I N D E X

PROCEEDINGS OF THE FIRST CONFERENCE
of the
NATIONAL SOIL SURVEY COMMITTEE

C.E.F., Ottawa - MAY 7-11th, 1945

Opening Session, May 7th, 2 p.m.

The Chairman called the meeting to order and introduced those present.

Members of the National Soil Survey Committee present:-

G.B. Whiteside, Dominion Experimental Station, Charlottetown, P.E.I.
G.R. Smith, Prof. of Agricul. Chemistry, N.S. Agri. College, Truro, N.S.
D.B. Cann, Dominion Soil Surveyor, N.S. Agr. College, Truro, N.S.
H. Aalund, N.B. Soil Survey, U.N.B., Fredericton, N.B.
R. Baril (representing J.E. Thériault) Quebec Soil Survey, Ste. Anne de la Pocatière, Quebec.
P. Lajoie, Dom. Soil Surveyor, Macdonald College, P.Q.
W.A. Delong, Asst. Prof. of Chemistry, Macdonald College, P.Q.
G.N. Ruhnke, Prof. of Chemistry, Ontario Agr. College, Guelph, Ontario.
F.F. Morwick, Ass. Prof. of Chemistry, Ont. Agr. College, Guelph, Ontario.
N.R. Richards, Dom. Soil Surveyor, Ontario Agr. College, Guelph, Ontario.
L.J. Chapman, Ontario Research Foundation, Toronto, Ontario.
J.H. Ellis, Prof. of Soils, University of Manitoba, Winnipeg, Man.
Wm. Shaefer, Dominion Soil Surveyor, Winnipeg, Manitoba.
H. Moss, Dominion Soil Surveyor, University of Sask., Saskatoon, Sask.
F.A. Wyatt, Prof. of Soils, University of Alberta, Edmonton, Alta.
W.E. Bowser, Dominion Soil Surveyor, Univ. of Alberta, Edmonton, Alta.
L. Farstad, Dominion Soil Surveyor, Univ. of B.C., Vancouver, B.C.
D.G. Laird, Asst. Prof. of Agronomy, Univ. of B.C., Vancouver, B.C.
L.E. Wright, Soil Chemist, Science Service, Ottawa, Ontario.
E.S. Hopkins, Associate Director, C.E.F., Ottawa.
A. Leahey, (Chairman) C.E.F., Ottawa.
P.C. Stobbe, (Secretary) C.E.F., Ottawa.

Guests attending regular meetings:-

Charles E. Kellogg, Chief, U.S. Soil Survey, Beltsville, Maryland, U.S.A.
R.E. Wicklund, Provincial Soil Surveyor, Truro, N.S.
A. Scott, Prof. of Soils, Ste. Anne de la Pocatière , P.Q.
A. Mailloux, Soil Surveyor and Geologist, Ste. Anne de la Pocatière, P.Q.
L. Webber, Provincial Soil Surveyor, O.A.C., Guelph, Ontario.
A.L. Willis, Soil Analyst, Ontario Agricultural College, Guelph, Ontario.
W. Ehrlich, Dom. Soil Surveyor, University of Manitoba, Winnipeg, Man.
P.O. Ripley, Soil Fertility, C.E.F., Ottawa, Ontario.
H. Atkinson, Soil Chemist, C.E.F., Ottawa.
W. Dickson, Research Assistant, C.E.F., Ottawa.

Guests Attending occasional meetings:-

Dr. G.C.H. Barton, Deputy Minister of Agriculture, Ottawa.
Dr. E.S. Archibald, Director, Experimental Farms Service, Ottawa.
R. Bishop, Soil Analyst, Science Service, Ottawa, Ontario.
R. Levick, Soil Analyst, Science Service, Ottawa, Ontario.
Dr. C. Rowles, Department of Munitions and Supplies, Ottawa.

Members not present:-

Dr. J. Mitchell, Prof. of Soils, University of Sask., Saskatoon, Sask.
Mr. J.E. Thériault, Director of Quebec Soil Survey, (represented by Mr. Baril)

The Chairman called on Dr. Barton to address the opening session of the conference.

Dr. Barton was pleased to see that the Committee had been able to get together in order to tackle their work.

He briefly outlined the formation of the National Advisory Committee on Agricultural Services and its relationship to the National Committees such as the Committee presently in session. He pointed out that the main function of these committees was that of co-ordination and correlation of work performed. The need of this is very important as in this country we have extensive machinery for agricultural services and in this respect we are better equipped than most countries. We have to assume much federal responsibility, yet there are many provincial institutions. It is obvious that not all organizations can assume the responsibility which they think they should assume. It is, therefore, important that those institutions which are better organized and equipped should get preferences in certain fields of work.

He stated that the soil survey is a big service and there could not be any question of the need for the type of work performed by this organization. It is unavoidably expensive work but recent plans have made provision for it. He pointed out the difficulty in dramatizing this work. To most people it is dull reading because the soil language is not understood, soil analyses are not appreciated, and also because it is often difficult to present concrete evidence. There is a great need for making the work speak for itself. We have material with which this can be done and we should make most effective use of same. The data collected by soil surveys should be made use of in our agricultural development. The work can be properly supported only if it is made to live.

The Chairman expressed the thanks and appreciation of the Committee to Dr. Barton for coming to the meeting and delivering his talk.

The Chairman presented a brief report reviewing the policies and aims of the organization. The report has been reproduced on the following pages:-

REPORT OF CHAIRMAN

OF THE NATIONAL SOIL SURVEY COMMITTEE OF CANADA

A. LEAHEY - May 7, 1945

To me this occasion is a momentous one in the history of soil surveying in Canada as besides being the first general meeting it is the first time that men representing soil survey organizations in all the provinces have met together in a meeting that is to be devoted entirely to soil survey matters. In the past the soil surveyors in the Prairie Provinces have met to discuss some of their problems and most of us have met on occasions at the Soils Group meetings of the C.S.T.A. However, this is the first time that surveyors from P.E.I. to British Columbia have been together to discuss their work.

Our field of work has passed through several vicissitudes since it was first started in Canada. However, I feel that we have passed the worst of our misfortunes as it seems to me that our work is now or is in the process of being established on a more permanent basis than ever before. This happy circumstance is attributable to the fact that soil surveyors in this country have by their good effort shown the necessity of sound basic soil information in the agricultural development of our country.

The principal criticism of soil survey work in Canada is that too many differences exist between the surveys in the different provinces in their systems of soil classification, in the nomenclature used in describing the characteristics of the soil and in the manner in which soil survey information is presented to the public. This particular criticism is justified to a considerable extent for while many of the differences in the methods used by the various soil survey organizations are more apparent than real, these differences do constitute a limiting factor in the utilization of the information provided by soil surveys. This particularly is the case when it is desired to use soil survey information for regional or national purposes or when it is used for local purposes by men whose field of work may extend into two or more provinces.

Two main factors have been, in my opinion, responsible for the differences now found in soil survey methods in use in the various provinces. One is the nature of the work itself and the other relates to the organization of soil survey work in Canada.

The science of classifying and describing soils is comparatively young and hence it is still developing. Many advances have been made in recent years but serious difficulties still exist in evolving a uniform system of soil classification that will satisfactorily fit all the complex soil conditions that exist in Canada. The other factor, i.e. of organization, has probably been of greater importance. As you know, the organization for soil surveys in Canada has been by provinces. I am not criticising this kind of a set-up as its advantages under our particular conditions far outweighs its disadvantages. However, in the past it had the serious disadvantage in that no provision was made for bringing the men in charge of soil survey work into personal contact with each other.

In order to at least partially overcome this gap in the organization for our work, the National Soil Survey Committee was formed some years ago by the National Advisory Committee on Agricultural Services upon the initiative of Dr. Archibald, Director of the Experimental Farms Service. An organization committee composed of Prof. G.N. Ruhnke, Prof. C.L. Wronshall, and myself was appointed on November 15, 1939 to prepare an outline of the organization and duties of a National Soil Survey Committee. The report of this small committee was adopted by the National Advisory Committee as our Constitution and we have functioned according to this report up to the present time. I would point out that this Constitution may be changed or modified if you so desire, such changes being of course subject to the approval of our parent Committee.

I do not think it is necessary for me to review the report of the organization committee as copies of it were placed in your hands in 1940. However, I would like to repeat the duties of this committee as outlined in this report. These are:

1. To promote greater efficiency in soil survey work by:
   (a) bringing about a greater measure of uniformity between provinces in all phases of soil survey work.

   (b) utilizing the joint experience and efforts of the soil surveyors toward the solution of common problems affecting their field of work.

   (c) providing a clearing house whereby any new developments or improvements in technique in any one province can be made available to all others in this field in Canada.

2. To recommend the location of areas where soil survey work should be done in relation to land settlement or for other purposes.

3. To act as an advisory body on soil survey matters to the parent committee.

These objectives or duties can only be carried out by meetings such as this and by the efforts of sub-committees dealing with specific topics. While in the early years of the Committee's life, the various sub-committees were quite active it is fairly obvious that the Committee as such could not hope to accomplish very much until we were able to hold a general meeting. The disruption brought about by the war has prevented the holding of such a meeting until the present time.

Last winter your executive decided to try to hold a meeting this spring despite the fact that the war in Europe was still raging. The considerations upon which we reached this decision were not altogether associated with the fact that a general meeting was long overdue. With the end of hostilities in Europe, we felt that there was a reasonable expectation that there would be a decided expansion in soil survey activities and we believed this meeting should be held before this took place. Again with the cessation of hostilities in Europe, it is highly probable that the members of this Committee might be prevented, owing to pressure of work, from attending a meeting of this kind.

The attendance at this meeting shows that you are eager to make this Committee serve a useful purpose. I quite realize that many of you are making a considerable sacrifice in coming here as you are busy men. However, I hope that you will feel when you go home that these meetings have been worth the efforts you made to be here.

The program for these meetings was drafted with the view that the reports of our various sub-committees must be presented at this time and that there should be ample time allotted for the discussion of these reports. Some provision also had to be made for the discussion of certain other matters pertaining to the work of this Committee. When this was done we found that there was no time for the inclusion of other papers or talks on subjects which would be of direct interest to us. Of course, we do not know how much time will be required for the discussions on the various reports but on the average these discussions will probably require all the time allotted to them. The program this afternoon appears to be somewhat crowded and it may be necessary to carry over part of it until tommorrow. The evenings have been left open but it may be necessary, if we get too far behind in our program, to hold either an evening meeting or else dispense with the field trip in Carleton County.

