Transactions of the International Congress of Soil Science
Amsterdam 1950. Volume I.

GROWTH FACTORS AND SOIL PRODUCTIVITY

Results of a multifactor-analysis

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Introduction

The soil productivity can be defined as the capacity of the soil to produce crops and is dependent on the results of the influence of many growth factors on the plant with all their interplays. Consequently, if there is a possibility to unravel the relations between growth factors and yield, we should have fixed the influence of each separate growth factor. In this case one can use the very growth factors that are necessary for our purpose, i.e. soil evaluation, classification, land-use planning and soil improvement. Vice versa the yield can be fixed beforehand, if all factors are known.

In this respect there is no need to make any fundamental difference between natural factors, such as soil qualities and climate, and human influence, such as management, manuring etc. Nor is there any difference between not or very hard changeable factors and those that can easily be changed.

To be able to research all problems in respect of changeable as well as of not changeable factors W. C. VISSER of the Netherlands projected a way of research, quitting the usual experimental fields and using single plots, distributed over a wide area. These plots have to be chosen without much regard to the equality or difference of growth factors. In this way as many factors as possible are drawn into the research. In this respect VISSER worked out a graphic method of statistical analysis, the so-called *multifactor-analysis*, by which it is possible to unravel the influences of all these growth factors and to determine from the collection of data the quantitative effect on the growth of the crop for each quality of the profile, the hydrological situation and the content of plant nutrients.

This method gives us i.a. all necessary information for a scientific and objective soil evaluation, classification and land-use planning.

Next we will give a short summary of the way in which the experimental plots are laid out and of the results of this method.

Design for the system of experimental plots.

The research was made in 1948 on the creek soils in a riversilt district, namely the Bommelerwaard, which district forms a unit in agricultural and hydrological respect. In this district of which the area is about 10,000 ha, 230 experimental plots of half an are each were laid out on which the potato-variety Bevelander was grown. As the analysis requires a regular and wide variation we chose the plots in such a way that the result was a regular and wide variation for the various growth factors. This was easier because this region had already been surveyed and many soil analyses were available.

The multifactor-analysis shows *graphically* in a *quantitative* way the relation between growth factors and yield and requires therefore a *quantitative* description of all growth factors.

As characteristics of the acidity and the content of essential plant nutrients we took the pH (water), P-citr. (phosphate content soluble in 1 % citric acid) and K-HCl (potash content soluble in 0.1 N. hydrochloric acid).

The profile was described by the content of organic matter of the arable layer and by the clay content (particles with a diameter $< 16\,\mu$) in arable layer and successive layers 30—70 and 70—120 cms under surface. The gley-symptoms were expressed in depths under surface, on which certain reduction-colours exist; for this purpose we took 2- and 5-grey which show respectively the clear start of reduction and the depth where some oxydation is still noticeable.

The groundwater level and the fluctuation (the difference in depths at 2 dates) were available as hydrological characteristics.

The structure was expressed by a figure of the visual structure evaluation and by the percentage dry weight of stable aggregates with diameter of 1.0—4.6 mms.

As a topographical factor we took the distance of field from farmstead.

Results of a multifactor-analysis

It is characteristic of the multifactor-analysis that it represents the influence of a growth factor on the yield as a curve. To represent the influence of one factor we use one curve. To fix the influence of two factors (the so-called interaction of the 1st order) 3 curves are used, if the variation of the 2nd factor is given in three classes, viz. low, moderate and high. In this way we can proceed and represent interactions of higher order. An example of an interaction of the first order is the influence of the pH on the yield for different potash conditions (fig. 1).

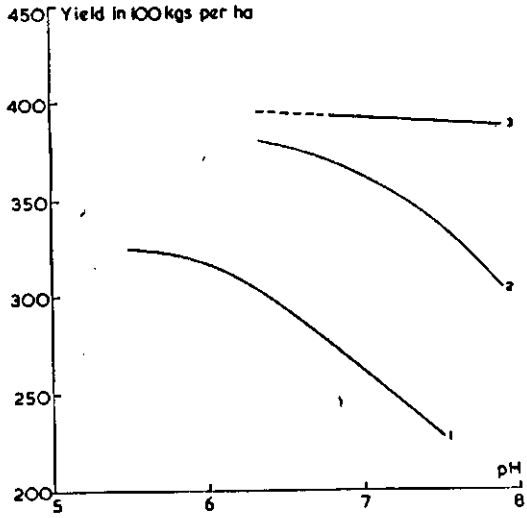

Fig. 1. The relation between pH and the yield of potatoes at different potash contents of the soil (1 low, 2 moderate, 3 high).

The potash content turned out to be one of the most important factors. Figure 2 shows the average influence of the potash content on the yield.

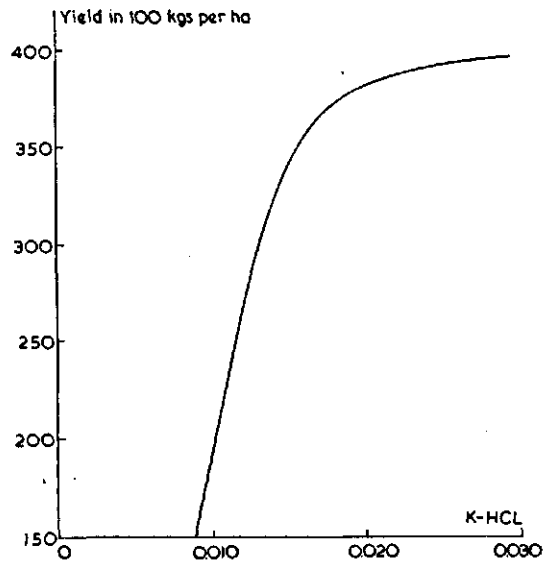

Fig. 2. The average relation between the potash content of the soil and the yield of potatoes.

