in the row when the seed is drilled or planted. This method should be used only with seed that can tolerate contact with fertilizer, such as the small grains.

BROADCASTING— BEFORE PLOUGHING

Spreading fertilizer uniformly over the field. Ploughing mixes it with the turned layer.

Broadcasting Before Ploughing



BROADCASTING—AFTER PLOUGHING

Spreading fertilizer uniformly over the field on the ploughed soil.

Broadcasting after ploughing

DEEP DRILLING—AFTER PLOUGHING

Placing fertilizer in bands at desired depths in the soil.

DEEP FURROW APPLICATION

Putting fertilizer in a band on the bottom of each furrow before the next furrow is turned. Fertilizer is thus placed deep in the soil and encourages deeper root growth.

SIDE DRESSING

Putting fertilizer along the row after crops have started growing.

BEDDING

Applying fertilizer in the bottom of the furrow, then bedding or covering before planting.

STARTER SOLUTIONS

Dissolving fertilizer in water and applying at the time of transplanting various crops is a common practice. Young plants are easily injured by highly concentrated fertilizer solutions, so care should be taken when applying fertilizer in solution form.

TOP DRESSING

Applying fertilizer on the surface of the soil.

IRRIGATION

Adding soluble fertilizers to irrigation water.

VARIATIONS

Variations and combinations of these methods are often used. Part of the fertilizer is sometimes placed on the fields by broadcasting, the remainder drilled or banded; some may be ploughed under, the rest broadcast after ploughing.

Chemical fertilizers contain plant foods in a strong concentration. Care should be exercised in their application.

For the best method of fertilizer placement you should consult your State Department of Agriculture or the Village worker.

FERTILIZER DOSES

The exact doses of the various fertilizers to be applied to different crops depend on the nature of the soil, crop, climatic conditions of the region and the fact whether an area has irrigation facilities or not. The Departments of Agriculture in the various States of India have been working on this subject for a number of years. They have worked out elaborate manuring schedules for all important crops such as paddy, wheat, barley, maize, jowar; bajra, groundnut etc., etc., for most of the important regions of our country. These should be invariably followed and the doses given in them of the various manures and fertilizers should be used.

For full details about the doses of the various fertilizers to be applied to different crops, you should, therefore, consult your State Department of Agriculture or the village worker.

Fertilizer prices & distribution

It is essential that artificial fertilizers should be supplied to our farmers at attractive prices so that their use is economic and our cultivators can use them more and more. The Central Government has, therefore, consistently taken steps to see that the prices of the main chemical fertilizers required by farmers in our country should be kept as low as possible. Sulphate of ammonia is now supplied to States at Rs. 315/- per ton and the State Governments have also generally agreed to resell it in retail to farmers at Rs. 345/- per ton. This important fertilizer is, therefore, available to farmers in our rural areas at about Rs. 12/5/- per maund.

Although there is no control over the distribution of superphosphate, in most States it is available at about Rs. 255/- per ton i.e. at about Rs. 8/4/- per maund.

In order to help farmers to use more and more fertilizers, most of the State Governments have made arrangements for the supply of ammonium sulphate and superphosphate on taccavi loans. For this purpose and further information you should contact your local Agricultural Officer or the Village worker, who will explain to you the method of getting fertilizer on loan.