With regard to the discussions we feel that if we are to get through our program by Friday noon, it will be necessary for the discussions to be pertinent to the subject under consideration at that particular moment. If the discussion on any report is completed in a shorter time than we have allotted, the chairman of the next sub-committee listed on the program should be prepared to present his report. If we can get a bit ahead of our program so much the better as it will give us more time to discuss other topics not covered in the reports of sub-committees. The general procedure that should be followed in handling the reports of the sub-committees will be a matter of discussion at the business session scheduled for this afternoon.

I would suggest to you that the discussions should be quite frank. If you disagree with some proposal or some of the findings of the sub-committees, please feel perfectly free to state your case. I believe I am expressing the opinion of the members of this Committee that we would welcome contributions by any of the visitors. We are honoured in having with us Dr. Kellogg who has promised me that he will not merely be an interested onlooker, but that he will take part in our discussions. I trust that Dr. Kellogg along with the other visitors will consider that as far as our discussions are concerned that he is a member of this Committee.

Dr. Barton has told you something of the purpose of the National Advisory Committee on Agricultural Services and its various National Committees. However, for your further guidance I am going to read the following memorandum which has been received from Dr. Barton at an earlier date.

MEMORANDUM FOR THE GUIDANCE OF NATIONAL COMMITTEES OPERATING UNDER THE NATIONAL ADVISORY COMMITTEE ON AGRICULTURAL SERVICES

The National Advisory Committee on Agricultural Services was established primarily for the co-ordination of governmental and institutional agricultural services. It was not the general idea that this Committee would draft agricultural policy, but rather that it should make recommendations to the various administrative authorities with respect to work to be done by various agricultural service units. On this basis it is suggested that Executives of national committees keep the following points in mind:

1. The term "agricultural services" used above refers to the following public services designated in the constitution: Federal and provincial departments of agriculture, agricultural and veterinary colleges, provincial research foundations, National Research Council, Dominion Bureau of Statistics, Dominion Board of Grain Commissioners, Canadian Society of Technical Agriculturists, agricultural and colonization departments of the Canadian National Railway and Canadian Pacific Railway, and such other organizations as the National Advisory Committee on Agricultural Services may nominate. It is, therefore, felt that the future membership on national committees operating under the National Advisory Committee on Agricultural Services should be confined to employees in the designated services.

   At the same time, in view of the contribution that they may be in a position to make, employees of commercial organizations which are not included in the membership of the National Advisory Committee on Agricultural Services may be asked to meet with the national committees in an advisory capacity to discuss matters of mutual or common interest, and such employees will be eligible for membership on sub-committees of national committees where their special knowledge will be of benefit in formulating recommendations for the consideration of national committees.

   (Note: In establishing a National Committee, the usual procedure is for the National Advisory Committee on Agricultural Services to name a small nucleus "with power to add to their numbers". The resultant group constitute the National Committee. This group may appoint sub-committees -- see Section 3 hereunder -- and it is these sub-committees that are referred to in the paragraph immediately above.)

2. The Secretary of the Executive of the National Advisory Committee on Agricultural Services will be a standing member of the Executive of each of the national committees operating under the National Advisory Committee.

3. National committees are empowered to set up, where necessary, one or more sub-committees to study in detail various fields of activity coming within the scope of the main committees.

4. National committees and their sub-committees may explore fields of activity in research, promotion, and control; collate information that has been published and secure further information by detailed studies wherever necessary arrangements can be made. Out of studies made and discussions engaged in by sub-committees, recommendations may be made to the main committee for allocations of work to various agricultural service units. National committees and their sub-committees may also be given definite assignments by governmental authorities. Committees, however, have no authority to instruct units to do certain work, but only to request units to secure authorization from administrative authorities to undertake the work suggested by the committees.

5. It is expected that out of the studies and discussions of national committees and their sub-committees certain definite lines of activity will be suggested as desirable. When a national committee arrives at a point where it feels that recommendations should be made with respect to programmes, such recommendations should be made to the Executive of the National Advisory Committee in order that the Executive, through its Chairman, may take these matters up with the Dominion Minister of Agriculture and through him with the provincial or other authorities concerned.

6. In other words, while national committees can, and are expected to, make recommendations relating to departmental programmes, decisions and statements regarding such programmes must be made and issued by properly constituted authority, which in the final analysis is the Minister or Ministers concerned. Consequently committees should not announce recommendations but should leave decisions and announcements to the governmental authorities concerned.

Ottawa, September 13th, 1944.

In closing, may I express my personal pleasure at being able to welcome you here today. I hope that your visit here will be both pleasurable and profitable. This is your meeting and the degree of success it achieves depends on you.

The Chairman's report was followed by a brief report from the general secretary:-

REPORT OF THE SECRETARY
Of The
N.S.S.C. to The FIRST GENERAL MEETING

In view of the fact that this organization is now 5 years old, and seeing that during this time no official meeting of the committee has been held, it was deemed advisable that the secretary should give a brief account of the activities of the organization since its inception up to the present time. It would be well to point out that the entire executive of the committee has never met all together during those five years, and the various problems that had to be delt with were discussed by correspondence, and this, as you all know, is not always satisfactory. Fortunately the chairman and secretary from time to time had the opportunity to contact the members of the executive separately and discuss the various lines of activities which have been undertaken. Of necessity, some of the decisions on action to be taken had to be made by the chairman and secretary.

After the appointment of this committee, in May 1940, the various members were supplied with reports of the organizing committee, outlining the aims and purposes of the organization, and each member was also given a definite task to perform. A report on the purposes and on the set-up of this organization was also given by the chairman to the soils group of the C.S.T.A. in 1940 at Winnipeg, where a number of western members were present. This report was published in Scientific Agriculture and was thus made available to all concerned.

At the end of the 1940 field season, the secretary requested the various sub-committees to get down to work and prepare reports on the respective phases of Soil Survey work. The Chairman of the sub-committees were instructed to make a survey of what was being done in the various provinces along the lines of work with which the sub-committee was concerned. The sub-committees were further asked to present, if at all possible, some definite suggestions for the consideration of the parent committee.

It has been very gratifying to see the energy and enthusiasm with which the various sub-committees went to work. There seemed to be a feeling that it was high time something along these lines should be done and this was a good opportunity to start. In the late spring and early summer of the following year reports were received from the following sub-committees: (1) Land Settlement, (2) Utilization of Soil Survey Information. (3) Soil Classification, (4) Landscape Terminology and (5) Soil Ratings for Land Classification.

These reports were copied and distributed in the following fall to all the members for consideration and study. It was thought by this means every one would have an opportunity to become thoroughly familiar with the various problems at hand and with the suggestions made in order to take an active part in the discussions at a general meeting which would be called for this purpose.

Unfortunately, due to war conditions it has been impossible to call this meeting until the present time. The various sub-committees meantime felt that there was little they could do until some action was taken at a general meeting and as a result the formal activities of the organization in the last two years dwindled to a stand still. However, the chairman and secretary, during the performances of their regular duties had the opportunity to contact the different members and at this time the different reports were discussed. The members were urged to test the various suggestions made in the reports and to send such comments as they wished to make to the chairman of the different sub-committees.

Earlier during this year when authorization was obtained to hold a general meeting, the members were informed immediately and the chairman of the sub-committees were requested to review their reports and to make such changes and modifications as they deemed desirable. Also those sub-committees which had not completed their reports were strongly urged to do so.

It probably should also be mentioned that during the past five years the secretary was requested to prepare annual statements of the activities of the committee for the National Advisory Board on Agricultural Services. During the first two years this was a pleasure as we felt we were actually accomplishing something worth while. However, in more recent years this bacame an increasingly embarrassing chore as the committee as such was not actively functioning. An inactive committee can under some circumstances become a serious handicap.

In all fairness, however, it should be said that during these recent years the chairman and the secretary in their contact with the different members and through visits to the various soil surveys parties in the field have noticed a general improvement in soil survey work in the Dominion. In some cases those changes have been small, perhaps, only some small changes in the conception or definition of a certain topographic phase, while in other cases those changes have been more noticeable. It is difficult to say how much of this general improvement has been due to the activities of this committee or to the closer contact that has been established in the Departmental Soil Survey Organization, or to the greater experience of the surveyors concerned. Nevertheless, the chairman and the secretary feel that this organization, although it has never officially met until to-day has greatly helped them in the performance of their duties and they also believe that it has contributed in some measure at least toward the general improvement of soil survey work during this comparatively short period.

BUSINESS MEETING

The chairman opened the meeting for a brief business session in order to make certain announcements and to discuss some questions concerning the procedures to be followed during the meeting.

Two field trips will be arranged at the conclusion of the official sessions. One trip will be into Quebec in order to see the podsols of the Appalachian region. The other trip will be into South-Western Ontario in order to see the mature grey-brown podsolic soils in that area. Anyone who wishes to go on one or the other of these trips should notify the secretary in order that transportation facilities can be provided for.

As the constitution provides for two elected provincial representatives on the executive, one from Western Canada and one from Eastern Canada, the provincial members were asked to meet during the convention week under the chairmanship of Dr. F.A. Wyatt and Prof. G.N. Ruhnke and to elect their representatives on the executive for the coming year.

The chairman suggested that a committee be set up which would review the constitution of the organization and suggest such changes as may seem desirable. The following were appointed to the constitution committee Mr. W.E. Bowser (Chairman), Prof. G.N. Ruhnke and Dr. G. Smith.

Another committee on resolutions was suggested. This committee would be required to draft all resolutions which will come out of the convention excepting those which will deal directly with the reports of the sub-committees or the committee on constitution. The following were appointed to the Resolution Committee, Dr. D. Laird (Chairman), Mr. R. Baril and Mr. H. Aalund.

The Chairman asked the delegates to present to the secretary any notices of special topics which are not covered by the Sub-committees and which the members would like to have discussed at the present conference.

The Chairman then outlined the procedure which will be followed in respect to the sub-committee reports. The sub-committees will be called upon to present their reports which will be followed by a full and preferably frank discussion. Then before accepting or rejecting the report as a whole or in part the report will be referred back to the respective sub-committee so that it will be able to make such changes as it thinks fit to make in the light of the discussion which has taken place. Towards the end of the convention on Thursday or Friday the sub-committees will be asked to report back to the convention.

In view of the fact that the following day, May 8th, is V-E Day the Chairman asked what the wishes of the members were regarding the sessions on V-E Day.

It was moved by Prof. J.H. Ellis and seconded by Mr. H. Aalund, that in view of the fact that our time is limited the committee should continue with its program on May 8th - Carried.

It was moved by Prof. G.H. Ruhnke and seconded by Mr. L. Farstad that the Secretary be instructed to dispatch a telegram to Dr. John Mitchell expressing the sympathy of the committee in his illness which has prevented him from attending this First National Soil Survey Conference and conveying to him the best wishes of the conference for an early recovery - Carried.

