Soil Science in the Netherlands,
Indonesia and Suriname
PREFACE

The Organizing Committee of the Fourth International Congress of Soil Science takes much pleasure in offering to the members of the Congress this survey of activities in the field of soil science in the Netherlands, supplemented by some aspects of the work accomplished in Indonesia and Suriname.

Also the papers to be read at the Congress on "Soil Science and its applications in the Netherlands" by A. J. Zuur, F. van der Paauw, F. Dechering and P. A. den Engelse have been inserted. It is hoped that this exposition will prove to be useful, especially to those who wish to pay a visit to or to establish scientific contacts with the different institutes, laboratories etc.

The editing of this booklet has been done by Mr P. Buringh, whose services should certainly be duly acknowledged here.

Mr B. Gerritzen of the Ministry of Agriculture, The Hague, has been so kind to translate this volume in English from the original Dutch text. We want to thank Mr Gerritzen for his valuable contribution to the Congress.

Wageningen, June 1950

C. H. Edelman
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PART I. THE NETHERLANDS

Chapter 1

THE AGRICULTURAL EXPERIMENT STATION AND INSTITUTE FOR SOIL RESEARCH T.N.O.

Groningen

P. Bruin

The task of the Agricultural Experiment Station and Institute for Soil Research is to study problems of the soil and soil fertility. To perform this task research work at laboratories coupled with pot cultures is supported by work on experimental plots and on growing crops in collaboration of agronomists, soil scientists, biologists, chemists and physicists (28 research workers, total number of staff 170). Some groups of subjects under investigation will be quoted here.

In studying soil fertility in connection with manuring and nutrition of crops (arable and grassland) special attention is paid to the mutual effect of plant nutrients under varying conditions of soil. The trials on nitrogenous, phosphatic, potassic, calcareous and magnesium nutrients are numerous but also the importance of minor elements is well attended to (large number of trial plots and series of simple experiments resp. sample spots). Experiments are also conducted on farmyard manure, compost, town refuse and other organic fertilizers. Except by soil analyses, soil fertility is also judged by determination of the chemical composition of crops.

During the last few years much attention has been paid to biochemical problems arising from the provision of nitrogen to crops, more particularly to potatoes and grass. These investigations were performed by an agronomist of the Central Nitrogen Sale Office attached to the institute.

The significance of different kinds of manure and the method of application in practice have been thoroughly investigated. Another group of subjects concerns factors affecting soil fertility and soil, which are not easy to modify. In addition to effects of profile, granular composition and height of the watertable in the soil also problems of a chemical and/or a mineralogical character are considered (fixation of potash and phosphate, weathering of minerals and gradual availability of plant nutrients). Much attention is paid also to the study of the structure of soils in relation to the humus problem and the nitrogen supply in soils.

Other problems of a fundamental character to soil scientists are the phenomenon of irreversible desiccation of peaty soils, the development of mechanical analysis and the determination of the cohesive properties of soil particles, more particularly of the mineral soil complex.

Agrohydrological research is gradually extending. The acquired knowledge is applied to problems of drainage, barrage of brooks, depletion of water from soils by canalization and normalization etc. Lately a fundamental study has been taken up of the movement of water in the soil and finally the effect of the watertable and the water supply on the growth of crops is being investigated.

The botanical research is at present concerned with rooting of arable and grassland crops. The nature of these crops in regard to rooting is being examined and also the effect of manurial treatment, water supply and soil profile on this characteristic. The influence of root development
and of the humus formed from root residues left behind after withering on deeper layers is being pursued.

The microbiological department is engaged in research on the following subjects: the problem of parasitical diseases of peas, preparation and preservation of farmyard manure, the significance of microbiological processes to the nitrogen supply in the soil and to the availability, respectively fixation of other plant nutrients (phosphates, manganese, iron), inoculation of soils on behalf of leguminosae and finally the study of the applicability of the Aspergillus method on the determination of plant nutrients, including minor elements, should be quoted here (phosphate, potash, magnesia, copper, zinc).

Chapter 2

THE SECTION SOIL RESEARCH OF THE WIERINGERMEER ADMINISTRATION (NORTH EASTERN POLDER RECLAMATION)

KAMPEN

A. J. ZUUR

Since 1919 the work of enclosure and reclamation of the floor of large parts of the Zuyder Zee, after the water has been pumped out, has been taken in hand. In total 220,000 ha of fertile land will be acquired and 10 percent will finally be added to the formerly cultivated area of the Netherlands. So far 70,000 ha have been reclaimed. The hydraulic works, the reclamation of the soil, the construction of farmsteads and dwelling houses and the development of the social amenities are executed by the Government; when all this work has been completed, the farms will be let to private occupies.

Owing to the extent of the work to be accomplished it is obvious that many problems must arise in connection with the reclamation of the mud flats which cannot be solved without an agricultural research station being available. Consequently a Division for Agricultural Research has been founded to assist the Management of the North Eastern Polder (Managing Director Dr S. Smeding).

This Division is situated at Kampen. The staff consists of 12 scientists, 15 employees with a certificate of a secondary agricultural school, 8 analysts with a certificate of a secondary school, 15 employees with a primary school education, 7 draughtsmen, 8 administrative employees and temporarily and permanently engaged workers. The Division has its own pedological and microbiological laboratory, an experimental farm of 40 ha and runs several temporarily experimental plots covering an area of about 100 ha in total.

The Division consists of the following sections:

I General Agricultural and Botanical Research (Chief Ir W. A. Bosma; Agronomists: Ir J. Jonker and Drs D. Bakker)

This section is investigating the problems in the province of manuring, soil cultivation, choice of crops and strains or varieties, crop rotation and control of weeds.

II Soil survey and soil analyses (Chief Dr A. J. Zuur; Agronomists: Ir B. Verhoeven, Ir W. H. Sieben, Ir W. H. van der Molen)

This section is engaged in soil mapping, renders advice on surface and
pipe drainage, performs physical and chemical analyses of soils (silt, sand, composition of sand fraction, carbonate of lime, humus, potash, phosphorus, salt, interchangeable bases) and studies the utilization of the water supply in soils and soil manuring. These investigations are not only conducted on soils in the Zuyder Zee Polders, but also on other soils of marine origin in the Netherlands intended for enclosure.

The effect of the establishment of the Zuyder Zee Polders on the hydrological conditions of bordering areas on the old land has produced the necessity of various additional investigations of a peculiar nature (desiccation of peat soils, relation between yield and groundwater level).

III Microbiological Research (Chief: Dr D. Van Schreven)

This section is involved in problems relating to the microflora, organic matter and the utilization of nitrogen in the soil. In addition pure cultures of radicicola bacilli are prepared on a large scale for inoculation of soils before leguminous crops will be grown on them for the first time.

IV Statistics and Advisory work Extension (Chief: Ir C. Kalisvaart, Agronomist: Ir G. Veldman, civil-engineer: Ir G. Enserink)

This section renders advice on improvement of soils, on construction of infiltration (subsoil irrigation) installations and on destination and rentable value of land; after letting, the staff takes charge of the general agricultural advisory work to the benefit of the tenants.

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**Chapter 3**

THE RESEARCH SECTION OF THE GOVERNMENT SERVICE FOR DRAINAGE, LAND IMPROVEMENT AND REALLOCATION

**Utrecth**

**W. C. Visser**

The Government Service for Land Improvement and Reallocation is a Section of the Ministry of Agriculture being engaged in the advancement of measures aiming at the increase of producibility of the soil by means of land improvement, drainage and commassation of scattered landed properties into compact holdings. Reclamation and reconditioning of land, improvement of avoidance of water from established polders and reallocation of land arouse a large variety of problems touching almost every branch of agricultural science. In order to find solutions of these problems within the limits of attainability fixed by the nature of the essential operations, a Research Section was established in 1942. With the assistance of regional operation groups Government Land Improvement and Reallocation Advisers design the working schemes for the provinces.

The performance of this task is particularly focused upon practicability. Fundamental research does not belong to the domain of this section, and even laboratory work, if necessary, is delegated to other institutions. The investigations must render results, involving all aspects of productiviness and farm management. Therefore the objects of investigation can be of a very varied nature and not only the objects themselves have to be thoroughly studied but also their mutual effect has to be carefully considered.
The investigations are spread over three large fields: the producibility of the soil, the classification of the soils belonging to the holdings and the economic results and possibilities of application of measures leading to improvements.

Productivity of soils is determined by morphological soil properties, plant nutritive conditions and water supply. By determination of the growth-affecting factors belonging to these groups and subsequent designing of experiments on trial plots, the effect of each factor on the yield can be ascertained. Mathematical statistical methods to disentangle the complex effect of these factors have been worked out in regard to these ecological investigations and they are of great importance to the determination of the causes of failing producibility and of possible means of improvements.

In order to be able to judge the properties, the water supply and the plant nutritive conditions of the soils in a certain district, data are recorded and mapped out and so maps of the important profile properties and hydrological maps are drawn and surveys compiled of the results of chemical soil analyses. These data arranged in accordance with the results of ecological investigations open prospects in many directions. It is possible to judge the producibility of profiles with the aid of all known factors. From this it is possible to decide which growth-affecting factors are unfavourable and the result will give indications in regard to essential soil improvements or soil reconditioning schemes.

Also the necessity of improvement of drainage or the desirability of improvements in the water supply will become evident. By involving also the factors on tending of crops, such as the distance of a field from a farm, spacing of drills or rows of plants etc. these investigations can also be of great use to the agricultural advisory work.

The lay-out of the land belonging to the farm, in other words the planology of a district, involves an investigation on the time required for cultivation of the fields and tending of crops and livestock. The data afford particulars on the most suitable allocation of the land belonging to one village. Also the possibilities of utilization must be well kept in mind. Land suitable for labour-intensive crops should be distributed in compact blocks as far as possible, but in the case of labour-extensive crops less far-reaching commassation would suffice. The conceptions attained by the ecological investigations in regard to land improvement are also playing their part here.

The investigations on the possibilities to adapt soil conditions to the planological requirements of a holding may show the way to greater flexibility in choosing the most economic type of holding.

Finally the aim of economic investigation is to determine the benefits of re-allocation, improvements in the control of water supply and land improvement in order to decide on the extent technical measures are desirable. The results of the preceding ecological and planological investigations are to be well kept in mind here. The necessity of giving a forecast of the monetary consequences of the improvements under consideration prevents the soil scientific work to aim at a summarizing description of the soils, but rather at a survey of a differentiating character. Every factor acting as a unit in regard to technical improvement, as perviousness, watertable etc. is considered separately and for every measure of a technical nature the necessity and economic possibility can then be independently judged.
Chapter 4

THE SOIL SURVEY INSTITUTE

WAGENINGEN

C. H. EDELMAN

The mapping of soil conditions obtaining in the Netherlands is a problem that has been attracting much attention for a considerable time. Already in 1867 Dr W. C. H. STARING compiled a soil-map of the Netherlands on a scale 1:200,000.

Dr W. A. J. OSTING († 1942) started soil mapping on an agronomic and pedological basis. During the second world war writer continued this work assisted by students of the Agricultural University College at Wageningen. This led to the establishment of the Soil Survey Institute in August 1945. This institute took up its task by surveying and mapping the areas inundated and devastated during the war. Similar work has since been proceeded with in almost all parts of the country. At present many detailed and survey maps (scale 1:10,000 and 1:25,000 respectively) with accessory reports are compiled. The investigations concern a careful study of the natural conditions in close relation to agricultural and horticultural practice and the classification of soils is consequently based upon both a sound theoretical and a sound practical foundation. Besides much attention is paid to the suitability for certain crops and productivity ratings, being the preliminaries of land classification.

The field investigations are supplemented by analyses of soil samples at the Soil Testing Laboratory at Oosterbeek. There is a close collaboration with the Government Advisory Services and the Agricultural Experimental Station and Institute for Soil Research T.N.O. at Groningen.

Of the Soil Surveys already completed, about 10 have now been published. (with coloured soil maps and circumstantial summaries in English, see the Excursion Guide to the 4th International Congress of Soil Science). At present 16 soil-scientists (graduates of the Agricultural University College), a geographer and a geologist are now working at the Soil Survey Institute. Also an archaeologist has been detached to this Service (see chapter XVI). Some ten agronomists and soil scientists are adopted as guest-collaborators at the Institute. Also two Turkish agronomists are detached to it for the duration of two years. The soil scientists are assisted in the fieldwork by 40 assistants with a secondary agricultural school diploma. One soil scientist is charged with soil mapping and town development schemes, another one is charged with the exploration of land extremely suitable for horticulture, a third one is engaged in writing reports on research work and a fourth one is secretary to the board.

Several young soil scientists having worked at the Institute for a few years have found employment in similar occupations in Indonesia, Surinam and foreign countries. Their places are taken up again by newly graduated agronomists, who will specialize themselves further in soil science. A close collaboration has been established with our Belgian colleagues. Endeavours are being made to design soil maps in the two countries according to corresponding systems.

Soil survey has achieved a great success in the Netherlands within a few years. The data are utilized for several purposes. Owing to the dense population, a highly developed agriculture and intensive utilization, the
soil of the Netherlands has to meet high requirements. Agricultural production can still be augmented and more intensified. Soil maps are a suitable foundation to devise schemes for the increase of production and reduction of production costs. Particularly for this reason such a great interest is taken in detailed soil investigation in the Netherlands today.

Chapter 5
THE SOIL TESTING LABORATORY
OOSTERBEEK
F. DECHERING

The interest taken by farmers in soil testing has led to the foundation of a laboratory at Groningen by agricultural organizations in 1927. Its task is to test soils on behalf of agriculturists and horticulturists and of trial fields, and to carry out other pedological investigations on behalf of the Government Advisory Services and research institutes.

Consequently it is not a research institute itself, but is equipped to analyse samples in series expediently. The laboratory is now property of the "Stichting voor de Landbouw" (Foundation for Agriculture), the co-ordinating organization of all agricultural organizations. Owing to the increase of the number of samples to be analysed it has been necessary to open branches in other parts of the country. In 1942 the first one was established at Geldrop (North-Brabant), another one in 1947 at Oosterbeek (at the same time main laboratory) and in 1948 at Goes (Zeeland). For analyses exact standard methods have been adopted, being performed mechanically in series by female workers under supervision of chemists and analysts. The tests consist of the following determinations: pH (acidity), humus, calcium carbonate (if present), liming factor, phosphate, potash, magnesia, copper, granular composition, salt residues (for glasshouse soils), chlorine content (for inundated soils) and in special cases permeability.

The basis for the advices is an interpretation of results of soil testing by results obtained on a large number of trial plots laid out by the Agricultural Experiment Station and Institute for Soil Research T.N.O. and the Government Advisory Services. These institutions are closely cooperating. Advices to farmers and growers are rendered by specialists, designated by the Agricultural and Horticultural Advisers. The development of the Soil Testing Laboratory can be shown by quoting some data put on record.

In 1927 the number of samples forwarded amounted to approximately 8,400, and for these some 65,000 determinations had to be accomplished. In 1947 the number of samples tested by the two laboratories then existing was over 90,000 and the number of determinations surpassed the million mark, an average of 3,300 determinations daily.

In 1949 the capacity of the four laboratories has been increased to 10,000 determinations daily. The capacity for potash analyses is now 1,200 daily. The number of soil samples analysed in 1949 amounted to 125,000 and the number of determinations was nearly two millions. The staff of the four laboratories now numbers 210 people, of whom 120 work at Groningen.

Preparations are made to start a fifth laboratory in the eastern part of the country.
Chapter 6

SOIL AND MANURIAL RESEARCH IN HORTICULTURE

F. W. G. PIJLS

The Agricultural Experiment Station and Institute for Soil Research at Groningen (chapter VIII) occasionally pays attention to problems arising in horticulture. One of these problems is the salting of soils in glasshouses and its control.

Manurial research as has been carried out in agriculture in the course of a large number of years, has never been performed in horticulture. The foundation for an interpretation of results from analyses of soil samples has therefore been very unsatisfactorily established. This is caused by the fact that no proper data are available from a large number of manurial experiments performed for the different branches of horticulture.

In order to attain improvements in the conditions prevailing a statistical investigation has been organized in 1948 with the aim to establish a better basis for the interpretation of the results from soil analyses in the interest of the advisory work on manuring. This research work is founded upon experiences with apples, vines, tomatoes and tulips. A detailed survey has been made of the soil profiles on the spots chosen for experimental plots, soil and crop samples have been taken and the conditions of these crops have been expressed in figures. The samples taken have been chemically analysed. The intention is to apply mathematical statistical methods to the data recorded in order to establish the existing correlations of structural and chemical factors of growth appertaining to the soil on the one hand and the chemical constitution and growth of the crops on the other. Not only the value for horticulture of the extraction-method applied by the Soil Testing Laboratory is verified by this investigation but also that of the method of Morgan-Venema.

