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Problems of Soil Fertility in India
Management of Soil Fertility
Soil fertility status in India
Soil Productivity
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Soil Fertility:

Soil fertility may be defined as the inherent capacity of a soil to supply available nutrients present in it to the plants in proper amounts and in appropriate proportion.

The soil which has the capacity to provide all the plant nutrients in adequate amount and balanced proportion to the plants for their maximum growth and maximum yield is called fertile soil.

Essentials of a Fertile Soil:

A soil is fertile if it fulfills the following conditions:

- It should have proper water holding capacity.
- There should be good aeration in it.
- It should have organic matter which decomposes in presence of such minerals which dissolve rapidly to meet the requirements of the soil.

The aim of a farmer is to obtain the correct combination of the aforesaid conditions for the proper growth of the crop. This shows that it is essential for the soil fertility that there is a proper combination of physical, chemical and biological conditions of the soil. In case the soil has all the plant nutrients in adequate amounts and proper proportion but it does not have proper drainage and aeration and favorable conditions for friendly micro - organisms, the soil fertility will be low.

Factors influencing Soil Fertility:

The factors which maintain or increase the soil fertility are divided into two types:

1. **Natural Factors:** These factors affect the soil structure. Their effect starts from the beginning of the soil formation. These are:
 - **Parent Material:** Soil formation takes place due to weathering of rocks. If the parent material of rock has plant nutrients in large quantity, the soil formed from it will be fertile. The soils formed from kaolinite clay mineral have comparatively low soil fertility. The soils formed from sedimentary rocks are more fertile.
 - **Climate:** The main components of climate are moisture, rain, temperature and air. The plant nutrients flow from the upper surface of the soil to the lower layer due to leaching at high temperature, the the organic matter decomposes rapidly. This decreases soil fertility. Due to wind, the upper soil particles are carried away causing low fertility of soil.
 - **Depth of Soil Profile:** The soils having deep soil profile are more fertile than other soils like sandy soils. It is due to the fact that the roots of plants spread deep in the soil and absorb water and nutrients in large quantities.

- **Soil Age:** The old soils undergo decrease in plant nutrients due to their weathering, erosion, leaching and growing crops. Therefore, newly formed soils are more fertile than soils formed from long period of time.
- **Topography:** Due to erosion and leaching, the soils of upper regions undergo loss of nutrients which collect at lower levels. Therefore, the fertility of sloppy and mountain lands is low as compared to the soils of planes and lower regions.
- **Physical Conditions of Soil:** In soils with good physical conditions, the aeration is proper, water holding capacity increases, the roots of plants develop properly and the micro-organisms act smoothly. In good physical conditions of the soil, the plants absorb their nutrients without any problem. Hence, soil structure and texture affect the fertility of the soil. In soils with large particle size, water goes down rapidly because the water holding capacity of such soils is very poor. Hence, the sandy soils having large particle size have low fertility. The fertility of silty and clayey soils having fine particles is high.
- **Soil Erosion:** Soil erosion takes place due to wind or flow of water from the upper surface of the soil towards the slope. It takes away the plant nutrients from the surface of the soil leaving the soil less fertile. It is observed that soil erosion causes 20 times more loss of nutrients than in crop production.
- **Inhibitory factors:** These factors include soils acidity, alkalinity and surplus water. In acidic soils, Fe, Mn and Al being more soluble convert the phosphorus to insoluble form. As a result, phosphorus becomes unavailable to the plants. Acidic soils become deficient in Ca and Mg. Hence, the soil becomes less fertile.

Alkali soils have sodium salts in excess. Soils become less fertile due to alkaline medium. Because of improper drainage, the nutrients are lost due to their flow with water and the soil becomes less fertile.

If surplus water stands on the soil, aeration does not take place properly and accumulates CO_2 . In such a condition, the roots of plants do not grow properly and the activity of micro-organisms is adversely affected. Hence, soil fertility decreases.

Artificial Factors:

- **Water Logging:** When an excess of water is filled on a soil for a long period, it is harmful for the physical conditions of the soil. Under water logging conditions the activity of aerobic micro - organisms is lost due to poor aeration and harmful micro - organisms become active, soluble plant nutrients go down due leaching and the soil fertility is affected adversely.