SUB-COMMITTEE REPORTS

THE REPORT OF THE SUB-COMMITTEE ON WAYS AND MEANS OF UTILIZING SOIL SURVEY INFORMATION

Was presented by:-
PROF. G.N. RUHNKE

Members of Sub-Committee

Dr. E.S. Hopkins,
Central Experimental Farm, Ottawa.

Dr. J. Mitchell,
University of Sask., Saskatoon, Sask.

Mr. L. Farstad,
Dominion Soil Surveyor, Vancouver, B.C.

Prof. G.N. Ruhnke, (Chairman)
Ontario Agricultural College, Guelph, Ontario.

The complete report as revised after discussion follows:

WAYS AND MEANS OF UTILIZING SOIL SURVEY INFORMATION

INTRODUCTION

Since soil surveys in the various provinces may be made for a variety of purposes, it is only natural that the type of survey, scale and detail of mapping, and nature of the soil report, should vary greatly, to meet the local needs and conditions.

This variation in soil maps and reports, undoubtedly influences the uses to which soil survey information may be put in different parts of the country.

Because of this, it is not to be expected that all soil surveys, maps and reports, may be equally valuable, or adapted to all of the existing or proposed uses for soil survey information. Nevertheless, it has seemed advisable to compile as complete a list as possible, of the established means and ways of utilizing soil survey information, even though many of these may not apply generally or may, for some time to come, remain to be developed as circumstances will permit.

The various ways in which soil surveys have been used, or may be utilized, are indicated in the tabulation which follows, in the hope that this report may be of some value in, (1) suggesting potential new uses for existing maps and reports, (2) the planning of new survey projects so that their utility for established uses may be increased in the future, and (3) suggesting the wide range of uses for soil surveys which should be emphasized in an educational programme, intended to make the soil survey work more widely known and better appreciated by the public at large.

Utilization of Soil Surveys

1. As the fundamental basis for a systematic and effective research programme dealing with soils and crops, under such headings as:

   (a) Drainage problems.
   (b) Tillage problems.
   (c) Erosion control.
   (d) Organic matter maintenance.
   (e) Lime and fertilizer problems.
   (f) Adaptation of soil to crops.
   (g) Crop rotation - effect on soil.
   (h) Crop zoning - variety tests in relation to soil types.
   (i) Crop diseases.

2. Soil maps and reports provide County or District Agricultural Representatives and County or District Farmers' Committees a sound basis for planning soil and crop improvement programmes:

   (a) Index to soil problems of an area.
   (b) Guide for location of demonstrations.
   (c) Comparison of results obtained on one farm with those on another, with proper recognition of the same or different soil types.
   (d) Use of experimental results from a soil type in one county, on similar soils in adjacent counties.

3. As a basis for co-ordinated planning for land use adjustment in connection with:

   (a) Soil conservation programmes.
   (b) Reforestation of non-arable and waste areas.
   (c) Location of wild life conservation areas.
   (d) Establishment of recreational areas.
   (e) Location of irrigation projects.
   (f) Development of district drainage projects.
   (g) Development of reclamation projects.
   (h) Rural zoning.

4. As a primary basis for land appraisal in established agricultural areas:

   (a) Farmers - selection of land for farms.
   (b) Government appraisers - rural credit and loan boards.
   (c) Private appraisers; loan, trust, and insurance companies; banks.

4. (d) Municipal officers - land assessment adjusted on basis of producing power of land as disclosed by soil survey reports.
(e) Railway companies - agricultural departments.
(f) Real estate operators - selection of farm properties, home sites.

5. For land settlement in new areas; re-settlement in old established areas.

6. In designing engineering structures;

(a) Highways.
(b) Bridges and dams.
(c) Airports, runways and landing fields.
(d) Location of pipe-lines; corrosion problems.
(e) Location of radio stations.

7. For educational purposes:

(a) In teacher training courses in Normal Schools and Colleges.
(b) In secondary schools teaching agriculture.
(c) In agricultural schools and colleges.
(d) In agricultural short courses.

8. For other purposes, by:

(a) Plant pathologists (plant disease surveys).
(b) Entomologists (insect pest control).
(c) Horticulturists (physiological disorders in crops).
(d) Agricultural economists (economic surveys).
(e) Ecologists (ecological surveys).
(f) Geographers (detailed surveys).
(g) Pasture specialists (research and extension in pasture improvement).
(h) Weed control investigations (incidence of weeds in relation to soil type).
(i) Nutrition specialists (incidence of mineral deficiencies in crops, animals and humans in relation to soil).
(j) Medical specialists (incidence of disease in relation to nutritional problems).
(k) Industrialists (location of canning factories, fertilizer factories, etc.).
(l) Defence Department Engineers (soil conditions in relation to operations with tanks and other traction equipment).
(m) Foreign countries (exchange of scientific information on soils and crops).

The suggested uses for soil survey maps and reports, as listed above, under the various headings, offer a wide field for the utilization of soil survey information. As pointed out previously, the range of usefulness of the soil survey data for a given area, will be influenced by the mapping scale, the nature and detail of information recorded, and the character of the report prepared to accompany the map. Regional or reconnaissance surveys are extremely valuable for certain purposes, but more detailed surveys recorded on larger scale maps, would appear to be necessary if the information is to have wider utilizatio. Further, while the usual classification of soils into types on the basis of profile characteristics, and the mapping of the extent and distribution of these types alone, is fundamental, the mapping of topography, slope, stoniness, degree of erosion, etc., also may be necessary, if soil maps are to have the widest use possible. Since the Sub-Committee on Soil Maps and Reports is dealing with this problem in detail, it is unnecessary to elaborate further in this discussion.

SELLING THE SOIL SURVEY

To bring about the widest possible utilization of information from soil survey, it is important that the report and maps, covering a given area, be released at the earliest possible time, following the completion of the survey. Long delays are undesirable since they result in withholding from potential users the specialized information which the surveys are intended to provide. To meet the local and more immediate needs, the preparation of photostat copies of the soil map from the finished field sheets and concise mimeographed reports on the soils, for use by the agricultural representative and other extension officials, is to be recommended. This practice followed by the United States Soil Survey is being adopted by several of the provinces here in Canada. The provision of such tentative soil maps and reports should not be considered, however, as a substitute for the publication of the regular soil survey report. The fact that, the survey of a particular area is decided upon as an essential project, and that the expenditure of time and funds for field operations and laboratory studies is considered warranted, justifies the assumption that the project should be completed, and that the benefits from the survey should be made available to the public at large with the minimum loss of time. The ultimate publication of the report and the necessary map or maps to accompany it, should be considered as a definite commitment, essential to the complete execution of the project.

The publication of the survey report is, in itself, merely a first step toward making the results of the survey available and of use in the larger agricultural programme. It is necessary to ensure that the soil maps and reports come to the attention of all those who may be potential users, so that they may be made aware of the kind of information available. This involves the problem of <u>planned distribution</u> of soil survey maps and reports to key men in the various fields of use tabulated above. It would appear that, psychologically, the best time to make the distribution to these key men, is immediately following the release of the maps and reports from the printing office. Interest in the results of the survey of an area is at its highest peak at that time, and the opportunity to seize on it should not be lost.

A carefully prepared statement of the work and accomplishments of the soil survey of an area, and the uses to which the information can be put, should be released to the press at the same time. Editors of local papers, and farm journals serving the area, should receive also a copy of the map and the accompanying report, along with the press article.

Newspaper publicity alone, of course, will not sell the soil survey, either to the people who should be using the information, or to the general public. People have to discover the value of soil surveys in their own field of work and when they have made this discovery, soil survey maps and reports will be in demand, if they provide the right kind of information, presented in the proper form. In the final analysis, "The Proof of the Pudding is in the Eating" and the soil survey projects should be planned to take care of the maximum number of potential uses, if it is possible to do so.

Government departments, other than Agriculture, (such as Lands and Forests, Health, Natural Resources, Education, Highways, etc.) should also receive maps and reports, for in this way unexpected uses for soil survey information may be developed through their activities.

Executive officers of local farm organizations in the area should also be included on the key list, since they may be able to give very effective assistance in the general educational programme.

The above include only a few of the outlets through which more effective utilization of soil survey information may be obtained. The organization varies somewhat from province to province and hence it is possible only to make general suggestions in this connection. The important point is that, planned distribution of reports should be followed, based on a careful survey and listing of the most suitable outlets. Soil surveyors are always pressed for the maximum amount of field work in the minimum time and are frequently discouraged from giving much attention to the ultimate utilization of the fruits of their work. The immediate problem has been to get the area surveyed, the map and report completed, and then to commence another project.

It would seem that in the past, this has been a weakness common to soil survey work even outside this country. Now that we are asking ourselves the question, "How can soil surveys be utilized more effectively?", we should undertake to "follow through" in the application of the results and not leave this to chance or circumstance.

Although it may be a debatable question as to whether the soil survey specialist should become involved in extension and service work in the follow-up programme in a surveyed area, nevertheless it should be recognized that he is probably in the best position of all, with regard to adequately appraising the soil problems of the area and advising on the most effective land use. To adopt a policy of leaving an experienced member of the field party in the surveyed area for at least another season, to work with the agricultural representative and other local officials in developing the application and use of the soil survey information, would be an excellent means of making the survey work of more direct and practical value to the farmers on the land. The men working in the field can impart a great deal of knowledge about their work and go a long way towards selling the Soil Survey by coaching the farmers, agricultural workers, leading agricultural men, etc. in the district, by politely answering all questions, occasional field trips, close co-operation and maintaining friendly relations at all times. It is not necessary to spend a great deal of time with these people but enough to keep them well informed about the work and to become thoroughly familiar with their problems. This is of considerable advantage for both surveyor and farmer. This is a responsibility which may well be assumed by the soil survey organizations in this country. It is significant that it has been adopted as a regular practice in the United States. While such a policy would require more men trained and experienced in soil survey work, than at present available, it would seem to be a worthy objective for the future.

It may be necessary to supplement the standard type of soil map and report with specially prepared interpretive, non-technical reports, for special purposes, if the widest field of usefulness is to be explored. While the fundamental classification, the soil type map, and its descriptive report, are basic in the field of soil science, there is a limit to their utilization, not always recognized by administrative officers, workers in other fields and the public. Keeping this in mind, we may be expected in the future to study more effective means for interpreting and translating this basic survey work into more practical media, for use by others than soils men.

This trend may appear to be in the direction away from standardizing soil survey work, maps and reports in all the provinces, yet it would seem to be necessary if the results of the soil surveys are to be more widely utilized than in the past.