The latter method is particularly tried out as it would i.a. furnish possibilities for attaining quickly an idea of the condition of some of the most important trace elements present in the soil. This insight is essential as in the Netherlands horticulturists have always applied large amounts of farmyard manure to their land and relatively even more fertilizers. The result has been that deficiency of trace elements is frequently shown by horticultural crops.

Experiments on deficiency symptoms are specially conducted at the Laboratory of "Zeelands Proeftuin" (experimental Garden) at Wilhelminadorp near Goes.

In addition many experiments have been divised on application of organic manures. Particular attention is paid to compost of town refuse, of garden rubbish and of sewage sludge and to green manuring. With green manuring crops special attention is paid to their effect on the water supply and structure of the soil and not anymore to their value as supplies of nutrients to the soil.

Since 1948 experiments have been conducted with soilless culture. These trials have been initiated owing to some diseases in floricultural crops, spreading through the soil. One of the most injurious ones is foot rot (Verticillium cinerescens) of the carnation Phialophora.

Experiments are conducted at the Laboratory of the "Experiment and Research Station for Fruit and Vegetable Glasscrops" at Naaldwijk.
in connection with salination of the water in polder and main water­
courses and of soils in the province of South Holland. Finally research
work is performed on the relation between the structure of the soil profile
and growth of crops. The results will be the foundation of advices to be
given to horticulturists on the establishment or transfer of holdings and
on work to be performed for soil improvement and draining. They also
are of paramount importance to advisory work on town and village deve-
lopment schemes and on the horticultural settlement scheme of the
Netherlands. The problems quoted above are also subjects of investiga-
tion at:
The Laboratory of Agricultural Chemistry at the Agricultural University
at Wageningen, (chapter 10).
The Soil Survey Institute at Wageningen, (chapter 4).
The General Technical Department of T.N.O. at The Hague.
The Laboratory of the Experimental Fruit-farm of the Institute for the
Improvement of Fruit-farming at Geldermalsen.
The Staff of the Horticultural Adviser at Wageningen in charge of
problems relating to the soil also performs experiments on a modest scale
but otherwise its task is a purely co-ordinating one.

Chapter 7

MANURIAL EXPERIMENTATION OF THE MANUFACTURING
INDUSTRY OF AND TRADE IN FERTILIZERS
IN THE NETHERLANDS

A. C. Schuffelen

In addition to research advanced by and the advice given to Dutch
farmers from official quarters, there is also in this country an advisory
service organized and experimental work carried out by the manufac-
turing industries of fertilizers.
Pamphlets are issued and lectures on and excursions to the demon-
stration plots laid out by them for the advancement of advisory work to
farmers and growers are organized. Next to this work of an advertising
character, also scientific investigations are performed to entrance a more
profound knowledge of the nature and application of the fertilizers made
or sold by them. Of course, the interest is particularly focused upon the
three principal plant-nutritive elements and lime.

In regard to supply of nitrogen the experiments concern the assimila-
tion of nitrate, ammonia and the nitrogen compounds in organic matter.
Attention is also being paid to the fixation of nitrogen by legumes. The
investigations are not restricted, however, to nitrogen as a factor affect-
ing growth by itself. Much attention is being paid to all kinds of factors,
afflicting the assimilation of nitrogen in order to get an idea as complete
as possible of the possibilities connected with the application of the
various nitrogenous fertilizers. For this reason the significance of a well
balanced nutrition with P and K and also with trace-elements in connec-
tion with the assimilation of nitrogen and with its utilization is investi-
gated. It will be clear that these investigations cannot be limited to the
management of more or less complicated experimental plots, but that
also trials with water and pot cultures must be conducted. Crop analysis now being in the favour is applied regularly by private concerns.

The exploration of the possibilities ensuing from the application of phosphoric manures has proceeded much during the last ten years. Formerly also the phosphate status was considered as being an independant factor. At present the influence of other elements on phosphate nutrition is being studied, magnesium, soil acidity and trace elements being of particular importance to the action of basic slag. With regard to investigations on the potash nutrition of crops special attention is being paid to magnesium and soil acidity, both being of particular interest under Dutch conditions in determining the proper amount of potash to be applied. By regular soil testing and crop analysis the essential data can be recorded to explain various phenomena.

In our country copper slag flour is used as a copperish fertilizer next to copper sulphate and comparative experiments are being performed.

The lime problem again has an aspect of its own, culminating particularly in endeavours to compose a quickly acting fertilizer. The Dutch industry has its own laboratory for this purpose being also engaged in investigations on an agricultural foundation. Again, these are not restricted to lime only but except to the magnesia investigations, which are, of course, self evident, very elaborate soil investigations are being conducted to explore the action of various products on soil fertility in its entity.

It is very fortunate indeed that the Dutch manufacturers of and dealers in fertilizers take a broad view of their task in this respect. They contribute a great deal to entrance the general knowledge on plant nutrition and manurial treatment of the soil.

_Laboratories of the manufacturing industries of and dealers in fertilizers in the Netherlands._

Centraal Stikstof Verkoopkantoor N.V. (Central Nitrogen Sale Office, Ltd), Agronomist Dr Ir E. G. Mulder, detached to the Agricultural Experiment Station and Institute for Soil Research T.N.O., Eemskanaal Zz 1, Groningen.

Laboratorium voor Bemestingsonderzoek van het Inlichtingenbureau voor Chilisalpeter (Laboratory for manurial research of the Information Bureau for Chilean Nitrate), Diedenweg 20, Wageningen. Director Dr J. J. Lehr.

Landbouwkundig Bureau voor Kopermeststoffen (Agronomic bureau for copperish fertilizers), Postbus 113 (P.O. Box 113) Arnhem.

Landbouwkundig Bureau voor Thomasslakkenmeel (Agronomic Bureau for Basic Slag) Hamelakkerlaan 13, Wageningen, Director Ir H. J. Gerritsen.

Nederlandse Kali Import Maatschappij N.V. (Netherlands Potash Import Company Ltd) Heerengracht 342, Amsterdam C. Agronomist Dr Ir J. Temme.

Stichting Nederlandse Landbouwkalk Bureau (Institution the Netherlands Agricultural Lime Bureau) Nw Veemarkt 4, Zwolle, Director J. Bausch.

Chapter 8

THE CERAMICS RESEARCH INSTITUTE T.N.O.
GOUDEA

M. J. Singer

The aim of soil research carried out by the Ceramics Research Institute T.N.O. is to collect data on Dutch soils in order to judge in how far they could supply suitable raw material to the ceramic industry more particularly for the manufacture of coarse ceramic articles.

The surface layer involved has a depth of 1—5 metres. An auger with either a twist bit or a spoon bit is used for taking samples at regular intervals and usually two samples are collected from each boring hole, each metre depth of the layer to be investigated.

The mechanical analysis of samples is yielding important data on the properties of the articles to be manufactured from the kind of earth concerned. If necessary these data are supplemented by the results of a complete or a partial chemical analysis and of baking experiments or of technological determinations (RIEKE-PFEFFERKORN).

By applying mechanical analysis according to the sieve-pipette method, the bottom limit of the coarsest fraction is 200 or 300 μ, the top limit of the fine fraction is usually 10 μ, but occasionally 2 or ½ μ.

If it is necessary to investigate the significance of the mineralogical composition of the soil, the methods of X-ray structural analysis are applied.

Whether it would be possible to forecast with sufficient certainty the drying conduct of the manufactured ceramic article from data recorded from soil-investigations is at present a subject of research.

Chapter 9

THE GOVERNMENT SERVICE OF ARCHAEOLOGICAL RESEARCH
AMERSFOORT

P. J. R. MODDERMAN

In the Netherlands the archaeological soil-investigations are performed by a central institution. The aim is to trace the history of mankind in the widest sense of the word by soil investigations. For its attainment excavations are carried out all over the country, the assistance of experts being called in if necessary to study certain details. In this respect pollen analysts, architects, geologists, art-historians, biologists etc. should be mentioned. Excavation is done according to the most up-to-date methods and several improvements in the excavation technique initiated by the Dutch archaeologist Prof. Dr A. E. van Giffen, are applied.

The objects pursued by the archaeological investigations are various. Except purely prehistorical objects such as barrows or palaeolithic finding places, Roman castella, mediaeval churches and castels and also ships of the 17th and 18th century, buried in the floor of the formal Zuyder Zee, are being excavated.
It also belongs to the duties of the Archaeological Service to survey sites of archaeological importance.

As the soil is the object of study of several scientists, differently inclined, it is obvious that some investigations overlap. In the Netherlands this applies particularly to archaeology on the one hand and to soil science on the other, the latter being interested in the origin of soil types.

From a geological point of view the soil of the Netherlands has only been recently formed. More than half of the area consists of holocene sedimentations, the other half mainly consists of pleistocene formations. That means that almost the entire area of the Netherlands was formed during the time that mankind already existed on earth. In the east of the country older formations come to the surface but in the west the more recent soils, some time very recent ones are to be found. In this connection the reclamation of parts of the Zuyder Zee may be referred to here, as marine silts have been drained dating from after 1600 A.D.

Owing to these circumstances Dutch archaeologists have already been engaged for some decades in the solution of soil problems such as positive and negative changes in level and the formation of the heath podzol profile. It is impossible, however, for an archaeologist to solve these problems independently. These problems are considered by soil scientists from a quite different point of view and a useful collaboration in this province has been established between them and archaeologists. The former have now become interested in archaeology as an auxiliary science. Dr W. A. J. OOSTING already pleaded in detail on the desirability of it in his thesis.

Archaeology is now rendering useful services to the survey and mapping out of physical properties of soils. Owing to traces of ancient inhabitation it has been possible in certain cases to get a better understanding of the formation of these soil types and the dating of their origin. The archaeologica are used as guiding fossils to the historical interpretation of the origin of soil types. On the other hand archaeology is profiting by the great interest shown by soil-scientists from Wageningen in this branch of science. Newly discovered ancient inhabitations have been reported by soil surveyers to archaeologists by the hundred.

By collaboration between archaeology and soil-science the soil-scientists get a better understanding of the origin of a landscape. To archaeologists on the other hand it is extremely valuable to get to know the circumstances in the locality in ages gone by.

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Chapter 10
THE AGRICULTURAL UNIVERSITY COLLEGE
WAGENINGEN

A. C. SCHUFFELEN

There is only one establishment in the Netherlands where agriculture is taught on a University basis, viz. the Agricultural University College at Wageningen. This College has gradually developed from the first Agricultural School in this country founded in 1876. After many reorganizations the school attained the University status in 1918. At the Agricultural University College students are trained to become "Agricultural
Engineers” 1) (comparable to M. Sc (Agr) in Great Britain and USA). They are entitled to the doctor’s degree in agricultural science if they write a thesis to the satisfaction of the Senate of the College.

The Agricultural University College has not a special department for studying soil science exclusively. A combination of subjects to be chosen by a senior student for special study can include a soil scientific subject. The soil scientific subjects being taught are: agricultural chemistry, knowledge of forest soils, regional soil science, field soil science, theory of land improvement, theory of land drainage and discharge of water from polders, theory of irrigation.

The theory of manurial treatment of soils, as far as the practical application of manures for particular crops is concerned, is taught in substance as a contributory part of the subjects: cultivation and breeding of agricultural crops, cultivation and breeding of tropical agricultural crops and cultivation and breeding of horticultural crops. Soil scientific problems are also dealt with by the tuition of the subjects: mineralogy and knowledge of rocks, geology, microbiology, theory of wood production.

As many professors are members of several committees, the contact with practice and other institutes in the country is properly maintained. All tutors supplement their instructions by practical demonstrations and the organization of excursions.

The departments specially concerned in soil scientific subjects and performing experimental work in this field in addition to tuition are:

1. Laboratory of Agricultural Chemistry (soil chemistry, soil physics and theory of manurial treatment). In addition to theoretical tuition, practical instruction is given in soil and crop analysis and senior students work out solutions for minor problems. At the laboratory scientific collaborators carry out investigations particularly on: silt (clay), minerals (electrochemical properties, differential thermic analysis), humus (chemical composition, synthesis, influence upon texture of the soil), utilization of the water supply in the soil (measurements of quantities and tension of soil moisture); assimilation of ions by the plant (theory and practical problems on the ratio of ions, pot experiments and experimental plots). Professor-Director: Dr A. C. Schuffelen.

2. Laboratory of regional soil-science, geology and mineralogy. At this department a lecturer is in charge of the instruction in geology and mineralogy, the regional and field soil science is taught by the professor-director. In addition to theoretical instruction concerning the moderate zone and the tropics the students must undergo a practical training in soil surveying to get experience of field work. As the director of the laboratory is at the same time director of the Soil Survey Institute a close co-operation of the two institutions is ensured. The scientific investigations are mainly concerned with the geology of the Quarternary, coupled with survey and mapping out of Dutch soils in connection with agricultural objectives, X-ray analysis of clay-minerals, the granular composition of soils. Professor-Director: Dr C. H. Edelman, lecturer: Dr D. Doeglas.

3. Laboratory of Land Improvement and Reallocation.

At this department instruction is given on drainage and discharge of water from polders and land improvement (reclamation, acquisition

1) This title will not sound so strange to English speaking people if they realise that the words engineer and ingenious are closely related.
of land, reallocation). In addition to the theoretical tuition supplied students are obliged to go through a practical training on the land for a fixed period in order to study certain problems. The investigations carried out at the laboratory are especially concerned with problems of reallocation, utilization of the water supply in peat soils, determination and calculation of discharge coefficients. Professor-Director: Ir F. Hellinga.

4. Laboratory of microbiology.
   At this department in addition to general microbiology, special soil-microbiological subjects are taught and except the theoretical instruction students must attend practical lessons in microbiological methods. Senior students having chosen microbiology as a special subject for their examination must also undergo another extra practical training in a special subject during about half a year. The experiments conducted at the laboratory in the province of soil science are mainly concerned with studies on deficiency diseases and the development of microbiological methods on the determination of trace elements. Professor-Director: Dr J. Smits.

5. Laboratory of road building and hydraulic works (i.a. irrigation)
   Professor-Director: Ir W. F. Eijsvogel.

6. Laboratory of Agricultural Engineering (i.a. soil cultivation)
   Professor-Director: Ir F. Hellinga.

7. Laboratory of Agricultural plant breeding (i.a. manuring)
   Professor-Director: Ir W. J. Dewez.

8. Laboratory of tropical agriculture (tropical crops)
   Professor-Director: Dr Ir C. Coolhaas.

9. Laboratory of Horticultural plant breeding
   Professor-Director: Dr Ir S. J. Wellemsiek.

10. Institute for Forestry Research
    Professors-Directors: Dr Ir J. H. Becking, Dr Ir G. Houtzagers.

Chapter 11

SOIL SCIENCE AT THE UNIVERSITIES AND A FEW OTHER INSTITUTIONS

J. P. Bakker

At the Government University at Groningen Prof. Dr J. H. Engelhardt lectures on agronomy to students in biology, chemistry and economics, the fundamental subject being soil science but agricultural-hydrological subjects are included. Dr S. B. Hooghoudt and Dr F. van der Pauw lecture on soil-chemistry, soil-physics and botanic soil science.

At the Government University at Utrecht, Prof. Dr C. H. Edelman lectures on regional soil science for the Netherlands to students in geography and geology.

At the Municipal University at Amsterdam Prof. Dr J. P. Bakker lectures on "weathering and soil formation" to students in physical and social geography and to advanced students in physical geography on corresponding selected subjects appertaining to soil science of the Netherlands and Flanders. Besides for three months during the summer geomorphological-pedological maps are drawn up with the students in physical and social geography. At present soil mapping and the corresponding investigations are performed in the provinces of Friesland (Barradeel, N.
of Franeker), North Brabant (sea-silt region), Groningen (sea-silt region) and North Holland (neighbourhood of Grootebroek near Enkhuizen).

At the Technical University College at Delft a few lectures are read on soil mechanics to students in architecture but also students in road construction and hydraulic technique attend. In addition some time is devoted to problems related to soil science in these lectures.

