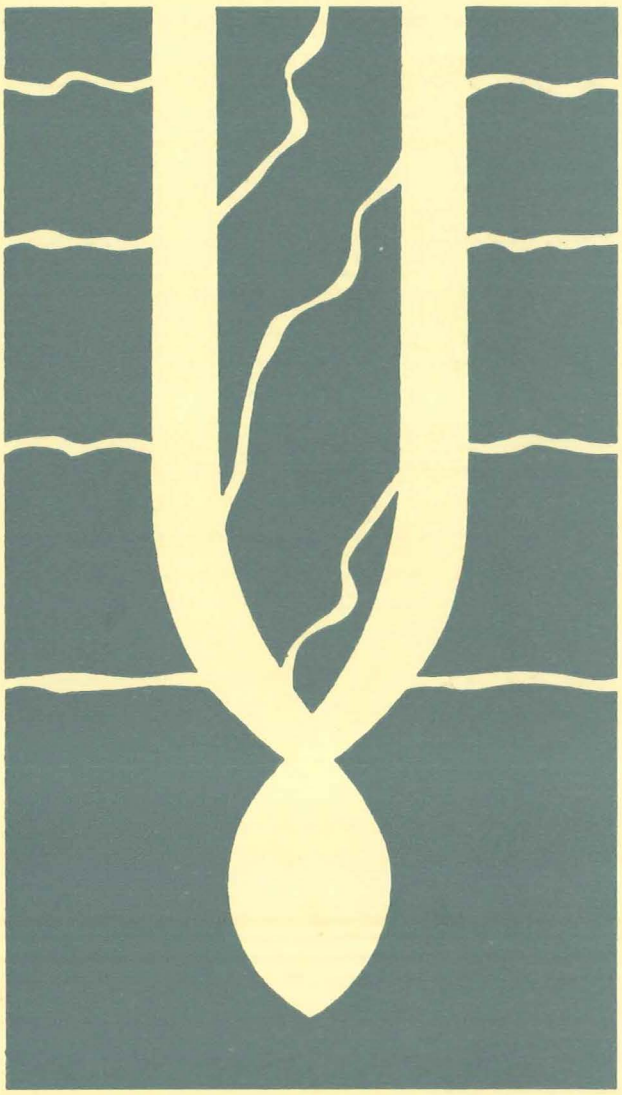
Soil Survey Papers, No. 8

THE SUITABILITY OF THE SOILS OF THE NETHERLANDS FOR ARABLE LAND AND GRASSLAND



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SOIL SURVEY INSTITUTE, WAGENINGEN, THE NETHERLANDS — 1974

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CONTENTS

PREFACE

Towards the end of 1967 the Netherlands Soil Survey Institute published an explanatory memoir: *De geschiktheid van de bodem van Nederland voor akker- en weidebouw*. It was edited by A. P. A. Vink and E.J. van Zuilen and contained a map in 4 sheets to the scale 1 : 200,000, entitled: *Zeer globale bodemgeschiktheidskaart voor akker- en weidebouw van Nederland* (*General Soil Suitability Map for Arable Land and Grassland of The Netherlands),* with legends in Dutch and English.

Two reasons were decisive in bringing this publication, in a modified and adapted version in English, to the attention of readers outside The Netherlands.

The first was that this is the first official map that shows the suitability of all the soils of the country for use as arable land and grassland. This is a remarkable achievement, even from an international point of view.

The second reason was that the methods used in assessing suitability and in compiling the map might be of interest to readers abroad.

Methods of assessing suitability are, of course constantly being revised. In recent years for instance, the Netherlands Soil Survey Institute gives more attention to indication of the limitations imposed by certain soil characteristics and qualities.

Needless to say, the suitability classification described in this publication is only applicable to the conditions prevailing in this country (climatic, economic, and social) and is only relevant at the level on which agriculture is practised here. The map is, intrinsically, subject to obsolescence as a result of technical and economic developments in agriculture and society.

As already stated, this publication is based on the Dutch explanatory memoir. Some modifications were necessary for which use was made of, among others, the publication mentioned in the list of references as VINK, 1958. For instance, the procedure followed in compiling the map has been described more fully. The chapter that treats in detail the suitability of certain regions has been left out, since it would be of little interest to foreign readers. The General Soil Suitability Map for Arable Land and Grassland of The Netherlands is not included in this publication. Instead, four fragments of the map showing four different landscapes serve as an illustration. As a part of the Dutch publication the complete map can be ordered from Pudoc, P.O. Box 4, Wageningen, The Netherlands (price Nfl. 23.40).

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SUMMARY

This paper is the English edition, adapted and modified in translation, of the explanatory memoir to the General Soil Suitability Map for Arable Land and Grassland of The Netherlands, scale 1 : 200,000 (VINK and VAN ZUILEN, 1967) and is being published to give readers abroad an idea of the methods used in compiling the map and of the substance represented on it. The map was derived from the Soil Map of The Netherlands, scale 1 : 200,000. Even several years before that map had been completed, in 1961, the need had been felt for an outline of the suitability of the country's soils for agricultural purposes.

Chapter 1 explains the considerations that led to the decision to publish a soil suitability map.

Chapter 2 deals mainly with the technical aspects of organization during the several stages of map compilation. Early in this process, two soil evaluation scales, one for arable land and one for grassland, were developed (Table 1), and the soil mapping units in every province of the country were judged and classified by the regional soil survey departments. The resulting provincial evaluation tables (see e.g. Table 2A) were then compared on the basis of the national soil map. The data thus obtained served to group the soil mapping units into national suitability classes and enabled a nationwide legend for a soil suitability map to be drafted. In a series of successive stages, during which many critical comments and helpful suggestions were made, the final map and report, representing the result of contributions from the entire Institute, were prepared.

Chapter 3 opens with considerations on the purposes and usefulness of interpretative maps. Although it is possible to show the results of soil survey interpretation in tables or graphs, one or more interpretative maps are often prepared in addition to the soil map. These are meant to give the reader a clear overall picture of the possibilities of applying soil survey in a given area. In this particular case, the soil survey interpretation is concerned with the suitability of soils for arable land and grassland, and is presented in terms that can also be understood by map users who are not conversant with soil science. The chapter concludes with some information that may help the reader towards further understanding of the map. This includes a number of assumptions made during the compilation of the map, pertaining to factors that influence the suitability rating given to the soil: the skill of the farmers, water management, etc. This evaluation is based on the economic situation and the technology of farm management prevailing around the year 1960, when the draft of the map and the memoir were virtually completed.

The first part of Chapter 4 discusses the concept of suitability as used for this map. Not only is the yield important for the suitability of the soil for a crop or range of crops, but also the consistency of yields under weather conditions varying from one year to the next, the quality of the product, the cost of production and the soil pattern.

In the rest of the chapter a description is given of the agricultural aspects by means of which the suitability for arable land and for grassland has been assessed to arrive at this descriptive suitability map.

Chapter 5 deals with the legend of the suitability map (Appendix 1), which consists of five major classes (BG, GB, B, G and O), subdivided into 20 classes. The letters B (*bouwland* = arable land) and G (*grasland* = grassland) denote a certain suitability for these respective forms of land use, whereas letter O (*ongeschikt* = unsuitable) indicates unsuitability for these purposes.

In chapter 6 each major class and class are described in general terms. Appendices 2 and 3 show the relation between soil mapping units and suitability classes, and vice versa, and Table 3 the areas occupied by the various classes.

1. INTRODUCTION

The Soil Map of The Netherlands, scale 1 : 200,000, was published in 1961 (STICHTING VOOR BODEMKARTERING, 1961), and the companion explanatory memoir (in Dutch) in 1965 (STICHTING VOOR BODEMKARTERING, 1965). In addition, eleven separate memoirs — one for each of the provinces of The Netherlands — have been, or are being, published. These memoirs describe the soils according to their inherent characteristics and their regional distribution in relation to pedogenetic processes. They also give some indication of the properties of the soils for their use in agriculture, horticulture, and forestry. Even during the field work for the soil map, consideration was being given to the potential use of the map and plans were envisaged to derive one or more soil survey interpretation maps from the soil map. In fact, before its official publication, the soil map had already served as a basis for the production of a number of maps on various subjects:

a) the priorities for rural development and reconstruction plans
b) the suitability of soils in horticulture
c) town and country planning in the western part of the country (RIJKSDIENST VOOR HET NATIONALE PLAN, 1958)
d) development of the areas with heavy soils in the younger river clay regions of The Netherlands (VINK and VAN DAM, 1959)
e) the suitability map for arable farming in the marine clay region of the Province of Groningen (DE SMET, 1957)

At an early stage it had become evident that there was a need for a general soil suitability map for arable land and grassland for the whole country. And so preparations began for the compilation of such a map, based on the soil map and on a scale of 1 : 200,000.

As a matter of fact, much of the information obtained in the soil survey interpretation for this map was used in compiling several of the maps listed above.

Soil suitability classifications for arable land and grassland often form the final stage of a soil survey. The aim of suitability classifications is to indicate the degree of success with which the soils can be used, e.g. for crops, rotations, types of farming, under stated conditions of management, economics, and other items; the climatic differences are not large in this country.

2. WORKING METHODS IN MAP COMPILATION

The task of co-ordinating and stimulating the preparation and compilation of the suitability classification was in the hands of the present authors, who were assisted by a Land Classification Comittee constituted by members of the scientific staff of the Netherlands Soil Survey Institute. In addition there was the Working Group on Soil Suitability Classification, which consisted not only of members of the scientific staff of the Netherlands Soil Survey Institute, but also those of other institutes, representing several other branches of applied agricultural research. The exchange of ideas within this group appreciably contributed to the work. Without the thorough discussion of all aspects of soil survey interpretation by the Committee and the Working Group, its development in The Netherlands would scarcely have been possible. The map and the memoir were finally tested as to their practical consequences by a committee appointed by the Board of the Netherlands Soil Survey Institute and consisting of high ranking officials from the various executive branches of the Ministry of Agriculture and Fisheries.

All data for the suitability map were collected by the regional soil survey departments of the Netherlands Soil Survey Institute, during and after the soil survey. They had access to all available information on soil suitability, collected during previous soil surveys of limited areas but to larger map scales. Twenty odd of these have been published in the series „The Soil Survey of The Netherlands", of which the following may be mentioned: PIJLS (1948), VAN LIERE (1948), SCHELLING (1949), VEENENBOS (1950), EDELMAN et al. (1950), BURINGH (1951), SCHELLING (1952), SONNEVELD (1958), DE SMET (1962). Some others have only been published in short papers in the series „Auger and Spade" *(Boor en Spade),* as excerpts from mimeographed soil survey reports. These reports and many other soil survey and soil suitability data used in the map, have never appeared in print. A few selected examples were published in the proceedings of international congresses (PONS, HAANS and VINK, 1956; VINK, 1956; VINK, 1960) and in other accessible publications (e.g. DE BOER and PONS, 1960; EDELMAN, 1963; VINK et al., 1963).

DE BOER and PONS (1960) is an example of research into the relationships between soil conditions and grassland.

The regional soil survey departments also had at their disposal the advice and data generously contributed by the Netherlands Agricultural Extension Service, as well as by private organizations and individual farmers. The regional departments were responsible for collecting and sifting all the material in each individual province or region on the basis of the draft soil map; at this stage the Land Classification Committee provided only a certain amount of assistance on the methodology.

During the subsequent stage, evaluation scales were drawn up and further developed on the basis of experience gained during the first stage as well as on general considerations of methodology. These scales — one for arable land, in a slightly shortened version, and one for grassland — are shown in Table 1 (VINK, 1958). Chapter 4 contains more details, of the criteria used in the soil evaluation scales.

Agreement on the system and contents of these scales was reached at joint meetings of the regional soil survey chiefs and the Land Classification Committee; at each meeting, a particular soil landscape was discussed. The soil mapping units occurring in the provinces were rated by means of these scales — shown in Table 2A for the Province of Overijssel. From the results obtained a few experimental drafts were made

for soil suitability classifications on a provincial level — see Table 2B for the Province of Limburg.

In the third stage the provincial evaluations of the mapping units were compared.

Table 1. Scales used in evaluating the mapping units of the soil map

I Arable land

1. Suitable for extensive crop rotation with wheat as principal cereal crop.
2. Suitable for limited crop rotation with wheat as principal cereal crop (generally very good yields of wheat and sugar beet).
3. Suitable for very limited crop rotation with wheat as principal cereal crop.
4. Suitable for extensive crop rotation with rye as principal cereal crop.
5. Suitable for limited crop rotation with rye as principal cereal crop.
6. Suitable for dry limited crop rotation with rye as principal cereal crop.
7. Suitable for wet limited crop rotation with rye as principal cereal crop.
8. Suitable for dry very limited crop rotation with rye as principal cereal crop.
9. Unsuitable for arable land (too wet and/or too heavy).
   Subdivision: a. too wet (mostly sand or peat)
   b. too heavy
   c. too wet and too heavy
   d. structure too poor (sticky).
10. Unsuitable for arable land (too dry).

II Grassland

Only permanent grassland is meant; leys are included among arable land.

a. Suitable for grassland with good yields and good growth the year round.
b1. Suitable for grassland with good yields but with moderate summer depression.
b2. Suitable for grassland with good yields but with heavy summer depression.
c1. Suitable for grassland with moderate yields and moderate summer depression.
c2. Suitable for grassland with moderate yields and heavy summer depression.
d1. Suitable for grassland with good yields and late in spring, no or hardly any summer depression.
d2. Ditto, with moderate yields.
d3. Suitable for grassland with moderate to good yields, late in spring, mostly wet in autumn, with heavy summer depression.
e. Grassland with bad to moderate yields and heavy summer depression.
f1. Suitable for grassland, very wet (rather soft sod), often very good growth and yields (variant of d1 but with a softer sod). Suitable for grazing.
f2. Ditto, unsuitable or poorly suitable for grazing, but good hayfields.
g. Too dry for grassland.
h. Too wet for grassland (at most moderate hayfields).
j. Too saliferous for grassland.

Explanation of terms used in Table 1, part I

Crop rotation with wheat as principal cereal crop

Extensive: all crops that grow on good clay soils; hence, not only wheat, sugar beet and

Tabel 1. (continued)

potatoes, but also e.g. crops that make exacting demands of the soil: flax, peas, poppy seed and such like.

Limited: wheat and other cereals, and to a lesser extent potatoes and sugar beet, but excluding those seed and fibre crops that make heavy demands of the soil: flax, poppy seed, etc.

Very limited: a rotation consisting mainly of cereals, including wheat.

Crop rotation with rye as principal cereal crop:

Extensive: apart from the usual sand soil crops: rye, oats, potatoes, mangolds, also wheat and sugar beet.

Limited: apart from the usual sand soil crops: rye, oats, potatoes, mangolds, also grass leys of several years' duration.

Dry, limited: rye, oats, potatoes, but in a limited degree mangolds and grass leys of several years' duration.