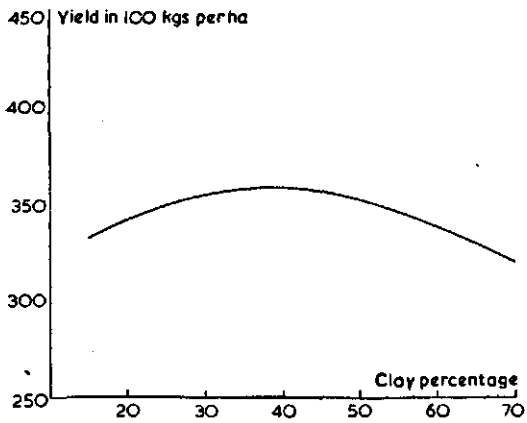

Fig. 3. The average relation between the clay content of the arable layer and the yield of potatoes.

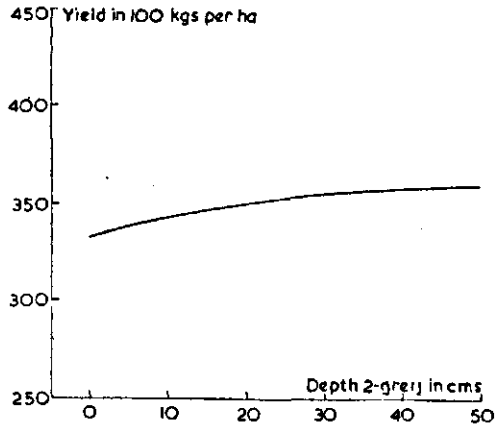

Fig. 4. The average relation between the depth of 2-grey and the yield of potatoes.

The profile qualities had only a small influence on the yields of that year, less than was generally expected. Figure 3 and 4 show the influence of 2 profile qualities respectively of the clay content of the arable layer and the depth of 2-grey.

It is very hard to express in a figure the farmer's care, knowledge, skill etc. In order to draw in this factor, we took the distance from the farmstead and this turned out to be of much importance (figure 5).

The influence of 15 factors was analysed in this way and we found for the various factors the following maximal variation expressed in

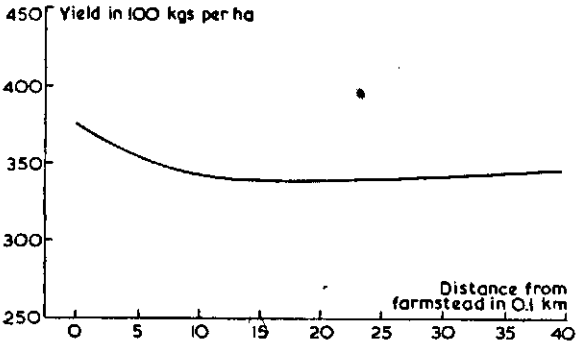

Fig. 5. The average relation between the distance from farmstead and the yield of potatoes.

percentages of the average yield of 34,800 kgs per ha (31,042 lbs. per acre)

potassium manuring . . .	17	organic matter content . .	8
date of planting	10	potash content	71
distance from farmstead . .	12	clay content arable layer .	15
visual structure.	7	ground-water level	8
% stable aggregates . . .	6	fluctuation	4
pH	12	depth 2-grey	8

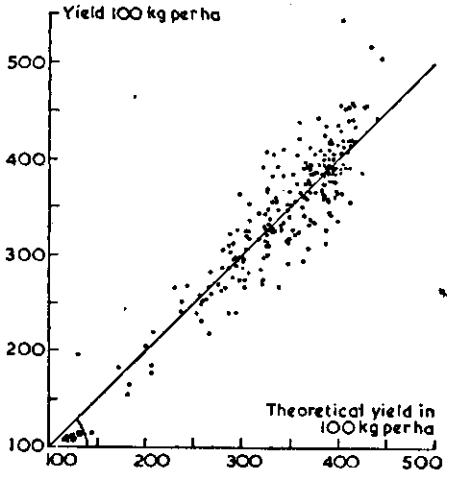

Fig. 6. The correlation between the calculated yields and the actual yields.

Figure 6 shows to what extent this analysis for each factor succeeded and makes at the same time plausible that the correlations between the various factors are indeed eliminated. We calculated the theoretical yields for each field, in which calculation we took into account the influence of 12 factors and these yields are plotted against the actual yields. The result is striking, especially considering that the error of the

yield determination in this material is about 5 %. The correlation coëfficient is 0.88.

The influence of each factor seems to be correctly interpreted and the correlations appear to be eliminated. Besides, it turns out to be possible to fix the soil productivity for each parcel in this district, if the value of each growth factor is known.

Conclusions

The possibility exists to get an exact idea of the influence of each factor on the soil productivity by means of the multifactor-analysis. At the same time a synthesis of all growth factors is the result. If this research would be repeated for some years and for several crops an objective and exact view of the influence of various natural factors — soil, topography and climate — and of human management would be acquired.

From the results justified conclusions can be drawn about the soil evaluation, land-use planning and all the measures that must be taken for soil improvement.