Except at the Universities, University Colleges and the purely pedological institutions, the Geological Service at Haarlem and the Laboratory of Soil Mechanics at Delft conduct investigations related to soil science or of importance to this branch of science. The geological map of the Netherlands on the scale 1:50,000 is undoubtedly a very useful basis of soil science more particularly the sheets which are not yet obsolete, even though the map has a purely geological character and no special provisions have been made for the mapping of soils. In addition stratigraphical facies surveys of the most important sediments at or close to the surface were of fundamental significance to ensuing soil mapping, as a foundation of more detailed indications. In the future more refined granulometric and mineralogical surveys of the subsoil to be performed by the Geological Service will also advance a better understanding of the utilisation of the water supply and other physical problems of the soils.

An elaborate survey was made of the soils on Dutch aerodromes by the Delft Soil Mechanics Laboratory in collaboration with the Agricultural Experiment Station and Institute for Soil Research and the Soil Testing Laboratory at Groningen. Other investigations were and are still conducted by the Soil Mechanics Laboratory i.a. on the hydrological properties (undergroundwater and perviousness included) and the effect of frost on or in the soil. On behalf of the Management of the Zuyder Zee polders this Laboratory performed experiments on the shrinkage of the soils, to be anticipated after the water has been pumped out.

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Chapter 12

THE NETHERLANDS SOCIETY OF SOIL SCIENCE

P. Bruin

The section "The Netherlands" of the International Society of Soil Science, since 1947 known as "The Netherlands Society of Soil Science", was established on 8 November 1935 on the initiative of Dr D. J. Hissink. The aim of the Society is a dual one, viz. to assemble for discussions research workers, either engaged in purely scientific work or in study of characteristics or of problems of soils from a practical point of view and to create a centre for all of those who are more indirectly concerned with soil investigation or take an interest in the problems presenting themselves. Therefore two meetings are being held annually, sometimes combined with an excursion. The 25th meeting since the foundation was organized this spring.

The versality of the Society is particularly showing itself by the selection of the subjects discussed at the meetings (soil profile, utilisation of potash by soil and crop, geology and pedology, soil science and instruction, soil evaluation and determination of producibility of cultivated soils, etc.) The meetings attack a large attendance (of approximately a
quarter to a third of the total membership). The number of members is ever increasing and is at present about 500. The number of members who also joined The International Society of Soil Science has never exceeded 40.

The Committee originally consisting of three members, has been extended in 1946 and consists now of representatives of different scientific branches of the Society (soil-scientists, agronomists, geologists, biologists, civil engineers, soil mechanicians, ceramicians, archaeologists, etc.)

The change in name referred to above should not be attributed to a decline in interest in soil science from an international point of view and in the international organization engaged in the advancement of soil science. The new name is more in accordance with the general character of this Dutch Society. The Netherlands Society of Soil Science has shown its international inclination immediately after the liberation of the country by publishing its report “Draft report concerning the future organization of the international Society of Soil Science and report of the Netherlands Section for the period 1936—1946”, and has gladly accepted the task of organizing the Fourth International Congress of Soil Science in 1950.

The Executive Committee:
P. Bruin, chairman
W. C. Visser, secretary-treasurer
F. Hellinga

Chapter 13
THE STANDARDISATION COMMITTEE 38 AND SUB-COMMITTEES 38a AND 38b

P. Bruin

In 1933 the Executive Committee of the Council for Standardization in the Netherlands decided to appoint a Committee 38 on standardization of the classification and denomination of soil types. Apparently it had become essential not only for agriculture, horticulture and forestry, but also for geology, hydrology, soil mechanics, road building and ceramics to design a scheme of an unambiguous classification of soils for general application but also applicable to raw materials prepared from natural soils by simple processes, such as washing, sifting and mixing.

After ample consideration the committee has at first restricted their task to a considerable extent. In 1939 they had prepared three normal sheets N 209, N 210 and N 213 relating to the classification and denomination of soil samples with a suspensible fraction (particles smaller than 16 μm) of less than 10 % in weight.

N 209 gives the directives on the general principles to be followed up by classification and denomination. N 210 contains a further classification for sand and gravel based upon the size of particles i.e. by applying different methods according to requirements. We just quote here the classification of sand according to the specific superficies of the sand fraction (U figure); the terms fine and coarse in various grades have been exactly defined on the basis of the U figure. (This figure expresses the ratio of the total superficies of all particles to the total superficies of the
same weight of particles with a diameter of 1 cm of the same material —
Verslagen Landbouwkundige Onderzoekingen, 41B, 's Gravenhage, 1935)
Standard samples were established in accordance with this classification.
The methods applied for testing sand and gravel are described in N 213.
Committee 38 is now engaged in the compilation of a normal sheet of
symbols to be used for bore profiles, field profiles and maps.
In 1940 a sub committee 38a was established, being a free studygroup of
representatives of the divergent interests referred to, to study the
"heavier" soils. The aim of this committee is to accumulate more know­
ledge on the nature of heavier soils and on the varying compositions and
properties of clay and silt soils in the Netherlands. As a matter of fact
standardization must be considered as being a consolidation of that know­
ledge. On the occasion of a "Clay-day" organized by the Netherlands
Society of Soil Science in the spring of 1950, sub committee 38a gave a
recapitulation of the problems concerning classification and denomina­
tion of heavy soils and disclosed some of the results of their investigations.
The joint study of the heavier soils by sub-committee 38a proved that
mechanical analysis at the laboratories in the Netherlands as a matter of
fact, was performed in broad lines according to the same methods, but
that the instructions to analysts on several points were by no means
identical. Therefore sub-committee 38b was charged with the task of
preparing the standardization of mechanical analysis. They have drafted
a normal sheet on pipette and sifting methods.
Chairman of the Committees referred to P. BRUIN
Secretariat of Committee 38: Central Bureau for Standardization
Secretary to Committee 38a: JAC. VAN DER SPEK
Secretary to Committee 38b: W. R. DOMINGO.

Chapter 14

THE GOVERNMENT SERVICE OF PHYSICAL PLANNING
THE HAGUE
D. BURGER

Few countries have to put up with so many difficulties in regard to
the utilization of their soil as the Netherlands. On an area of 3½ millions
ha more than 10 millions of people are now living i.e. appr. 300 people
per square km (world average 16). More than half of the population is
concentrated in the polderland in the West, most of the land there is
lying several metres below sea level. About 84 % of the total land area
is cultivated and yet there is a dire shortage of land with regard to food
supply and recreation, due to the ever increasing population. The immen­
se reclamations in the former Zuyder Zee represents a considerable addi­
tion to the cultivated area but they are barely sufficient to compensate
the loss of land due to development of towns, villages, roads, aerodromes,
etc.
The present utilization of the land is shown by the following figures:

<table>
<thead>
<tr>
<th>Land use</th>
<th>Hectares (ha)</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>cultivated area</td>
<td>2,730,000</td>
<td>6,825,000</td>
</tr>
<tr>
<td>built up areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cemeteries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>recreation grounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rivers, brooks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>canals, aerodromes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>roads, railways</td>
<td>300,000</td>
<td>750,000</td>
</tr>
</tbody>
</table>

...
Other land within the borders are:

<table>
<thead>
<tr>
<th>Description</th>
<th>Area (ha)</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste land</td>
<td>200,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Water</td>
<td>770,000</td>
<td>1,925,000</td>
</tr>
<tr>
<td>Total area of the country</td>
<td>4,000,000</td>
<td>10,000,000</td>
</tr>
</tbody>
</table>

The cultivated area is utilized as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Area (ha)</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horticulture</td>
<td>130,000</td>
<td>325,000</td>
</tr>
<tr>
<td>Arable land</td>
<td>1,000,000</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Permanent grass</td>
<td>1,350,000</td>
<td>3,375,000</td>
</tr>
<tr>
<td>Forests</td>
<td>250,000</td>
<td>625,000</td>
</tr>
<tr>
<td>Total</td>
<td>2,730,000</td>
<td>6,825,000</td>
</tr>
</tbody>
</table>

The proportion of these classes of land has been subject to considerable alterations in the past. The pressure brought to bear upon cultivated land by the increasing population causes extreme strains, being intensified in consequence of the fact that the soil in many countries is still too much neglected though the world population is constantly on the increase. Therefore it is necessary in this country to determine the importance of the various interests and find the most convenient solution for the conflicts. In every one of the eleven provinces of the Netherlands a service has been established under the auspices of the Provincial authorities and a Government Service is working under the Ministry of Reconstruction and Housing at the Hague, 19 Lange Voorhout. Director Dr. J. Vink. The name is: "Rijksdienst voor het Nationale Plan" (Government Service of Physical Planning). The statutory basis of this service is of a temporary character but a definite act is now being drafted. The Service has a staff of 55 people. In order to promote coordinated utilization of land the task of the Service is:

1. Designing national plans to be statutorily enforced by the Government after their approval,
2. Supervising the drafting of regional and municipal plans,
3. Advising the Minister of Reconstruction and Housing on objections raised against the execution of intended works, if they do not harmonize with plans, already adopted or still in preparation.

No general national plans have been adopted so far but plans on special interests are being designed. The "vocational" Ministers are to a large extent responsible for the technical preparation and the Government Service have to provide for co-ordination with other interests if any. The Ministry of Agriculture, Fisheries and Food e.g. are drafting a plan concerning horticulture and another one concerning forestry.
PART II. INDONESIA

Chapter 15

SOIL RESEARCH IN INDONESIA

F. A. van Baren

Short historical notes

The history of soil research in Indonesia dates back to the second half of the last century. Although the investigations carried out hardly could be other than incidental it seems worthwhile to quote a few.

In the years 1858/59 Rost van Tonningen reported on chemical and physical examination of five sugar-cane soils of Pasuruan (E. Java). In 1866 Holle pointed to the danger of erosion which threatens the coffee culture. In 1873 van Hall wrote on the exhaustion of the soil. Koorders rendered his views on the relation of soil fertility and natural vegetation in 1893, and so on. For a full review of the literature on soil research in Indonesia may be referred to C. H. Edelman's outstanding bibliography on this subject, covering about a century of tropical soil science: Studiën over de Bodemkunde van Nederlands-Indie. 2nd impr. 1947 (H. Veenman, Wageningen, Netherlands).

Up to 1905 the research was carried out on behalf of private plantations only. In that year however the first Government Institution for Soil Research was established at Buitenzorg under the directorship of Prof. Dr E. C. J. Mohr, today's nestor of tropical soil research, who was the first soil scientist, to devote his time particularly to this subject.

In the meantime several private agricultural experimental stations for the larger estates were organized and in 1941 before the outbreak of the Pacific War we find a well equipped, fully staffed Governmental Institution for Soil Research at Buitenzorg next to five or six experimental stations also well organized and especially established for research on agricultural problems connected with coffee (Djember), sugar (Pasuruan), tobacco (Klaten), tea and rubber (Buitenzorg) all in Java, and two at Medan, one for rubber and oilpalm and one for tobacco. Each of these institutions had their own scientific journal in which the results were published including those of soil investigations. Next to scientific data soil-maps were prepared of sugarcane, rubber or tea plantations but the soils in the area were only classified according to the specific needs. The Government Institute for Soil Research however was the only institution, systematically carrying out mapping and research of soils in areas scattered over the whole Indonesian archipelago. Over 200 reports on soils were prepared; however, none of these was ever published.

In a sense the task of this institution was a dual one. On the one hand a systematic soil map of Java had to be prepared, on the other hand soil mapping for other purposes had to be carried out in the outlying parts of the Netherlands East Indies viz. in Borneo, Celebes and New Guinea, as well as in Sumatra and Java. The purpose of the mapping on the second type were more strictly agricultural as the maps prepared had to serve as a basis for the migration of natives from the overpopulated isle of Java to other parts of the archipelago should soils suitable for agricultural utilization be adequately available.

The latter survey included reconnaissance work over a vast area before
a decision could be taken, which area would be submitted to mapping for the purposes mentioned.

Next to this type of survey, investigations were carried out on behalf of the Agricultural Extension Service and of the Land Revenue Service. The following synopsis summarizes the total area of Indonesia, which has been surveyed and mapped in one way or another.

### Synopsis of Soil Surveys of Indonesia

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Island</th>
<th>Area in acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migration and colonization of Javanese</td>
<td>Sumatra</td>
<td>12,250,000</td>
</tr>
<tr>
<td></td>
<td>Borneo</td>
<td>1,800,000</td>
</tr>
<tr>
<td></td>
<td>Celebes</td>
<td>1,700,000</td>
</tr>
<tr>
<td></td>
<td>New Guinea</td>
<td>1,600,000</td>
</tr>
<tr>
<td>Agricultural Extension Service and Land Revenue Service</td>
<td>Sumatra</td>
<td>130,000</td>
</tr>
<tr>
<td></td>
<td>Borneo</td>
<td>750,000</td>
</tr>
<tr>
<td></td>
<td>New Guinea</td>
<td>352,000</td>
</tr>
<tr>
<td></td>
<td>Java</td>
<td>5,750,000</td>
</tr>
<tr>
<td>Systematic Soil Mapping</td>
<td>Sumatra</td>
<td>11,000,000(1)</td>
</tr>
<tr>
<td></td>
<td>Java and Madura</td>
<td>4,600,000</td>
</tr>
<tr>
<td></td>
<td>Total area covered</td>
<td>40,000,000 acres</td>
</tr>
</tbody>
</table>

The scale adopted for the soil maps depended on the intention of the survey. For instance maps on behalf of the Agricultural Extension Service were drawn on a scale of 1 : 250,000, those for migration investigations on 1 : 100,000; for the systematic mapping of Sumatra a scale of 1 : 200,000, of Java and Madura of 1 : 100,000 was applied.

It is out of the scope of this short review to refer to the publications on special subjects. However attention may be drawn to the Congress of Scientific Personnel of Experimental Stations held in 1941 at Buitenzorg (Java), which was wholly dedicated to the subject “Soil-Fertility” and the Proceedings of this Congress published in the same year are proof of the amount of work done 2). The volume covers 440 pages and deals with 25 subjects all connected with fertility problems as influenced by chemical, physical, mineralogical, microbiological and/or other processes.

Attention may be drawn to a few of the papers read:

- **CH. COSTER, (1941):** Vegetation, Soil type and erosion (Dutch) (Proc. Soil Fertility Congress Buitenzorg, Java: 55—84).

1) Soil mapping carried out by the Agricultural Branch of the Mining Department at Bandung in the period 1928—1933. The work had to be discontinued owing to the economic depression and has not been carried on again.

2) Verslag van de 28e Vergadering van de Vereniging van Proefstation-Personeel: p. 451, Buitenzorg, 1941.
The present situation

Owing to the devastation caused by the World War and its aftermath of disorganization, also in Indonesia, the activities more particularly of the private institutions came to an end. Even today it is hardly possible to carry out field work in large parts of Indonesia as it is not safe to move on the plantations. Of the pre-war scientists, who were fully occupied with soil research, only a few did return after the war. In fact there are today only three men, who can devote part of their time to soil research and then only to field-investigations viz: Dr H. A. MIDDELBURG, pre-war Director and soil scientist to the Vorstenland Tobacco Experiment Station at Klaten (Middle Java). His special field of interest is soil chemistry. Dr A. P. A. VINK has recently been appointed agricultural adviser of the Tea Experiment Station at Buitenzorg. His field of activity is general soil science, fertility and classification. Ir A. M. SÄNGER occupies a similar position at the Rubber Experiment Station at Medan (Sumatra). The rehabilitation and re-organization of the Governmental Institute for Soil Research, which has been taken in hand directly after the war, shows a very favourable development. The academical and technical staff numbers 22 people.

Post-war activities, Soil mapping

In the past few years field work could be carried out only to a small extent as in the first place it did take time to organize staff and equipment. Of the academic staff only M. VAN DER VOORT and T. W. G. DAMES had extensive experience of soil mapping. In the second place owing to the internal troubles of Indonesia it was until recently, irresponsible to send out any field-parties.

In the eastern Archipelago however the field work has been taken up again for about 2 years now and an additional million acres has been surveyed and either a reconnaissance map or a detailed map has been prepared, mainly of areas in Borneo, Celebes and New Guinea.

Publications

The results of the scientific work are mostly published in the periodical "Communications of the General Agricultural Experimental Station", Buitenzorg (G.A.E.S.) and/or in the Journal of the Association of Agricultural Extension Officers "Landbouw" Buitenzorg.

The following list of post-war papers will conclude this short review:

- BAAK, J. A. 1) (1948) (†): The mineralogical composition of some recent volcanic ashes of Java.
  Landbouw 20: 269—274.