Wet, limited: the summer crops of the sand soils: oats, potatoes, mangolds and grass leys of long duration

Dry, very limited: mainly rye, with the addition of oats and potatoes

Table 2A. Example of a provincial evaluation table (Overijssel)

Units on draft of Soil Map	Arable land evaluation of Table 1 I	Grassland evaluation of Table 1 II	Fodder quality [1])
202	9a	f1/d1	III
203	9a/7	b1/d1/f1	II
204/204g	9a/7	b1/d1/d2	III
204bc	9a/7	b1/d1	III
204h	9a/7	e	III
205	9a	f1/h	III
208	5/6//7	e/g//b2	III
210	6/5//9a/7	g//b1/d1	III/II
211	4/6/5//9a/7	g/c//b2/b1	II
212	6/5//9a/7	g/e//b1/d1	III/II
217c/d	5/6	g/e	III
219c/219cg	6/5	g/e	III
221c/221cg	6	g/e	III
225c	6	g	III
232	5/6	b2	III
234	6	e/c	III
234bc/d 234bc/dg	5/6	e/b2	III
235	8/10	g	III
235bc/d	6	e/g	III
235e	10/8	g	III

[1]) I = very good, II = good, III = moderate

Differences were discussed and their causes investigated. Some differences were due to lack of evidence on the suitability of certain units in provinces where they occupy only a very limited area, or to the underestimation of soils situated in particularly unfavourable conditions of drainage or parcellation. Some causes had to be investigated in the field and were found to be inherent either to main differences in the soil landscape, resulting in a different overall drainage, or to variations in the soil profile which, due to generalizations, are not shown on the soil map nor in its legend. Had they been indicated on the map, they would have been shown as soil phases. In both instances a subdivision of the soil mapping units was made to allow for different suitability classes, but only when the areas concerned were sufficiently large and the soil landscape and soil profile were essentially different.

In the fourth stage a draft was made for a national legend of the soil suitability map and a copy of the soil map was coloured acccordingly. This copy was circulated among the provincial and regional departments to obtain their comments and was subsequently discussed at a meeting of the scientific staff. The final amendments were then made and introduced and the final map and memoir were prepared in a number of substages which need not be mentioned in detail. The publication, delayed for a few years by minor technical difficulties, took place in December 1967.

As will be clear from the above, the present authors mainly fulfilled the role of co-ordinators of the basic work, which was a joint effort of the entire Institute.

Table 2B. Draft for a soil suitability classification for arable land and grassland at the provincial level (South-Limburg)

Provincial classes and subclasses	Description
1	Soils generally suitable for arable land with an extensive crop rotation; suitable to very suitable for grassland
1a	with normal fertilizer requirements, very suitable for grassland
1b	requires more than normal amounts of fertilizer because of mineralogical properties; suitable for grassland; more hazardous than the better soils of class 2.
2	Soils whose suitability is primarily determined by sloping topography; where slope exceeds 8 % poorly to moderately suitable for arable land and grassland, otherwise suitable for arable land with extensive crop rotation, however with limited possibilities as regards tillage; suitable for grassland.
3	Soils suitable for arable land with an extensive crop rotation, but with limitations as regards some crops; grassland with moderate summer depression and moderate to good yields.
4	Wet soils, suitable for grassland; poorly suitable for arable land.
5	Soils poorly or moderately suitable for grassland (strong summer depression); suitable for cereal growing, poorly to moderately suitable for root crops and commercial crops [1]).
6	Soils poorly or moderately suitable for grassland (strong summer depression); suitable for cereal growing, poorly to moderately suitable for root crops and commercial crops [1]).
7	Soils unsuitable for arable land and grassland.

[1]) Seed and fibre crops and, in a few cases, some other speculative crops

3. PURPOSE OF THE SUITABILITY MAP AND SOME ASPECTS OF ITS DESIGN

3.1 Soil maps and soil survey interpretation maps

Basically, soil maps indicate the differences between the soils of a region in so far as these are of a more or less permanent nature and in so far as the scale of the map allows it. To be able to use such maps to full advantage, the results of soil survey should be interpreted. The differences between soils are not of equal importance for all uses to which the map may be put. Every kind of agricultural enterprise and each type of crop make their own specific demands of the soil. A difference in clay or humus content of the top soil, or in horizons and layers of the soil profile may be decisive for one crop, whereas for another it may scarcely have any influence on its growth or production.

Furthermore, map-users not conversant with soil science often find it difficult to interpret a soil map, owing to the complicated nature of the map and the highly specialized terminology of its legend. Both, however, are unavoidable in the soil survey proper, where the soil, as a natural product of the soil-forming factors (climate, parent material, relief, vegetation, time and man), has to be mapped and described within its natural landscape; they are even unavoidable when surveying such largely "man-made" landscapes as the Dutch polders. To overcome this difficulty, most soil survey memoirs give a description of the agricultural use of the different soils, and often also of their potential use. These descriptions may be accompanied by tables which give more or less quantitative information on the agricultural aspects of the soil mapping units. This, however, still leaves the map user with the task of trying to visualize the soil groupings given in the memoir, or arrived at by himself when looking at the soil map, and to do this repeatedly while studying the memoir.

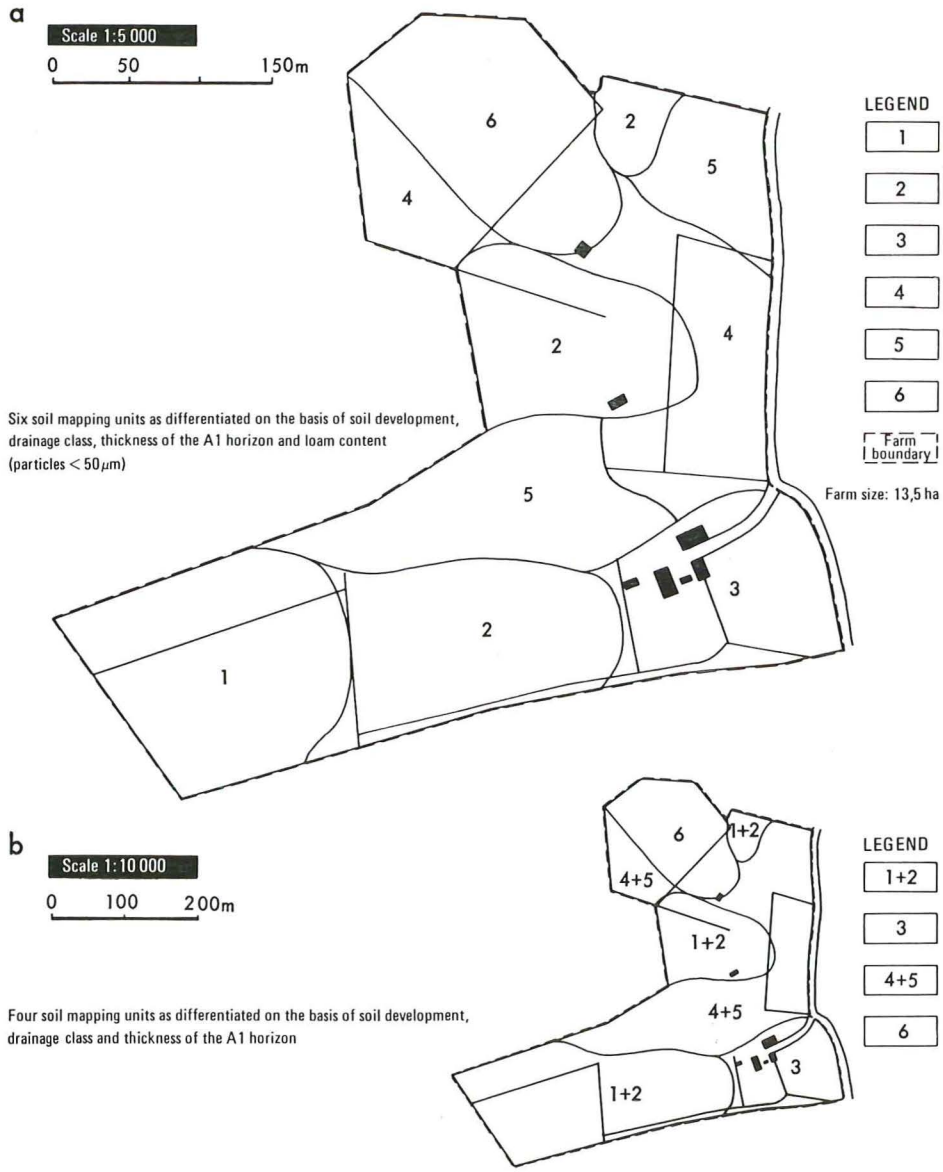
This may be overcome by the preparation of easily understandable soil survey interpretation maps, that will provide the user with a sufficiently complete and overall picture. They should preferably be discussed in the memoir and added as appendices. The map itself should show only those units (classes i.e. groups of soil mapping units intended as an interpretative soil grouping for a particular purpose), which have a direct influence on some of the problems in hand. An alternative is to enable the map user to obtain noncoloured copies of the soil map which he may colour himself (SOIL SURVEY STAFF, 1951 p. 403), as is being done with the Soil Map 1 : 50,000 of The Netherlands.

It should be understood, however, that the soil map remains the permanent base, of long validity, from which soil survey interpretation maps may be derived, each depending on the needs of the user.

It is sometimes said that the soil survey interpretation map is a product of a lower order than the soil map itself, as it gives less information than is given by the soil map. This of course is not true; it is of a higher order, because the interpretation is added to the soil data. It brings the data from the soil map forward into one of the various fields in which they are needed. However, as it is specialized in a particular direction, it gives only a part of the picture and its validity depends on the nature of the criteria selected and on the kind of assumptions made with regard to those factors which are not directly related to the soil (see VINK, 1960, 1963a and 1963b). Without a good scientific basis, the soil survey interpretation maps may become subjective "ad hoc" documents.

3.2 Maps scale and some assumptions on which the classification is based

The scale of a map is of particular importance as it is closely related to the details that can be read from it, and therefore to the kind of use to which it can be put. Figure 1 (STEUR and WESTERVELD, 1965) shows a single farm near Wageningen on soil maps of different scales. On each map the generalizations are appropriate to its scale. Figure 1a is a soil map on which soil differences of any importance to farming have been mapped. In Figure 1b the farm is still visible with all its fields, but some mapping



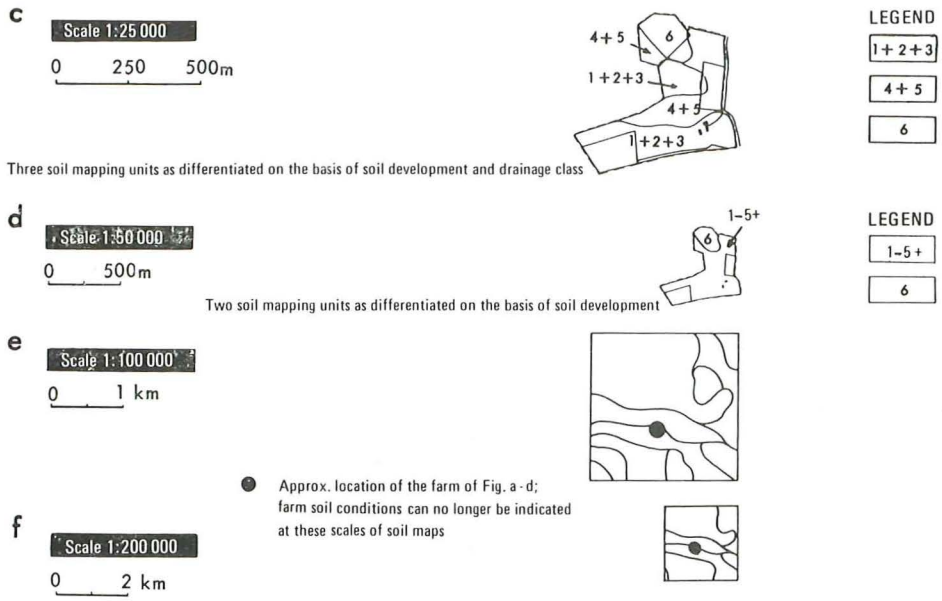


Fig. 1. The smaller the scale of the map, the less details are shown (after STEUR and WESTERVELD, 1965)

units had to be generalized into associative groupings. This tendency increases strongly on succeeding maps, until at a scale of 1 : 100,000, and even more at 1 : 200,000, even the position of the farm itself can only be vaguely indicated (Fig. 1c, d, e and f). This example shows that with the reduction of the map scales the variations within the mapping units increase. Furthermore it can be stated that mapping units on small scaled maps are generally less "pure" than those on larger scaled maps. This is reflected by increasing suitability variations within the mapping units, especially when a map of the whole country on a relatively small scale is concerned, as the one that is the subject of this paper.

There is in fact one more possibility of variation in suitability: it is related to the generalization of the assumptions which have to be made in establishing a suitability classification. Suitability, therefore, never has an absolute value. It must be kept in mind that the soil is only one of a complex of natural and artificial factors which together determine the productivity of a farm. To be able to appraise the part played by the soil, it is necessary to normalize the other factors as much as possible.

In this respect the following factors are of particular importance:

— skill and natural aptitude of the farmers
— water management
— land parcellation and accessibility
— soil improvement
— type of farming
— technical possibilities as to plant protection, plant breeding, agricultural mechanization etc.
— the general economic situation (selfcost, prices of products, etc.).

It stands to reason that this normalization stretches the facts to some extent. Certain variations in some of these factors (e.g. economic situation, water management) will be unavoidable. This can be reflected in differences in the evaluation of suitability of similar soils in different areas.

It will therefore not be surprising that the wording of the legend is rather vague in places, and that fairly strong variations in suitability may occur within a single mapping unit. The map is not intended to be applied to problems in small areas, its purpose being to present an overall view. It seems to be useful as a contribution to the knowledge of the potential use of the soils of the Netherlands.

The assumptions made in the factors mentioned above can be summarized as follows:

Good management was normalized by taking as point of departure what a good farmer — one who knows his job, has a considerable aptitude for it, and is conversant with the newest methods — can be expected to do.

With regard to water management, the best system existing within sufficiently large areas of a soil mapping unit was taken as normal. As has been explained, this caused subdivision of soil mapping units in some cases, viz. when such soils are predominantly used for arable land in one part of the country and for grassland in others.

For land division and accessibility, no optimal system was indicated in any detail as this is outside the soil scientist's area of knowledge. It was simply assumed that all fields were as close as possible to the farm buildings, were readily accessible, and had an unspecified favourable form and size.

Soil improvement, in so far as it is not shown on the soil map, was not taken into account.

As to the type of farming, the suitability was assessed in accordance with the normally existing types. An exception was made for some soils, particularly in the marine clay landscape, which are to a very large extent used for crops, but definitely also have a certain, often high, suitability for grassland.

The economic and technological situation prevailing around the year 1960, when the draft map and memoir were completed, was taken as standard.

Considering that the economic and technological situation is undergoing constant change, and considering also the number of years since the draft map was completed, the map and its memoir are admittedly subject to obsolescence. In due time they will need revision.

4. CONSIDERATIONS ON SOIL SUITABILITY ASSESSMENT

4.1 Introduction

The map exclusively treats the "use-suitability" as has been defined in preceding publications (VINK, 1960, 1963 a and b; VINK et al. 1963). The term soil suitability, as we use it here, is defined as "the degree of success with which a crop or range of crops can be regularly grown on a certain soil, within the existing type of farming, under good management, and under good conditions of parcellation and accessibility".

As principal factors determining this suitability of a soil can be mentioned: yield of crops on that soil, the consistency of yields under the climatic variations occurring from one year to another, the quality of the product, the cost of production and the soil pattern.

Yields of crops are, of course of great importance, although it must be said that often one-sidedly attention is paid to very high yields. Of the other factors, the consistency of the yield deserves special consideration. The low reliability of a soil mapping unit for consistent yields is in particular expressed by the great variation in yields over the years, brought about by varying weather conditions and the sensitivity of the soil to deviations from practices optimal for that soil. The risk and limitations accompanying the cultivation of a certain crop on a certain field often decide the kind of crops that will be grown there. The risks may be caused by drought — as long as we exclude special measures such as sprinkler irrigation or infiltration — by excessive moisture, bad structure, limitations in the tillage or in the bearing capacity of the sod for grazing, etc.