This brief presentation is considered to be in the nature of a progress report. Had time permitted, it would have been desirable to circulate to all soil survey workers in Canada, a questionnaire covering the subject matter of this Sub-committee to determine more definitely how successfully previous soil surveys have been utilized to date in the various ways tabulated in this report.

The Sub-committee wishes to express its appreciation to all those who contributed suggestions by correspondence and in the discussion during the conference.

DISCUSSION

Prof. Ellis - pointed out that soil survey information may become of great value in medical research. One medical doctor in rural Manitoba has a soil map in his office on which he plots the incidence of disease in various localities and he believes in some cases this can be correlated to soils.

Dr. Leahey - pointed out the assistance soil survey maps had given us in making recommendations regarding the location of engineering structures for the army.

Dr. Kellogg - pointed out that the question always arises: what and how much information should be placed in the report? Should the soil survey report deal only with the description and interpretation of the soils or should it be a complete handbook on the area in question? He pointed out that it is important to present the information as early as possible after an area has been surveyed; but this is not always possible. The U.S. Soil Survey is following the practice of preparing brief preliminary mimeographed or type-written reports and photostats of the maps which are distributed to key men interested in the area in question. These reports are later expanded and revised for publication.

He also pointed out the value of using single interpretation maps, such as regarding the use of lime, the suitability of the soils for orchards, etc. Such maps are easier understood by the average layman than the more complicated master soil map, which is often difficult to interpret.

He then mentioned some further uses which have been made of soil survey maps. During the war, soil survey information has been used in planning military tactics. It has been especially of great aid in planning landing operations in the Pacific area, in the use of mechanized equipment generally, and in the construction of camouflage in Africa. The international information on soil survey work has been of great importance during this war. Soil survey information has been used to advantage in locating radio stations. The best locations are found to be on well-drained soils with a high water holding capacity and a high concentration of soluble salts. Many Chernosem soils are ideal in this respect. Soil survey information has also been of importance in studying soil borne diseases.

Prof. Ellis - Suggested that an outline in the report, indicating where, what type of information is contained would be of value as it would refer the reader who is looking for specific information to the exact place in the report and he would not have to read a lot of information which he can not understand and is not interested in.

Dr. Laird - pointed out that many officials seem to think that the survey is an end in itself. In B.C., and in the Fraser Valley in particular, the general farmer makes very little use of the soil survey information, but produces of special crops, such as canning crops, study the soil survey maps more closely. Also the dairymen who buy most of their fodder have found out that they can obtain fodder of better quality from certain communities where the soil is more suited and they are, therefore, much interested in soil survey maps. The army in B.C. is doing some research work in connection with the relation of health and especially health of teeth to the nature of soils.

Mr. Farstad - pointed out that in view of the fact that the individual farm holdings are small that the soil survey of the Fraser Valley was not made in sufficient detail to assist all the individual farmers.

Prof. Ellis - Suggested that in order to show the amount of soil variation which exists in an area which has been covered by a reconnaissance survey, it would be desirable to select a small sample area in which the soils were mapped in more detail.

Dr. Smith - In N.S. the soil survey work has received greatest support from the staff of the Experimental Farms and from the county agricultural representatives. These men are interested because the soil survey information assists them in their work. However, in order to improve this useful and valuable connection it is necessary that soils men address more agricultural meetings which are sponsored by the district agricultural men and especially meetings of the agricultural representatives themselves in order that these leaders in the communities become more thoroughly familiar with the work.

Also more research work is needed to learn the important differences between the different soils mapped. Some very interesting results on the behaviour of the different soils to treatments have recently been obtained through pot test studies. More work of this nature is necessary.

Mr. Wicklund - One of the difficulties that has hampered the use which is made of soil survey information is that the soil language is not widely understood.

Dr. Ripley - Thought it would probably be to greater advantage to start with the education of men in the other agricultural sciences instead of with the farmers.

Dr. Kellogg - pointed out that the men in the other sciences usually blame the soil scientists for complicating the simple nomenclature and the simple picture that has been held of soil conditions. The men in other sciences often do not realize that soil conditions are often complicated. This can be partly overcome by taking the men in the other lines of agricultural work out into the field where surveys have been made and by pointing out the differences that do exist and the problems which arise from them.

Dr. Hopkins - Suggested that generally there is too great a lack of contact between the soils men and the men in other fields of work.

Mr. Moss - Pointed out that in Saskatchewan they have had some joint trips into the field with men in other lines of work, especially the forage crop men. These joint trips have been of great value not only for the forage crop men but for the soil surveyors themselves.

Dr. DeLong - Suggested that more fundamental training in soils should be compulsory to all graduates of agricultural institutions. This would be of great advantage when these graduates assumed their positions in public or private life.

Mr. Farstad - Suggested that the soil surveyors could do a great deal towards selling the soil survey by discussing the work with farmers, agricultural representatives and men engaged in the various agricultural sciences, during the course of the survey.

The meeting was adjourned at 5.15 p.m.

TUESDAY, MAY 8th

The Chairman - Called the meeting to order at 9 a.m.

The Discussion of the report on Ways and Means of Utilizing Soil Survey Information WAS CONTINUED

Dr. Kellogg - Pointed out that in the U.S.A. the soil survey work has been greatly strengthened through its contacts with the county extension agents (representatives) and this link-up is becoming closer.

Now the general policy in the U.S. is not to survey an area until a request for this work has been received from the Local government or body of agricultural leaders. The request must contain some of the reasons why the survey is wanted and what the information will be used for. This is done in order to assure an interest in the work by the people in the area concerned.

It is also generally insisted upon that the county or the area in question make some contribution toward the survey. A few surveys have been financed almost entirely by the county. The county is at least requested to provide an office for the soil survey. The office is commonly open one evening during the week when farmers and other interested people can drop in and discuss things. It is very important that this be arranged through the district representatives office.

In some problem areas where an intensive demonstration and research program is planned, a college graduate is taken on the survey staff and left behind after the completion of the survey to carry on with the work as an assistant to the Agricultural representative. This has worked satisfactorily in the Tennessee Valley area. These men often become county representatives and it is an advantage to have some agricultural representatives come up through the soil survey route.

In all cases the soil survey men must recognize other experts in the various lines of work in their contacts during the survey.

It is a great mistake to propose to farmers things which are above their means. The farmers have to use such equipment as they have available.

Prof. Ruhnke - pointed out that in Ontario we now try to work through the county agents and usually go into a county after requests have been made for survey work by some agency in the county. He considered the approach outlined by Dr. Kellogg as fundamental.

Dr. Leahey - pointed out that sometimes it is necessary to go into an area without local requests or co-operation in order to get work started.

Dr. Wyatt - stated that in Alberta the surveys started as a result of specific requests for work in badly eroded areas of Southern Alberta. As the survey developed most urgent requests have come in from local governments, financial houses, irrigation farmers etc., for more land surveys and land valuation.

This concluded the discussion on the Utilization of Soil Survey Information.

(Note: Many of the points raised during the discussion have been incorporated in the revised report)

TUESDAY, May 8th

Morning Session 9 a.m. - 12 a.m.

THE REPORT OF THE SUB-COMMITTEE
ON
SOIL CLASSIFICATION

Was presented by P.C. STOBBE

Members of Sub-Committee

Mr. P.C. Stobbe (Chairman)
Prof. F.F. Morwick
Mr. W.E. Bowser

The revised report is given in the following pages:-

SOIL CLASSIFICATION

INTRODUCTION

The classification of soils generally and the creation of a uniform system of classification in particular are very complex problems, largely because not enough facts are known about the soils. Nevertheless, as the soils are being studied and mapped, the data concerning the soils must be classified to permit systematic handling and orderly treatment.

Reports received from the different provinces show that there is still some lack of uniformity in the classification of soils in the various provinces, although considerable progress in this direction has been made in recent years. In some provinces individual soils have been mapped as separate units without much attempt to correlate and group them into larger categories, while in other cases much stress has been laid on the grouping into larger categories according to certain relationships between different soils.

Fortunately the different soil units in all cases have been established and mapped on the bases of characteristics expressed in the soil itself, i.e. the soil profile. It is true that the sizes and concepts of the mapped units, such as series, associations, etc., or the variability within the mapped units often vary from province to province and even within provinces depending on the detail with which the soils have been mapped and the purpose for which a particular survey has been made. This fact often creates some difficulties in the classification of the soils, although it is not an insurmountable obstacle.

Although there are some differences in the classification of soils between the different provinces, these differences are often not as great, as one who is not intimately familiar with the work, is led to believe because of differences in nomenclature and terminology which are in use. The lack of uniformity in terminology, as well as differences in the actual classification involving various concepts, cause a great deal of confusion to the laymen and to those agricultural scientists who have very little technical training in soils. It also makes the task of correlating the soil and of presenting a dominion-wide picture very difficult. This situation does not further the best interests of soil survey work in the Dominion.

The sub-committee feels that it would be very desirable to adopt a practical system of soil classification which would be acceptable to all parties concerned. It is very questionable whether absolute uniformity in classification can be attained and uniformity should only be stressed as far as it is feasible to do so. The general system of classification which may be adopted should therefore not be too rigid and should be flexible enough to take care of unforseen conditions and should allow scope for individual initiative.

Soils may be classified on different bases depending on the purpose of the grouping and on the use for which it is desired. It is not probable that any one system of classification can be devised which will fulfill all the various needs. A scientific pedological classification based on the inherent characteristics of the soil which at the same time could be used for practical applications in the field should be the final goal. Unfortunately such a system is not known at the present.

The units of the pedological classification which has been developed by Marbut and his co-workers will have to be much closer defined and probably additional genetic soil types will have to be established before all the Canadian soils can be classified with any degree of accuracy according to this system. Although this classification scheme is of great value in describing common characteristics of a large number of soils, it is of little immediate value to the surveyor in the field. In soil survey work and in cartography in general we have to be able to indicate individual as well as progressively larger groups of related soil units. The individual categories as defined in the above system do not lend themselves to such treatment.

The sub-committee feels that for immediate use we need a more practical system of grouping and classifying our soils. Such a system should take into consideration the inherent pedological characteristics of the soil and the various factors that control soil development. It should also take into consideration pedological relationships of one soil to another and it should give a picture of the land pattern of related soils.