- **Time and Method of Soil Cultivation:** If the cultivation of soil is done at a right time, the physical condition of the soil remains proper and soil fertility increases. In case the cultivation of sloppy fields is done parallel to the slope, more soil erosion takes place and more plant nutrients flow with the water making the soil less fertile. On ploughing sloppy field's perpendicular to the slope, the soil erosion is less and soil fertility remains almost unchanged. Soil fertility increases on deep ploughing.
- **Cropping System:** If the same type of crop is grown in a field continuously for several years, the same nutrients are utilized more and the soil becomes deficient in them leaving it less fertile. Hence the same crops should not be grown in the same soil for years together. The crops should be grown in a soil scientifically. The soil fertility is maintained by growing different crops alternatively in a soil including legume crops. Thus, crop rotation and mixed farming are necessary for carrying soil fertility.
- **Soil Organic Matter:** Organic matter is a store - house of nutrients for the plants. Therefore, more the organic matter in a soil, the more fertile it would be. Due to the presence of organic matter, the aeration and water holding capacity of the soil increases. Organic matter is also the main food material for soil micro-organisms. Hence, soil fertility status is maintained by adding sufficient organic matter like FYM, compost and green manures in the soil.
- **Control of weeds:** Weeds (unwanted plants) also utilize moisture, air, light and nutrients similar to plants. If these weeds are not removed from the soil, they consume a lot of nutrients for their growth and it decreases the soil fertility for the main crop.
- **Use of Manures and Fertilizers:** Manures and fertilizers provide plant nutrients to the soil and increase soil fertility. Hence, specific fertilizers and manures should be added to the soil to increase its fertility.

Problems of Soil Fertility in India:

People in India have been doing farming since even 1000 years before Christ. Manures are added to the soil from early times. With the increase in population, feeding requirement has increased many folds. For this, the importance of soil fertility has drawn the attention of all concerned. The green revolution has been quite successful in producing more cereals and other feeding stuffs.

The experiments carried out at agriculture research centers have shown the deficiency of different nutrients in soils of various regions. Soil testing program is found very useful for farmers. Such experiments reveal the following information:

- The deficiency of major plant nutrients (N, P, K) in the soil.
- The use of different fertilizers in different types of soils for different crops.
- The requirement of more fertilizers for the new varieties of high yielding crops.

- The deficiency of specific micro-nutrients for different varieties of crops.

On the basis of researches on soil fertility in various states of India, it has been found that:

- The soil in Punjab is deficient in zinc and iron micro-nutrients.
- The soils in Maharashtra and Gujarat have the deficiency of manganese and molybdenum micro-nutrients.
- Bihar has boron deficient regions.
- Trai lands in U. P. used for paddy (rice) crop have deficiency of zinc.
- The soils of Punjab, Haryana, Delhi and Madhya Pradesh used for growing leguminous crops like ground nut, barseem and alfa - alfa are found to be deficient in sulphur.
- The regions of acids soils in Madhya Pradesh, Himachal, Karnataka, Chhota Nagpur in Bihar have the deficiency of calcium and magnesium as secondary nutrients for plants.

This shows that it is quite essential to take care of the soil for carrying its fertility. Soil fertility needs proper soil management and suitable water management.

Soil Management:

The soil management involves soil reclamation and soil conservation. The soil scientists in Punjab found that the saline and alkali soils are highly deficient in plant nutrients. Therefore, it is essential to add sufficient quantities of manures and fertilizers in these soils. Also, the bio-activities should be increased in such soils. So, farmyard manures (F. Y. M.) and green manures should be mixed in these soils. Besides, crop - cycle should be adopted by growing paddy, barley, wheat, barseem, sweetbeet and dhacha alternatively. The researches done at central saline soil research center, Karnal (Haryana) have shown that 1/4 of the prescribed quantity of gypsum should be added to the soil along with manures and fertilizers in order to reclaim saline - alkali soils which have exchangeable sodium in excess. Soil conservation programs should also be adopted in order to improve the soil fertility.

Soil Structure: The black and alluvial soils can be reclaimed by deep ploughing of the fields and adding more than 20 ton per hectare farmyard and compost manures to it. Some gypsum may also be added to improve the soil structure.

Water Management: There should be proper water management for high yielding crops. Canals and other sources of water for irrigation should be developed on large scale. Drainage system should be improved as best as possible. Multiple crop farming and other modern methods of farming should be adopted to grow better crops.

Management of Soil Fertility:

Management of Soil Fertility Status:

A good fertility status of the soil can be maintained by keeping in mind the following factors or by applying the following methods:

- **Proper management of drainage and aeration:** Proper drainage system is necessary to save the plant nutrients present in the soil from being lost by leaching. Proper aeration in the soil is also essential for the normal growth of the roots. The aeration does not take place properly in excess of water. The amount of CO₂ increases in such a situation and it hinders the development of roots of plants.
- **Control of Soil Erosion:** Due to soil erosion, the plant nutrients like N, P, Ca and Mg are destroyed from the soil, so soil moisture is preserved to maintain soil fertility. It is done by making bands around the fields, by growing grass on the upper surface of the sloppy soil, by ploughing the fields perpendicular to the slope and by growing early ripening crops during rainy season.
- **Proper Maintenance of Water in the Soil:** The deficiency and excess of water both are harmful for the soil properties and plant growth. Hence, the moisture is preserved in the soil in order to maintain soil fertility. It is done by plowing the fields at a suitable time, by adding organic matter in the soil, by destroying weeds and by stopping rain water.
- **Soil pH:** Neutral soils are suitable for growing most of the crops. The soil pH is controlled by adding lime in acidic soils and by using chemical amendments and organic matter in alkali soils in order to maintain soil fertility.
- **Weed Control:** Weeds have a competition with the main crop in respect of light, moisture and plant nutrients. They adversely affect the growing of the main crop. Hence, the weeds should be destroyed in order to maintain soil fertility. The weeds can be removed by hand, by cutting before ripening, by burning, by using mulches or by using chemicals like 2,4 - D, copper sulphate, 2, 4, 5 - T etc.
- **Control of Harmful Insects:** The harmful insects and micro-organisms should be destroyed from the soil in order to maintain soil fertility. The plowing of fields during summer and then leaving it as such under direct sun destroys many harmful insects of the soil.
- **Improvement in Soil Structure by proper ploughing:** the plowing of the soil in presence of less or excess moisture leads to the formation of lumps or muddy soil.