Other aspects which have in general a greater influence than was sometimes thought on the rating that farmers give to soils, are the quality of the product and the investments that have to be made to ensure a unit quantity on a certain soil, on a farm of a given size and type.

The influence of the soil pattern is difficult to assess, although it is highly significant in judging soils that show marked differences in suitability. Just how great its influence may be on the type of farming in a certain area has been demonstrated on the basis of a few simple examples, by VINK (1957) and by VINK et al. (1963).

Of necessity, the suitability classification as given on this map, is descriptive and has been made on the basis of general experience and local evaluation and knowledge. It is largely empirical, mainly as a result of a lack of quantitative data about the complex of all factors that determine the suitability of soils.

In section 4.2 and 4.3 a discussion is given of the general assessment and characterization of the suitability of soils for arable land and grassland, as was used for this classification.

4.2 Suitability for arable land

The suitability of the soils for arable farming has been mainly assessed on the basis of the kinds of rotation that were possible on the soils (Table 1). The more varied the range of crops that can be grown successfully, the greater the suitability. Even though modern agriculture provides techniques that compensate for some of the restricting effects that soils have on the crop rotation, nevertheless the range of crops that can be

included in the rotation remains one of the most typical characteristics of arable farming.

An added advantage of classifying soils in this manner is that it enables soils to be judged according to their long-term use potential. A soil considered suitable for an "extensive rotation" has a broad use potential. Such a soil will, for example, be less vulnerable to variations in prices of products. A soil with good, but specialized and therefore limited, use possibilities, i.e. a "limited rotation", is economically far less flexible.

The various kinds of rotation used in this classification are shown in Table 1. Each kind is characterized by a number of typical crops. The different rotations are easily understood by farmers and agronomists in this country. In practice, of course, the rotation does not necessarily include all of the crops mentioned.

4.3 Suitability for grassland

Evaluation of soils for grassland has long presented problems and still does to a certain extent. For the evaluation the gross yield is important, though only in rather broad lines. The farmer, moreover, is more interested in the net yield, i.e. that part of the yield actually utilized by the cattle.

There are some other highly significant aspects of grassland farming which are influenced by the soils. These are:

1. the distribution of grass growth over the growing season
2. the bearing capacity (firmness) of the sod
3. the fodder-quality of the herbage and of the products derived from it.

After a few experimental classifications in small areas, it was found that these three items, together with a very rough indication of the gross production, gave a good picture of the suitability of soils for grassland in The Netherlands and moreover that these could be determined in a general way with the empirical methods available.

The distribution of grass growth over the growing season has a great influence on farm management. On farms with a predominantly late growth of grass in spring, but with a good summer production, i.e. on most peat soils and on wet mineral soils, the cattle often have to stay indoors for a long period. The stocking rate, however, can often be high, since sufficient grazing is available in mid-summer.

On farms with a predominantly early grass growth, the period the cattle spend indoors is shorter but the stocking rate must be often restricted because the grass growth in summer is usually less. This is strongly correlated with the drainage of the soils, their position in the landscape, their water retention capacity and capillary water movement.

An insufficient or poor bearing capacity in wet periods presents great problems both in grazing and in trafficability. This may partly be due to poor management, but soils with a marked tendency of this kind remain sensitive, even under good management. On such soils, especially in wet years, damage by poaching will lead to an unfavourable return (ratio between net and gross yield). Furthermore, once a grass sod has been damaged, it will continue to influence yields for a number of years. A poor bearing capacity will hinder any contemplated increase in stock, and gives rise to problems in the mechanization of farm work. In such extreme cases as the wettest peat soils, no grazing at all is possible and the grass has to be mown for hay and silage.

Like the bearing capacity of the sod, the distribution of grass growth over the growing season is of great importance for the return of production. These two factors largely determine management practices, including the potential intensification of the land use.

The influence of the soil on the fodder quality is difficult to assess as shortcomings can be greatly compensated by fertilizer dressings and other appropriate management practices. Nevertheless an influence remains which is not easily corrigible and which must be attributed to the permanent characteristics of the soil. After consulting several experts on grassland quality and management, we decided that three "quality classes" could be introduced in assessing the suitability of the soils of this country for grassland.

Class I : "very good fodder quality". This includes soils on which the old and well-known cattle-breeding areas are situated. These soils are considered excellent for breeding and for the production of beef-cattle, while it is also felt that milk-production here is higher per unit of fodder.

Class II: „good fodder quality". This contains those soils considered to be reasonably suitable for the purposes mentioned under class I. Many of the newer cattle-breeding areas are situated on these soils. The excellent results, obtained on soils of class I seem to be matched sometimes, but more effort and higher investments are required and the financial risk is greater.

Class III: "moderate fodder quality". This contains those soils where practical experience has shown that high yields of milk are obtainable, but that cattle breeding and meat production encounter more difficulty. In extreme cases cattle on these soils seem to be more prone to disease.

We have, in general, not considered a soil's suitability for ley farming, all evaluations being made for permanent grassland. Insofar as ley farming is considered, this has been done as part of the arable land evaluation.

The suitability for leys has, however, been indicated for several of the classes discussed in Chapter 6.

5. THE LEGEND OF THE SUITABILITY MAP

Because of the small scale of the map and the variations in suitability which can occur within its units, the map legend must nesessarily involve lengthy descriptions. If reality is to be correctly interpreted, the most common suitability and the most frequent variations found within the suitability classes, must be mentioned. For easier reading, each class is represented by an abbreviated term. Descriptions and abbreviations can be found in Appendix 1.

The legend consists of five major classes: BG, GB, B, G and O. Each major class is divided into a number of classes and one of these, BG2, is subdivided into two subclasses. Any class symbol containing the letter B (*bouwland*) indicates a certain suitability for arable land, and the letter G *(grasland)* a certain suitability for grassland. The absence of these letters means that the soils are considered to be poorly, or not at all, suitable for these purposes under existing management practices (O = unsuitable). At any rate, they are less suitable than soils of classes which do contain the letter in question. This need not be an absolute unsuitability. Some permanent grassland certainly occurs, for instance, on soils of the classes B and O (i.e. without the letter G in their symbols). In many cases this is due to particular circumstances (home fields etc.). Mutatis mutandis, the same applies to the occurrence of arable land on some soils of major class G.

Major class BG contains soils which are generally suited to both arable land and grassland. Major class GB contains those soils which, at least under the best conditions observable today, are generally better suited to grassland than to arable land, but which still have a certain suitability for the latter.

The sequence in which the classes have been arranged in the legend has been chosen according to the principle that the soils with the widest range of use capabilities rank first, followed by soils with a gradually descending scale of capabilities. The numbering and the description of the classes do not in any way indicate their financial value, nor their aptitude for improvement.

6. DESCRIPTIONS OF THE MAJOR CLASSES AND CLASSES

In the following descriptions the different soil mapping units are indicated by the numbers shown on the basic soil map (STICHTING VOOR BODEMKARTERING, 1961). The nine sheets of this map are supplemented by legends in Dutch (Sheet 10) and English (Sheet 11), both with glossaries printed on the back. A full description in Dutch is given in the explanatory memoir accompanying the map (STICHTING VOOR BODEMKARTERING, 1965). The sheets of the soil map also form part of the Atlas van Nederland (STICHTING WETENSCHAPPELIJKE ATLAS VAN NEDERLAND, 1963—), in which explanatory texts in both languages have been printed on the back of each of the eleven sheets.

The terminology of the English legend sheet of the soil map is used in this paper. It should be noted that the terms for texture are literal translations of the Dutch terms. Their meaning is explained in the glossary of the English legend sheet and may deviate appreciably from similar terms used in publications by the U.S. Department of Agriculture or in other textural classifications published in the English language.

Not all the soil mapping units belonging to a suitability class are always mentioned in the description of that class, nor, for the sake of brevity, are all cases mentioned where only a part of a soil mapping unit has been incorporated into that particular suitability class (see Chapter 2, third stage). A full account is given in Appendices II and III, in which the soil mapping units and the corresponding suitability classes are listed individually. Table 3 shows the total area occupied by the suitability classes and by some nonclassified soil groupings.

Table 3. Areas occupied by the suitability classes and two groups of non-classified soils [1])

Suitability class	Area ha	In %	Suitability class	Area ha	In %
BG1	409 500	12.4	G1	208 200	6.3
BG2a	189 500	5.8	G2	51 800	1.6
BG2b	37 500	1.1	G3	74 000	2.2
BG3	149 300	4.5	G4	139 000	4.2
BG4	38 800	1.2	G5	17 500	0.5
BG5	127 300	3.9			
BG6	11 000	0.3	O1	117 400	3.6
BG7	121 700	3.7	O2	45 100	1.4
GB1	470 600	14.3	Non-classi-		
GB2	170 500	5.2	fied I [2])	96 000	2.9
GB3	150 600	4.6			
			Non-classi-		
B1	51 300	1.6	fied II [3])	22 100	1.1
B2	325.900	9.9			
B3	270 700	8.2	Total	3 295 300	

[1]) Figures have been rounded off to the nearest 100 hectares and to 0.1 %.
[2]) Areas with strongly varying soil conditions or hydrology and reclaimed sand excavations.
[3]) Foreland soils (soil mapping units 3, 4 and 5).
Note: Not included in this classification are the most recent polders (the IJsselmeerpolder Zuidelijk Flevoland and the Lauwerszee area).

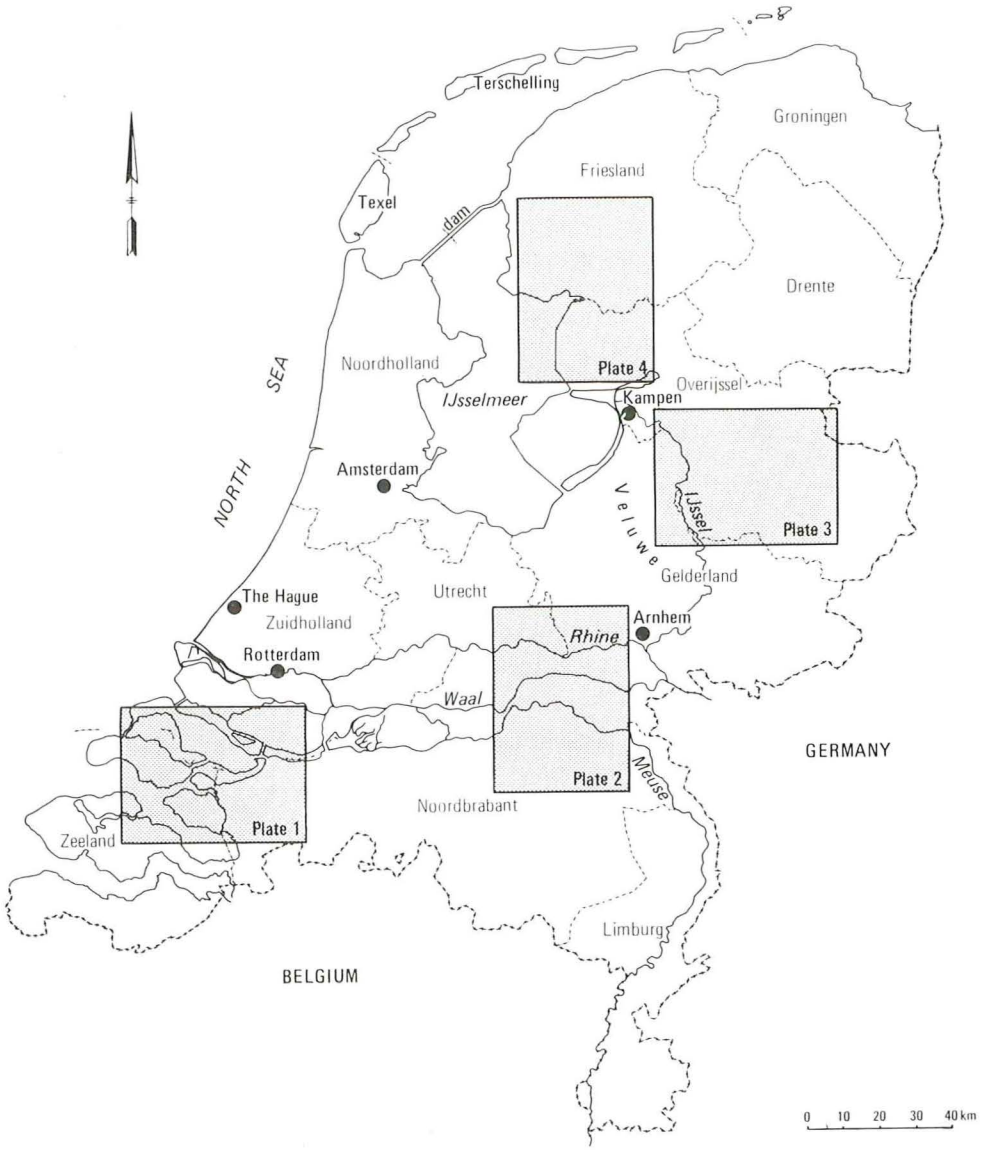


Fig. 2. Location of the areas on the fragments (Plate 1, 2, 3 and 4) of the General Soil Suitability Map for Arable Land and Grassland of The Netherlands.

Several tables list acreages of crops that have been grown successfully on the soils of several of the suitability classes, together with some yield data. These data are estimates, based on a very heterogeneous material, both as to origin and to accuracy. In many cases their only value is to give an example of a certain soil mapping unit in a certain area. Although these data, taken from the Dutch text (see Tables 4-12) are no longer up to date, we have included them as they provide the reader with a general orientation.

Fig. 3. Class BG1: Arable land and grassland soils of very wide suitability in the Wieringermeer polder in Noordholland. This class can support an extensive crop rotation with wheat as the principal cereal crop or can be used as grassland (Photo: Cas Oorthuys)

MAJOR CLASS BG ARABLE LAND AND GRASSLAND SOILS

Soils generally suited to arable land and usually also to grassland.

Of the five major classes that have been distinguished, this major class covers the largest area. Within the seven classes of this major class, the ratio of arable land to grassland varies considerably. In view of the generalizations inherent to the scale of the map, it is a matter of course that here and there soils may occur which are suited to grassland only.

BG1 Arable land and grassland soils of very wide suitability

generally, if well drained, very well suited to most arable crops, with good to very good yields and a high yield security, locally slightly drought-susceptible; with good water-management well suited to grassland, but partly with a summer depression, very good fodder quality.

Generally speaking, this class contains those soils which can be considered the best arable land soils in the country. They are mainly calcareous or slightly calcareous clayey sand to clay soils. They are found particularly in the Provinces of Groningen and Friesland and in the southwestern deltaic part of the country (young sea clay soils, soil mapping units 7, 8 and 10), in the IJsselmeerpolders and the Provinces of Holland (Zuiderzee-bottom soils, units 48, 49, 50 and 51; old sea clay soils, units 54, 55 and 56, see Fig. 3). Owing to the heterogeneity of several of their units, classes BG1 and BG2 overlap in certain respects. Thus, because of its limitations in some parts of the country, the heavy calcareous to slightly calcareous young sea clay soil (unit 9) has been grouped with class BG2a, although a large area of it, e.g. in the Province of Zeeland, has much in common with similar units of the Zuiderzee-bottom and old sea clay soils of class BG1.

The soils of class BG1 are mainly used as arable land, but in certain areas also as grassland, for instance on parts of the sandy clay to clay soils (unit 8) in Friesland. On the "Kampereiland", near the town of Kampen, soils of this unit are entirely under grass.

