14. PREDICTING YIELDS USING NUTRIENT FUNCTIONS

Nutrient function Crop yield is a function of 4 major factors:

Yield = f (crop, soil, climate, management).

Nutrient functions are fitted using data obtained in experiments conducted either in *deductive* or *inductive* approach.

Deductive approach

Deductive approach utilizes the natural variation in soil fertility for calibrating soil test values. Multilocation trials are carried out with same set of treatments. The responses are then fitted in the fertilizer prescription models.

Colwell (1967) developed this approach on the basis that some variables, which affect the response of crop to fertilizers, if omitted from the correlation between soil test an [illegible] ed to poor correlations. To prevent this difficulty, a calibration model was suggested based on the generalization of coefficients of an *orthogonal polynomial yield-response model*, which can include all the variables affecting the responses to fertilizers.

Inductive approach

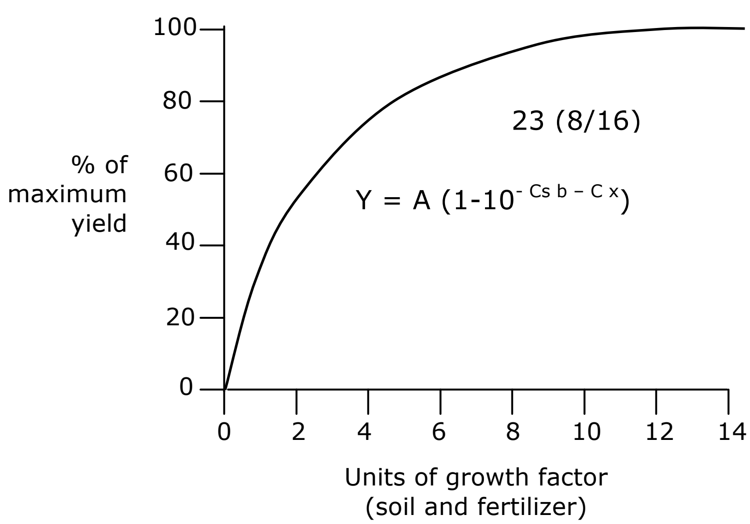
This approach is by creating fertility gradient artificially in a particular experimental location by addition of fertilizers. The approach of inducing fertility gradient (Ramamoorthy, 1970) aims at eliminating influence of the 3 out of 4 factors in the yield function, namely: crop, climate and management in the experimental location.

A large field having wide variation in fertility is chosen in a location. It is divided into 4 strips, which are treated with 4 doses of N, P and K fertilizers, viz., control ($N_0P_0K_0$), ½ normal dose ($N_{½}$ $P_{½}$ $K_{½}$), normal dose ($N_1P_1K_1$) and double dose ($N_2P_2K_2$). The normal doses are fixed based on **nutrient fixing capacity** of the soil. Exhaustive crop like maize is grown. The calibration crop experiment is then laid out. For the purpose of correlation, 21 treatments having one untreated check plot are tested.

Quadratic Model:

Percentage of yield maximum concept (sufficiency concept)

This is commonly known as Mitscherlich and Bray approach. An empirical relationship is developed between percent yield, soil test, and fertilizer maximum yield (Bray, 1944).



Presently, this approach is modified and used by the Department of Agriculture, Tamil Nadu for giving site-specific fertilizer recommendations.

The modified Mitscherlich-Bray equation is:

$$\text{Log}\,(A\text{-}Y) = \text{Log}\,A - C_s b - Cx$$

Where,	A	=	calculated maximum yield
	Y	=	percentage yield
	C_s	=	proportionality factor for soil nutrient
	b	=	soil test value
	x	=	dose of fertilizer added.

The maximum yield (A) is calculated by extrapolation.

Quadratic Model:

Regression model for maximum profit

The amount of fertilizer that produces the greatest profit per hectare is called the optimum dressing (Cooke, 1972). Ramamoorthy (1974) established a significant relationship between soil tests, added fertilizers and crop yields by fitting a multiple regression of the quadratic form (*orthogonal polynomial yield-response model)*:

$$\begin{aligned} Y = A & + b_1SN + b_2SP + b_3SK + b_4SN^2 + b_5SP^2 + b_6SK^2 \\ & + B_7FN + b_8FP + b_9FK + b_{10}FN^2 + b_{11}FP^2 + b_{12}FK^2 \\ & + b_{13}SNFN + b_{14}SPFP + b_{15}SKFK \end{aligned}$$

Where	Y	=	Crop yield (kg/ ha)
	A	=	Intercept
	bi	=	Regression coefficient

SN, SP, SK	=	Available contents of soil N, soil P and Soil K
FN, FP, FK	=	Fertilizer N, Fertilizer P, Fertilizer K

Fertilizer calibrations for varying soil test value for obtaining maximum profit per hectare could be derived where the response to added nutrient follows the law of diminishing returns (Ramamoorthy, 1974)

Fertilizer adjustment equation is derived in the form:

$$FN = a - b\,SN - c\,R$$

$$FP_2O_5 = a - b\,SP - c\,R$$

$$FK_20 = a - b\,SK - c\,R$$

Where,

$$R = \frac{\text{Cost of fertilizer nutrient (Rs./kg)}}{\text{Value of produce (Rs./kg)}}$$

Linear model:

Targeted Yield approach

Fertilizer recommendation must aim at providing balanced nutrition to crops. Balanced nutrition shou 23 (10/16) nutrients to be present in available forms in adequate quantities and required proportion for the plant in order to produce maximum yield. The requirement of nutrient to produce the expected yield can be worked out based on **nutrient uptake**.

Nutrient requirement of crops

Crop	Nutrient Requirement (kg) to produce 100 kg of economic produce		
	N	P_2O_5	K_2O
Rice	2.01	1.12	3.00
Wheat	2.45	0.86	3.28
Maize	2.63	1.39	3.58
Sorghum	2.24	1.33	3.40
Finger millet	2.98	1.13	3.90
Chick pea	4.63	0.84	4.96
Soya bean	6.68	1.77	4.44
Ground nut	5.81	1.96	3.01
Potato	0.39	0.14	0.49
Cotton	4.45	2.83	7.47

Liebig's law of minimum states that the growth of plants is limited by the plant nutrient element in the smallest quantity, when all others being present in adequate amounts. This forms the basis for fertilizer application for targeted yields, first advocated by Troug (1960) by significant **linear relationship** between the yield of grain and uptake of nutrients. Yield target can be projected within the linear region of the response function.

This approach, popularly known as **Soil Test Crop Response** Function (**STCR**), implies that [illegible] specific yield (grain or any other economic produce) a definite quantity of the nutrient must be taken up. This value can be determined by the magnitude of the expected yield (T in q/ha) and the nutrient requirement to produce unit quantity of that target (NR in kg/ha).

Once it is known for a target yield, the fertilizer dose (FD kg/ha) can be estimated.

It is done by taking into account the efficiency of soil contribution (CS in percent) from the soil available nutrients (STV in kg/ha), and the efficiency of fertilizer of fertilizer contribution (CF in percent) from the fertilizer nutrients (FD in kg/ha) towards the total uptake.

$$FD = \frac{NR}{CF} \times 100\,T - \frac{CS}{CF} \times STV$$

Where F and S stand for fertilizer and soil nutrient in Kg/ha and T is yield target in q/ha.