LECTURE 13

. **SOIL FERTILITY EVALUATION**

Calibration, Correlation of crop responses, yield prediction, fertilizer recommendation

SOIL TESTING RESEARCH IN INDIA

Farming is a business and, like all businesspersons, the farmer operates farming business for profit. Obviously, to reach a decision before planting a crop, a farmer needs all of the reliable information from the country's soil evaluation programme. In our country, system of fertility evaluation is being modified from time to time in various stages incorporating crop response data.

Some Important landmarks in soil testing research in India:

Year	Landmark
1953	Soil fertility and fertilizer use project
1955	Establishment of Soil Testing Laboratories
1956	All India Coordinated Agronomic Research Project
1960s	Establishment of Agricultural Universities
1967	All India Coordinated Research Project on Soil Test Crop Response (STCR) correlation
1967	All India Coordinated Research Project on Micronutrients in Soils and Plants
22 (6/6)	All India Coordinated Research Project on Long term Fertilizer Experiments
1980s	Emphasis on fertilizer prescription for whole

cropping system based on initial soil tests.

Since Liebig's time around 1840 many methods and approaches have been tried to get a precise or workable basis for predicting the fertilizer requirements of crops. The fertilizer use project initiated in 1953 following a study by Stewart (1947) was the first systematic attempt in the whole of the country to relate the knowledge of soils to the judicious use of fertilizers. The establishment of soil testing laboratories was initiated in 1955-56.

The project on Model Agronomic Experiments on Experimental Farms and Simple fertilizer trials on cultivators' Fields was started in 1957. The Soil Test Crop Response (STCR) correlation work carried out at Indian Agricultural Research Institute, New Delhi had resulted in the selection of soil test methods and categorizing the tests into low, medium, and high soil fertility classes.

Soil fertility evaluation

Soils are very heterogeneous in respect to forms of nutrients they contain, which greatly complicates the interpretation of Soil Test for assessing fertilizer needs. The total amount of a nutrient present in a soil offers little information relative to the amount of that nutrient which is available. Numerous extracting solutions and procedures have been used to remove nutrient elements from the soil, but none remove exactly the amount that plant roots obtain.

This means that, in order to interpret the data, the results from each analytical procedure must be correlated with the plant response obtained in field experiments by applying that fertilizer nutrient.

By this calibration, the requirement of fertilizer is calculated for achieving specific yield target. Soil fertility evaluation preferably employs a particular method of calibration as per the utility of the outcome.

Crop Response Data

In nutrient rating experiments, soil test data is correlated with the response of crop. The response is measured in terms of 'percent yield' or 'percent yield increase'. Both represent the ratio of the yield obtained in unfertilized soil (nutrient limiting deficient soil) to the yield in fertilizer nutrient applied soil (non-limiting or nutrient sufficient soil). The yield in non-limiting soil is otherwise known as maximum attainable yield or yield of standard treatment with all nutrients applied.

While comparing native fertility, in experiments that are conducted at different locations, *percent yield* is used.

$$\text{Percent yield} = \frac{\text{Yield without fertilizer nutrient}}{\text{Yield in standard treatment}} \quad X\ 100$$

While conducting multi location trials, or a pot experiment in a single location with soils brought from different locations, *percent yield increase* is worked out for every level of fertilizer application. The highest yield obtained in the experiment with all fertilizer nutrient applied, is taken as Maximum attainable yield

$$\text{Percent yield increase} = \frac{\text{Yield at fertilizer nutrient level} - \text{Yield without fertilizer nutrient}}{\text{Maximum attainable yield}} \quad X\ 100$$

The soils analyzed by standard nutrient extraction method are grouped. The soil tests are calibrated into different fertility groups by various procedures.

Present approaches in formulation of fertilizer recommendations extensively used in India:

Soil testing programme was initially started adopting the International soil fertility evaluation and improvement programme (Fitts, 1956). In this approach much stress is laid on laboratory characterization, followed by potted-plant studies ultimately leading to field - verification trials. These two initial steps help in eliminating arbitrariness of field trials. However, this approach had low adoption as it arrived one critical value below which economic responses are possible. Later, many improvements were suggested.

AGRONOMIC APPROACH

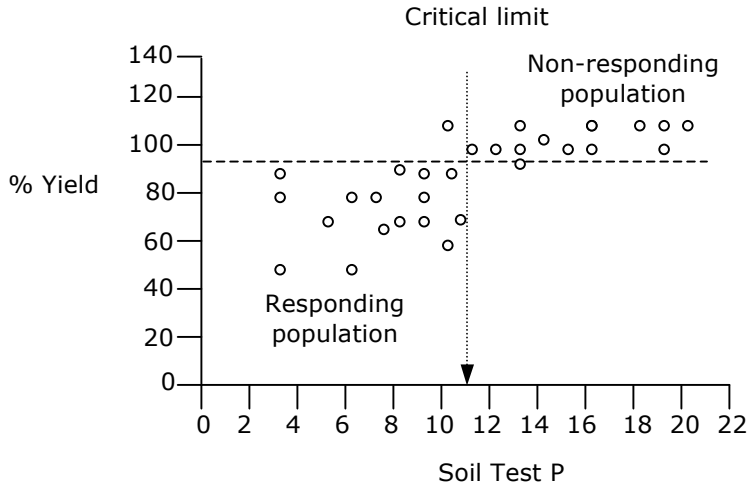
This is based on **fertilizer rate experiments** (recording yield at increasing nutrient levels) conducted at many locations. The level at which yields are high are recorded and averaged. From these results, the optimum dose of fertilizer is recommended for a crop at given agro-climatic region.

Eg. A blanket dose of 120-50-50 kg/ha of N, P_2O_5, K_2O respectively is recommended for rice.

CRITICAL LIMIT APPROACH

Waugh and Fitts (1965) developed this technique which is largely meant for less mobile nutrients like P, K and micronutrients. Soils vary considerably in fixing capacities. Due to it a part of applied P, which is fixed in soil, is not readily available to plants.

The method includes incubation study. For P, Soil is incubated for 72 hours with graded doses of soluble P in the form of monocalcium phosphate. Then, the amount of phosphates released (extracted) with an extracting reagent (Olsen or Bray) will be determined. The extracted P versus the amount of P applied is plotted. If the relationship is unique, then for high P fixing soils a larger amount of fertilizer P application is needed. This amount of P fixed is estimated as X-value.



Then, in potted experiment fertilizer P is added at 0, 0.5X, X, 2X levels, and the test crop was grown to find out the soil critical value. The percentage yield obtained is plotted against the soil-test value for different soils. By using a plastic overlay, these data are grouped into two populations as described by Cate and Nelson (1965). The soil-test value where the vertical line crosses the x-axis is designated as the soil critical limit.

Critical limit for the soil test value is *the limit below which a positive or economic response to added fertilizer is possible and above which the response diminishes at a faster rate or vanishes*.

The validity of critical value is verified by conducting verification trials in the field locations where from the soil samples have been collected for pot studies.