Table 4. Rotation and yields on a soil of class BG1. (example taken from the southwestern young sea clay area)

Crop	Estimated % of arable area	Estimated yields in kg/ha [1])
Cereals		
Winter wheat	15	5 000
Spring wheat	3	4 500
Spring barley	20	5 000
Oats	2	5 000
Root Crops		
Sugar Beet	15	50 000
Potatoes	5	33 000
Pulse Crops		
Brown beans	7	2 500
Field beans (small seeded broad bean, horse bean, etc.)	tr	—
Blue peas	13	3 800
Marrow fats etc.	tr	—
Commercial Crops		
Flax (unrippled)	15	9 000
Poppy seed	3	1 150
Cole seed	tr	3 000
Grass seed	2	—
Canary seed	tr	—
Caraway seed	tr	1 800

tr = only very small areas.
[1]) For lbs/acre subtract roughly 10 %.

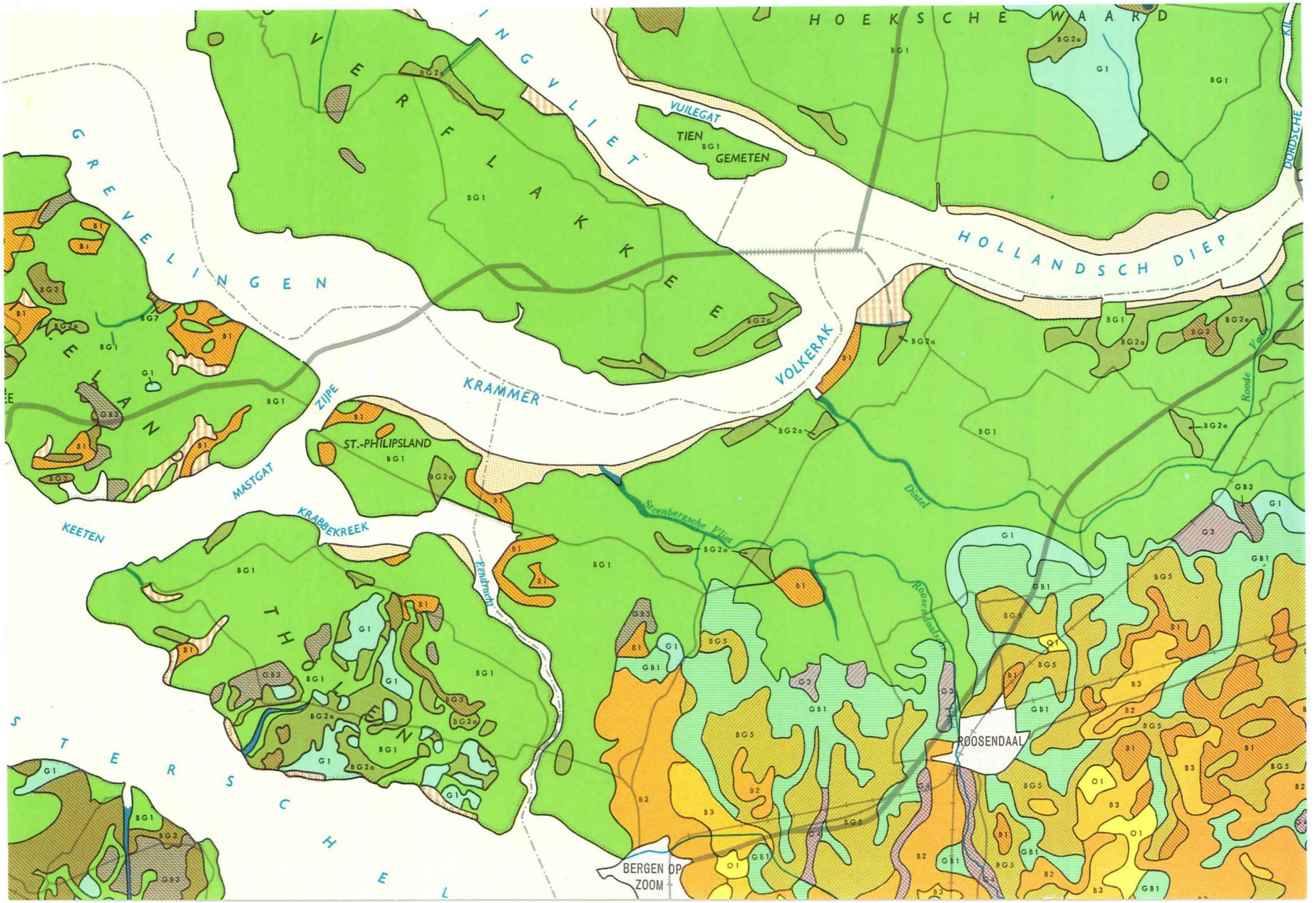
The heavy clay soils belonging to the old sea clay soils (unit 56) in the polders north of Amsterdam are also predominantly used as grassland.

If used as arable land, the soils of this class generally have a deep artificial drainage, whereas if used as grassland, a shallower drainage wil be applied.

Under arable land use and with deep drainage, the lightest soils of this class, those with clay contents of less than 12%, are somewhat susceptible to drought and the yields of most crops (e.g. wheat, sugar beet and pulses) are slightly lower than on the heavier soils, although still high from a national point of view. These lighter soils often need higher fertilizer dressings and are more susceptible to structural deterioration (slaking) and to weed infestation, but on the other hand they are easier to work in all seasons.

The heavier soils, and in particular those with more than 35% clay, have limitations with regard to workability and mechanization. (The harvesting of potatoes and sugar beet, for instance, presents particular problems). The result is an increasing preference for the lighter soils (12 to 25% clay).

The soils of this class are considered suitable for an extensive crop rotation with wheat as the principal cereal crop and a wide range of other crops. The rotation takes on different forms in different parts of the country. This is partly due to differences in


HOEKSCHE WAARD
VERFLAKKEE
GREVELINGEN
VUILEGAT
TIEN GEMETEN
HOLLANDSCH DIEP
KRAMMER
VOLKERAK
ZIJPE
ST.-PHILIPSLAND
MASTGAT
KRABBEKREEK
KEETEN
THOLEN
STERSCHE
ROOSENDAAL
BERGEN OP ZOOM

farming types and marketing possibilities, but more to variations in the nature of the soil, possibly combined with different climatic conditions. The last mentioned factors affect the yields of different crops, the quality of the products (flax, potatoes), the possibilities and costs of tillage and harvesting practices (root crops versus some seed crops) etc.

Table 4 gives an example of the rotation and some yields on a typical soil of this class.

The soils of this class are generally very suitable for grassland farming, provided that water management is adapted to its needs. Gross yields and net production are both good, while the distribution of growth over the growing season is generally good too, although there is a certain growth depression, in particular on the lighter soils, in dry summers. The fodder quality of the herbage produced on these soils is generally very good; some of the better known cattle-breeding areas, e.g. the Beemster polder north of Amsterdam, are found on these soils. Very few of the problems encountered with cattle (deficiency diseases, repeats of insemination necessitated by fecundation failures) are met with on these soils.

BG2 Arable land and grassland soils of wide suitability

generally, if well drained, well suited to most arable crops but with limitations for some crops and/or a lower yield security; generally well suited to grassland, but with a more or less strong summer depression, very good fodder quality.

This class contains very good agricultural soils, although they present more difficulties than those encountered in class BG1. These, however, need not be regarded as serious problems, but because the shortcomings are of a different nature, this class has been subdivided into two subclasses:

BG2a with limitations caused by chemical and/or physical properties (clay content, structure, potash fixation, lime deficiency, luxuriancy).

Belonging to this subclass are, in the first place, all the river clay levee soils except the light ones and those with a subsoil of heavy clay (units 66 and 72). They have a less favourable structure and are less homogeneous horizontally than comparable soils in class BG1. Furthermore, they sometimes differ from the better sea clay soils by their less favourable chemical properties (potash fixation). This does not mean that these soils are regarded as being inferior, but some crops, such as flax do not grow well on them and other crops often do not give the high yields that can be obtained on the better sea clay soils. Also grouped in this subclass are several old sea clay soils (units 58, 59, 60, 61 and 64) and young sea clay soils (e.g. units 9, 13, 19, 20, 24 and 25, see Fig. 4), on which yields are generally lower and production costs often higher, owing to their high clay content, less favourable structure, a non-calcareous topsoil, less homogeneity, etc. In addition, the rotation often consists of a more limited number of crops. On the heavier soils, for example, root crops, and particularly potatoes, are grown with

Plate 1. The delta area in the south-west of The Netherlands (Fig. 2) largely consists of calcareous young sea clay polders with many excellent arable land and grassland soils (class BG1). Some older embankments (particularly in the south-west and north-east) reveal greater differences in suitability (subclass BG2a, and classes BG3, GB3, G1). Along the estuaries are strips of non-classified soils I and II, most of which are subject to flooding. In the south-east are pleistocene sand soils (belonging to several classes including BG5, GB1, and B2).

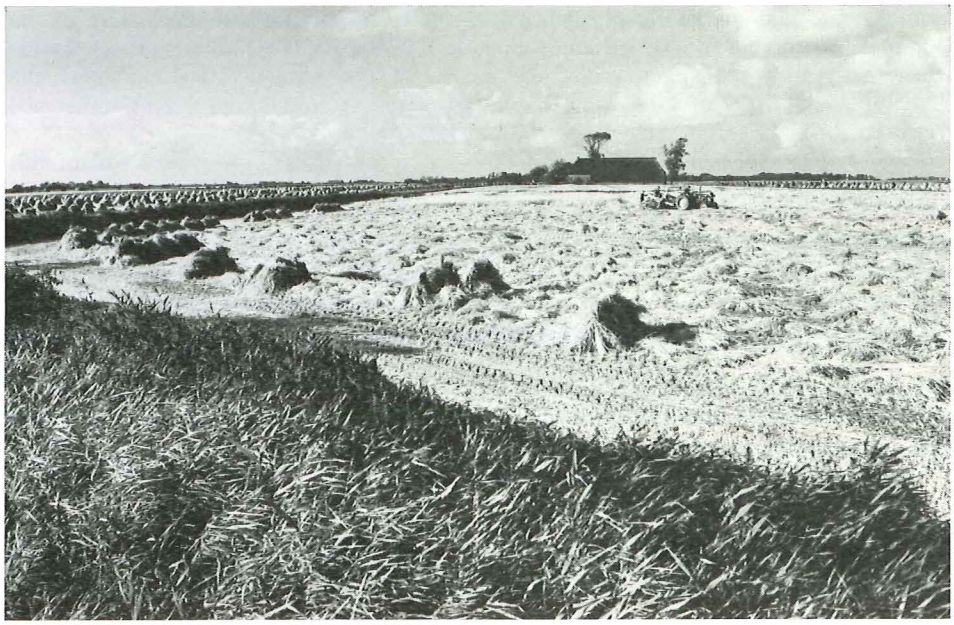


Fig. 4. Class BG2a: Arable land and grassland soils of wide suitability but with certain limitations owing to physical properties (texture, structure) in the northern part of the Province of Groningen.
These soils can support a limited crop rotation with wheat as the principal cereal crop or can be used as grassland (Photo: Cas Oorthuys).

less success than is generally the case on soils of class BG1. On these heavy soils certain limitations also apply to the cultivation of flax (its quality) and some fine seed crops.

On some old sea clay soils, the high organic matter content of the topsoil will hamper its use as arable land. The topsoil of the lighter sea clay soils often has an unstable structure, thus increasing the risk for certain crops such as peas and flax. Yields on these soils are generally somewhat lower and production costs higher than on the calcareous soils of similar texture in class BG1. Notwithstanding these limitations, from a national point of view the soils of class BG2a still have a high suitability for use as arable land.

As far as grassland farming is concerned the soils of this class are generally well to very well suited. On the lightest soils which are often also the most elevated a more or less marked growth depression due to drought may occur, even in normal summers. The fodder quality, as far as is known, is very good.

Table 5 shows acreages and yields of crops on two soils of subclass BG2a, a young river clay soil and a heavy clay soil from the northern young sea clay area (Groningen).

BG2b with limitations caused by slope and/or age of the soils.

This subclass contains the good loess soils of South-Limburg (units 141, 144 and 146). They are different from any other soils in The Netherlands, both as to their nature and to their landscape. Type and size of farms are different too. For all that, and although they have their rightful place among the very good soils along with the other

Table 5. Rotation and yields on two soils of class BG2a

Crop	River clay area		Northern sea clay area	
	estimated % of arable area	estimated yields in kg/ha [1])	estimated % of arable area	estimated yields in kg/ha [1])
Cereals				
Winter wheat	tr	—	20	4 500
Spring wheat	20	3 800	15	4 000
Winter barley	tr	—	10	4 000
Spring barley	10	4 500	—	—
Oats	20	4 000	15	4 500
Root crops				
Sugar beet	15	43 000	5	40 000
Mangolds	5	90 000	—	—
Potatoes	25	30 000	tr	—
Pulse crops				
Brown beans	tr	—	tr	—
Field beans	—	—	5	3 000
Blue peas	5	3 200	10	2 500
Marrow fats etc.	tr	—	tr	—
Commercial crops				
Flax	—	—	tr	—
Cole seed	tr	—	tr	—
Spinach seed	—	—	tr	—
Grass seed	tr	—	5	1 200
Canary seed	—	—	5	2 500
Caraway seed	—	—	5	1 800
Beet seed	—	—	5	3 000

tr = only very small areas.
[1]) For lbs/acre subtract roughly 10 %.

soils of BG2, they still present more problems than the soils of BG1. The often rather steep slopes make farming operations more difficult all-round and, concurrent with these, the soils are less homogeneous than those of the good sea clay areas. Their structure is often less stable (subject to slaking), and they often have some less favourable chemical properties. Because of all this, some crops (flax, peas) meet with difficulties. Other crops, wheat for instance, often produce high yields under good management. The fertilizer dressings needed for such yields are often higher than those applied on soils of class BG1.

The soils of this subclass are well to very well suited to grassland farming, they produce high yields throughout almost the entire growing season. The fodder quality as far as is known, leaves nothing to be desired. Table 6 gives some data about rotation and yields.

Table 6. Rotation and yields on a soil of subclass BG2b (loess area of South-Limburg)

Crop	Estimated % of arable area	Estimated yields in kg/ha [1])
Cereals		
Winter wheat	20	4 000
Spring wheat	tr	—
Winter barley	5	4 000
Spring barley	10	4 200
Oats	5	4 000
Oats/barley	15	4 200
Root crops		
Sugar beet	15	45 000
Mangolds	15	90 000
Potatoes	20	29 000
Pulse crops		
Blue peas	tr	—
Commercial crops		
Cole seed	tr	—
Grass seed	tr	—

tr = only very small areas.
[1]) For lbs/acre subtract roughly 10 %.

BG3 Arable land and grassland soils of fairly limited suitability

generally, with adequate water-management, well suited and locally very well suited to a limited crop rotation with wheat as principal cereal crop, locally however less favourable or even unsuitable; moderately to well suited to grassland — the wetter parts late in spring — sometimes with a more or less strong summer depression, good to very good fodder quality.

Into this heterogeneous class have been grouped all those soils of the sea clay and river clay areas which are suitable for arable and grassland, but which, owing to their high clay content, less favourable structure, profile deficiencies and similar limiting properties, are poorly suited to commercial crops like flax and fine seeds which impose heavy demands on the soil. Other arable crops too are subject to limitations. Locally areas of higher suitability occur, but these are too small to be indicated on a map of this scale.