In this report the sub-committee is submitting a tentative system of field classification of Canadian soils for the consideration of the members. The sub-committee hopes that the members will investigate the practical application of the proposed system and if it promises to fulfill our present needs it should be accepted dominion-wide. The sub-committee suggests that soils which have been mapped and grouped according to the proposed classification scheme can be rearranged and regrouped for local needs as the occasion demands. It is also hoped that as we proceed to map and study the Canadian soils it will be possible to establish and define more accurately the various genetic soil types which occur in the Dominion. Eventually it may become necessary to regroup all our soils according to some improved scientifically sound pedological system of classification. It may perhaps even be desirable that the latter classification should be developed and applied simultaneously with the field classification proposed in this report.

SUGGESTED SYSTEM OF FIELD CLASSIFICATION FOR CANADIAN SOILS

In the proposed system of field classification the soils are grouped into the following categories:

Soil Regions
Soil Zones
Soil Subzones
Soil Associations or Catenas
Soil Series, Members or Associates
Soil Type or Soil Class
Soil Phases.

The Soil Regions

The sub-committee would like to suggest that the Canadian Soils be first of all grouped or divided into three main regions according to their common morphological characteristics and according to the environmental factors under which the soils have developed. These are:

1. The tundra soils region
2. The woodland soils region
3. The grassland soils region

The division is not based on vegetative cover alone and thus is not a botanical or vegetative classification as some would perhaps like to suggest, but is more associated with the characteristics of the soil itself. The soils of the grassland region have developed under a grass cover and have characteristic profiles in which the organic matter is intimately mixed with the mineral fraction of the soil in the upper horizons. They usually have a layer of lime accumulation in the subsoil and have or tend to have a columnar or column-like structure. The woodland soils have developed under forest vegetation and the organic matter in these soils is usually concentrated on the surface of the soil, rather than intimately mixed with the upper horizons of the soil itself. The layer of lime accumulation is often, although not always, absent and the structure of the sub-soil tends to be nutty or cloddy rather than columnar. The woodland soils generally show more signs of leaching and have a lower pH than the grassland soils. The grassland and woodland soils correspond generally to the so-called pedocals and pedalfers respectively; however, those wooded soils which have a layer of lime accumulation present, partially due to excessive amounts of residual lime, would be classed with the woodland rather than with the grassland soils.

Although very little accurate information is available about the tundra soils it is tentatively suggested that the tundra region includes those soils with an ever-frozen subsoil and the tundra vegetation, (due to the enormous extent of the forested area great soil variations must be expected from the typical woodland soils to the tundra soils and it may become desirable, as information is accumulated, to establish a woodland-tundra transition region).

Soil Zones

It is suggested that the soil zones should be the main sub-division of the soils region. The soil zone at present is in practically all provinces the largest category of soils recorded. They are largely determined by soil characteristics which can conveniently be correlated with climate and vegetation over comparatively broad areas. In studying the various reports it appears that the interpretation of a soil zone may vary somewhat between some of the provinces. In some cases a soil zone is taken to represent a great soils group, for example, podsol zone and podsol soil group; black earth (chernosem) zone and chernosem soil group, etc. The committee would like to point out that the terms "soil zone" and "great soils group" can not be used synonymously. A soil zone should be defined as a broad belt of soils in which the dominant normal soils correspond to the soils of a great soils group, such as podsols, black earths, etc. The dominant soil forming processes in a zone are towards the formation of a definite genetic type of soil (podsol, black earth, etc.) but due to local conditions many soils may be formed in a soil zone which are not of the same "type" as the dominant soil. Thus, for example, the podsol zone contains true podsols and a number of soils which are not or only slightly podsolized due to drainage conditions or parent material, or both. Similarly the black soil zone contains a large proportion of black earth soils but also various wiesenbodens, saline and alkali soils and locally leached or podsolized soils. A soil zone, therefore, is a large complex in which different "types" of soils can be found. However, the dominant soil forming processes in a zone are toward the formation of a definite genetic "type" (podsol, black earth etc.) from which the respective zone has derived its name.

In the past on some occasions in this country and more commonly elsewhere, the various "great soils groups" have been shown on maps as covering large areas of land. The areas thus represented actually contain besides the particular great soils group, say chernosem, which has been specifically defined, a large number of related soils, in this case wiesenboden, solonetz's, solonchak's degraded chernosems etc. In order to avoid this confusion and misrepresentation the term "soil zone" is suggested for these large areas of related soils.

In connection with the definition and delineation of the different soil zones much work needs to be done. Most of the men in the different provinces have a fairly definite idea of what they mean by each zone and generally the ideas held in the different provinces coincide fairly closely. However, in the transition belts from zone to zone, personal factors in interpretation come into important play as our present definitions are in many instances too loose to take the minor variations into account. This makes it often difficult to establish uninterrupted zonal lines across provinces even if the soil has been studied and mapped with great care. These difficulties can only be overcome by much closer contact between the surveyors of the different provinces and by a joint study of the different zonal variations that are permitted in the respective provinces. This not only applies to zonal differences but also to individual mapping units in adjacent provinces. In other words the members of one province should know more about what the adjacent provinces are doing and how they are doing it.

In some cases large areas of soils are uninvestigated and unsurveyed to date and no definite soil zone lines can be established in such areas until the facts about these soils are known. In other cases considerable information concerning the soils has been collected by surveys and by other investigations and the zones have been fairly well established.

It is suggested that three main soil zones should be recognized in the grassland region, namely, the brown, the dark brown and the black earth zones. It is also suggested that these zones should be defined in collaboration by the surveyors of the three prairie provinces and the senior dominion surveyor from Ottawa and that the zonal lines should be checked along the borders jointly by the surveyors of the institutions concerned.

In the woodland region the soils have in most instances not been sufficiently studied to permit the establishment of zonal lines as closely as has been done in the grassland region. However, from information at hand it would seem that the following zones should be recognized.

(1) The grey wooded soil zone. (2) The podsol soil zone. (3) The grey brown podsolic soil zone. (4) The brown podsolic soil zone, and (5) the Soil zone along the Pacific coast (yellow-brown podsolic?). Although lack of information may at the present not permit the exact definition and delineation of these zones, nevertheless, work done to date is sufficient to indicate that these zones exist and that the soils of the respective zones differ in their characteristics and can definitely be correlated with climatic and vegetative conditions. Every effort should be made by all provinces to define and delineate the soil zones more clearly. It is possible that with more intensive study it may become desirable to establish one or two additional zones. There is for instance a very large area of permanently frozen soils which differ from the tundra in having a forest cover.

Sub-Zones

Many of the soil zones are very extensive and contain marked, broad and fairly consistent variations. Some of these variations are quite gradual and are associated with gradual climatic and vegetative changes only, while in other instances these differences are accentuated by marked changes in the parent materials over extensive areas. It is suggested that some of the major broad soil variations within a zone, which can be linked with gradual climatic and vegetative changes and which may or may not be accompanied with changes in parent materials, be recognized as sub-zones, rather than separate zones, because several of the sub-zones may have many characteristics in common with the soils of any one of the major soils groups.

Such variations have already been recognized in a number of provinces and have been designated as zones. Examples of such variations are the "Deep" and "Shallow" black zones or "sub-zones" in Alberta, the "Black-dark-brown" transition zone, the "Black" and "Northern black" zones in Manitoba and the "Degraded-black" or "Black-grey wooded" transition zone in all the three prairie provinces. In a similar category would probably fall the "Rendzina" soils in Manitoba. It may become desirable to establish other sub-zones as our information concerning the soils accumulates. It may become desirable to establish a "Grey-brown" sub-zone as a transition from the brown earth to the grey desert soils. Other sub-zones within the grey wooded zone may become necessary as these are studied in more detail.

Similar sub-zones would be of great assistance in separating some of the major variations in the podsol and podsolic zones in the Eastern provinces and in B.C.

Associations or Catenas

As mentioned earlier, great variations in soils exist in any one of the different zones or sub-zones. Some of the greatest of these variations are caused by differences in the parent materials of the soils. Numerous examples could be quoted of so-called "normal" soils in any one zone which greatly differ in morphological and chemical characteristics due to the effect of the parent material from which the soils have formed. In the case of the so-called "intrazonal" soils the effects of the parent materials on the characteristics of the individual soils are in some cases even more pronounced than in the case of the "normal" or "zonal" soils, while in other cases they are less marked. It is therefore, suggested that the soils be grouped within a zone according to the nature of the parent material from which the soil has formed and which has given the soil some of the more important characteristics.

In describing the parent material two questions come foremost to our minds. First, how did it get there or what is its mode of deposition? Is the parent material residual material, glacial till, lacustrine or outwash deposits? Secondly, What is the nature of the parent material or in other words what is its composition, its ease of weathering and its consequent effect on the soil? It is often difficult to determine the exact nature of the parent material, but where differences in soils can be attributed to differences in the nature of the parent material these differences can be brought out by simple descriptive terms supplemented by such data as is available. The description of either the mode of deposition or the nature of the parent material alone is not sufficient to give an accurate picture.

Soils on similar parent material may vary according to local features of relief and soil climate and according to other factors such as salt concentration etc. Thus on a particular parent material may be found the "normal" well-drained soil, shallow or eroded soils on steeper slopes (i.e. if the particular parent material has the required topography), imperfectly drained soils, various poorly drained soils etc. This group of soils reoccurs within the same zone or sub-zone wherever this particular parent material is found and forms a definite landscape pattern. The nature of the individual soils of the pattern vary from one parent material to another. The sub-committee would like to suggest that the group of soils which are associated together on the same parent material to form a land pattern be designated as a Soil Association or Soil Catena.

In a number of provinces the soils have been mapped and grouped on the association basis and the term "association" has come into common use in these provinces. The association as defined above corresponds very closely to the soil catena which has been used by the U.S. Soil Survey. It appears that in some of the provinces where the soils have been mapped on the series basis the term Catena would be preferable. The sub-committee would like to leave the final decision concerning the name of the entire membership of the parent committee. In order to avoid confusion it would be desirable to adopt either one or the other of these names.

As stated above in many provinces the soils have been mapped on the association basis. Where the soils have been mapped on a series bases the individual series, if correctly defined and mapped, can easily be grouped into an association.

In some reconnaissance surveys mapping units have been established in which the nature of the parent materials may vary somewhat although it is of the same mode of deposition. Such mapping units should be considered as complex associations until such time when it will be possible to separate the individual associations by more detailed surveys.

SOIL SERIES, MEMBERS OR ASSOCIATES

The individual soils which make up the soil association and which often form the mapping unit have been variously called the Associate, Member or Series. If the proposed system of field classification is adopted it will be necessary for the entire membership to come to an agreement and adopt one of these terms for use dominion-wide. Various arguments in favour of one or the other of these names have been advanced by the different members. At the present time the sub-committee is not prepared to make any definite decision on this matter.

The morphological differences between the different soils of the same association are brought about by various local environments.