1) Dr J. A. BAAK deceased in 1946 in New Zealand where he stayed for recuperation of health after three years internment.
A comparative study on recent ashes of the Java volcanoes Smeru, Kelut, and Merapi.
Comm. no. 83 G.A.E.S.: pp. 60.

Erosion, cause, consequence and control.
Comm. no. 8, Department Economic Affairs Batavia: pp. 135.

On the petrology of the volcanic area of the Gunung Muriah.
Comm. no. 60 G.A.E.S.: pp. 69.

The sediments of the Sunda Sea.
Landbouw 20: 231—236.

Short contribution to the knowledge of the soils of New Guinea and their agricultural value.
Landbouw 20: 210—229.

Experiments on the use of ammonia in irrigation water applied to rice.
Comm. no. 70, G.A.E.S.: pp. 18.

Some data on irrigation water with special reference to the potash-supply in irrigated rice culture.

The influence of improper soil management on erosion velocity in the Tjiloetoeng basin (Residency of Cheribon, West Java).

The different rate of erosion within two adjacent basins in Java.
Comm. no. 84, G.A.E.S.: pp. 10.

On the occurrence of diaspore and zunyite in detrital sediments of Palembang.
Comm. no. 67, G.A.E.S.: pp. 5.

On the occurrence of the mineral orthite on Sumatra.

On the occurrence of a new mineral species in the deposits of the river Pekoeringan, District Masamba, Celebes.

Unfavourable influence of sulfur bearing waste water on paddy soils and fish ponds.
Landbouw 20: 291—298.

Preliminary pot experiments with acid forest peat from Borneo.

Investigations into the electrolyte content of saline soils.
Landbouw 20: 265—268.

Preliminary report on the mineralogical examination of soil profiles.
Landbouw 20: 283—290.

Agriculture on peat soils.
Landbouw 20: 1—50.

Observations on the behaviour of crop cultures on peat.
Landbouw 20: 249—264.

2) D. VAN BEUSECHEM died on duty in 1948.

3) W. L. M. VOGELZANG perished during internment.

4) Dr. J. H. DRUIF, Dr. H. E. STEUTEL and MAS WISAKSONO WIRJODIHARDJO left the Institute for Soil Research in 1945/7.


PART III. SURINAME

Chapter 16

SOIL RESEARCH IN SURINAME

J. M. VERHOOG

As soon as, in 1903, an Agricultural Experimental Station had been founded, chemical soil research was started in Suriname. The chemists who were charged with this work, however, had to accomplish many additional duties and little time was left for actual soil-research. Consequently, in the years up to 1930 only some incidental work in the field of soil-chemistry was performed, though with success. The names of Dr J. SACK, Miss Ir J. E. van AMSTEL and Ir J. W. van DIJK are closely connected with this work.

In 1930 conditions improved by a division of activities, so that a newly appointed chemist, Dr H. J. MüLLER, was able to devote more time to soil-research. Numerous samples were analysed in the laboratory since then and this work has yielded a general knowledge of the chemical and physical properties of a large number of soils, more particularly of those found in those parts of the coastal area where the land has been occupied for agricultural purposes.

Moreover in 1948/49 the Royal Netherlands Geographical Society, the Netherlands Society for Scientific Research in the East- and West-Indies, the Foundation for Scientific Research in Suriname and Curaçao and the National Development Fund of Suriname sponsored an expedition in Suriname which i.a., undertook a physiographic investigation of some parts of this country under leadership of Prof. Dr J. P. BAKKER. A large number of soil profiles and samples was collected, which are being analysed in Holland.

In November 1948, when the Agricultural Experimental Station was reorganized, a pedologist was appointed on the staff and at last, soil-research was thus founded on a more harmonic basis. Within the organization of the Experimental Station, the following subjects are being tackled by several members of the staff in close collaboration.

Soil Survey

In planting different crops, the agricultural industry in Suriname often fails to take heed of the typical soil characteristics, to the soil-scientist the basis of the distinction of soil types. Consequently, land utilization is not yet based upon sound economic principles. Moreover, a great demand for more arable land has developed owing to an increase in population, improved possibilities of mechanical cultivation and schemes for immigration. If the most suitable areas will be chosen for this extension of occupation, it is obviously necessary to let land settlement be preceded by soil survey and soil mapping. The same applies to the plans in development aiming at the introduction of new crops, in order to broaden the economic basis of Suriname. To attain this aim the following programme is being pursued at present.

Very detailed soil maps on a scale 1:2500 will be drawn of existing experimental gardens, experimental fields, etc. and of sites intended for the conduct of fresh experiments. The aim is to prevent that the varia-
bility within the experiments is unnecessarily enhanced by variations in soil conditions and also to record data applicable to certain types of soil. A soil map of this nature has now been prepared for the Economic Gardens (Cultuurtuin) of the Agricultural Experimental Station and before long the survey of the experimental polder in Nickerie will be taken in hand.

In addition, a detailed map on a scale 1:10,000 is at present being prepared of an area West of Paramaribo, this being the first stage of the mapping out of a region with a width of 6.25 km at a right angle to the coastline, with the aim to obtain, as soon as possible, a proper conception of the soil types existing in Suriname. The results of this mapping will be published in separate sheets, which will correspond with the sheets planned for the topographical map.

Finally, soil reconnaissance of virgin areas are regularly made in order to decide whether particular regions would be suitable for agricultural development. Up till now such surveys have been made at different localities, mainly in the Nickerie region in the northwest of Suriname, a total distance of some 125 km having been covered.

Soil analysis in the laboratory

To supply the necessary data for the soil maps, the soil samples collected by the surveyors are regularly analysed according to a fixed scheme. This routine scheme includes: mechanical analysis, determination of organic matter, pH-water, pH-KCl, hydrolytic acidity, total exchangeable bases, phosphates soluble in 2% citric acid and potash soluble in 0.1 n HCl. On the same line, other determinations are occasionally carried out, as of Mg and Ca content, chloride and sulphate content, CaCO$_3$ content, etc., in cases of soil types requiring a more extensive characterization. Efforts are being made to limit the time taken up by these determinations by introducing rapid analytical techniques.

Specific research is performed in order to add to our knowledge of Suriname soils in general and to investigate the effect of certain methods of soil improvement. To this type of work belongs a recent chemical investigation on the formation of "katteklei" soil. It has been proved already that the formation of these soils in Suriname is due to the same causes which have led to the occurrence of similar soils in the Netherlands, viz. the presence, in the subsoil, of considerable quantities of iron sulphide and pyrite which are oxidized to sulphates on exposure to the air.

A second series of investigations concern the influence of irrigation water, taken from tidal rivers, on the soil and the crop. The water from the Suriname rivers will undoubtedly be suitable for irrigation purposes. However, up to a certain distance from the mouth of the river it contains varying quantities of chlorides and therefore it is essential to know the limit of the chloride content which could be tolerated.

Shortly an investigation will be started on the influence of lime applications on magnesium clays. The silt soils in the younger part of the coastal zone of Surinam are characterized by a Ca/Mg ratio in the adsorption complex of less than 1:1, usually of about 1:3. It is our aim to determine whether the composition of the adsorption complex can be altered by application of lime and the effect of this application on the yields of different crops.
Research on drainage problems

Under natural conditions the groundwater level in the coastal zone is generally too high to procure optimum yields of most crops and consequently the establishment of proper systems of drainage is essential. The fluctuations in the level of the watertable in different soil types and under varying circumstances are now being recorded in order to ascertain the normal requirements for an adequate drainage system.

The experimental polder in Nickerie provides facilities to study various systems of drainage. More particularly the possibilities of mole drainage of the heavy clay soils in that polder will be investigated.

Aerial Survey

Besides the Agricultural Experimental Station, the Central Bureau for Aerial Survey, which was established in 1948, is concerned with pedological work. A soil scientist has been appointed on the Staff of this Bureau for the interpretation of aerial photographs from a soil-scientific and an agricultural point of view. In close collaboration with the pedologist of the Agricultural Experimental Station this scientist investigates to what extent, under Suriname conditions, the aerial photographs can be used for soil mapping purposes. The conclusion has already been arrived at that aerial pictures, used as a topographical basis, are an indispensable aid to mapping in the field and in cultivated areas they often afford means to define exactly the borderline between soil types. Further research will have to prove in how far it will be possible to draft soil maps of virgin areas by interpretation of aerial photographs.
Chapter 17

SOIL SURVEY AND SOIL MAPPING IN THE NETHERLANDS

A. J. Zuur

The soil is a product of the factors: time, parent material, relief, living organisms and climate. But these factors as well put their hallmark to the set of soil problems of a country, which are connected with the conceptions soil mapping and soil classification. The climate, for example, a factor of great importance to the formation of soils, varies little in a small country like the Netherlands and therefore the climate here is not a decisive differentiating factor with regard to the formation of soils. The same applies to a certain extent to time. Almost all Dutch soils have been formed in the quaternary era and one could go even further by saying that the largest majority of sandy soils are of the late pleistocene age and practically all heavier soils and peat soils of the holocene age.

The Netherlands, however, is the country of enclosed and drained lakes and mud-flats; half of the silty soils are younger than 1000 years. The active formation of soils is therefore much more prevalent here than elsewhere and so are the first stages of development. The changes from a soil-scientific point of view are considerable during the first centuries and consequently they are very important in classifying the heavier soils. The names of van Bemmelen, Hissink and Maschaupt are closely connected with this study of soil formation on marine calcareous silt; they investigated the speed of lime leaching, gradual shrinkage of the soil, changes in bases content, the pH etc. The following table contains some figures derived from a publication of Hissink:

Properties of Dollard-silt (= 70 % particles < 16 mu) at various ages

<table>
<thead>
<tr>
<th>Property and layer (cm below land surface)</th>
<th>Age of polder in years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Calcium carbonate in topsoil (g per 100 g dry matter)</td>
<td>9.5</td>
</tr>
<tr>
<td>Total content of exchangeable bases in topsoil (m.e. per 100 g of silt/humus)</td>
<td>-</td>
</tr>
<tr>
<td>pH topsoil</td>
<td>-</td>
</tr>
<tr>
<td>Pore space in percents of volume</td>
<td></td>
</tr>
<tr>
<td>± 30 cm</td>
<td>73</td>
</tr>
<tr>
<td>± 50 cm</td>
<td>73</td>
</tr>
<tr>
<td>± 70 cm</td>
<td>73</td>
</tr>
<tr>
<td>± 90 cm</td>
<td>73</td>
</tr>
<tr>
<td>Permeability of layer 25—75 cm (m per 24 hours)</td>
<td>11</td>
</tr>
</tbody>
</table>
When dealing with living organisms in other countries only the influence of the natural vegetation on the soil is usually considered. As a matter of fact this factor also exists as an independent one in the Netherlands but is not of much importance. Besides it is rather difficult to study as, in a densely populated country with soils already having been cultivated for centuries, a natural vegetation is hardly present. On the other hand the effect of another living organism, man, has been enormous; in order to raise the producibility of the soil many tens of thousands ha's have been excavated, raised or turned round; moreover, the water discharge of at least one million ha's is not natural anymore. All these measures on cultivation have affected the soil profile, just as the soil profile has affected the ways of cultivation, performed by man.

Particularly Oosting has investigated this interaction and he adopted it as a starting point for soil surveying and mapping just about in the same way as the natural vegetation is applied to soil-survey and mapping in other countries (the vegetation affects the soil, but alternately the vegetation adapts itself to the soil and therefore is an indicator of soil conditions). On this line of thought e.g. Edelman and his pupils have built their system of soil-survey. One of the maps designed by Oosting is reproduced here.

On this map relating to a sandy area, 15 types of soil have been indicated. Of these, when keeping reclamation out of consideration, 6 types are based upon differentiations, relating to human influences and from these influences a considerable number of properties can be derived. On the map e.g. a soiltype is indicated as grassland, formerly arable land, the former utilisation being traceable in the profile. Now the fact that a
field is under grass indicates that it is low lying land with a high water-table, leading to an inconsiderable development of the profile and a rather shallow layer of humus.

This field has been used for growing arable crops in times, when arable farming was of more importance than today. It has been chosen as it was higher than other ones and therefore was and is less troubled by an excess of water in wet periods. On the other hand it does benefit less from the groundwater. The arable land was formerly dressed with enormous quantities of pure, well matured farmyard manure, viz. heath-sod manure. In consequence the layer of humus on this field of grass is deeper. As the land is higher, the grass starts earlier to grow in spring than on surrounding land and due to the high humus content the water holding capacity and resistance to drought is still considerable. Quite a series of properties can therefore be attributed to human utilisation and is characterised by same.

The influence man has on the soil in the Netherlands also shows itself in its content of plant nutrients. In consequence of the high applications of artificials in the Netherlands the store of nutrients in the soil now often is hardly related to the natural soil-profile. The result has been that in the Netherlands a special system of soil-survey has been developed under the auspices of the Soil Testing Laboratory in order to map out these plant nutritive conditions. This work will be separately described in another chapter (chapter 19).

As variations in climate, time and living organisms, the human influences referred to above excepted, are of little value as starting points for soil-survey and mapping, only the factors relief and parent material are left over for consideration. It is quite natural that special attention has been drawn to these and that the study of them and the differentiations being considered are much more detailed in this country than elsewhere. There is another reason for this detailed distinction. Agriculture in the Netherlands, the average size of a holding being not quite 25 acres, is a very intensive industry and is carried on by well educated farmers. Differentiations, of value for soil-survey and mapping in other countries, would be too crude here and are already latent knowledge in the region concerned.

Relief and parent material are factors therefore, which, in combination with the influence of man, are very important to soil-survey and soil science. Relief is usually so faint that it is hardly of any significance to erosion and to arousing variations in irradiation. Of extreme importance however is the relief or, in a wider sense, the topography in relation to the height of the watertable.

The groundwater in a low country like the Netherlands is usually at a high level and this is of extreme importance to the agricultural value of the soil, as about half of the area of the Netherlands consists of loose sandy soils, only humous in the surface layers. If the humous layer is rather shallow, these sandy soils have a low water holding capacity and in that case their producibility depends very much upon the level of the watertable; a difference of 10 or 20 cm is already of great significance as is shown by the following diagram compiled by SIEBEN.

With silty soils, the level of the watertable affects their structure, the rooting of crops, the excess of water during winter etc.

The importance which must be attached to the watertable in regard to the agricultural value of Dutch soils has led to many investigations relating to this matter: the investigations into the laws of water motion,
the application of these on land improvement technique (discharge and supply of water) and the capillary phenomena (Hooghoudt), into the relations of watertable and producibility (Visser, Pijls, Sieben) and of watertable and rooting of crops (Goedeewagen) should be referred to.

The height of the watertable is usually determined from the level of the glei phenomena in the profile, the introduction of the level of the glei horizon as a quantitative measure in surveying and mapping originates from Pijls. A very detailed characterisation of the groundwater is applied by Visser. It is founded upon the level of the watertable itself and not only the average level of that table, but also its fluctuation is considered in the investigation.

The significance of topography to the level of the watertable has as ever two aspects: it is one of the factors decisive to the level of the watertable and it is the characteristic by which the differences in that level on one field can easily be perceived. Consequently the topography is a contributive aid in soil-survey. Particularly Edeelman and his pupils apply the very faint topography of the Dutch fields — it is often a matter of only a few decimetres difference in altitude — on their soil-survey work.

The relief is often determined by the surface geology of an area and consequently the study of the surface geology is also closely connected with the soil mapping work of Edeelman. Another consequence of this close relation of surface-geology and type of soil is, that also the work of geologists and geographers on surface geology (e.g. J. P. Bakker) is of importance for soil mapping.

Coming to the last factor to be dealt with, the parent material, the significance of it to survey and mapping is shown by the fact that the first soil map of the whole country, also the oldest one in the world, designed by Staring, was almost exclusively based upon differentiation of parent material. Just as was done by Staring, the soils in the Netherlands are still classified as sandy, peat and silt soils. The peat soils are sub-divided according to botanical composition and degree of weathering. With sandy soils the depth of the humous top soil and the size of the sand particles underneath are decisive; due to human influence (dressings of heath-sod farmyard manure) that depth of humous top soil varies considerably. The silt soils are classified according to the silt content. This classification is of greater importance here than in some other countries because investigations of Hudig and Favejee have shown that
almost all silt in the Netherlands has a similar mineralogical composition. Moreover in very young silty soils numerous properties of agronomical importance (potash-, phosphate- and humus-content, waterholding capacity, several physical characteristics) are closely correlated to the silt content. Surveys as are being performed by the Zuyder Zee Works, of very young silt soils showing no relief at all, and also by the Agricultural Experiment Station and Institute for Soil Research T.N.O., are mainly based upon the silt content of the soils. But even in older soils remnants of this correlation can be traced, more particularly with regard to water holding capacity and physical properties; therefore the silt content is considered in any case.