Hence the rotation on these soils is limited. The yields of some crops, which form part of the rotation, root crops for instance, may be rather disappointing in some years, whereas in good years the yields may be good too. On the heavy clay soils, which are often noncalcareous, potatoes and in many cases sugar beet cannot be included in the rotation principally because of their difficulty in obtaining a good seedbed, plus the problem of harvesting. The heaviest soils of this class are too heavy for arable

land. Pulses encounter problems on those soils where poor structure forms the main limiting factor. Even some of the crops that should do well on these soils (cereals, mangolds) produce less consistently good yields than those obtained on soils of classes BG1 and BG2, even with good water management.

As is clear from the above, the problems met with on soils of this class can be of a widely varying nature. Moreover, because of their positions in the landscape, these soils are often very heterogeneous; this means that the clay content, thickness, and other characteristics of their main horizons and layers may vary within rather short distances. This is another element contributing to the fact that arable farming is more difficult here than on soils of either of the two previous classes. A higher input is demanded for satisfactory yields; they are not only more expensive in fertilizing, tillage harvesting, etc., but they also require more effort, attention, and knowledge on the part of the farmer.

The heterogeneity and the uneven surface of many of the soils often constitute a problem for water management. Consequently, this class comprises soils that are too wet for arable land as well as soils which, when under grassland, show a marked growth depression in summer, as a result of deep drainage.

Allowing for the restriction with regard to water management, the soils of this class are, in general, suitable for grassland farming. Most of them have a solid sod with a sufficient bearing capacity for grazing, and the fodder quality can be appraised as good to very good. The extent to which these soils are used for grassland farming varies.

It is very difficult to give any quantitative norms on so heterogeneous a group of soils. The data in Table 7 pertain only to one particular soil mapping unit in the river clay area (unit 67: calcareous to slightly calcareous clay soil with a subsoil of non-calcareous heavy clay).

Table 7. Rotation and yields on a soil of class BG3 (river clay area)

Crop	Estimated % of arable area	Estimated yields in kg/ha [1])
Cereals		
Winter wheat	tr	—
Spring wheat	30	3 200
Spring barley	20	3 500
Oats	15	3 500
Root crops		
Sugar beet	10	40 000
Mangolds	15	85 000
Potatoes	10	25 000
Pulse crops	tr	—
Commercial crops	tr	—

tr = only very small areas.
[1]) For lbs/acre subtract roughly 10 %.

BG4 Arable land and grassland soils of limited suitability

well to very well suited to an extensive rotation with rye as principal cereal crop, locally also to some commercial crops — the wetter parts, however, are too hazardous for winter crops; moderately to well and locally very well suited to grassland, good fodder quality.

The soils of this class occupy an intermediate position between the good sea and river clay soils and the sand soils. This is evident from the kinds of crops that can be succesfully grown on them. The most suitable rotation is an extensive one in which, although rye often predominates among cereal crops, wheat is also important. Wheat growing is certainly possible, although the costs are higher and the yields lower than in classes BG1 and BG2. The same holds good for sugar beet, also regularly and successfully grown in class BG4.

Yields are usually lower than on soils of class BG3, although this does not apply to all crops. Production costs are often the same, and sometimes even lower.

The main crops are rye, wheat, oats, barley, potatoes, mangolds and sugarbeet. Also some pulse crops are grown, often with fairly good results; peas may give very reasonable yields on most of these soils in favourable years. Limited possibilities exist for some commercial crops. "Winter" crops are hazardous on the wetter parts.

Soils of this class are often found side by side with soils of classes BG5 and BG1; for this reason the most common type of farming is the mixed arable-grassland kind. For all that, the suitability for permanent grassland is only moderate for most of these soils, as they are always more or less susceptible to drought. The wetter parts, however, are well suited, and sometimes even very well suited, to grassland. Generally these soils are very well suited to leys which can extend for several years.

This class consists of the high-lying brown older river clay soils, very clayey sand to sandy clay, generally with textural B horizons (unit 79) and the sandy loam soils, (old arable soils or soils with textural B horizons) of the loess and cover sand landscapes (units 139, 140, 142, 143, 145).

Table 8 gives some data about rotation and yields on soils of class BG4.

Table 8. Rotation and yields on soils of class BG4

Crop	Estimated % of arable area		Estimated yields kg/ha [1]	
	I [2]	II [2]	I [2]	II [2]
Rye	20	20	3 500	3 500
Oats	10	5	4 000	4 200
Oats/Barley	10	5	4 000	4 200
Spring barley	—	10	—	4 000
Winter wheat	20	5	3 800	3 500
Sugar beet	15	5	43 000	40 000
Mangolds	10	10	85 000	80 000
Potatoes	10	30	28 000	30 000
Blue peas	5	10	2 000	2 200
Grassland [3]	5 to 10	ca. 40	—	—

[1] For lbs/acre subtract roughly 10 %.
[2] I = Older river clay soils with textural B horizon (unit 79).
II = Old arable sandy loam soils in cover sand area (unit 142).
[3] As % of total land use.

Fig. 5. Class BG5: Arable land and grassland soils of very limited suitability in south-eastern Drenthe (peat reclamation districts). Soils which can support an extensive rotation with rye as the principal cereal crop along with oats and potatoes; apart from these sugarbeet and wheat can also be grown (Photo: Cas Oorthuys).

BG5 Arable land and grassland soils of very limited suitability

generally well suited to rye, oats, potatoes and mangolds — the more loamy and/or clayey or humose parts are also more or less suited to sugarbeet and/or wheat; more or less suited to permanent grassland.

Belonging to this class are the good, but rather dry, sandy soils (units 106, 119 126 and 127) and some of the peat reclamation soils: the high and medium high older and younger soils reclaimed from cut-over peat (units 98 and 99, see Fig. 5). Most of the normal arable crops common to the sandy areas of The Netherlands can be grown on these soils. Within both the sandy areas and the peat reclamation areas, soils with a higher content of loam*), clay or organic matter occur, but with acreages too small to be shown on the soil map. These soils, which are rather similar to those of class BG4, can grow sugarbeet, and sometimes wheat, with reasonable results.

The wetter soils, often occupying a lower position in the landscape, are suitable for grassland, as are most of the more loamy, clayey or humose soils. This class also contains soils that are too dry or, at their best, only moderately suitable for permanent grassland, but which are nevertheless generally suited to leys, of several years duration.

*) i.e. particles < 50 μm.

Three types of farming are found on soils of this class: the normal type of mixed arable-grassland farming on most of the sandy soils, the arable land farming of the peat reclamation areas and a type of pure grassland farming alternating with horticulture on many beach-ridge soils.

Table 9 gives some data about rotation and yields on sandy soils of class BG5.

Table 9. Rotation and yields on soils of class BG5

Crop	Estimated % of arable area	Estimated yields in kg/ha [1])
Rye	30	3 000
Oats	5	3 000
Oats/Barley	10	3 000
Potatoes	10	28 000
Mangolds	10	65 000
Sugar beet	10	35 000
Ley	25	ca. 4 000 [2])

[1]) For lbs/acre subtract roughly 10 %.
[2]) Net yield of starch equivalent.

Fig. 6. Class BG6: Arable land and grassland complex of strongly varying suitability in South-Limburg; because of steep slopes and other factors these soils have a widely varying cropping system but in general have a very limited suitability for arable and grassland farming (Photo: Agricultural Bureau of the Netherlands Nitrogen Fertilizer Industry)

BG6 Arable land and grassland complex of strongly varying suitability

soils varying considerably over short distances: the best parts are equivalent to those of class BG2; considerable areas, however, poorly suited to arable land and grassland are also included.

This class and the text one take up a rather different position from the previous classes, inasmuch as the soils vary considerably within short distances. None of the classes, of course, is completely free of variability, but in these two particular classes the range in suitability within short distances may be considerable. Locally soils occur which, in a more detailed survey, would certainly have been mapped as class BG2 (the good soils in loess), and on which most arable crops can be grown, although with some difficulty. On the other hand soils are found within a distance of 100 metres or less, which only have a very limited suitability for arable land because of their shallowness (a thin topsoil of loess on flint; chalk soils and soils weathered from chalk). In between, moreover, soils occur that have such steep slopes that they are completely unsuitable, whether for arable or for grassland farming, their soil profiles ranging from rather suitable to those consisting exclusively of scree.

This class (see Fig. 6) contains the association of chalk soils, soils weathered from chalk and loess soils (unit 148) and the "slope complex" of coarse sandy gravels, flint, chalk and loess loam (unit 149) found predominantly in the chalk area of South-Lim-

Fig. 7. Class BG7: Arable land and grassland complex of limited suitability in the area of the River Vecht in de Province of Overijssel. High old arable soils (Plaggen soils) with oats and rye alternate over short distances with grassland on gley soils (Photo: Cultuurtechnische Dienst)

burg. The soils of the small loess area on the southern slopes of the Veluwe, near Arnhem, also belong to this class.

BG7 Arable land and grassland complex of limited suitability

soils with a suitability varying considerably over short distances: the drier parts are generally well suited to rye, oats and potatoes, locally also to mangolds and poorly suited to grassland; the wetter parts are poorly suited to arable land but well suited to grassland with a good gross production and a slight summer depression, well suited to grazing, moderate to good fodder quality.

This class, too, combines soils of very different suitability, which could not be indicated separately on a map of this scale. The class contains, for instance, the soils of the "Twente association" (unit 125: gley soils, occasionally low humus podzols and high, sometimes medium high, old arable soils; very poor sand, loamy in low parts, non-loamy and slightly loamy in the higher parts). These soils belong to those parts of the cover sand landscape which have a very strong and detailed microrelief. Small ridges with non- or slightly loamy old arable land often alternate within some tens of metres with loamy gley soils which are only suitable for grassland. The "Achterhoek association" (unit 137, see Fig. 7), which has similar characteristics, also belongs in this class, as do the medium-high to high sand and peat soils reclaimed from older sphagnum moss peat (unit 97), the association of calcareous to non-calcareous low and medium-high dune-sand soils (unit 129), and the association of soils on weathered tertiary clay (unit 136).

A a result of the often strong variability of both soil characteristics and drainage, the suitability varies widely. In this "complex" class, soils of the following classes, arranged from dry to wet, may occur side by side:

Dry ——————→ Wet

B2 - BG5 - GB1 - G1 - G2.

Reference is made to the descriptions of these classes.

MAJOR CLASS GB GRASSLAND AND ARABLE LAND SOILS

Soils generally suited to grassland and in many cases also to arable land.

This major class, comprising three classes, covers soils which, although sometimes well suited to certain kinds of arable farming, are predominantly better suited to grassland. This is often due to a relatively low position where drainage is insufficient for arable land, for example in the brook valleys of the cover sand area in the Province of Limburg. Because of their irregular microrelief, the lower parts of these valleys are too wet for arable land and, locally, even for grassland. In other cases, for instance with the heaviest of the gley soils in the older river clay area and the heavy clay soils of class GB3, the high clay content of the topsoil is a further limiting factor for arable farming.

GB1 Grassland and arable land soils of fairly limited suitability

productive grassland soils — the driest parts with a slight summer depression, the wettest late in spring, locally too wet for grassland, well suited to grazing, good fodder quality: the well drained loamy or clayey parts are well to very well suited to an extensive rotation with rye as principal cereal crop, in some cases to a limited rotation with wheat as principal cereal crop and locally also to some commercial crops, the other soils are partly too wet and/or too heavy for arable land.

Class GB1 occupies a larger area than any other class on the suitability map. It con-

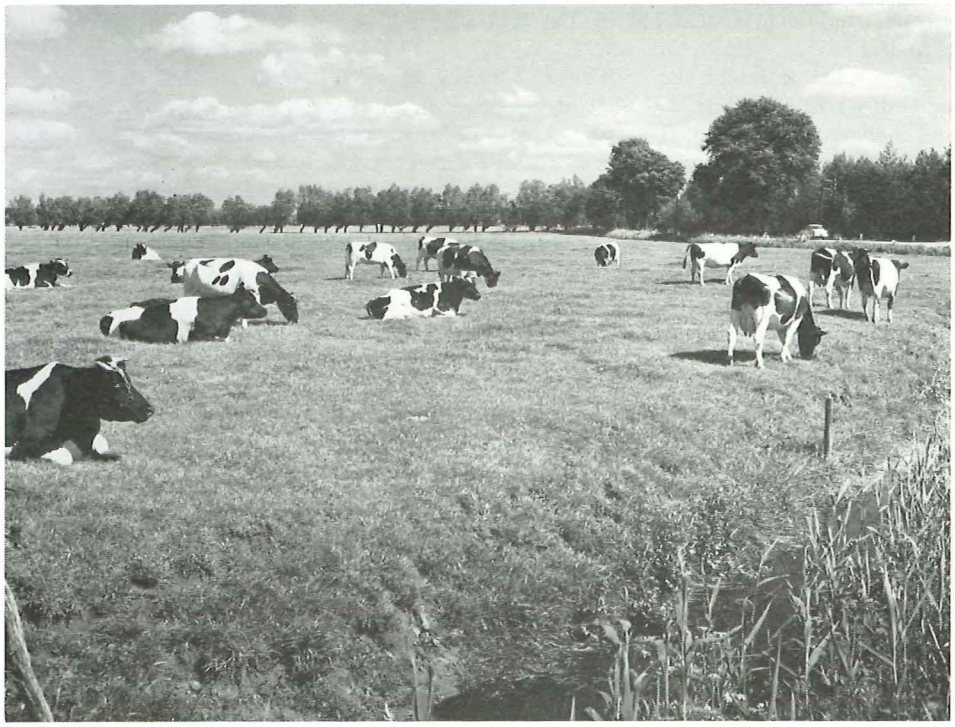


Fig. 8. Class GB1: Grassland and arable land soils of fairly limited suitability in the river clay area. This class contains soils which in general are very well suited to grassland — as can be seen in the photo — and depending on drainage and texture, moderately to well suited to arable farming (Photo: Cas Oorthuys)

tains many different soils and therefore possesses a fairly large variability of agricultural possibilities. Grassland, however, predominates in this class, for which in general the soils are indeed very well suited (see Fig. 8). Under good management they are highly productive and well suited to grazing, having a sod with sufficient bearing capacity and a good fodder quality. Depending on the degree of drainage, the growth of grass on some soils starts only late in spring, whereas the better drained soils may show a more or less pronounced growth depression in summer, the ensuing losses in gross production are generally compensated by an earlier growth in spring. The wettest parts of some of the poorly drained soils are liable to suffer from poaching.

The grass productions obtained on these soils under good management are among the highest of The Netherlands. Many of the country's more recent cattlebreeding areas are located on soils of this class; the good results being obtained in such areas point to a good fodder quality.

The sandy soils belonging to the young sea clay and Zuiderzee-bottom soils (units 6, 14, 30, 36, 42, 46, 47) occupy a special position within this class. They are generally provided with subsoil irrigation and, with high gifts of manure and fertilizers, they can carry good grassland. The incorporation into class GB1 of the non-irrigated areas reflects their potential productivity when irrigated, although in their present state they belong more under major class B. Similar marine sandy soils on Texel Island, where

subsoil irrigation is ruled out by the lack of fresh water, have been grouped under class B1.

For arable farming, the well-drained loamy or clayey areas in this class have a suitability corresponding with that of the better parts of class BG4. Rye, oats, potatoes, and mangolds yield well, while sugarbeet, and often wheat too, give reasonable results.