(a) Moisture relationship and soil drainage.

The local soil variations on similar parent material can be attributed largely due to local changes in soil climate i.e. the moisture-temperature relationships in the soil. Soil climate is closely associated with drainage conditions and relief. Thus there are, on similar parent material, normal soils which have developed under well-drained conditions, locally arid hillside soils, excessively drained soils, imperfectly and poorly drained soils. In cases where the variations in drainage conditions have an important influence on the soil and where the range in drainage conditions is very great, it may be well to establish a number of drainage units, each having its characteristic soil profile.

(b) Salinity

In Western Canada on some parent materials the salt concentration of the soil seems to be associated to some extent with drainage conditions. The greater salt concentrations are usually found on the poorer and intermediate drained soils on lower positions due to the washing down of salts from higher positions. As a result of these conditions, saline, alkaline and degraded alkali types of soils may develop on some of the parent materials.

(c) Degradation

On locally moist soils and in wooded areas of the black earth zone, degradation of the soil often takes place. At the same time the better drained and more arid soils on higher position, as a rule, show no signs of degradation. In the black-earth-grey wooded transition zone or sub-zone the degradation is usually more pronounced and may be slight, marked or great. Similarly in the woodland region the extent of leaching and soil degradation may vary with local soil climate. On some parent materials the extent of leaching may be greater with increasing degrees of poor drainage, while on other parent materials it may be less.

SOIL CLASS OR SOIL TYPE

Most parent materials, even if they are for all practical purposes uniform (of same mode of deposition and nature), vary sufficiently in texture to make a further textural differentiation desirable. It should however be pointed out that in a soil association or in the smaller mapping units of an association the textural range which is permitted can not be very wide. If the textural range becomes too great the entire nature of the parent material will change and the soil should fall into a different association.

The textural variations, although present are often not consistent enough to permit the separation and mapping in ordinary survey work and in such cases it is advisable to indicate the range in texture of the mapping unit, example, Waskada loam to clay loam, etc. In many cases, however, it is possible to map out the major textural soil classes.

In cases where the mapping unit is the "soil Associate" or series the different textural classes correspond to the U.S. soil type. However, where the mapping unit is greater than the "associate" and consists of an "association" or "complex of associations" the textural units cannot be compared to the U.S. soiltype, as the variations in profile characteristics are greater than the U.S. soil type permits. The term "type" of soil in Europe and to some extent in this county has been used to describe the kind of soil formation that has taken place, for example, podsol type of soil, solonetz type, black earth type, etc. For this reason it is suggested that the textural soil units which are being mapped should be referred to as "soil classes" which would be in line with the textural classes which are used universally.

The definition of the individual textural units, including the range and size of soil particles and their methods of determination will be dealt with by another sub-committee.

SOIL PHASES

The mapping units can be further sub-divided according to external soil characteristics and physical features such as stoniness, topography, etc. It is suggested that the term "Soil Phase" should be reserved to such external characteristics of the soil and not to internal soil features such as variations in soil profile, i.e. degraded phase or poorly drained phase. The various physical soil features which should be taken into consideration will be dealt with by another sub-committee.

DISCUSSION

It is perhaps in order to examine the soil units which have been mapped and classified in Canada to date in relation to the proposed classification scheme. In many cases, especially in the older surveys, the established units are soil series and soil types. These represent mapping units which could be conveniently established and in most cases probably satisfy practical demands.

In some cases the series correspond to the "associate" as defined above and satisfy the theoretical definition of the U.S. Soil series. In other cases the soil series, as mapped in the past, corresponds either to an "association" or a part of an "association" and in some cases in reconnaissance surveys the soil series as mapped represents a number of associations or what may be called a "complex association". As a result the significance of the term "soil series" has become very vague in Canada. In some cases it represents a large body of soils with considerable variations, while in other cases it represents a rather small and fairly uniform unit. What makes matters somewhat more confusing is the fact that, as a rule, the soil series is described by giving a description of the most common soil profile with very little regard to the other soils which help to make up the mapped soil unit. Unless one is personally familiar with a soil series in question it is often difficult to obtain an accurate picture of the existing conditions. This situation has not had a very favourable impression on many agronomists and agriculturists generally, as well as on farmers, who have been led to believe, partly by the description of one single profile, that any mapped soil unit is a uniform piece of land. What has been said about the soil series also applies to the soil type, perhaps even to a greater extent.

In the above outlined classification scheme much of this confusion would be avoided. It will still be necessary to map soil units of various sizes and various complexity but these different units would not all be labelled by the same name, each soil unit would fall into its respective category and would have to be described as such. For example if the Association is the mapping unit it will be necessary to describe each member of the association in order to describe the land pattern.

In order to bring the soil classification work done in the past in line with the present scheme it will be necessary to examine critically the soil series or other soil units established to date. For instance some soil series of Saskatchewan would probably prove to the "complex associations" and others would be associations. Whenever the time comes when more detailed information is needed the finer sub-divisions into associations and associates can probably be made without difficulties. In other provinces some soil series may perhaps prove to be associates or associations and in some cases perhaps even some other fractions of associations. In many cases it may be sufficient to describe some of the minor, less important, associates of an association to give a better picture. No doubt there will be some mapping units which will not fit into the suggested scheme. As time goes on it may be possible or desirable to make the necessary separations and corrections and, if not, it would at least be of value to know the position of these units in relation to the other soil units.

The classification scheme as discussed above should be considered as a field classification. It may perhaps be desirable to regroup the soils in a different manner for local needs and purposes according to their productivity or suitability or according to soil problems that they have in common. In talking to the average layman it may not be desirable to talk in terms of associations, associates or series for that matter. It may perhaps be more desirable to talk in terms of certain soils, for example, the Regina soils, or Regina clay soils, the Caribou soils or Caribou loam soils, the Red River soils or Red River clay soils, etc. These are the particular soils in which certain individuals are interested. However, for the technical men and administrators which want to know the relationships between soils and their characteristics over a wider range of territory, or even dominion-wide, the proposed classification will be more satisfactory, as it will show these relationships.

It will be noticed that the suggested field classification diverges in principle from the U.S. pedological classification in the Association or Catena category. It will be noticed that a catena or association may and usually does contain more than one genetic soil group. The reason why the U.S. pedological soil classification has not been adopted more widely for soil surveys in Canada is that it is difficult to be applied in the field under our conditions. Very often we find two, three or even more different genetic soil types or groups in one field which can only be separated by a detailed survey. Consequently it is not possible to indicate these different genetic types, which are rated among the higher categories, on any general reconnaissance map. Another serious difficulty which this classification presents in practice is the difficulty of placing many of the intrazonal soils. At the present some of the intrazonal groups are too wide and too all embracive. For instance in the podsolic zones the half bog soils, according to definition, include some of our choiciest mineral soils as well as useless swampy lands.

The sub-committee believes that much work is required in order to study our genetic soil types and to establish and define new genetic types especially in the intrazonal groups. These genetic types should be drawn up in appropriate key or table form and could then be used to characterize the established and mapped units. For instance the well-drained member of the Red River Association is a "chernosem" or "black earth" type, the poorly drained member of the same association is "wiesenboden" type of soil, a saline member of the same association may be a "solonchak" type of soil, etc. If this were done it would be easily possible to regroup all our soils at any time and list them on paper according to the genetic group or "type" of soil to which they belong.

The committee also feels that no matter what classification scheme is being adopted more correlation work will have to be done in order to obtain greater uniformity. The men in one province should know more about what the men in other provinces and especially in the adjacent provinces are doing and how they are doing it. A correlation body should be established which actually has contact with the various men and the different soils in the field. It may perhaps even be more desirable to have two such bodies, one consisting of one representative from each of the western provinces, together with a representative from Ottawa and the other consisting of one representative from each of the eastern provinces with an official from Ottawa. Such a correlation committee would not only be able to bring about uniformity in the classification but would also be able to compare the individual soils.

It is also urged that each province should have available a complete up-to-date list of soils which have been established, together with full descriptions of each soil. This description should include all the different headings mentioned in this discussion in connection with the classification scheme, a description of profile or profiles concerned and should indicate the approximate extent and occurrence as well as the productivity and suitability of the soils. This information can usually be obtained from reports where such are available, but we all know that reports are often not available for a long time after the field surveys have been completed, and furthermore many details are often not mentioned in the reports. Such inventory of the individual soils is essential for any correlation work whether it is done by an organized body or by individuals.

Soil Profiles

From a review of the descriptions of soil profiles as reported from the different provinces it is seen that there is a complete agreement as to the general meaning of the A, B, and C horizons. The A horizon is the zone of maximum weathering and of maximum removal or leaching of the products of weathering and the whole or part of the A horizon is also the zone of maximum accumulation of organic matter. The B horizon is the zone of maximum illuviation of the colloidal materials which have been removed from the A horizon and it is generally heavier in texture than the A. Theoretically every soil should have an A and B horizon or solum; however, in some soils the C horizon or slightly altered parent material comes close to the surface and the B horizon may be absent or may be very thin.

Some lack of uniformity has been observed in the naming and identification of the different sub-horizons. This lack of uniformity is partially due to the different nature of soil profiles which are dominant in the various provinces and partly due to the interpretations of the individual surveyors. It is suggested that the following horizons should be recognized in soil descriptions if present:

A_0 Partly decomposed organic debris, such as, leafmats, rootmats and grass remains. This horizon may often be absent on grassland soils and may in some cases have been destroyed by fires on forest soils.

A_1 Surface layer of mineral soil containing the highest amount of well decomposed organic matter and it is generally the darkest layer of the profile. This layer is frequently absent in podsol soils or may be so thin that it cannot be sampled. In other cases the A_1 horizon may be quite deep and it may be desirable to describe it as upper and lower A_1.

A_2 Zone of maximum elluviation or leaching. When well developed it is white in colour but may also vary from light to dark grey. It is most pronounced in podsolized and solodized soils.

A_3 Transition zone from A_2 to B_1 but more like A_2 than B_1, often absent. This layer may vary in colour from light grey in solodized soils to greyish brown and yellowish grey in podsolic soils.

B_1 Upper part of illuviated horizon, usually heavier in texture than A. Varies in colour from greyish to reddish brown and often somewhat cemented.

B_2 Second illuviated horizon in podsolized soils. May vary from B_1 in colour, structure or compactness. Frequently absent especially on grassland soils or may be transitional zone between B and C.

B_3 Transitional horizon from B_2 and C_1, occurs in deep soils but is often absent.

B_{ca} Zone of lime carbonate accumulation typical of western grassland soils but may also occur on podsolized soils where parent material is high in lime and or drainage is poor.