The classes based on silt content are usually very numerous and mechanical analyses, to control the estimations are performed on a large scale. The classification according to the sizes of the composing ultimate particles and their ratio is even a subject of discussion in several Standardisation Committees. One of these (Standardisation Committee 38, chapter 13) has, as the first in the world, classified the sandy soils — not the fractions — according to the size of the ultimate particles. This classification is founded upon the total superficies of the sand-particles, a magnitude as ZUNKER has proved, closely related to the capillary ascent of water in a soil and to its permeability; classification of sands according to this magnitude is therefore undoubtedly of importance to agronomists.

Practically all soils in the Netherlands are sediments. With water deposits the variation in composition is connected with the regime of water currents during deposition and therefore with the surface-geology. This too is one of the reasons why surface-geology plays such an important part in Dutch soil surveys.

Also the profiles are often dishomogeneous vertically. With water deposits e.g., the origin of a large part of Dutch silty soils, the deposited material normally is heavier near the top. A top-soil of heavy silt is overlying silt and a topsoil of light silt is underlain by sand. A topsoil of heavy silt overlying sand is an exception and therefore often it is not necessary to map out all separate layers, but a limited number of profile type classes will suffice for a certain area as most soils can be placed within these classes. Owing to several causes the lighter profile types often lie higher than the heavier ones and consequently there is a relation between altitude and watertable. This complex of factors (profile type, altitude, watertable) has, of course, influenced vegetation and human occupation and the latter again has affected the complex. Consequently there is a relation of profile type — watertable — human influence.

The correlations of water table, structure of profile and human occupation are the foundations of soil type classification in the Netherlands and are adopted as such in the system applied for soil survey and mapping by the Soil Survey Institute. Here follows a soil-map, compiled by the Soil Survey Institute, showing clearly the amalgamation of surface-geology (riverridge soils-basin soils), watertable (higher sandy soils — lower sandy soils) and human occupation (old arable soil).

As a matter of fact the correlations referred to and the soil types based upon them are of great assistance to arrange the phenomena in a surveyable manner. On the other hand correlation of different properties is not at all definite and a survey based upon this correlation is inclined to stress similarities and to overlook differences.
The more intensive types of husbandry are applied, or the more surveying is aiming to attain a special objective, the more it will become necessary to pay particular attention to the individuality of each case. For that reason the single-value method is also applied in the Netherlands by the Agricultural Experiment Station and Institute for Soil Research.


T.N.O., the Zuyder Zee Works and the Research Section of the Government Service for Drainage, Land Improvement and Reallocation. Here all necessary characteristics of the soil are investigated. The maps are often typologically more detailed than soil-type maps but, as the survey technique is more difficult, they are not quite so perfect from a topographical point of view.

The largest number of properties are recorded on Vissers' single value maps. Characteristic in this case is also that mapping is coupled with investigations of every mapped property on its importance to the behaviour of the soil from an agricultural point of view. This opens the way to interpret the behaviour of every profile by the knowledge acquired.
As the same maps must be used for several purposes (drainage, re-conditioning of reclaimed soil, re-allocations) the interpretation of the maps is not always the same; in the case of drainage for example the content of plant nutrients in the top soil is of less importance than with re-allocations; alternately the presence of a layer of peat at drainpipe level is more important, when a field is to be drained than when it is included in a re-allocation scheme.

It is desirable therefore, that the individual properties recorded are not taken together into soil types but that they are indicated separately. This requirement would lead to overburdening if all properties surveyed were recorded on the same map. Therefore the characteristics are indicated on several maps as is shown in the following specimen; it is easy to see e.g. what types of soil are present at drainpipe level.

Classification includes both soil classification, i.e. the design of a classification scheme, and land classification, i.e. the evaluation of the soil types. As to soil classification, but little has been achieved in the Netherlands, being due to the fact that modern soil-survey has not been practiced yet for a considerable time.

Land classification, meaning the agricultural evaluation of the different types of soils and their properties, on the other hand is of extreme importance in the Netherlands as the surveys are not carried out for
scientific purposes, but for the solution of concrete problems. Therefore it will be necessary to know the agricultural interpretation of the types recorded on the maps. To investigate this problem the Soil Survey Institute and the Zuyder Zee Works in the first place interrogate farmers and correlate their experience with the results of soil survey. Intelligent

CATCHMENT BASIN OF THE RIVER AA

PROFILES WITHOUT LOAMY SAND PAN  PROFILES WITH LOAMY SAND PAN

FIG A
CONSIDERABLE INCREASE OF WITHERING WHEN WATERTABLE IS LOWER THAN 120 cm

FIG B
WHEN DEPTH OF HUMUS LAYER IS LESS THAN 35 cm A SLIGHT INCREASE IN WITHERING IS POSSIBLE

FIG C
THE GRAIN SIZE OF THE SANDY SUBSOIL HAS A STRONG INFLUENCE ON WITHERING

FIG D
OTHER INFLUENCES NOT ELIMINATED

FIG E
WITHERING GETS LESS SEVERE WHEN DEPTH OF LOAMY SAND PAN INCREASES

FIG F
WHEN A LOAMY SAND PAN IS PRESENT, THE DEPTH OF THE WATERTABLE HAS NO INFLUENCE ON WITHERING

FIG G
THE PRESENCE OF A LOAMY SAND PAN ELIMINATED THE INFLUENCE OF THE U-NUMBER OF THE SUBSOIL

FIG H
OTHER INFLUENCES NOT ELIMINATED
farmers are good judges of the differences in yield and the behaviour of their land and by combining the experimental data of several holdings thus recorded, it is often possible to arrive at a system of land classification suitable for many practical purposes. This scheme is supported by testyields conducted on characteristic fields and by studying yields from mapped out fields, the data often being obtainable in this country with its high administrative development. The Zuyder Zee Works were the first to apply this method (Kalisvaart).

A very special method to determine the significance of mapped-out characteristics was worked out by Visser. He argued that the productivity of the soil depends on a large number of factors, mutually affecting each other. In order to verify this, Visser developed a scheme of quantitative estimation of soil characteristics and yields of crops. As estimations do not ask for much time, it is possible to collect a large number of data within a short period. These data are subsequently subjected to a mathematical treatment according to a system, also developed by himself, viz. poly-factor analysis, enabling him to define the effect of the separate factors from their combined effect. The diagrams on page 38 show the result of such an investigation.

This case relates to an investigation of sandy soils on which the following soil characteristics were estimated: presence of a loamy sand pan in the subsoil and its level, the watertable, the depth of the humous layer and the fineness of the sand (indicated by the so called U number) under the humous layer; as an agronomical factor the rate of withering has been estimated. For documentation the original estimations of withering are shown on the Y-axis of the figures D and H, one of the unimportant soil-characteristics being recorded on the X-axis. In the other figures in each case the relation is shown between one of the characteristics recorded and withering, after the effect of all other factors has been eliminated by poly-factor analysis. The diagrams show how poly-factor analysis can be applied for determinations of the effect on desiccation of the separate factors.

Finally a few words on the importance of soil-survey in the Netherlands. The Netherlands is a densely populated country with a surplus agricultural population. This demographical pressure implies that many provisions had to be made and all sorts of works must be carried out: determination of rent by statutorily established bodies, drafting of plans for the extension of horticulture and town development, for reallocation, for land improvement and land acquisition. It is quite obvious that such schemes could not be executed at all if no reliable surveys of soil conditions, in other words no proper maps, were available. Mapping takes up an important place in soil science once more, since the work had come to a stop for a long time after the endeavours of Staring.

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Chapter 18

EVALUATION OF SOIL TESTING IN THE NETHERLANDS

F. van der Pauw

In the subsequent paper of Dechering a survey will be given of the development of soil testing. Before this agronomical testing and its organisation will be discussed.
The reason of the introduction of Soil Testing

The occurrence of serious symptoms of diseases with crops on sandy soils, resulting in a considerable decrease in yields, was the first induction to soil research. It was proved that manganese and magnesium deficiencies were responsible. These deficiencies are closely connected with the reaction of the soil. Even if the typical symptoms were not evident, the large importance of soil reaction of sandy and silt (clay) soils for the attainment of optimum yields was apparent.

The need of investigations on phosphate and potash, the large scale use of which was an early practice in the Netherlands, was less related to the distinction of differences in fertility, inherent to the soil, than to the establishment of rational methods of application of these fertilizers.

Adoption and development of methods

The choice of methods was decided by scientific and practical insight. From a practical point of view methods must conform to the following requirements: 1. the scale of application must be extensive, especially in the sensitive part, 2. the determination must be quickly accomplished, 3. the method must be applicable to as many types of soil as possible under varying circumstances.

It will be clear that what will be determined, must relate to that constituent of the soil, which is decisive to plant growth. The attainment of this objective has been aimed at as much as was possible with the knowledge available at the time. The development has been an empirical one and a feature in the Netherlands has been that the development has always proceeded hand in hand with the development of trial plot experimentation. The main methods applied will be discussed by Dechering.

Criticism on Soil Testing

When soil testing was adopted as a basis of practical advice much criticism arose. The proviso that under very varying conditions and for very different types of soil a test must give equivalent results, was considered to be contrary to scientific and practical experience. Another objection was expressed in the fear that a pressure on experimentation in a correlative direction might hinder the development of research along causal lines and might result in inflexibility. The opinions in regard to the usefulness of these methods were therefore divided.

The establishment of the Laboratory for Soil Testing

It is due to the vision and pushing power of men like Hudig and de Vries that soil testing was introduced in the Netherlands and a start was made with intensive research in relation thereto. The establishment of the Laboratory for Soil Testing took over much routine work from the research institute and the possibility of an advisory function based upon results of soil analyses on a large scale was decisive to the further development of research and advisory work on such a scale as could not even be foreseen at that time.
Field experiments

a) Provisional evaluation of Soil Testing on behalf of practical farming during the first few years

The establishment of a laboratory charged with soil testing for practical purposes necessarily led to a careful agronomic evaluation of the data recorded. Considering the then ruling conditions in the system of trial plot experimentation it was a heavy task. Results of existing long-term trial plots of the Agricultural Experimental Station and those of a few other institutions had at first to be used for comparison. New plots could be laid out on a moderate scale. The technique to be applied here developed slowly. It proved to be necessary to establish trial plots on several types of soil, showing a large variation in condition, e.g. in regard to lime content from extreme deficiency to a considerable excess. This course led to a new system of experimentation, viz. application of the graphical method of studying data (Visser, Ferrari, Transactions, I).

From these originated later on the larger series of investigations, the variations not being realized on one field only but by a large number of experiments of the same design on small plots under the varying conditions in agricultural practice, performed simultaneously (Visser, van der Paauw, Transactions, I).

Preliminary investigations showed that variations in the contents of lime, phosphate and potash, resulting from different manurial treatments during a large number of years and to which crops show a conspicuous reaction are evident from the results of soil analysis. It was possible to arrive at approximate border-line figures for lime and other plant nutrients. If the content of a nutrient in the soil exceeds the relevant border-line figure, no further dressings of that nutrient are called for, if it is lower it shows the probability of deficiency. The experience gradually accumulating from soil testing applied to practice, afforded as expedient to verify these conclusions.

The most thorough test was obtained of the pH determination. The results of a rather large number of lime experimental plots in different parts of the country became available. It was possible to determine the relation of pH and yields of different crops. The optimum value of pH varied rather much, on sandy soils nearly always between 5 and 6. It was also clear, however, that the degree of fertility of the soil affects the optimum value of pH, very fertile soils tolerating a lower pH than less fertile ones.

b) Soil Testing as a basis of research

Except plot experiments to evaluate soil testing other experiments were devised simultaneously. In the first place investigations on the method of drawing soil samples and on sampling errors should be referred to. These also offered an opportunity to get an idea of the uniformity of the soil. Chemical experiments with solvents of various concentration, varying extraction ratios, repeated extraction of the same quantity of soil, resulted in a deeper insight in the nature of the constituents of the soil and created a clearer conception of the soil analysis method itself.

A great drawback of soil testing became apparent after it had been repeatedly applied to the same field. Some values showed to be susceptible to considerable variations endangering its practical applicability.
Some of the causes were found on further investigation. Later on it became clear that next to variations due to seasonal influences also annual fluctuations exist showing a remarkable periodicity (van der Pauw, Transactions, II). However, attention is still being paid to the use of methods, less susceptible to these influences.

The extensive application of soil testing to experimental plots supplied well defined knowledge concerning the assimilation of nutrients by crops, losses caused by washing out and fixation. Soil testing afforded the possibility of comparing the results of existing trial plots, formerly only of local importance.

Phosphate experiments on grassland for soil testing in the Netherlands. 1. marine sand, coastal dunes; 2. younger sea clay; 3. fluviatile clay; 4. peat; 5. older sea clays; 6. preglacial, glacial and postglacial sand; 7. loess; 8. experimental fields in 1947 or 1948; 9. series of 20—21 exp. fields on clay, peat and sand in 1939, 1940 and 1941 respectively; 10. “experimental spots” in 1943.
The ever expanding investigations in behalf of practical farming procured data for the mapping out of the fertility conditions obtaining in practice (DECHERING). The intention is to arrange all results attained in a punch-card system. An extremely valuable record will then be available as a basis for studying chemical soil-fertility all over the country.

It should be stated that also various methods applied abroad have been compared with those applied here. The most elaborate work in this respect has been done by studying the results of a large number of experimental fields. The results did not justify the substitution of any method for another one. Obviously alternative methods will only be adopted by an already operating organisation if they are evidently better than those being applied.

c) Organized check on the results of Soil Testing on a larger scale.

The continuous development of soil testing for practical purposes brought about the realization that the preliminary and rather incidental check on the merits of soil testing was absolutely unwarranted. Systematical and detailed evaluation had to take its place. In course of time the opinion arose that this was only practicable by collecting results of numerous observations accomplished under comparable conditions.

A first attempt in this direction was the check on the P and K status of Northern sea silt soils by the results of 170 trial plots laid out in 1937 and 1938 according to the same simple design. The result of this investigation opened quite new views on the value of the figures for this type of soil. It became apparent that in interpreting the data it is necessary to take also other soil factors into consideration. To give an example, the value of the potash content is also affected by the CaCO$_3$ content of the soil whilst also the suspensible fraction must be taken into account.

This circumstantial investigation showed how this problem should be tackled and how the recorded data should be interpreted diagrammatically. Encouraged by the success, an extensive P and K investigation on grassland on some types of soil was carried out in the neighbourhood of Groningen in the years 1939—1941.

The investigations, however, still bore too much a local character and it was thought necessary to include the whole country in further investigations. In 1941 this resulted in the design of a national plan for experimental field-work, comprising in the first place the evaluation of soil testing for the principal types of soil in the Netherlands. Except large series of a simultaneously run small size experimental plots of one year's duration, long term experimental plots have been devised in order to study the development of soil conditions with different manurial treatments. These investigations were started in 1943 during the German occupation. Nevertheless the laying out of some 50 long-term phosphate experimental fields, distributed all over the country, was accomplished.

As it seemed probable that the serial experiments necessary to checking could not be performed during the next few years, attempts were made to satisfy the needs by some simple means. The most successful attempt was the correlating of the results of soil testing with the P and K contents of the young crop instead of correlating with differences in yields from experimental plots. Usually the latter are supposed to be decisive in checking. But differences in yields are often affected by secondary factors. From a physiological point of view it is not very likely that the reaction to a soil factor is best shown by differences in yields (VAN DER PAAUW, Transactions, I). In this case the design of experimental
plots becomes redundant and therefore recourse has been taken to so-called "spot investigations". Samples were drawn simultaneously from the growing crops of very small areas of \( \frac{1}{4} \) m\(^2\) and from the soil of these spots in many places in the country. The investigations were performed on grassland and on arable land under rye. In both cases approx. 520 samples were collected (fig. 6).

After the war national planning has been taken up again. A number of about 60 long-term lime-potash experimental plots were added to the phosphate plots.

Series investigation could be started in 1947. In that year 200 P trial plots were laid out on grassland in various parts of the country and in 1948 another 130 trial plots (fig. 6). In the same year 75 K experimental plots were started on grassland.