The clayey sand and clay soils of the sea clay area which have been grouped in this class (e.g. units 20, 22, 26, 27) have a suitability that can better be expressed in terms of a limited rotation with wheat as the principal cereal crop. A few of these soils can be used for some commercial crops. The heavier soils of class GB1, however, are less suited to root crops, and there are even exceptional cases where soils are unsuitable for arable farming because of their heavy tillage.

Also included in this class are soils where the rotation is more limited than has been mentioned thus far, and where only some of the normal sand soil crops and sometimes sugarbeet can be grown. Examples are the gley soils in loamy fine sand (unit 102) and the association of brook clay soils (unit 131). Even then, drainage has to be well-adapted to arable farming, which often is not the case on these two soil units. They are indeed predominantly in use as grassland, for which they are very well suited. Table 10 gives some data about rotation and yields on relatively well-drained gley soils of the older river clay area (unit 75), wich also belong to class GB1.

Table 10. Rotation and yields on a soil of class GB1 (gley soils in the older river clay area).

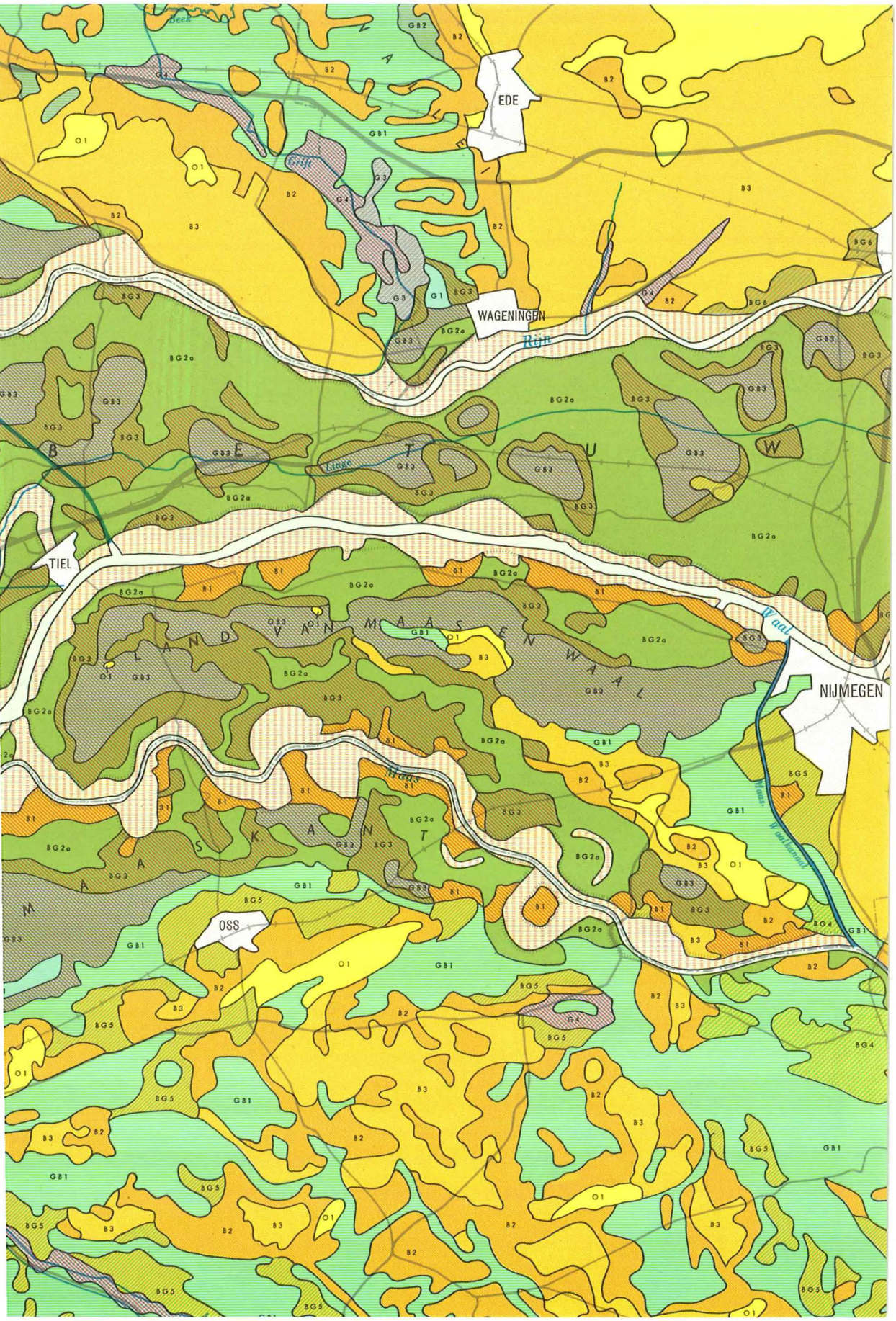
Crop	Estimated % of arable area	Estimated yields in kg/ha [1])
Winter wheat	25	3 800
Rye	15	3 200
Oats	10	3 800
Barley/Oats	15	3 800
Sugar beet	15	43 000
Mangolds	10	95 000
Potatoes	tr	25 000
Blue peas	5	2 000
Various fodder crops	5	—

[1]) For lbs/acre subtract roughly 10 %.

GB2 Grassland and arable land soils of limited suitability

grassland soils with a good gross production, but often late in spring, locally poorly suited to grazing (too wet), moderate fodder quality; generally more or

Plate 2. The area of younger river clay soils in the centre of the country (Fig. 2), originating from sedimentation of the rivers Rhine and Meuse (Maas), consists of often calcareous natural levees, behind and between which are back swamps of non-calcareous heavy clay. The levees shown on this fragment of the map cover the area of subclass BG2a and class B1 and largely the area of class BG3. The back swamps are mainly classified as GB3. Non-classified soils I are found along the river beds and are inundated when river levels are high. To the north and south of the river clay soils are pleistocene sand soils belonging to several classes including BG5, GB1, B2, B3.


EDE
WAGENINGEN
Rijn
Grift
Linge
TIEL
Waal
NIJMEGEN
Maas
Maas-Waalkanaal
OSS
BETUWE
LAND VAN MAASEN WAAL
ZANDKANT

less suited to an extensive rotation with rye as principal cereal crop, but partly too hazardous for winter crops — the wetter parts are unsuitable for arable land.

In some aspects of their use potential these soils resemble those of class GB1, but there is a more general tendency towards poor water conditions. The low-lying high moor peat reclamation soils (units 94, 95 and 96) and the low humus podzols (unit 101) belong to this class. In grassland, when under good water management these soils have a good gross production, but growth is often late in spring. In general, they show only a slight growth depression in normal summers, except locally on the higher parts of the low humus podzols. In some cases the soils are very wet and if so, are poorly suited to grazing.

Because of their humidity these soils are on the borderline of what can be regarded as suitable for arable land. For a large area the production of winter crops is hazardous or too hazardous and many parts are definitely too wet for arable land. Because of their sandy texture these soils, even if well-drained, do not have the same suitability for arable land as do comparable soils of class GB1. The nature of the humus of the, sometimes peaty, topsoil also makes these soils less favourable. This is also reflected in the fodder quality of the grass crop, which in practice is considered to be only moderate. The suitability for wheat is very limited and is certainly less than on many soils of class GB1, although on some of the better soils of class GB2, such as the low younger peat reclamation soils (unit 96), wheat can be grown. The suitability for sugarbeet is better than for wheat, but the beets are often odd-shaped and ramified. The yields of oats, rye (only on soils where winter crops are not too hazardous), potatoes and mangolds may be very good. The quality of the potatoes for consumption, however, often leaves a lot to be desired.

GB3 Grassland and arable land complex of limited suitability

soils of strongly varying quality when under grass — the best parts have a good gross production, are late in spring, but without summer depression, the driest parts have a low gross production with a strong summer depression, the wettest parts are too wet for use as grassland — moderate to good fodder quality; the soils have in some parts a limited suitability, but are in general too heavy and/or too wet and/or too peaty for arable land.

This "complex" class covers a group of soils that in general are better suited to grassland than to arable land. Many of them are even definitely unsuitable for arable farming, under the prevailing technical and economic circumstances.

Typical of this class are the heavy grey backswamp soils of the younger river clay area (unit 69), wich generally also have a very poor drainage. Scattered throughout this class are soils which do have a certain suitability, although limited, for arable farming. Among the back-swamp soils there are, for instance, small areas where either the topsoils or the subsoils have a lower clay content, but these could not be indicated separately on a map of this scale. They can be important locally, as they enable the farmers to grow some fodder crops. Rather similar conditions prevail on some complex soil mapping units in the Provinces of Friesland and Overijssel, where the texture of the topsoil may vary from sand to heavy clay.

Some areas of the "rejuvenated" marine clay soils of Groningen (unit 37, sandy clay and clay overlying more or less slowly permeable clay within a depth of 60 cm) have a certain suitability for arable farming, determined by their somewhat lighter topsoil, which has a more favourable structure. If it is thicker than 40 cm, arable land is

reasonably productive under good management, but the choice of crops is very limited. Similar conditions occur in the river clay area where thin covers of light crevasse deposits overlie heavy back-swamp soils.

With such a heterogeneous group of soils, the suitability for grassland naturally varies widely, but it is roughly similar to that of class G2, with the exception of some very wet locations.

MAJOR CLASS B ARABLE LAND SOILS

Soils generally suited to arable land, but mostly poorly or not suited to grassland.

The use potential of the soils in this major class is largely decided by their poor water-holding capacity, a low groundwater table or a combination of both. Hence, they are in general either poorly or totally unsuitable for permanent grassland, and these factors also limit their potential for arable farming. Arable crops that are fairly resistant to drought, or which have an early growth, can, however, be grown.

B1 Arable land soils of limited suitability

only suited to drought resistant and/or early crops, locally well suited to a few commercial crops; at most moderately suited to permanent grassland (low gross production).

Included in this class are soils of various groups all having one feature in common: that they experience severe drying except in very wet summers. Apart from this they possess rather favourable properties. In general they are not suited to permanent grassland but are well suited to leys of several years duration.

This class is only poorly to moderately suitable for those crops which have to remain on the land until late in summer (beet, late potatoes for consumption) whereas they are well suited for fairly exacting crops which can be harvested early (early potatoes for consumption, seed potatoes, seed onions and flax). This applies particularly to the soils in the coastal areas, including the young sea clay soils with clay-poor sand beginning within 50 cm depth (unit 11) and also, although to a lesser degree, some soils of the river clay area (clayey sand and very sandy clay, units 65 and 71).

With regard to cereal crops, the suitability for wheat is moderate, with a preference for winter wheat. Suitability for rye and barley is often good; oats often suffer from drought in dry summers. For root crops, sugarbeet is preferable to mangolds, although the former suffer from drought even in moderately dry summers.

The high old arable soils in very loamy fine sand (unit 115), which also belong to this class, are in principle agriculturally similar to the soils mentioned above.

Among the areas classified as B1, there are soils which locally have more favourable characteristics than those described. Owing to the small scale of the map, they could not be shown separately. They are particularly found in the coastal areas as sandy soils which contain more clay and to a somewhat greater depth, and in the sandy inland areas as soils with a better moisture regime. They are, however, more susceptible to drought than are soils of classes BG1 and BG4.

B2 Arable land soils of very limited suitability

generally well suited to rye, oats and potatoes and in the wetter or more moisture retaining areas also to mangolds.

Fig. 9. Class B2: Arable land soils of very limited suitability in the Achterhoek (Province of Gelderland). Old arable soils (Plaggen soils) on which a rotation of rye, oats, potatoes and mangolds is possible; also often suitable for leys (Photo: Netherlands Soil Survey Institute, No. R25-114)

This class covers all soils that are suitable for the normal crop rotation of the sandy soils of The Netherlands: rye, oats, and potatoes. Their suitability for mangolds is limited, except in localities with better than average moisture regime. Mangolds are nevertheless usually grown on these soils because they are necessary within the existing system of farming. As a rule, the varieties less susceptible to drought are used in such circumstances, even though these have the disadvantage of a lower dry-matter content. In ploughed-up grassland or after a ley lasting some years, even the less drought-resistant and more productive varieties of mangolds can be grown with reasonable success, except in very dry summers. For all crops the hazard of strong yield depressions due to drought is greater on these soils than on the wetter, but otherwise often comparable soils of class BG5. Generally speaking, class B2 contains soils whose suitability for the usual rotation can vary considerably with small variations in local climate, water retention capacity or water table.

In general, their suitability for permanent grassland is poor, since they may become too dry during the rainless periods even in normal summers. This is most pronounced in the southern and south-eastern parts of the country, where the incidence of dry periods in the growing season is most frequent. In the central and northern parts of the country a considerable portion of the soils of this class is under permanent grassland, particularly in those areas where a high percentage of the total area is occupied by rather wet grassland soils. In such regions, the farming system tends towards a predominance of grassland (sometimes more than 85% of the total area); the drier soils are also incorporated into this system and are even quite highly rated because of their high grass production in early spring. Their often considerable drought depression in sum-

Table 11. Rotation and yields on soils of class B2

Crop	Estimated % of arable area	Estimated yields in kg/ha [1])
Rye	25	3 000
Barley/Oats	15	3 500
Oats	10	3 300
Potatoes	30	30 000
Mangolds	15	65 000
Various fodder crops	5	—

[1]) For lbs/acre subtract roughly 10 %.

mer is then of lesser importance since there is a sufficient acreage of moist soils with a high summer production available (soils of class GB1 and GB2). The soils of class B2 are, in general, well suited to leys, but their duration generally does not exceed a period of about 3 years.

Class B2 consists mainly of most of the medium high and some of the high soil mapping units of the sandy regions (units 104, 105, 107/110, 112/114, 122; see Fig. 9). Table 11 gives data about rotation and yields of arable crops on soils of this class.

B3 Arable land soils of extremely limited suitability
generally at most moderately suited to rye, oats and potatoes.

The driest soils that still have a certain suitability for arable land farming are grouped in this class. In wet summers and under good management they may give reasonable yields of rye, oats, potatoes and sometimes even mangolds, but the hazard of poor yields is great, even in normal summers (VINK, 1956). The relatively short periods of drought, which occur during the growing season of almost any year immediately affect the productivity of these soils, particularly if they occur at critical moments of crop growth.

Table 12. Rotation and yields on soils of class B3

Crop	Estimated % of arable area	Estimated yields kg/ha [1])
Rye	40	2 300
Oats	10	2 500
Oats/Barley	20	2 500
Potatoes	30	27 000
Mangolds	tr	below 60 000

tr = only very small areas.
[1]) For lbs/acre subtract roughly 10 %.