A_{ca} In cases where the soil has no B horizon due to large amounts of lime in the parent material the lime may not have been removed from the A horizon and it is suggested that such A horizons be designated as A_{ca}.

G. Glei horizon, usually found in poorly drained and swampy soils. It is a severely mottled or discoloured horizon often found below the B horizon but may also occur in the positions of the B_1 or B_2 horizons. It is not found in well-drained soils or soils with low watertable.

C_1 Slightly altered parent material which is more closely related to the unweathered parent material than to B. In many cases it is difficult to separate B from C. In many of the glacial soils the C_1 is heavier in texture and somewhat more compact than the upper horizons.

C_2 Unweathered parent material. In many soils C_1 and C_2 cannot be separated and the entire horizon is referred to as C.

D. Underlying foreign material (bed rock, till, clay, etc.) which is not related to the parent material of the soil. This layer is absent in most soils.

It is further suggested that the designation A_c or Ak be used for the mixed cultivated surface layer when it is desirable to refer to this layer by a short symbol. This is not so important on grassland soils with a deep A_1 horizon where the whole cultivated layer consists of A_1, but it is very important in podsolized soils where the cultivated layer consists of A_0, A_1, A_2 and B_1 or any two or three of these horizons. These cultivated layers have at times been referred to as A_1 or A which is very confusing. Ak or simply "cultivated" or "plowed layer" would be more significant and would avoid confusion.

It very often is difficult to determine whether a layer belongs to the A or B horizon as it may have some characteristics of both. It is suggested that such horizons be designated as A-B.

Some of the above mentioned horizons may not be encountered in certain areas and may only be found rarely in other areas. A mere definition of the horizons may be of some help in bringing about a clearer understanding and better interpretation of the profile descriptions, however, the committee feels that the greatest uniformity can only be maintained by closer contacts between the different surveyors, by field meeting or through a correlation committee.

The separations in the field are usually based on such characteristics as, colour, structure, consistency and other morphological characteristics. The visual morphological characteristics of the soil are often not very distinct and in such cases data on chemical and physical analysis often give sufficient evidence to establish the horizons in question.

The above mentioned horizons cannot very well be applied to certain soils, especially the recently deposited alluvial and wind blown soils with no definite profile development and to organic peat and muck soils. It is suggested that in such cases the different layers should be referred to by such common terms as surface, sub-surface and subsoils, giving the depth and thickness of each layer instead of applying definite horizon designations. The committee would also like to suggest that in case a surveyor is not certain in his mind whether a horizon should be designated as an A_3, B_1 or G horizon, etc., it would be more satisfactory to refer to them by depth and descriptive terms and thus avoid confusion.

Soil Structure

In reviewing the question of soil structures it is seen that there is a general agreement in terminology between the different surveyors. A list of the soil structure terminology used by the different surveyors in Canada is given below:

Structure	N.S.	N.B.	P.Q.	Ont.	Man.	Sask.	Alta.	B.C.
Single grain or structureless	yes	yes	yes	yes	yes	yes	yes	yes
Granular	"	"	"	"	"	"	"	"
Crumb	"	"	"	"	-	-	"	"
Nut-like or nutty	"	"	"	"	yes	yes	"	"
Fragmental	-	"	"	"	"	"	"	-
Cloddy	yes	"	"	-	"	"	"	" (angular)
Prismatic	-	-	-	-	"	"	"	"
Columnar	-	-	-	-	"	"	"	"
Platy	yes	yes	yes	yes	"	"	"	-
Laminated	"	"	-	-	-	"	-	-
Massive	"	"	"	-	"	"	"	-
Mulch	-	"	"	"	-	-	-	-
Round top & flat top	-	-	-	-	-	"	"	-
Cubic	-	-	-	-	-	"	"	-
Ortstein	-	-	-	-	-	-	-	"
Amorphous	"	-	-	-	-	-	-	-
Porous	-	-	-	-	-	-	"	-
Friable & fluffy	-	-	-	-	-	-	"	-
Fine grained	-	-	-	-	-	-	-	"

From this table it is seen that certain types of structural classes are commonly used in all provinces while others are only used in individual provinces. In the case of some structures such as prismatic, columnar, round top and flat top the reason why they have not been used in the eastern provinces is because they are absent. However, it is hardly conceivable that such "structures" as ortstein, amorphous, cubic, porous, friable and fluffy and fine grained are only found in single provinces and such structures as crumb, fragmental, laminated and mulch are only found in a number of provinces. It is highly probable and in some cases certain that these structures are not considered as separate types in the other provinces and they have been described by other structural designations. As an example, the crumb structure of some provinces is described as a granular structure, in others the fragmental structure of some provinces is described as a nutlike structure, etc. Besides the irregularities in structural types shown in the table, other irregularities do exist in the interpretation of certain structural types. Thus a structure which is considered as granular in one province is often referred to as nutty or nutlike in another, etc.

It is evident that if more uniformity is desired all soil surveyors must have the same conception what is meant by the various structures. This can be accomplished by standard definitions of the different structures and by joint field meetings of the surveyors.

It is suggested that the number of structures used should be as small as possible, and the definition should be wide enough to permit variations within that type. Variations within a structural type should be described in simple explanatory terms. The consistency of the soil which denotes the degree of cohesion of the soil mass, the porosity of the soil and its resistance to breaking up into structural aggregates should also be indicated in simple self explanatory terms, such as: loose, soft, friable, crumbly, mellow, brittle, firm, hard, compact, indurated, cemented, tenacious, stiff, tight, tough, impervious, plastic, sticky, porous, spongy, cellular, tubular, etc.

The following structural types are suggested for the description of soil structures.

1. Structureless or single grain.

Loose, each grain by itself due to lack of colloidal material.

2. Massive.

Large uniform and cohesive masses of soil, almost amorphous or structureless with irregular cleavage faces. Usually found in heavier soils but may also be found in lighter textured soils containing very sticky clay fractions.

3. Granular.

Irregular shaped small aggregates with weakly to moderately defined edges and surfaces. May be sub-divided according to size into fine and coarse granular; it is often desirable to indicate size.

4. Nutty or nut-like.

Nut-like, blocky, aggregates, irregularly shaped with more or less clearly defined edges and faces; larger than granular. May be subdivided according to size into small, medium and large; it is often desirable to indicate size.

5. Fragmental.

Firm aggregates with irregular cleavage lines and more or less sharp corners and edges, often wedge shaped. May vary in size and can be sub-divided accordingly.

6. Cloddy.

Aggregates are irregularly shaped complexes with feebly defined edges and faces. Vary in size, usually larger than nutty.

7. Prismatic.

Blocky aggregates with a vertical axis longer than the horizontal and with well defined and regular edges and surfaces. The tops of the aggregates are usually flat. May be sub-divided according to size.

8. Columnar or column-like.

Similar shape as prismatic but the edges and surfaces are not so well defined, and the tops are usually rounded. May be sub-divided according to size.

9. Platy.

Thin horizontal plates or aggregates in which the horizontal axis is longer than the vertical. Usually found in the A horizons of podsolized and solodized soils.

10. Laminated.

Thin horizontal layers, usually longer than platy and often continuous. A condition confined to the inherent layers of thin bedded sediments of the parent material and often noticeable in the C and lower part of the B horizons.

The above list consists primarily of the main soil structures that have been used generally in Canada and the United States. There is still the possibility that two different surveyors may not agree in their interpretation and identification of certain structures and some members may desire more accurate and detailed definitions of the different soil structures. In this regard the committee wishes to draw the attention of the members to a classification of soil structures by C.C. Nikiforoff in Soil Science, No. 3, Vol. 52, 1941. This classification appears to have some merits and it would be desirable that the members give it close study. Perhaps it would be desirable to adopt Nikiforoff's system of classification or some phases of same.

DISCUSSION OF THE REPORT ON SOIL CLASSIFICATION

PROF. MORWICK, speaking as a representative of Ontario and as a member of the sub-committee, pointed out that this report may be criticized as being utilitarian and not entirely scientifically sound. It proposes to classify a continuous body instead of individual units or points as is the case in, for example, a botanic classification. It is utilitarian as it is designed to be most useful for people who are using land. For example, if one takes a catena with 8 different members based (as is generally the case) on moisture relationship, it would be difficult to classify all these members on a zonal or intrazonal bases. Yet if these soils are classified on this bases the differences in moisture relationships which often are only small, would cause these soils to fall into very widely separated groups. Thinking of an individual field or farm we may often, and usually do have, two or more members of a catena represented due to differences in drainage. With improved drainage the significant practical differences between the different soils are wiped out yet according to the U.S. Soil classification using the zonal and intrazonal concepts, these soils would be in widely separated classes. Using the catena concept the relationship between the soils would be clearly indicated without having to commit oneself to the exact higher categories and this would meet our present need. In the past soil series, types, etc. have been used widely without much attention to higher categories.

DR. LEAHEY suggested that the present discussion be confined to general ideas and principles involved and that the terminology be taken up later by another sub-committee.

DR. KELLOGG pointed out that one trouble with the suggested classification scheme is that it has too much geographical bias. DR. MARBUT once made a very important simple statement. - "Classification must be based on something". In the case of soils it must be some soil characteristic or characteristics. Yet Marbut, himself, introduced a great deal of geographic bias. Thus, series were individual landscape units, while great soils groups were zones. On Dr. Marbut's large map of the United States, published as a section of the Atlas of American Agriculture, the Areas shown as soil series are, in reality, geographic associations or landscapes dominated by the soil named. In "Soils and Man" the geographic bias was thrown into the higher categories. The pedocal and pedalfer grouping was thrown in, but it is now known to be obsolete.

In the committee's report the geographic bias is brought in clearly at the beginning. It is presumed that the classes are based on characteristics or causes of characteristics. The main fault, however, is that we assume a straight line relationship between causes and characteristics. This, however, is not true and the characteristics are not simple functions of the causing forces. The soil as observed is the end result of all forces. In some cases small differences in causing forces may bring about big differences in characteristics. In other cases similar differences in causing forces may have only small effects. Thus differences in the parent material in the west are not so relevant as in the east due to the powerful effect of the grass vegetation. The vegetation is the most powerful causing force in the development of soil characteristics; as a result there are big differences between the soils of grasslands, woodlands, and tundra. However, the soil characteristics are not straight functions of the vegetation. Thus, sometimes we find trees on Chernosem, woods on Tundra, etc. It would, therefore, be better to express the definitions in terms of characteristics which would include landscape as well as soil characteristics.