All these experiments showed in general the high practical utility of soil testing. If we now look back to the criticism aroused when soil testing was in its infancy and make a comparison based upon experience, then it can be stated that the effect of soil factors is indeed not the same under all circumstances, but that it is influenced by other factors. These influences, however, have proved to be regular in many cases. Therefore, their identification enables us to take them into account. It is even safe to say that the results of soil testing, in eliminating secondary factors, are generally applicable to quite different soils. The variation of properties of the soil, decisive in evaluation, are apparently of less significance than was presumed.

Owing to this state of affairs soil testing becomes an indispensable attribute to recognise the numerous factors affecting fertility, decisive to the producibility of the soil. Investigations to disentangle the effect of all factors effecting the yield are at present performed in the Netherlands (Visser, Ferrari, Transactions, I). The importance of these investigations cannot be easily overstated as they may supply a basis to radical land improvement schemes for large areas. That such schemes should be put into operation without soil testing is impossible.

d) Determination of and check on other factors.

Though determination of lime, phosphate and potash has always been most prominent, endeavours to determine other factors have not been wanting. An improved microbiological Aspergillus method is applied to determine the copper content. The suitability of this method has been confirmed by field experiments. Also other elements are determined by this method.

It can further be stated that the adoption of a chemical method for the determination of magnesium has recently been introduced. Physiological investigations have clearly shown that application of this method for practical purposes will be difficult as the influence of other factors (N, K, Ca), are to a large extent decisive to the effect of Mg and therefore its determination will be mainly of scientific interest. The same applies even more to trace elements. Their determination according to colorimetric and spectographic methods is under investigation.

c) Organization and technical aspects of investigation.

It goes without saying that the development of the investigations described above had to go hand in hand with the development of organisation and technique. In the beginning the possibilities were very few
and pot experiments and a few field experiments, mainly on experimental farms, had to suffice. Help offered by practical farmers was gratefully accepted. Gradually the service could be extended and the necessary technical experience in the management of experimental plots was attained. They were usually laid out on land of farmers. Also the insertion of experimental plots designed by Agricultural Advisers where soil testing could be applied, proved to be very useful. In this way data could be collected in other parts of the country as well. This co-operation was established on a voluntary basis, but from some parts of the country no data were available, simply because manurial experiments were not considered as being urgent there.

The first elaborate investigation referred to above was devised in 1937, when the Agricultural Experimental Station an organization of Groningen farmers joined to conduct soil-fertility investigations. In close cooperation with younger farmers but under the management of the Agricultural Experimental Station, which held a considerable share in the technical work incurred, the investigations were successfully performed. As the technical service of the Agricultural Experimental Station succeeded in managing these 170 experimental plots in addition to all the other work, it is evident that this section had developed considerably.

At the same time a few Advisers decided to devise a large number of experimental plots in order to get a better idea of the value of soil testing for the types of soil in their advisory region.

This feature, however, was incidental. A great change took place during the war, when a strong co-ordination of the Advisory Service was planned. One of the consequences was the design of a national plan for manurial experimental plots. Investigations were co-ordinated and the experimental plots, thought to be of importance to the various types of soil, were projected centrally.

The experiments are conducted under the direction of the advisers, applying the results to their advisory work. The management and central interpretation of the results is in the hands of the Agricultural Experimental Station. Also this arrangement would not have been possible without a considerable extension of the technical staff of these advisers.

Investigations from other centres

So far reference has only been made to the work conducted by the Agricultural Experimental Station at Groningen in collaboration with other institutions. The soil research work of the Zuyder Zee Works is carried out quite independently. This experimental work is exclusively intended for advisory purposes in the newly reclaimed areas. Effects of cropping, which resulted in a great variety of soil conditions on the old land, were absent in the new polders, and therefore quite a different problem had to be solved.

Horticulture has problems of its own. In the research centre of Naaldwijk in the Westland with its glasshouse culture, numerous experiments have been performed to study the mutual effects of manurial factors and to interpret the data of soil testing. As horticultural crops require large amounts of nutrients special attention has been paid to the constituents soluble in water. The concentration of plant nutrients in horticulture is usually considerably higher than in agriculture and problems of interactions and the effect of trace elements are of particular interest. For this reason there is a need of simple methods of investigation (Morgan, mo-
modified by Venema) which allow for the determination of many factors simultaneously. The content of muriates and the conductivity of the soil suspension are important indications of injurious salt concentrations originating from heavy dressings of fertilizers and frequent irrigation with water containing small amounts of salt.

As to orchards, next to soil testing much attention is paid to tissue tests (Zeeland Experimental Garden at Goes).

Finally I must not omit to mention the important share the fertilizer manufacturing industry has had in the development of research and advisory work.

**Fundamental research to assist correlative soil testing**

The risk of inflexibility, when purely correlative soil testing was introduced, has already been referred to. Those engaged in the investigations as well as those rendering advice are apt to consider correlative factors as causal ones. Though undoubtedly this research has resulted to a certain degree in actual understanding, for example of the mutual influence of factors, it seldom leads to fundamental knowledge of causal relations. Therefore it is of importance to continue these investigations in this direction in concurrence with and as a support to conventional research. In this respect the experiments on assimilation of ions coupled with plant analysis performed at the Wageningen Agricultural University and the Agricultural Experiment Station should be mentioned here. By this investigation also the position of plant analysis was ascertained. Though of less avail to practical advice in agriculture (not in horticulture, see p. 45) it renders another aspect next to soil testing, i.e. the nutritive conditions obtaining in the crop, which are of great importance to the scientific study of plant nutrition and manurial problems.

More particularly the prospects of investigations on the essence of soil testing, being conducted at the Agricultural University should be referred to here. Instead of determining the concentrations of nutrients in the soil solution the determination of the physiological activity of the ions is attempted. What will be the prospects for science and practice, resulting from these investigations is an open question.

**Prospects of Soil Testing**

It has been stated that soil testing has become an indispensable expedient in agricultural research and that it renders its ever extending services in various directions. The question may be asked: What is the position in regard to its development into a basis for agricultural advisory work? Higher technical perfection will be necessary, in addition to the checking of effective methods not very sensitive to unreal variations in the field. The check on soil testing can certainly be still more extended and more up to date soil scientific views on the nature of different types of soil must be taken into account.

Yet, it is evident that a practical limit must be put to the value of such a check. The adviser will not be able to consider the subtle effects of many factors of minor importance. Simple methods are wanted which can be used by assistants with secondary agricultural school certificates. The best must be attained by the simplest means. This affords to the research workers a permanent stimulus to self criticism. It is their task to disseminate amongst practical farmers all their findings as far as they are scientifically justified through the offices of advisory institutions and agricultural schools.
Just a little more than 25 years ago farmers in this country felt more and more the need of an opportunity to have their soils analysed. On the basis of the results of a test in the laboratory it was possible to determine the lime status of the soil, to decide how much lime had to be applied and to know the most suitable compound for the conditions obtaining.

The more farmers became aware of the importance of soil testing the larger the number of samples forwarded to the Agricultural Experiment Station at Groningen. This gradually attained such proportions that the research work of this institution was adversely affected thereby and another solution had to be sought to comply with the wants of practical farming. With the sanction of the Government after consultation with Agricultural organisations, Ir J. Hudig initiated the establishment of an association for the management of a laboratory for soil testing on behalf of practical farmers, the national agricultural organisations and the Netherlands Heath Society joining as members. Soils would be tested for a charge equal to the costprice, a contract was made with the Government for testing soil samples sent in by research institutes and the Government Agricultural Advisory Service.

The laboratory was founded in 1927 at Groningen, the aim being to perform soil analysis at costprice for practical agriculture and the methods to be applied had to comply with the requirement that the results were a proper representation of the nutritive condition of the soil. At first the work was limited to sandy soils. It did not take long for the laboratory for soil testing to prove that it answered its purpose, as ever more farmers were sending in samples of their soils for testing (of course all of sandy soils). The laboratory is absolutely self-supporting and all expenses are covered by the money received in payment of the tests. In 1930 the determination of the P-figure (extraction of the soil with hot water) was added to the investigation of the lime status and in 1933 also the P-citric-acid figure was included henceforth (extraction of soil with 1% citric acid at normal temperature). In 1931 potash determination was taken in hand and also the testing of silty soils.

The organization of soil testing and co-operation with other institutes

Only a limited part of the plant nutrients in the soil is determined by the methods applied, viz. that part which is easily available for the plant and is present in one single extraction. This implies that the methods must be applied very exactly according to the prescription, as otherwise differences in degree might gradually introduce themselves, the possibility of comparison with former results would be forfeited and the basis for rendering advice might be lost. This is one of the reasons why it has always been attempted to keep soil testing for practical farming concentrated in one insitution in our country, implying an uniform judgement of the nutritive condition of the soil and the establishment of an uniform basis for advisory work. This would not have been possible if soil testing had been assigned to various institutions applying different methods, whatever their merits may be.
This intention has been satisfactorily realised so far, partly due to the close co-operation of the Laboratory for Soil Testing, the Agricultural Experiment Station and Institute for Soil Research T.N.O. and the Agricultural Advisory Service.

In this connection it may be mentioned that the late professor Dr O. de Vries, director of the Laboratory for Soil Testing from 1930 to 1945 was also Managing Director of the Agricultural Experiment Station and Institute for Soil Research a fruitful collaboration being obviously attained by this combination of offices. Now both institutions have a director of their own but the same close co-operation has been maintained.

After the laboratory at Groningen has been extended a few times to allow for accommodation wanted in consequence of the ever increasing number of samples received, it was decided in 1942 to decentralise the work and to establish another laboratory in the South of the country for the provinces of North Brabant and Limburg at Geldrop near Eindhoven. The advantage of decentralisation is that farmers at once are beginning to show more interest, as is confirmed by the fact that more samples are being sent by farmers in these areas but also that the investigations can now be adopted to the needs of these areas. A disadvantage, though of minor importance, is that a little more supervision and control must now be exercised in order to keep the methods of analysis at the various laboratories at the same level.

The decentralisation was proceeded with in 1947 when a laboratory was founded at Oosterbeek (near Arnhem) and in 1948 by establishing another one at Goes for the sea-silt area in the South-West of this country.

In regard to horticulture another course of development has been pursued, and the aim is to found separate laboratories for various crops (and types of soil). At the centre of the glasshouse district, Naaldwijk (near the Hague) an experimental garden with a laboratory for research was established in 1924.

It was decided that soil testing from the district should be performed here and the growers concerned have gratefully availed themselves of the opportunity. The methods of analysis applied here are not the same as at the Laboratory for Soil Testing.

Afterward the decentralisation made further progress, e.g. separate facilities became available to nurserymen of ornamental shrubs at Boskoop and of flowers at Aalsmeer and to market gardeners at Amstelveen (near Amsterdam). The intention was that research would be taken in hand here in addition to soil testing for practical growers. The latter part of the scheme has now been abolished as it was judged more appropriate (and easier and cheaper) to delegate soil testing on behalf of practice once more to the Laboratory for Soil Testing. The aim is to ascertain that soil analyses are performed uniformly.

The testing for glasshouse growers in the South Holland district, however, remained concentrated at Naaldwijk. The accelerated growth of crops under glass and the heavy dressings with fertilisers create some special aspects, i.a. extraction with water instead with acids and control of the salt content of the soil.

The governing body of the Laboratory for Soil Testing has been reorganised since the war. An all embracing top organisation of national farmers’ association was established viz. the Agricultural Institution. The Laboratory for Soil Testing is now working under the auspices of that Institution. The Board now consists of three members appointed
by the Agricultural Institution and three members appointed by the Ministry of Agriculture, Fishery and Food-supply.

Recently a Committee has been appointed with the task to render advice to the Board in regard to the methods of analysis to be applied. The Agricultural University College, the Agricultural Experiment Station and Institute for Soil Research T.N.O., the Central Institute for Agricultural Research, the Laboratory of the North Eastern Polder, the Government Agricultural Advisory Service and the Laboratory for Soil Testing are represented in this Committee. At the same time collaboration between the various institutions for research is hereby promoted.

The methods of analysis and checking them

The distribution of work between the Laboratory for Soil Testing and the Agricultural Experiment Station has been arranged so that now methods of analysis are devised by the latter and checked on the agronomical value. If a new method proved to be suitable the Laboratory is duly informed and here it is made adaptable to large scale investigations, usually still implying a great deal of experimentation. New methods must comply with a variety of conditions.

In the first place it must disclose the plant nutritive conditions in a correct way. Other requirements are that the method can be quickly accomplished and yet expediently and it must be cheap in its application, whilst the stretch covered by the data must be satisfactorily large in proportion to the standard error of the determination.

Soil testing is performed by girls; they are taught the work at the laboratory. Working under supervision of a skilled staff of analysts the results are satisfactorily exact.

With large scale analysis the methods are divided in stages; one group of girls performs one determination, e.g. of phosphates, but each group is engaged in one stage only. Experience has taught that a division according to determination must not be exaggerated and must be arranged so that the girls keep feeling themselves responsible for the final issue. It would be too much to enlarge further upon the methods applied. Those interested will be gladly further informed when a visit is paid to the laboratories.

8100 Determinations are performed daily, some further particulars are shown in the following table.

<table>
<thead>
<tr>
<th>Determination</th>
<th>Number of determinations daily</th>
<th>per girl</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>2200</td>
<td>300</td>
</tr>
<tr>
<td>Humus</td>
<td>1300</td>
<td>150</td>
</tr>
<tr>
<td>Phosphate</td>
<td>1500</td>
<td>110</td>
</tr>
<tr>
<td>Potash</td>
<td>1200</td>
<td>120</td>
</tr>
<tr>
<td>Sand and silt (clay)</td>
<td>300</td>
<td>33</td>
</tr>
</tbody>
</table>

The total number of determinations in 1949 amounted to 1,874,463 for the whole year.

It should be stated here that formerly potash was determined by the chemical method of precipitating it as potassium-cobalt-nitrite. In those days 11 girls could finish 140 determinations daily and now 10 girls
perform 1200 daily. In extraordinary cases a detailed mechanical analysis
is carried out, 17 fractions being distinguished from 2–1700 µ. If de-
sirable the moist content, the presence of pyrite, the salt content (glass-
house soils) and in special cases the total phosphate content and the
nitrogen content can be determined. The intention is also to determine
the Mg content of the soil in the near future.

The determination of copper is done according to the microbiological
method with the fungus Aspergillus Niger. Detailed experiments are
conducted at the University of Utrecht on the possibility of quantitative
determination of trace elements by Spectral-analysis or colometric me-
thods respectively, several institutions taking an interest in these in-
vestigations.

It is absolutely essential that the instructions provided are heedfully
adhered to in order to be sure that always the same results are attained.
A stringent control is kept therefore and daily a standard sample is
accompanying every determination, procuring a warning whenever any-
thing is going wrong. In addition 15 samples of different origin and
varying content are analysed at all laboratories every month, affording
an excellent control on the tests carried out by these laboratories. In
this way it has been possible to find out that e.g. a noticeable difference
in the P. citric acid figures determined at different laboratories was due
to a diversion of one cm of the stroke-lengths of the shaking machines,
used for shaking flasks containing soil and liquid horizontally and to the
number of strokes per minute not being exactly the same. After these
diversions had been corrected, the results were very satisfactory.

During the last few years speed-methods of soil testing have been
developed abroad involving e.g. trace elements. These methods are also
applied now and again in the Netherlands. Whether these methods should
be preferred to the speed-methods now applied here is now a subject of
investigation.

At the laboratory for horticulture at Naaldwijk, already referred to the
average number of soil samples completely analysed during the last
years amounted to 6000 per annum.

In this connection it should be recorded that soil scientists in this
country are in general not in favour of supplying farmers with outfits
to test the soils for themselves as too big mistakes are liable to occur.
However, in order to meet the pressure brought about from practical
quarters the laboratory for Soil Testing has opened years ago the oppor-
tunity to farmers to buy a so-called pomer-apparatus enabling them to
estimate the acidity of the soil by applying a solution of potassium rho-
dide. It is remarkable that these outfits are falling into disuse in the course
of time and farmers prefer to have their soils tested at the laboratory.

The development of soil testing in the course of years and the plans for the
future

After the foundation of the Laboratory for Soil Testing in 1927 the
number of samples received soon increased considerably but after 1930
it started to decline due to the general agricultural depression. Member-
ship decreased from over 8000 per annum to just over 1400 in 1933. In
that year soil testing was reorganised enabling farmers to have their soils
only tested for the determination of the pH at a low charge on condition
that all soils of a village were sampled for testing. As many sandy soils in
our country show an excessive acidity, due advantage was taken of this
opportunity. In the first year 50,000 samples were received for the fundamental pH determination and 65,000 in the second. In the meantime more complete testing, including determination of the humus, phosphates and potash content developed more every year. The fundamental determination of the pH in the long run gradually restricted itself to an annual number of 15—20,000 samples.