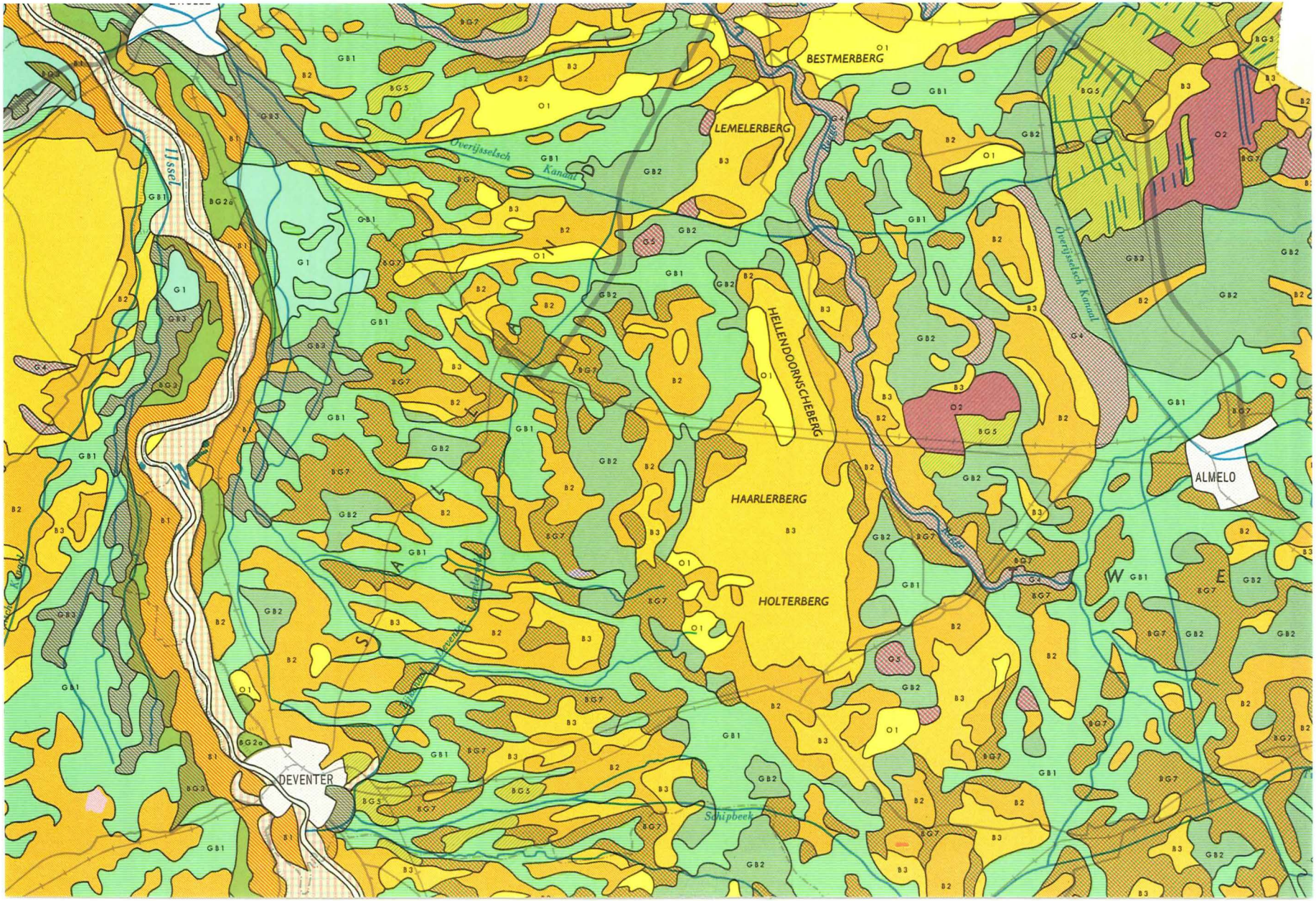

BESTMERBERG
LEMELERBERG
HELLENDOORNSCHEBERG
HAARLERBERG
HOLTERBERG
ALMELO
DEVENTER
IJssel
Overijsselsch Kanaal
Schipbeek
N
W
E
S

Fig. 10. Class B3: Arable land soils of extremely limited suitability on the Veluwe. Sand soils, poor in humus and without groundwater influence, they are at their best moderately suitable for rye, oats and potatoes (Photo: Netherlands Soil Survey Institute, No. R27-153)

Within the large total area occupied by this class on the map, there are many areas which have never, within historical time, been reclaimed and for which reclamation is decidedly inadvisable. One also finds land parcels which have been reclaimed at some time or other but which have later been left to revert to wild vegetation. On the other hand, the area occupied by this class on the map locally also contains soils which are more favourable than those described above as normal.

The hazard of poor yields is once again greatest in the south-eastern parts of the country because of the slightly drier climate, but even in the rest of the country these soils are never more than moderately suited to rye, oats, and potatoes.

Apart from some, more favourable, areas that could not be shown on the map because of its scale, the suitability for grassland is negligible. Nor are these soils very suitable for leys with perennial raygrass, although leys with grasses less susceptible to drought (Cocksfoot or orchardgrass, Dactylis glomerata L., etc.) and short duration leys for mowing are possible.

This class covers most of the high podzol soils (units 116, 117, 118, 120, 121 and 123, see Fig. 10). Table 12 gives some data about rotation and yields on soils of this class.

Plate 3. For the greater part typical of a pleistocene sand area with higher lying soils that lie in a ridge pattern and have a varying suitability for arable land (classes B2 and B3, the higher lying soils of class BG7) (Fig. 2). In between are low lying areas predominantly suited to grassland (classes GB1 and GB2, lower parts of class BG7). To the west is the valley of a lower branch of the river Rhine (IJssel) with young river clay soils (belonging to several classes including B1 and GB3, subclass BG2a). Ice-pushed sand ridges in the centre and at the western edge of the fragment are classified as B3 (e.g. the Holterberg), inland dunes as O1. In the north-east corner are various kinds of high moor peat soils (e.g. classes BG5, GB3, O2).

MAJOR CLASS G GRASSLAND SOILS

Soils generally suited to grassland, but mostly poorly or not suited to arable land.

Many excellent grassland soils are to be found within major classes BG and GB; in pinciple, however, these soils can also be used as arable land, although the scale of the map makes it impossible to show the parts that are, in fact, suited exclusively to grassland. In major class G, on the other hand, soils suitable for arable land occur only as a rare exception. They are not entirely lacking, and can be found in particular in those areas where a soil of major class G borders on soils of either major class BG or GB.

Grasslands are evaluated according to:

1. their gross production
2. the distribution of grass growth throughout the growing season
3. the properties of the sod (bearing capacity)
4. the fodder quality

These four facets serve to give an idea of the potential of grassland soils for practical farming, in the same way that the arable land soils were rated according to their potential for different kinds of crop rotation.

G1 Firm sensitive grassland soils

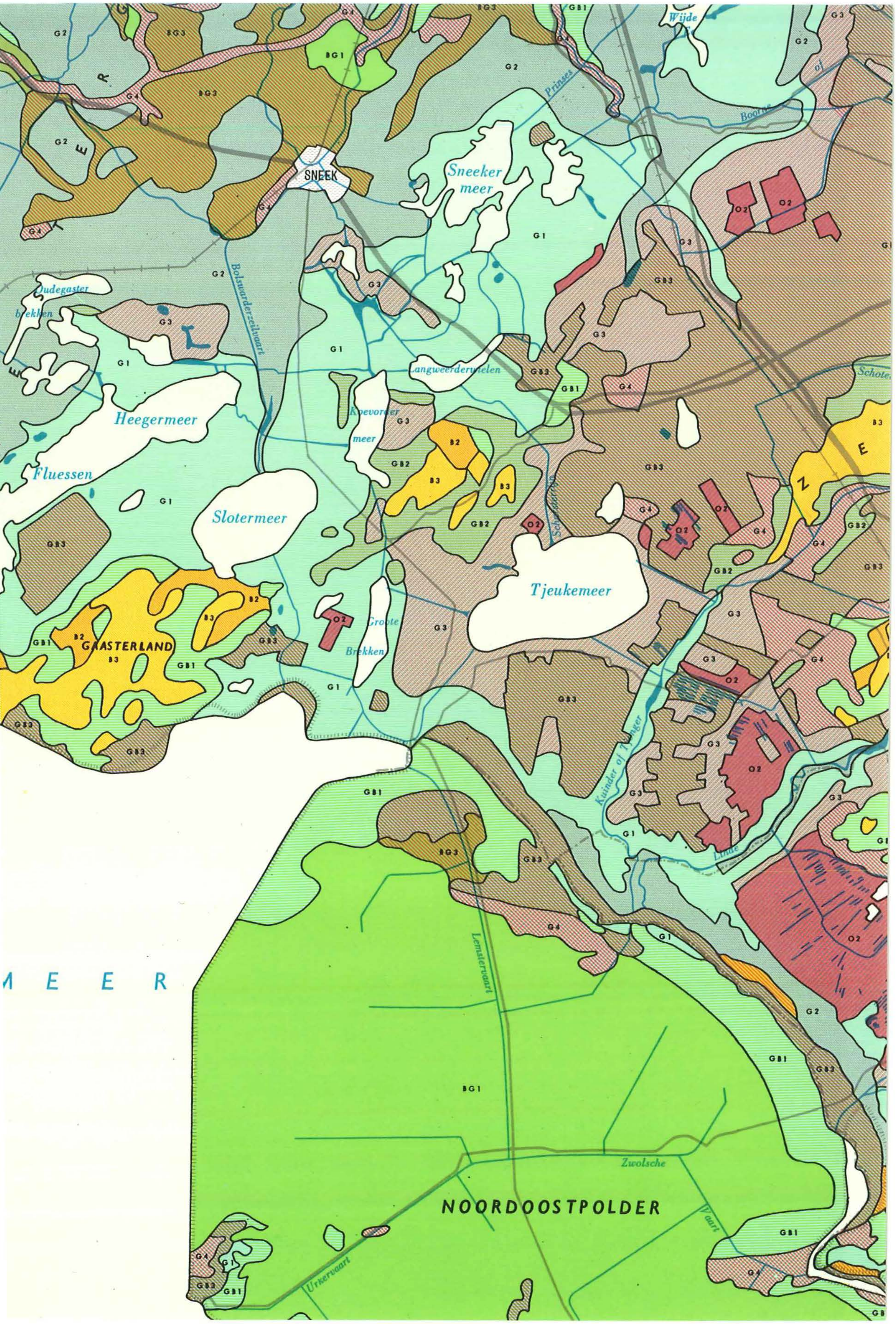
with a good gross production, but very sensitive to a good water management, sometimes late in spring, with a sufficiently firm sod, good fodder quality.

These soils are the best of major class G. They have a good gross productivity and, under good management, can produce gross yields belonging to the highest in the country. In principle the sod is sufficiently firm to be well suited to grazing. It has been observed from practical experience that under good management vegetation on these soil produces a fodder which can be considered good in all aspects, although perhaps not of the same high quality as obtained on soils of classes BG1 and BG2.

Their limiting factor is their dependence on good water management. This, of course, is true for many soils, but quite a few of the soils in this class readily become too wet after even a minor neglect of water discharge or field drainage so that the net production and, in serious cases even the gross production, is strongly affected. On the other hand, too deep a drainage may lead to a considerable depression in summer. Hence, included in this class are those soils which, under good management, are very suitable for grassland, but on which a minor neglect of water management and related practices can often tell plainly.

The greater part of this class is occupied by the non-calcareous heavy clay soils, often with unfavourable properties, on peat (unit 38, with the exception of Friesland) and some peat soils with a humose to peaty clay or sandy clay cover less than 40 cm thick (units 85 and 86, see Fig. 11). Soils of unit 86 in the Province of Groningen often have a highly ferruginous topsoil ("rodoorn" soils: addition g) and are then mainly used for arable land, although their suitability for it is very limited.

Plate 4. Among the soils in the northern part of this fragment (Fig. 2) are non-calcareous heavy young sea clay soils, some overlying peat (mainly classified as G2) and various kinds of peat soils (classes G1, G3, GB3), making grassland their obvious form of use. Here and there in the middle are pleistocene sand soils (including classes B2 and B3). Complexes of partly excavated low moor peat, filling in again with vegetation, are classified as O2. Along the southern edge is a IJsselmeer polder reclaimed in 1942 having mainly very good sea clay or sea sand soils (classes BG1 and GB1).



SNEEK
Sneeker meer
Oudegaster brekken
Bolswarderzeilvaart
Prinses
Boorne
Wijde
Langweerder wielen
Koevorder meer
Heegermeer
Fluessen
Slotermeer
Tjeukemeer
Groote Brekken
GAASTERLAND
Kuinder of Tjonger
Linde
Schoter
Lemstervaart
Zwolsche Vaart
Urkervaart
NOORDOOSTPOLDER
M E E R
G1
G2
G3
G4
GB1
GB2
GB3
BG1
BG3
B2
B3
O2

Fig. 11. Class G1: Firm but sensitive grassland soils in the Province of Zuidholland. Clay-on-peat soils which, under good management, make good pasture land (Photo: Cas Oorthuys)

G2 Firm late grassland soils
with a good gross production, often late in spring, sometimes with a more or less strong summer depression, firm sod, moderate to good fodder quality.

The nature of the soils in this class imposes certain restrictions as to their use. In general, they are heavy clay soils with an inherently less favourable moisture regime which is more difficult to correct by an improvement in water management than is that on the soils of class G1. As a result, the early growth of the grass vegetation is sometimes retarded when the soils are in a relatively wet position or if the spring season is a rather wet one. On the other hand a rather considerable growth depression may occur in summer on soils in a relatively dry position or when the summer is dry. Locally, particularly in Friesland, growth on soils of class G1 may be later in spring than those of class G2. Spring growth on soils of G2 is, however, always later than that on those of classes BG2a and BG3.

The most typical representatives of this class are the Frisian "knip" soils (sticky, non-calcareous young sea clay soils; heavy clay and unfavourable structure, unit 34, see Fig. 12). Comparable soils in other areas (Noordholland) also belong to this class. Another example is the Frisian area of the non-calcareous heavy sea clay soil, which also has those unfavourable properties, but is underlain by peat (unit 38). In Friesland, the suitability of "knip" soils for grassland farming may show strong local variations. Soil material from ancient dwelling mounds has been used for manuring these soils, thus adding to the thickness of their humose cover. The thicker that cover is, the more

Fig. 12. Class G2: Firm late grassland soils, sometimes with a more or less severe growth depression in summer; the photo shows part of the „knip" clay area of the Province of Friesland, very characteristic of this class (Photo of Agricultural Bureau of the Netherlands Nitrogen Fertilizer Industry)

favourable are the soil properties for grassland farming. Even differences of a few centimetres may greatly influence productivity.

G3 Soft sensitive grassland soils

with a good gross production, very sensitive to a good water management, usually late in spring, having a very sensitive sod under poor water management, strongly varying fodder quality.

Even more so than on soils of class G1, exacting requirements are demanded of water management if full use is to be made of the potential of these soils. Even then, the sod remains relatively weak and imposes restrictions on the use of the pastures in rainy periods. The risk is great that cattle will have to be brought in early in autumn and that they can only be taken back to pasture late in spring. On the other hand, too deep a drainage may cause irreversible drying-out of these soils.

From practical experience, it has been found that the fodder quality on these soils varies widely. The general impression exists that this factor correlates with the nature of the peat from which these soils have been formed, and that soils from wood peat have a grassland vegetation with a better fodder-quality than those from sphagnum moss peat or sedge peat.

This class consists solely of peat soils (see Fig. 13) whose topsoil has a limited mineral content ranging from clay-poor peat to peaty or humus-rich clay and sandy clay (units 81, 82, 83 and 84). In the Province of Groningen some of these soils have a

highly ferruginous topsoil ("rodoorn" soils, addition g on the soil map). Such soils are often used for arable farming, for which their suitability, however, is very limited.

G4 Grassland soils of varying suitability

generally with a good gross production — the driest parts with a summer depression, the wetter parts late in spring and sometimes with a soft sod — moderate to good fodder quality.

This class is a complex one, due to the variation in suitability within comparatively short distances, which results in an irregular growth on many fields. In this respect it is comparable to the complex classes BG6, BG7 and GB3.

Within one and the same field, there may be patches with an early growth in spring but an appreciable depression in summer, alongside areas which are damaged by poaching in spring but have a good production in summer. Nevertheless, gross production may exceed expectations. In many cases it is almost impossible to provide adequate management in view of the conflicting requirements of these heterogeneous soils. This is one of the reasons why this class occupies an intermediate position between the fairly good classes of G1, G2 and G3 on the one hand, and class G5, the class with the lowest suitability within major class G, on the other.