Thus, the soil texture does not remain proper and soil fertility also decreases. Therefore, plowing of land should be done at an appropriate time so that the water holding capacity of the soil and aeration in it remain proper.

- **Growing of Legumes:** Leguminous crops such as gram, pea, lobia, barseem, moong, urad, hemp and dhacha etc. have symbiotic bacteria in the nodules of their roots. These symbiotic bacteria fix the atmospheric nitrogen in the soil and these results in an increase in soil fertility. Therefore, the growing of legume crops is useful for the soil.

- **Use of Scientific Crop Rotation:** On sowing different crops alternatively, the soil does not become deficient in any one specific nutrient. Therefore, proper crop rotation should be observed in order to maintain soil fertility.
- **Use of FYM and Green Manure:** Organic manures have almost all the plant nutrients in proper proportion. Hence, FYM (Farmyard manure) should be added to soil and crops of green manuring should be grown and mixed in the soil before seed formation. Thus, organic manures enhance the fertility of the soil.
- **Use of Fertilizers:** On adding different fertilizers to the soil, the fertility of the soil increases. Hence, the required fertilizers should be added to the soil to maintain its fertility.

Soil fertility status in India:

In Indian soils not only the availability of major plant nutrients (N, P, and K) but also of secondary nutrients (Ca, Mg, S) as well as micro-nutrients like zinc is very low. The fertility of soil decreases on growing crops in it. Therefore, high yield varieties cannot be produced without using the fertilizers. Actually, by the application of 1 kg of fertilizer, 10 kg food - grains are produced. Approximately 70% of total production of grains in India could be possible by the application of fertilizers.

Soil fertility is related to the availability of plant nutrients, proper crop rotation and water management. Soil fertility decreases due to imbalance in major plant nutrients, deficiency of organic matter, soil structure, soil conservation and pollution of soil. Soil testing is essential to know the fertility status of the soil and the requirement of fertilizers.

Various research centers are working in different parts of the country to ensure high production of agricultural products. Crop - rotation is being observed keeping in view the fertility of the soil.

All out efforts are being made to maintain soil fertility in India so that it becomes self sufficient to feed adequately to the increasing population.

Maintenance of soil fertility:

Following efforts should be made in order to maintain soil fertility:

- To develop quality soil structure.
- To ensure proper drainage and aeration in the soil.
- Availability of water and proper water holding capacity of soil.
- To maintain proper organic matter level in the soil.
- To control weeds on the soil.
- To control soil erosion.
- To control harmful insects and pests.
- To control soil pH by using soil amendments.

- To adopt scientific crop rotation.
- To grow leguminous crops.
- To add fertilizers keeping in view the proper balance of plant nutrients.
- To use FYM, green manures and bio-fertilizers.
- To get soil testing done from time to time to check fertility of the soil.

Soil Productivity:

Soil productivity is the capacity of a soil to give maximum yield of the crop grown in it. It is measured in kilogram or quintal per hectare of the land.

Soil Productivity may be defined as under:

"The present capacity of a soil to produce crop yield under a defined set of management practices, is called soil productivity." A productive soil is always fertile but a fertile soil may not be always productive.

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Factors affecting Soil Productivity:

The productivity of soil depends upon various factors. Some main factors that affect the productivity of the soil are as follows:

- **Physical condition of the soil:** If the physical condition is good, the crops grow well and the productivity increases.
- **Soil fertility:** If a soil has the plant nutrients in proper proportion, the soil is fertile and its productivity will be more.
- **Situation of the soil:** The soil of nearby areas of a village or a town is comparatively more productive, other factors remaining the same. It is because vegetables are generally grown in such lands. These can be transported to the market easily and sold easily to get more money.
- **Demand:** If the demand of anything is more, its cost may be high. Due to more profit, it will prove more productive.
- **Means of Transportation:** Other things remaining the same, the productivity of the farms which are located on proper metalled roads, will be more as compared to those which are connected with muddy or ordinary roads.

The **inter-relation between the soil productivity and the factors related to it** can be expressed by the following relation

$$y = f(s, CI, v, m, 1)$$

Where,

y = Yield (Productivity).

f = function s = Soil.

CI = Climate.

y = Vegetation.

m = Management.

1 = Time.

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