In order to give an idea of the present extent of analysis the samples forwarded in 1948 will be quoted here. 122,000 Samples were received for complete analysis, i.e. over 98,000 from farmers and 23,000 from experimental plots. In total almost 2 million chemical analysis were involved. It should be put on record here that the Laboratory for Soil Testing advertised testing mainly by advisory work, agricultural education and the assistance of the agricultural press. The appreciation of soil testing grew gradually amongst farmers and at present it is considered by them as an essential attribute to farm management. Agricultural education has been of great significance in this respect and has preceded the development of the work at the laboratory. Most young farmers in this country have attended agricultural classes of one kind or the other and were convincingly informed on the usefulness of soil testing. The Agricultural and Horticultural Advisory Services are also performing an useful task. Over 800 assistants of the Government Agricultural and Horticultural Advisers draw in many cases (according to an estimate appr. 70—80 per cent of the total) the samples for testing.

It is difficult to foresee, what is going to be the final extent of soil testing work. In the designing of plans for the future 150,000 samples have been accounted for. The total cultivated area of the Netherlands covers 2,300,000 ha the size of the fields varying from $\frac{1}{2}$ or $\frac{1}{2}$ to $1\frac{1}{2}$ or 2 ha each. Small fields predominate and the total number of all fields is estimated at approximately 3,500,000. Analysis of 150,000 samples a year i.e. an average of 6 samples per 100 ha, means that as an average all soil will be tested once in 20 to 25 years. This period is considered as being too long and it would be much better to repeat testing once in 5 to 10 years. Future will tell whether that can be achieved.

In the near future the Laboratory for Soil Testing will take up crop analysis on behalf of practical agriculture in addition to soil testing. A new wing is being built at the Laboratory at Oosterbeek but the work will also be taken in hand at other laboratories. The special significance of crop testing comes to the forefront now most fodder will have to be grown at home.

A proper composition of the diet of livestock can only be achieved with the help of research and advisory work.

**Mapping out of the results of soil testing**

The Laboratory of Soil Testing is endeavouring to enter the results of their tests on maps as far as possible. This task was performed by the laboratory itself in the case of extensive regional investigations. Obviously it is far more difficult to map out results from samples forwarded by the farmers themselves. Several Government Agricultural Advisers, Principals of Agricultural Schools and the Service for Drainage Land Improvement and Re-allocation go into much trouble in this respect and not without success.

In cases of re-allocation the service concerned make a good use of such
maps and are exerting themselves still to map out results of tests of samples of soil of several years ago.

pH, Phosphates or potash maps of a region present useful surveys of the soil conditions in these respects. It is often found that higher soils are more acid than lower (often not so well drained) ones. Farmers are often under the impression that the reverse applies and call lower soils acid, resulting in a wrong application of lime.

A phosphate map often offers a mottled aspect. Great differences prevail on every farm and out lying fields are liable to show the greatest deficiency.

In the case of scattered holdings as occur in many regions of this country, it is not well possible to indicate the lay-out of the farms in addition to the results of soil testing usually represented by a variety of colours. It is done in Sweden, however, where most of the farms are now compact units, as re-allocation was applied here much earlier than in the Netherlands and an excellent survey of the location of the farms is attained.

Advice ensuing from soil testing

Advice ensuing from soil testing is based upon the results recorded for over 25 years of experimental plots designed by the Agricultural Experiment Station and the Government Agricultural Advisory Service. They are a very good foundation indeed. In his paper, Dr van der Pauw will supply more particulars on this subject and also Ir den Engelse will have to say more about it.

It will be possible to achieve much in this country by soil testing. Optima lime, phosphate and potash status of soils have by no means been attained for all soils and certainly not for grassland. It is necessary to produce on our own soils in the future as much as possible to feed a population of 10 million people and research and advisory work can contribute quite a great deal to achieve the objective aimed at.

Chapter 20

THE AGRICULTURAL ADVISORY SERVICE IN THE NETHERLANDS MORE PARTICULARLY AS FAR AS CONCERNED WITH SOIL INVESTIGATIONS

P. A. den Engelse

Agricultural Advisory work on farm technique in the Netherlands is almost entirely performed by Government officials. There has been established, however, a close co-operation between Government Advisers and organisations of farmers and growers, the latter also contributing a little towards the costs of research, education and advisory work in relation to agriculture. Great value is attributed in this country to a close contact between research, education and advisory work. Without research, rendering of advice would be impossible and advisory work based upon research is only appreciated by farmers who have had a proper vocational education. Due to a strongly developed specialisation the Department of Agriculture is split up in several sections, each with an Advisory Service of its own. The most important ones are Arable and
Grassland Farming (the advisers in this case are called Agricultural Advisers), Horticulture, Livestock Breeding, Dairy, Land Tenure, Service for Drainage, Land Improvement and Reallocation, and Forestry. Each Section takes care of a part of agricultural research, as far as appertaining to its province. The co-ordinating officer for all these Sections is the Director General of Agriculture.

Agricultural and Horticultural Advisers have a more extensive advisory task than their colleagues of other Sections who only are concerned with one branch of farming. The former, however, consider the holding as a unit. Therefore Agricultural and Horticultural Advisers also have to deal with agricultural economic advisory work and with problems relating to small holdings. It may seem strange that a horticultural adviser is not referred to as a specialist here, but that is due to the fact that horticulture in this country is pursued as a separate industry and not as a branch of agriculture.

Advice based on soil testing is rendered by 22 agricultural and 18 horticultural advisers, each with an advisory region of their own, a part of a province, counting some 6 to 7000 farmers or 1000 to 5000 growers.

The Sections Arable and Grassland Farming and Horticulture employ in addition Advisers in General Service covering the whole country. They are specialists and have the task to assist Advisers with an advisory region in their advisory work on special subjects. Each of the Sections mentioned employs e.g. an adviser specialised in soil-scientific problems. The reason why these specialists have been appointed is that the advisory work concerning soil analysis and soil survey and mapping give rise to so many new aspects and difficulties that a general adviser with an advisory region has not got sufficient time to tackle them. Advisers-specialists do not render advice directly to farmers and growers but leave it to the general adviser of the region concerned to inform them.

Advisers with an advisory region are assisted in their duties by an “Ingenieur” (agronomist), a few Chief Assistants, a number of Assistants and a staff of 3 or 4 administrative employees.

In addition to their advisory task advisers are also concerned with investigations, both in the field of the technique of cultivation and in the field of economics, this work being decentralised to a large extent but nevertheless centrally directed. These investigations concern problems being of direct importance to the advisory regions. It should be elementary and conducted on experimental plots, experimental farms, experimental gardens, sometimes equipped with a simple laboratory. As he has to look after a staff of 25 or 30 people, keep into contact with farmers or growers and their organisations an adviser has little time to spare for experiments. For that reason he can rely upon the help of an agronomist for the conduct of experiments in his region.

Except by graduated personnel, he is assisted by men with a diploma of a secondary agricultural school. The Advisory Services in the Netherlands are endeavouring to provide for the possibility of advice to any farmer who applies for it. Experience has shown that this actually includes all holdings, though one farmer is much keener than the other to show an interest. The most backward farmers, really most needing advice, feel not so much the want of it. On the other hand occupiers of well managed farms of whom it might be expected that they would be able to carry on independently, that is without asking advice, feel keenly that more research and more advice are necessary. They ob-
viously realise best that improvement are always possible and collaboration of research is essential.

If an advisory station performs its task efficiently, every holding should be visited at least twice a year by the advising officer. Experience has shown that in that case at least one officer is necessary to 200 to 300 holdings, and in horticulture even one to every 100—150 holdings. In Denmark the same conclusion has been arrived at for agriculture. In England and the U.S.A., however, one advising officer to every 1000 holdings is being aimed at, and in France one officer has to attend to 7—8000 holdings. Except rendering advice to farmers individually, endeavours are naturally made to get in touch with the farmers collectively as it involves a considerable saving on expenses.

The question now arises what should be the scientific training of these advising officers. At the Congress on European Agricultural advisory work organised by F.A.O. in 1949, it became evident that all countries, with the exception of the Netherlands, strongly adhered to scientific training. In this country we are of another opinion for two reasons: 1. for very intensive advisory work we have not enough agronomists available, 2. we would not be able to meet the high expenses on salaries required. Experience, however, has taught that much can be achieved with personnel, having gone through a secondary agricultural school training (chief assistants and assistants), provided that the applicants are subjected to severe selection and provided that they are working under close supervision of scientifically trained superiors and constant attention is paid to continued training. The population of the Netherlands shows permanently a considerable increase and this has the advantage that in appointing assistants a severe selection can be exercised. There are many farmers' sons, even if they have a diploma of an agricultural winterschool and have gone through a thorough practical training, who cannot possibly find a farm to earn their livelihood. Amongst these are many who can be advantageously engaged in advisory work. An Agricultural Adviser in an advisory region with some 6—7000 farms has approximately 20 assistants, each of them with an assigned district with 300 to 350 farms. In addition he has a few chief-assistants and assistants in general service, who are engaged as specialists in particular subjects and cover the whole advisory region. They must co-operate in keeping the district assistants properly informed on their special subjects. One of the specialists-assistants is concerning himself with soil testing and manurial problems.

Tens of thousands of soil-samples are analysed annually and in almost all cases the Advisory Stations have to perform a task both at the beginning and the end of the investigations, i.e. they draw the soil samples, they compile the advice based upon the analyses and discuss the latter with the farmers or growers concerned. There are several weeks that one Adviser may forward 200 samples of soil, and the results of the analyses are sent to him. A part of the work involved here should be decentralised and should come under the charge of district assistants. The samples are drawn on the request of the farmers by the district assistants or by temporarily engaged hands. The first inducement for soil analysis is very often that a crop does not do well on a field or a part of a field. If the assistant thinks that the cause must be attributed to nutritive conditions the farmer is usually easy to win over in having soil samples tested on his expense. Once his interest has been aroused he gradually arrives at the conclusion that soil analyses are essential, before an efficient manurial plan can be designed.
An important stimulant to soil testing is also a so called regional investigation, a large number of farmers in one village, hamlet or parish deciding to draw soil samples from all their fields for combined analysis at strongly reduced charges.

As stated, the results of the analyses are forwarded to the Advisers. Usually the primarily advisory work is accomplished by the district assistants, the advantage being that they usually know both the farmers and the fields from which the samples have been drawn. The advice cannot entail such a clear outline, that every analytical figure automatically involves a definite manurial advice. The advice must be justified not only from a scientific point of view but also practically and psychologically. The cropping schemes of the farmer must be taken into consideration, also the rotation of crops and eventually the quantities of liquid and farmyard manure he intends to apply. The term "psychologically justified" involves that notice should be taken of what seems to be attainable immediately. If one is sure beforehand that a farmer for several reasons will on no account apply the quantities of fertilizers considered to be theoretically necessary then it is better to induce him to apply smaller amounts, if he is inclined to do so. In that case more is achieved than with an advice that will be rejected. The district assistant designs a draft advice, alleging the reasons for any deviation from normal advices. It is necessary that this draft is judged by an expert attached to his Advisory Station, as a matter of fact by the specialist for soils and manuring, in order to attain uniformity in advices rendered by the station and to check the judgement of the district assistant, which cannot always be relied upon as being correct. Subsequently the advice is typed out and handed to the farmer concerned by the district assistant.

The Adviser in general service for "Soil-Scientific problems" on his turn must see to it that the specialists-assistants all over the country are kept properly informed and instructed. He can be likened to a two ways tap, on the one hand supplying the assistants with the latest results of research and on the other hand forwarding the problems assistants meet with to the research workers concerned for investigation.

What did soil testing teach about the nutritive conditions of the soils in this country? In regard to acidity 20—40% of the samples drawn from sandy and peaty soils have a pH below 5.2, i.e. too low. Many samples from old silt soils show a pH, which is also too low (under 7). High quantities of lime are applied in this country but obviously not enough yet, far from it. The phosphate status suffered very much during the war, after the war high dressings have been applied again but in a few regions in this country 30—50% of the samples show phosphate deficiency. Next to a certain degree of backwardness of the farmers there, some other factors are involved. In the first place many farmers were used to apply basic slag which is now only available in small quantities. Particularly on acid soils basic slag had a very favourable affect, due to its lime content. Consequently the fact that the acidity of these soils has not been eliminated to some extent, must be attributed to the shortage of basic slag. The farmers there are very reluctant in applying superphosphate instead. In the second place on ferrous soils the phosphates are turned into insoluble compounds resulting in phosphate deficiency.

In regard to potash, the conditions were more satisfactory during the war than today, as the occupying country supplied decent quantities of potassic fertilizers, of course keeping in mind that afterward there would be more food available for requisition. After the war imports of potassic
fertilizers declined considerably. In several regions, more particularly in those where many potatoes are grown, the potash status is now unsatisfactory and the soil samples tested, show potash deficiency in 50—70% of the total number. When the supply of potash was rationed, districts where this nutrient was very badly wanted were specially considered.

In many cases the results of soil testing in horticulture prove that smaller dressings with fertilisers will suffice. This particularly applies to cultures under glass. As in this case the soil is not affected by the rainfall, nutrients or their residues do not wash out but are piled up in the surface layer of a few cm. Under these circumstances it may be advisable to soak the soil during winter or to take the upper layer of soil away and put fresh soil from outside in its place.

But also with outdoor crops the application of fertilizers has often been too extravagant. In orchards on light loam and silty soils many deficiency diseases have shown themselves lately and they are almost all due to an excess of one or the other plant nutrient. Magnesium deficiency can be caused by excessive dressings of potassic fertilizers, manganese and iron deficiency by excess of lime, zinc deficiency by excess of phosphates, and potash deficiency is often experienced after excessive applications of nitrogenous manures.

The excess symptoms are usually noticed on intensively run, well managed farms. In so called farm house orchards an increase in dressings of fertilizers is advisable in many cases.

What is the value of soil testing in regard to advisory work and to farmers? I think it is justified that the Dutch feel a little proud of taking the first place amongst the nations in regard to the quantities of nutrients supplied to the crops per ha. This should not infer, however, that we are absolutely satisfied about the efficiency of our manurial treatments, and this applies both to the application of inorganic fertilisers and organic manures. To the latter, as a matter of fact, not enough attention has been paid of late.

The Advisory Service and farmers consider soil analysis as an expedient to decide upon the quantities of fertilizers to be applied. With the experience acquired so far, it is impossible yet to devise exact prescriptions based on soil testing.

With regard to determination of the quantities of nitrogen to be applied, soil analysis cannot yet be considered as a practical basis. A well founded advice on N application would be invaluable to farmers considering the high price of nitrogenous fertilizers and as the consequences of deficient or excessive dressings are so very prominent. Advices in this respect, however, will always remain very difficult to render as the quantities of N assimilated by the plants from the available N in the soil vary so much with the conditions of the weather. Also advices on application of potash to silty soils meet with many difficulties and the same can be stated in regard to liming of grassland and to phosphate dressings on phosphate absorbing soils.

Advices on applications of manganese and copper are usually not based on analyses, but on the occurrence of deficiency symptoms. Many investigations will still have to be conducted on different types of soil, before it will be possible to conclude from results of analyses what quantities of manures should exactly be applied.

Yet it is encouraging already that even with our great lack of knowledge we are able to carry on. It pleads for the sound foundation of soil
testing that both advisers and farmers attach great value to it and these determinations are more appreciated year after year.

Finally a salute is due to many of our farmers and growers for the marvellous results they have attained, without sufficient support from scientific quarters and from the advisory service, but by their practical insight on the conditions of growing crops and of the soil, resulting in the ability to decide upon a justified manurial treatment, more particularly in regard to nitrogen.

So far I have only dealt with the relation of advisory work and chemical soil analysis. It would not be possible to discuss in detail the relation of advisory work and soil profile investigations, but for the sake of completeness, it cannot be ignored altogether. In many cases chemical analysis did not disclose the cause of the poor conditions of a crop. This stands to reason and profile investigations are often as essential as chemical analysis. The former is of extreme importance for land evaluation, for choice of crops, for land improvement by subsoiling, deep-ploughing or deep trenching, for a proper control on the watertable in the soil. The interest shown to these investigations has considerably increased lately and the Advisory Services make a grateful use of the results. A Soil Survey Institute has been established and is very active. Mainly with grants of the Government, survey maps are designed. These survey maps can be used as a basis for the mapping out of holdings or single fields (scale 1:5000), the specialists on soil investigations of the Government Agricultural Advisory Service rendering a helping hand, but otherwise the expenses accruing from this survey have to be met by the occupier himself. In Horticulture such maps are applied for if a grower is considering to lay out an orchard or to construct glasshouses on a certain field. On the basis of the results an advice is rendered on the planting scheme, or on the most suitable site for a glasshouse, or on land improvements which should be carried out. In the centres of fruit and glasshouse-culture hardly any orchards are now planted or hardly any glasshouses erected before the fields concerned have been surveyed and mapped out.