Many different soils have been grouped within this class, e.g. two associations of

Fig. 13. Class G3: Soft sensitive grassland soils in the northern part of the Province of Zuidholland; very sensitive to poaching because of their wet and low position (Photo: Cas Oorthuys)

Fig. 14. Class G4: Grassland soils of varying suitability (very dry or very wet) in the Province of Overijssel. Association of brook-valley soils (unit 132): gley soils, peat soils, occasionally medium high and high sand soils (Photo: Cultuurtechnische Dienst)

brook valley soils (units 132, see Fig. 14, and 133), peat soils on sphagnum moss or sedge peat (with limited content of mineral material in topsoil, unit 80) and low and medium high colluvia in loess soils (unit 138).

G5 Grassland soils of moderate suitability

generally with a moderate gross production — locally too wet or too dry — moderate fodder quality.

This class covers those few soils which, even under good management, give only moderate results. Their organic matter is of poor quality, locally they are irreversibly dried-out or in the process of drying out (unit 63, at the fringes of the old sea clay areas towards the peat areas) and sometimes, in particular the fen soils in the sandy areas (unit 134), they have a very irregular moisture regime.

MAJOR CLASS O UNSUITABLE SOILS

Soils predominantly poorly suited to arable land and to grassland.

O1 Predominantly too dry soils
O2 Predominantly too wet soils

Grouped in these two classes are those soils which, even under good management,

Fig. 15. Class O1: Soils predominantly too dry for either arable or grassland farming; typical of this class are the coastal dunes (Photo: Cas Oorthuys)

give only very poor results, whether for arable or for grassland farming. Here too, the small scale of the map has led to a rather broad generalization. Locally, smaller surfaces occur within the area of these classes which have a higher grade of suitability, but even then their use potential does not exceed those of class B3 or class G5. The subdivision into two classes has been made to indicate the main cause of their poor suitability.

Class O1 contains the coastal dunes (units 100 and 130, see Fig. 15), the inland dunes (blown sand soils, unit 124) and the soils developed on flint (unit 150).

Class O2 covers more or less undisturbed and partly cut-over highmoor peats (units 88 and 90) and lowland peats which have partly been cut over and are filling in again with vegetation (unit 87). Technically, these wet soils could be improved and made suitable for agricultural use, but this would call for far-reaching and costly measures, involving a total change of the soil profiles, soil characteristics, and hence of soil suitability.

NON-CLASSIFIED

I Areas with extremely varying soils or hydrology and reclaimed sand excavations

II Foreland soils

Urban areas

Water

Apart from urban area soils, which have not been classified, there are several other soils that remain non-classified. These can be divided into two groups.

Group I covers those soils which, although having an undeniable and sometimes even great value for agriculture, are not easy to include in a specific suitability class, and certainly not on a map of this scale. With many of these soils the difficulty is due to their heterogeneity as a result of excavations or of a great natural variation in soil conditions within short distance. Furthermore, a considerable area of soils in this group may be regularly exposed to flooding (mapping units with addition w, i.e. soils enclosed within embankments that are too low to protect them from high sea tides or river floods). Several soil mapping units of this group (154, 155, 156) are even indicated on the basic soil map as non-classified soils, i.e. they have not been defined in pedological terms. Several state forestry areas in Drente (unit 155) and the soils of areas where sand was excavated and which have since been reclaimed (unit 128) have also been included in Group I; in neither case do these soils owe their significance to their potential use for arable and grassland farming, the soils of unit 128 being almost exclusively used for bulb growing, for which they are very suitable indeed.

The second group of non-classified soils (II) comprises the foreland soils that lie beyond the dikes. Because of their nature and location, their agricultural use has not (yet) come up for consideration. Here we differentiate between those soils that lie at average high tide level, or higher (units 3, 4 and 5), all lower-lying foreland soils being regarded as water.

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APPENDICES

Appendix 1. Legend of the General Soil Suitability Map for Arable Land and Grassland of The Netherlands, scale 1 : 200,000.

Appendix 2. Soil mapping units and additions of the Soil Map of The Netherlands, scale 1 : 200,000, and corresponding soil suitability classes.

Appendix 3. The soil suitability classes and their component mapping units and additions of the Soil Map of The Netherlands, scale 1 : 200,000.

Appendix 1. Legend of the General Soil Suitability Map for Arable Land and Grassland of The Netherlands, scale 1 : 200,000.

MAJOR CLASS BG

ARABLE LAND AND GRASSLAND SOILS

Soils generally suited to arable land and usually also to grassland.

BG1 Arable land and grassland soils of very wide suitability

generally, if well drained, very well suited to most arable crops, with good to very good yields and a high yield security, locally slightly drought-susceptible; with good water-management well suited to grassland, but partly with a summer depression, very good fodder quality.

BG2 Arable land and grassland soils of wide suitability

generally, if well drained, well suited to most arable crops but with limitations for some crops and/or a lower yield security; generally well suited to grassland, but with a more or less strong summer depression, very good fodder quality.

BG2a with limitations caused by chemical and/or physical properties (clay content, structure, potash fixation, lime deficiency, luxuriancy).

BG2b with limitations caused by slope and/or age of the soils.

BG3 Arable land and grassland soils of fairly limited suitability

generally, with adequate water-management, well suited and locally very well suited to a limited crop rotation with wheat as principal cereal crop, locally however less favourable or even unsuitable; moderately to well suited to grassland — the wetter parts late in spring — sometimes with a more or less strong summer depression, good to very good fodder quality.

BG4 Arable land and grassland soils of limited suitability

well to very well suited to an extensive rotation with rye as principal cereal crop, locally also to some commercial crops — the wetter parts, however, are too hazardous for winter crops; moderately to well and locally very well suited to grassland, good fodder quality.

BG5 Arable land and grassland soils of very limited suitability

generally well suited to rye, oats, potatoes and mangolds — the more loamy and/or clayey or humose parts are also more or less suited to sugarbeet and/or wheat; more or less suited to permanent grassland.

BG6 Arable land and grassland complex of strongly varying suitability

soils varying considerably over short distances: the best parts are equivalent to those of class BG2; considerable areas, however, poorly suited to arable land and grassland are also included.

BG7 Arable land and grassland complex of limited suitability

soils with a suitability varying considerably over short distances: the drier parts are generally well suited to rye, oats and potatoes, locally also to mangolds and poorly suited to grassland; the wetter parts are poorly suited to arable land but well suited to grassland with a good gross production and a slight summer depression, well suited to grazing, moderate to good fodder quality.

MAJOR CLASS GB

GRASSLAND AND ARABLE LAND SOILS

Soils generally suited to grassland and in many cases also to arable land.

GB1 Grassland and arable land soils of fairly limited suitability

productive grassland soils — the driest parts with a slight summer depression, the wettest late in spring, locally too wet for grassland, well suited to grazing, good fodder quality; the well drained loamy or clayey parts are well to very well suited to an extensive rotation with rye as principal cereal crop, in some cases to a limited rotation with wheat as principal cereal crop and locally also to some commercial crops, the other soils are partly too wet and/or too heavy for arable land.

GB2 Grassland and arable land soils of limited suitability

grassland soils with a good gross production, but often late in spring, locally poorly suited to grazing (too wet), moderate fodder quality; generally more or less suited to an extensive rotation with rye as principal cereal crop, but partly too hazardous for winter crops — the wetter parts are unsuitable for arable land.

GB3 Grassland and arable land complex of limited suitability

soils of strongly varying quality when under grass — the best parts have a good gross production, are late in spring, but without summer depression, the driest parts have a low gross production with a strong summer depression, the wettest parts are too wet for use as grassland — moderate to good fodder quality; the soils have in some parts a limited suitability, but are in general too heavy and/or too wet and/or too peaty for arable land.

MAJOR CLASS B

ARABLE LAND SOILS

Soils generally suited to arable land, but mostly poorly or not suited to grassland.

B1 Arable land soils of limited suitability

only suited to drought resistant and/or early crops, locally well suited to a few commercial crops; at most moderately suited to permanent grassland (low gross production).

B2 Arable land soils of very limited suitability

generally well suited to rye, oats and potatoes and in the wetter or more moisture retaining areas also to mangolds.

B3 Arable land soils of extremely limited suitability

generally at most moderately suited to rye, oats and potatoes.

MAJOR CLASS G

GRASSLAND SOILS

Soils generally suited to grassland, but mostly poorly or not suited to arable land.

G1 Firm sensitive grassland soils

with a good gross production, but very sensitive to a good water management, sometimes late in spring, with a sufficiently firm sod, good fodder quality.

G2 Firm late grassland soils

with a good gross production, often late in spring, sometimes with a more or less strong summer depression, firm sod, moderate to good fodder quality.

G3 Soft sensitive grassland soils

with a good gross production, very sensitive to a good water management, usually late in spring, having a very sensitive sod under poor water management, strongly varying fodder quality.

G4 Grassland soils of varying suitability

generally with a good gross production — the driest parts with a summer depression, the wetter parts late in spring and sometimes with a soft sod — moderate to good fodder quality.

G5 Grassland soils of moderate suitability

generally with a moderate gross production — locally too wet or too dry — moderate fodder quality.

MAJOR CLASS O

UNSUITABLE SOILS

Soils predominantly poorly suited to arable land and to grassland.

O1 Predominantly too dry soils

O2 Predominantly too wet soils

NON-CLASSIFIED

I Areas with extremely varying soils or hydrology and reclaimed sand excavations

II Foreland soils

Urban areas

Water

Appendix 2. Soil mapping units and additions [1]) of the Soil Map of The Netherlands, scale 1 : 200,000 and corresponding soil suitability classes

Soil mapping unit	Class
1, 2	Water
3, 4, 5	Non-classified
6	GB1; B1 on the island of Texel
7	BG1
8	BG1
9	BG2a
10	BG1; G2 on the island of Terschelling
11	B1; GB3 in Friesland
12	BG2a
13	BG2a
14	GB1 in the Head of Noordholland;
15	BG3
16	BG3
17	BG3
18	BG3
19	BG2a
20	BG2a; GB1 in Friesland
21	BG3
22	GB1
23	BG3
24	BG2a
25	BG2a
26	BG3 in Groningen; GB1 in Noordholland
27	GB1
28	GB1
29	G1
30	GB1 in the Head of Noordholland; B1 on the island of Texel
31	BG2a
32	BG3
33	BG3
34	G2
35	GB3 on the island of Terschelling; B1 on the island of Texel
36	GB1 in the Head of Noordholland; B1 on the island of Texel
37	BG3 in Zeeland; GB3 in Groningen; G2 in Friesland
38	G1; G2 in Friesland
39	GB3; BG1 on the former island of Schokland
40	G1
41	G2; BG3 in Noordholland and Noordbrabant
42	GB1
43	G4
44	BG2a; GB1 in Friesland
45	BG3
46	GB1
47	GB1
48	BG1
49	BG1
50	BG1
51	BG1
52	G1
53	GB1
54	BG1
55	BG1
56	BG1
57	BG3
58	BG2a
59	BG2a
60	BG2a
61	BG2a
62	BG3
63	G5
64	BG2a
65	B1
66	BG2a
67	BG3
68	BG3
69	GB3

[1]) The additions on the Soil Map have influenced the suitability classification only in the instances specified in the table

[2]) and [3]) with additions i and s respectively

Appendix 2. (continued)

Soil mapping unit	Class
70	GB3
71	B1
72	BG2a
73	BG3
74	GB1
75	GB1
76	B2
77	GB1
78	B2
79	BG4
80	G4
81	G3
82	G3
83	G3
84	G3
85	G1
86	G1
87	O2
88	O2
89	GB3
90	O2
91	BG3
92	GB3
92i[2])	G1 (only Twiskepolder in Noordholland)
93	GB3
94	GB2; GB3 in Friesland
95	GB2
96	GB2
97	BG7
98	BG5
99	BG5
100	O1
101	GB2
102	GB1; G4 in Friesland
103	G4
104	B2
105	B2
106	BG5
107	B2; GB1 in Friesland
108	B2
109	B2
109s[3])	GB1
110	B2
111	GB1
112	B2
113	B2
114	B2
115	B1
116	B3; B2 in Zeeland
117	B3
118	B3
119	BG5
120	B3
121	B3
122	B2
123	B3
124	O1
125	BG7
126	BG5
127	BG5
128	Non-classified
129	BG7
130	O1
131	GB1
132	G4
133	G4
134	G5
135	GB1
136	BG7
137	BG7
138	G4
139	BG4
140	BG4
141	BG2b
142	BG4
143	BG4
144	BG2b
145	BG4
146	BG2b
147	G4
148	BG6
149	BG6
150	O1
151	BG3
152	B1
153	GB1
154	Non-classified
155	Non-classified
156	Non-classified
All soil mapping units with addition	
. . . e	GB3
. . . w	Non-classified

Appendix 3. The soil suitability classes and their component soil mapping units and additions (Soil Map of the Netherlands, scale 1 : 200,000)

Major class	Class	Soil mapping units and additions [1]
BG	BG1	7, 8, 10 (except Terschellinig), 39 (on the former island of Schokland), 48, 49, 50, 51, 54, 55, 56
	BG2a	9, 12, 13, 19, 20 (except Friesland), 24, 25, 31, 44 (except Friesland), 58, 59, 60, 61, 64, 66, 72
	BG2b	141, 144, 146
	BG3	15, 16, 17, 18, 21, 23, 26 (in Groningen), 32, 33, 37 (in Zeeland), 41 (in Noordholland and Noordbrabant), 45, 57, 62, 67, 68, 73, 91, 151
	BG4	79, 139, 140, 142, 143, 145
	BG5	98, 99, 106, 119, 126, 127
	BG6	148, 149
	BG7	97, 125, 129, 136, 137
GB	GB1	6 (except Texel), 14 (in the Head of Noordholland), 20 (in Friesland), 22, 26 (in Noordholland), 27, 28, 30 (in the Head of Noordholland), 36 (in the Head of Noordholland), 42, 44 (in Friesland), 46, 47, 53, 74, 75, 77, 102 (except Friesland), 107 (in Friesland), 109s[3]), 111, 131, 135, 153
	GB2	94 (except Friesland), 95, 96, 101
	GB3	11 (in Friesland), 35 (on the island of Terschelling), 37 (in Groningen), 39 (except Schokland), 69, 70, 89, 92 (without addition i), 93, 94 (in Friesland), all mapping units with addition e
B	B1	6 (on the island of Texel), 11 (except Friesland), 14, 30, 35 and 36 (on the island of Texel), 65, 71, 115, 152
	B2	76, 78, 104, 105, 107 (except Friesland), 108, 109 (without addition s), 110, 112, 113, 114, 116 (in Zeeland), 122
	B3	116 (except Zeeland), 117, 118, 120, 121, 123
G	G1	29, 38 (except Friesland), 40, 52, 85, 86, 92i[4])
	G2	10 (on the island of Terschelling), 34, 37 (in Friesland), 38 (in Friesland), 41 (except Noordholland and Noordbrabant)
	G3	81, 82, 83, 84
	G4	43, 80, 102 (in Friesland), 103, 132, 133, 138, 147
	G5	63, 134
O	O1	100, 124, 130, 150
	O2	87, 88, 90
Non-classified [2])	I	128, 154, 155, 156, all mapping units with addition w
	II	3, 4, 5

[1]) The additions on the Soil Map have influenced the suitability classification only in the instances specified in the table
[2]) Soil mapping units 1 and 2 have been classified as water
[3]) and [4]) with additions s and i respectively

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