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Chapter 21

THE INSTRUCTION IN SOIL SCIENCE AT AGRICULTURAL AND HORTICULTURAL SCHOOLS AND AT COURSES IN THE NETHERLANDS

N. van Vliet

The aim of agricultural and horticultural education is to provide a theoretical foundation to the rational management of agricultural and horticultural holdings. Knowledge of soil conditions and everything related to them is an important subject in this respect.

The nature of tuition depends upon the standard of education of the pupils when they enter a school or start to attend a course.

General Agricultural or Horticultural Course

The most elementary tuition on agricultural and horticultural subjects is given to pupils having attained the age of 15 years, not being able to
attend classes in daytime. They attend a General Agricultural or Horticultural course during two winters in the evening for 150 to 225 hours per winter. 16 to 24 of these hours are spent on teaching knowledge of soil conditions. Actually the number of hours is larger as, in teaching subjects like botany, physics, chemistry and manurial treatment of soils, touching on soil scientific problems is self-evident. Elementary knowledge on the soil, essential to a better understanding of several practical operations as soil management (tillage), drainage, irrigation and manuring is imparted to these pupils.

Primary Agricultural or Horticultural School

Pupils being able to attend classes during a few days weekly, in addition to the work they are doing at the family farm, enter a Primary Agricultural or Horticultural School. Such a school has 4 forms. During the first year lessons are given on 2 days weekly and in the following three years on one day weekly. The subject matter of tuition on soil science concerns the same subjects as those taught at the General Agricultural and Horticultural Courses. In the case of Primary Agricultural and Horticultural Schools there is more opportunity for the teachers to demonstrate the subject matter on the field and therefore the tuition shows to better advantage to the pupils.

Agricultural and Horticultural Winter Schools

These are schools bearing a secondary character. The pupils when entering, usually have attained a higher standard of education than those who have only attended an elementary school. The curriculum of these winterschools is more elaborate and the teachers on soil science are usually either graduates of the Agricultural University College or school teachers with a certificate for agriculture and/or horticulture, who have specialised themselves on this subject. Therefore the tuition of soil science at these schools is of a less elementary nature than at the Primary schools and the courses. The curriculum in regard to this subject embraces: Constituents of the topsoil; texture; relation of water, air and heat in the soil; origin and properties of soil-types; adsorption; microbiological processes in the soil; physical and chemical analysis; soil management (tillage) and soil improvement. Due to a more profound tuition of Physics, Chemistry and Biology the results of lessons on Soil Science also show to better advantage. The fact that nobody can be admitted as a pupil unless he has been employed on a farm or nursery for at least one year, and pupils must be similarly engaged during the months when they do not attend classes, also contributes to these better results.

After leaving school the pupils return usually to the parental farm, but the lower staff of the Advisory Service is also regularly replenished by selection from those who were successful in getting a diploma.

Secondary Agricultural Schools

The Government and Denominational Secondary Agricultural Schools have an intermediate position between Agricultural Winter Schools and the Agricultural University College. The curriculum covers two years and a half. The first two forms consist of a winter term (beginning of October to the end of March) and a summer term (end of April to the middle of July). The periods between the winter and summer terms should not be considered as holidays, but are earmarked for taking part in practical
work on a farm. The same applies to the period of 2½ months between the summer and winter term. The third form ends after the winter term.

Pupils must be looked for amongst those prospective farmers to whom the study at the Agricultural University College would take too long or would be too expensive and who do not consider the attendance at an Agricultural Winterschool as being suitable in their case. They are of the opinion that the training afforded there is not elaborate enough for those who aim at a leading position in agriculture and therefore in the future might have to perform other duties, except those concerned with the management of a farm. The more teachers on a technical subject try to penetrate deeper into basic facts, the more a proper preparatory education of pupils becomes essential.

Accordingly youngsters wanting to be admitted to the first form of a Secondary Agricultural School must have attained a knowledge equal to those who have passed through the first three forms of a "Hogere Burgerschool" (Secondary School) or have the diploma B of an extended elementary school. Pupils with the latter diploma, however, must before being admitted attend a short supplementary course in Chemistry and Mathematics at the school, before the beginning of the first term. Youth wanting to be admitted at once to the second term must have a diploma of a "Hogere Burgerschool" (Secondary School with 5 forms of one year) or a diploma B of a "Gymnasium" (Grammar School), provided they are successful in attending beforehand a supplementary course on some subjects, being taught in the first class of the Secondary Agricultural School but either not at all or less extensively at the schools they just left.

As far as prospective pupils are not sons of farmers, they are required before being admitted, to have been employed for one consecutive year on one and the same farm for farmwork, have succeeded in acquainting themselves satisfactorily with the course of activities at that farm and have made notes of their practical experiences e.g. by keeping a diary. They must hand in a concordant statement duly signed by the farmer concerned.

The following subjects are taught at these schools:
Mathematics, Physics and Meteorology, Chemistry and Technology, Botany and Zoology, Geology and Mineralogy, Dutch, German, English, French, History, Geography, Polity, Economics, Commercial Science and Civil Law, Soil Science, Land Improvement and Soil Management (tillage), Manurial Treatment, Plant breeding, Anatomy, Breeding and Hygiene of large domestic animals, Livestock Nutrition, Dairying, Managerial Science, Bookkeeping, Technical drawing, Land surveying, Agricultural Engineering and Fruit Farming. Several excursions to important agricultural districts supplement the instruction.

Four subjects belong particularly to the domain of soil science in a more restricted sense viz: geology and mineralogy, knowledge of soil conditions, land improvement and soil management (tillage) and manurial treatment. The instruction on several other subjects, specially physics and chemistry are contributing a great deal in explaining all kinds of phenomena and observations. The lessons in geology and mineralogy embrace amongst others mineralogy, knowledge of rocks, significance of water, wind, ice and vegetation as geological factors and a survey of the types of soil in the Netherlands including: soils older than the deluvium, peat soils, silt soils, dunes and sand shifts. The instruction on knowledge of soil conditions is concerned with: main constituents and structure of the soil; relation of soil and air, water and heat; physical, chemical and
microbiological processes in the soil; soil testing; deviations in soil conditions, origin of soils, types of soil.

Lessons on soil improvement and soil management (tillage) include: drainage; water discharge of polders; irrigation; land reclamation; purpose of soil management, ploughing, harrowing, rolling, tillage of the principal types of soil considering the kinds of crops to be grown. Tuition of manurial treatment is concerned with a short explanation of plant nutrition, constituents of plants, carbon dioxide assimilation, nitrogen nutrition, ash constituents of plants, law of minimum, aim of manuring, classification of fertilisers, their composition, origin, manufacture, properties, control; action and application of organic manures; green manuring, manurial treatment of different types of soil and crops, design of experimental plots. The aim of training is to educate pupils into men capable of independent management of a farm of a decent size. The schools do not train them for any other occupations. Yet, long term experience has taught that men with a diploma of these schools are appreciated, when employed in other posts such as assistant or chief assistant of an Agricultural Adviser, posts with agricultural organisations or agricultural institutions, with the Central Bureau (federation of farm requisite co-operatives), provincial branches of the Agricultural Institutions, professional organisations of farmers, etc. Also the Government Service for Land Improvement and Re-allocation on several occasions has engaged people with a diploma of these schools, particularly for surveying and mapping out the soils in a region where projected schemes are going to be executed. The diploma gives admission to the Agricultural University College at Wageningen and to the veterinarian faculty of the Government University at Utrecht.

Secondary Horticultural Schools

These schools offer similar and versatile facilities to those who are inclined to occupy a leading or prominent position in horticulture and related industries or in horticultural organisations. The curriculum extends over three years and in general youth having successfully attended a secondary school for three years can be entered as pupils. Due to this preparatory training the pupils are capable of being given a more than elementary training in soil science.

In all other respects the instruction is almost equivalent to the one of agricultural secondary schools, but, of course, is more specially focused upon horticulture.

Two or three days a week are devoted to practical lessons in the garden or in the glasshouses and excursions are organised to the principal centres of horticulture. Consequently the pupils have plenty of facilities to become acquainted with soil scientific problems arising in practice.

Government Secondary School for Tropical Agriculture

What has been said above about Secondary Agricultural and Horticultural schools, training pupils according to conditions prevailing in Dutch agriculture and horticulture, or at least in temperate zones, also applies to the Government Secondary School for Tropical Agriculture at Deventer. Its pupils, however, are destined to find an occupation in tropical or subtropical countries. In most cases these pupils will have to perform in the future a task under rather primitive circumstances. They
cannot rely on services developed in more advanced countries such as research stations and laboratories. For that reason the instruction in soil science at that school is coupled with a practical training in the performance of soil analysis by the pupils themselves with simple accessories.

The teachers and their audience

Whether tuition of soil science will render favourable results, depends more particularly upon the knowledge of the teachers on the one hand and the intelligence of the pupils on the other hand. Teachers at courses give instructions in agriculture and horticulture as a sideline of their main occupation, being teaching at elementary schools during day-time. They were trained at special courses on agriculture and/or horticulture, but the subjects taught could not be treated into many details. Therefore it cannot be expected that they possess a thorough knowledge of matters concerning soils. Their daily task does not allow them to expand their knowledge very much.

The results of soil scientific tuition in this case depend more upon didactical capacities than upon thorough masterdom of the subject. The soil scientific knowledge of teachers at primary agricultural or horticultural schools is a little more advanced. Their training was practically the same as of teachers at courses but later on they had a little more time available to add to their knowledge on the subject. In regard to teachers at agricultural and horticultural winterschools and secondary schools the position is much more satisfactory. They were either trained at Wageningen or specialised themselves in soil science as a consequence of a particular interest aroused with them. In their teaching capacity they have ample opportunity to get acquainted with soil conditions prevailing within the area covered by the school.

The general education of pupils of courses and primary agricultural and horticultural schools is at a level that soil scientific subjects must be taught according to very elementary methods. The pupils have formerly only attended classes at elementary schools and are 15 or 16 years of age.

The general education of pupils entering agricultural or horticultural winterschool is at a little higher level. Usually they are 1 or 2 years older and their preparatory training has been better. They are able to understand satisfactorily a little more complicated soil scientific conceptions like "adsorption phenomena" and "biological conditions in the soil".

In order to facilitate that teachers at agricultural and horticultural schools keep themselves informed of up to date perceptions in the province of soil science, it is in the first place essential that they take cognizance of literature, useful for the purpose. Attention is drawn to new publications in the "Mededelingen van de Directeur van de Tuinbouw" (Informative notes of the Director of Horticulture) and the "Maandblad voor de Landbouwvoorlichtingsdienst" (Monthly publication of the Agricultural Advisory Service) being forwarded to all agricultural and horticultural winterschools.

But besides this it is necessary to make arrangements that teachers on the subject of soil science and research workers occasionally meet in order to refresh their knowledge of the former and to adapt it to the latest results of research. For that purpose "studydays" on soil science were organised in September 1948 under the auspices of Dr C. H. Edelman and Dr A. C. Schuffelen, professors at the Agricultural University College, assisted by their collaborators.
At "Horticultural days", organized on behalf of teachers in horticulture, experts are invited to read papers on soil scientific subjects.

Chapter 22

SOIL SCIENTIFIC PUBLICATIONS IN THE NETHERLANDS

The publications of Dutch soil scientific institutes are issued in the series: "Verslagen van Landbouwkundige Onderzoekingen" (Reports on Agricultural Research) of the Ministry of Agriculture, Fisheries and Food, The Hague. (Published by: Staatsdrukkerij en Uitgeverijbedrijf, The Hague), with summaries in English. A special series of the Soil Survey Institute is entitled: "De bodemkartering van Nederland" (Soil Survey of the Netherlands), some six volumes including coloured soil maps, having been published.

The soil scientific investigation of new soils in the Zuyder Zee polders are being published in a series edited by the Management of the Wieringermeer (North Eastern Polder Works) at Zwolle.

The Soil Survey Institute at Wageningen publishes annually a book entitled: "Boor en Spade" (Auger and Spade), containing a large number of short articles on several subjects concerning soil survey in the Netherlands. All contributions are followed by a summary in English. Up to now three volumes have been issued (Vol. I, 1948; Vol. II, 1948; Vol. III, 1949) by the publishers: N.V. Oosthoek, Utrecht.

On the scientific periodicals, often containing soil scientific articles, usually with a summary in English, published in the Netherlands the most important ones to be referred to here, are:


*Landbouwkundig Tijdschrift*, (Journal of Agricultural Science) a monthly, issued by the Netherlands Society of Agricultural Science, Wageningen. In 1950 the 62nd volume will be issued.


*Chemisch Weekblad* (Weekly on chemistry) issued by the Netherlands Chemical Society, The Hague, publishers: N.V. D. B. Cuiten's Uitgevers Mij, Amsterdam. In 1950 the 46th volume is being published.

Chapter 23

DIRECTORY OF INSTITUTE IN THE NETHERLANDS ENGAGED IN SOIL RESEARCH

Landbouwproefstation en Bodemkundig Instituut T.N.O.
(Agricultural Experiment Station and Institute for Soil Research, T. N.O.)

Acting Managing Director: Drs P. Bruin, Groningen, 3 van Hallstraat.

Bodemkundige Afdeling van de Directie van de Wieringermeer, afd. Noordoostpolderwerken.
(Section for Soil Research of the Management of the Wieringermeer, North Eastern Polder Reclamation)
Director: Dr A. J. Zuur, Kampen, P.O. Box 5.

Stichting voor Bodemkartering
(Soil Survey Institute)
Director: Prof. Dr C. H. Edelman, Wageningen, P.O. Box 37.

Laboratorium voor Regionale Bodemkunde, Mineralogie en Geologie
(Laboratory of Regional Pedology, Geology and Mineralogy)
(Agricultural University College, Wageningen)
Director: Prof. Dr C. H. Edelman, Wageningen, 2 Duivendaalse laan.

Laboratorium voor Landbouwscheikunde
(Laboratory of Agricultural Chemistry)
(Agricultural University College, Wageningen)
Director: Prof. Dr A. C. Schuffelen, Wageningen, 18 Heerenstraat.

Bedrijfs laboratorium voor Grondonderzoek
(Soil Testing Laboratory. Head laboratory at Oosterbeek, branch laboratories at Groningen, Geldrop and Goes)
Director: Ir F. Dechering, Oosterbeek, Mariëndaal.

Afdeling Onderzoek van de Cultuurtechnische Dienst
(Research Section of the Government Service for Drainage, Land Improvement and Reallocation)
Principal: Ir W. C. Visser, Utrecht, 21 Maliebaan.

Rijksdienst voor het Oudheidkundig Bodemonderzoek
(Government Service of Archaeological Research)
Acting Director: Dr P. Glazema, Amersfoort, 2 Kleine Haag.

Geologische Stichting
(Geological Survey Institute)
17 Spaarne, Haarlem.

Keramisch Instituut T.N.O.
(Ceramics Research Institute T.N.O. 1))
Director: Dr M. J. Singer, Gouda, 79 Lange Tiendeweg.

Laboratorium voor Grondmechanica, Delft
(Delft Soil Mechanics Laboratory)
Acting Directors: Ir E. C. W. A. Geuze and Ir W. C. van Mierlo,

Rijksdienst voor het Nationale Plan
(Government Service for Physical Planning)
Director: Mr J. Vink, the Hague, 19 Lange Voorhout.
Bodemkundig Instituut te Bogor, Indonesië
(Government Institute for Soil Research at Bogor, Indonesia)
Principal: Dr M. VAN DER VOORT.

Afdeling Mineralogie en Agrogeologie, Faculteit van Landbouwwetenschap, Universiteit van Indonesië.
(Section Mineralogy and Pedology, Department of Agricultural Science, University of Indonesia).
Director: Prof. Dr F. A. VAN BAREN, Bogor, Indonesia.

Landbouwproefstation Paramaribo, Suriname
(Agricultural Experiment Station, Paramaribo, Suriname).
Pedologist: Ir J. M. VERHOOG, Paramaribo, P.O. Box 450, Suriname.