There have been three definite stages in characterizing the soil. First there was the storage bin idea, i.e. the soil was considered to contain a certain amount of the various plant nutrients and if these were removed by the crops or by leaching they had to be replaced. Secondly the concept of the soil profile came in to being and soils were characterized largely on that basis. Now the landscape concept is considered to be more appropriate, i.e. the soil can not be characterized completely by individual profile characteristics, but must be considered in its relation to its surroundings.

There are twoor three kinds of soil associations. In the U.S.A., the association consists entirely of geographic units, which consist of a group of taxonamic units. The catena is another kind of an association. That is, the members of a catena have all been formed from the same kind of parent material and are separated from one another on the basis of differences brought about by relief. The catena must be used with great caution because small differences in moisture relationships often cause large differences in the soil profile. Then also, one soil series may reoccur in several catenas, i.e. on different parent materials that may cause series differences in the normal position but not in hydromorphic positions. The catena in the U.S. may or may not be a complex. A complex is an association which is not mappable at a given scale.

The soil series in the U.S. originated with Whitney who conceived them in analogy with broad geological formation. He conceived of types as sub-units within series, based upon texture of the upper soil. Thus a series of types developed from alluvium originating from one principal source might contain a clay type at one extreme and a sand or gravel type at the other. At first there were many types in a series but now the trend is more and more toward monotype series. The monotype differences are not greater than the differences in the native vegetation of a sward or in differences of the functional morphology of soils in relation to crops. Exceptions, are differences in depth, such as the depth of sand over other material.

In soil classification one must carefully consider both taxonomy and geography.

The chemical and plant sciences are based on taxonomy and the same should apply to soils. The men working with alkaline soils will be aware of the practical significance of the taxonomic aspect in soils.

We need a fundamental classification which fits all scientific needs, i.e. it should satisfy the chemist, physicist, and biologist as well as the surveyor. We have to stick close to what we see and not place too much dependence on climatic or other differences.

The scientific classification and mapping of the soils is for soil scientists. The people whom we are serving do not need a scientific soil map but rather the interpretation of the soil map by soils men. If a land map were made, of say, the grazing value of land, the map would not be adaptable for other uses, but it would satisfy those interested in the grazing conditions of particular pieces of land.

PROF. ELLIS - We are discussing two different things. Soil classification is not soil mapping. The job of the soil surveyor is to make a check list of the different soils before classification can begin. To take a limited number of soils and to classify all Canadian soils on this information is impossible. However, in mapping we have to group, or if you like to call it so, classify our soils in some orderly fashion because there are too many individual units to handle separately. So long as we mutually understand what we are talking about that is all that matters.

I understand that what Mr. Stobbe suggests is a field classification which can be used for the grouping of soils immediately and until we reach a stage when scientific classification is possible.

In describing the mapping or the taxonomic unit it should be considered with its entire landscape and not only on its profile. What is a profile anyway? It is not constant and it varies in three dimensions, i.e. depth, width and breadth. There is, in most cases, no sharp division and one unit gradually merges into another so what could be called the taxonomic unit? These variations are so closely connected with the landscape that they can not be considered separately.

Prof. Ellis strongly objected to the use of the word catena, as catena means chain. As pointed out above the soils represent anything but a straight chain, they form a complex pattern.

Combination-Association. In Manitoba the soil combination is equivalent to the American association. The combination represents a geographic unit which has certain physiographic conditions in common.

Association - Catena. The association concept as proposed in the committee report corresponds to the U.S. Catena. Prof. Ellis pointed out that the word "association" had first been used in printed form in connection with soils work in Canada and that it had been defined in the same sense as in the committee report. He, therefore, claimed priority on the use and definition of this term.

Associate or Member - Series. The member or associate of an association corresponds to the series which is a taxonomic unit of the catena.

Textural class - Soil Type. The textural class of a member or associate corresponds to the soil type.

The Complex - as used in Manitoba represents an unmappable unit on mixed parent materials. However, if the parent material is more or less uniform such vairable unit would be mapped as an association.

This scheme as outlined by Mr. Stobbe is a tentative convenient and practical field classification which can be used and improved as the work proceeds.

DR. KELLOGG. It would be a geographic grouping for the present, based on vegetation, but not strictly on soil characteristics.

PROF. ELLIS. The nomenclature would give the impression, while actually it is not entirely true. The nomenclature is not satisfactory in all the present classifications. Take half bogs, bogs, etc., these terms are also not satisfactory as they imply too specific characteristics. Some half-bog soils may be what the name implies, yet there are many so-called half-bogs which are first class soils and are anything but what the name implies. We must map soils as they are now and group them in some logic manner.

DR. LEAHEY - The grassland and woodland soils are not separated on the bases of vegetation as the names would imply, but on the bases of certain characteristics. The trouble is there is a lack of suitable words to describe these characteristics.

PROF. ELLIS - The correct wording would be soils developed under grass and forest vegetation.

DR. KELLOGG - We should classify soils on basis of the relevant soil characteristics, not on the basis of causes.

MR. STOBBE - The Discussion has turned into a quibbling over terminology. We all know what we are talking about when we say "grassland" and "woodland" soils. We mean soils with certain characteristics. By grassland soils we mean soils developed in semi-arid and arid climates under grass vegetation. Soils in which the organic matter is well incorporated into the surface mineral layers; which ordinarily, except under certain alkali conditions, do not display a light coloured leached layer, and which usually, but not necessarily always, have a zone of lime accumulation. By woodland or forest soils we mean soils which have developped under more humid climates and under forest vegetation; soils in which there is an accumulation of organic matter on the surface of the soil and in which the organic matter is not so intimately mixed with the upper mineral horizons as in the grassland soils. The woodland soils usually have more intensely leached horizons which are often plainly visible due to their characteristic colour and structure. They lack the layer of lime accumulation except on parent materials high in lime where a high lime layer exists which is difficult to differentiate from the zone of accumulation found in the grassland soils. We all know these characteristics of the grassland and forest soils. The trouble is to find a suitable name which would describe these differences. I do not know of any name that would fit and if anyone can suggest the appropriate terms or words, I would be glad to substitute them in the report for grassland and woodland soils.

PROF. ELLIS - The committee has attempted to use such words as are available. The vegetative terms used are descriptive and not functional. We all know what they imply.

DR. LEAHEY - We do lack sufficient descriptive terms in soils work and it may become necessary to coin some words.

MR. STOBBE - In the U.S. attempts have been made to coin descriptive words such as pedalfers and pedocals. These words refer to very specific soil characteristics. We all know that these characteristics are not constant and as a result the classification based on these specific characteristics is now being abandoned. The conception that was originally held for pedocals and pedalfers is very close to what we mean by grassland and woodland soils.

In the U.S. the soils are mapped as they are seen. As I understand it they are not classified immediately in the survey reports, but later, when the large amount of material is organized, the soils are classified and placed in the respective categories. It would appear that in the field very little use is made of the classification scheme. What we need is a classification scheme that can be used immediately in the field and into which the known facts can be fitted as they are discovered. A system which will be of value to the surveyors in the field and which will assist them in presenting a better picture to the public of what they have found. I find that the U.S. system does not provide this assistance, while our suggested scheme, although imperfect, is much better in this respect.

While we are using this system we should never lose sight of the pedological and scientific concepts and such characteristics which determine the fundamental pedological groupings should be carefully recorded. This of course would be done automatically by our scheme if the soils are classified correctly. Later, at any time we desire, all our soils could be regrouped so that they would fall into the systematic pedological classification which is used across the line or any other improved scientific classification.

DR. KELLOGG - Our classification is used to synthesize the results of other research work. It matters here a great deal whether or not our classification is based on specific pedological units.

MR. STOBBE - I quite agree that research work must be based on pedological units. In the field our work does not differ to any marked degree from the work done across the line. What we are trying to do is group our soils as we go along in order to present a better picture of our findings and in order to show the general distribution of our soils and soil problems on maps for those people who have to do with the planning and administration of our agricultural problems. At the same time we are collecting basic information which can be used to regroup our soils to fit them into a pedological system of classification.

Perhaps the committee has not made this clear enough in their report. The proposed scheme is not set up to displace the principles of the pedological classification. If the committee desires the recommendations could be made so that both types of classification would be developed simultaneously.

DR. KELLOGG - We have had considerable trouble in fitting our primary soil units into higher categories. The inspectors in soil survey in the U.S. have been requested to prepare a key of the soils by whatever method seems the most logical to them. It turns out to be, in most cases, based on relief and soil moisture relationships on the one side and on soil parent materials on the other side.

PROF. ELLIS - If the soils were mapped with the association concept in mind this would be much simpler.

MR. STOBBE - What Dr. Kellogg has requested his men to do is just what we are trying to do. Only we ask our men to keep this in mind as they are mapping in order to avoid a lot of difficulties later on.

DR. KELLOGG - If soils are mapped accurately there is no serious difficulty. The most important thing is to get accurate soil boundaries established. Poor mapping is the biggest hazard.

MR. CHAPMAN - I have studied Mr. Stobbe's report and I believe it has not been made clear enough that the proposed classification scheme is a utilitarian classification and is not to be confused with a separate scientific pedological classification.

As I understand it now the association is identical with the catena. Vearch in Michigan has used the term land type which is a geographical unit and it is probably more inclusive than the catena or association. In Ontario probably 50% of our land has been water lain and it is often difficult to separate the different kinds of waterlain materials. I would, therefore, suggest that we relax our definition of an association to allow the inclusion of different materials.

PROF. ELLIS - Where one parent material overlaps on another or where one gradually changes to another in Manitoba we map it as a transition.

DR. LEAHEY - Objected to the use of land type as it has been used very loosely by all kinds of people. Economists have one meaning for it, agronomists another and the soil surveyors should not include it into any classification scheme, unless it were used to designate an unseparable complex.

PROF. MORWICK - Objected to the mapping of complexes as it leads to sloppy mapping. If a complex is allowed the surveyors tend to throw into it everything which is difficult to map.

MR. STOBBE - What would you do with a very complex mixture or jumble of soils? Would you try to separate every individual, or would you map it as the average or dominant type? In my opinion if it is impossible, i.e. too expensive and too time consuming, to separate the individual soils such area should be shown as a complex and the different soils which make up the complex should be listed if possible in order of dominance, rather than describe the area by the dominant soil which occurs.

MR. BOWSER - When is a complex area an association, a transition or a "Complex"?

PROF. ELLIS - Illustrated his conception of the definition of the above named units with the aid of diagrams on the black board. In brief an association contains the different members which are related to relief and moisture relationships all on the same parent material. A transition area is an association in which the parent material gradually changes from one kind to another and the soils on it differ sufficiently from the soils on each of the respective parent materials. A complex is a badly mixed area where the parent materials are so mixed that it is not practical to separate them.

The meeting was adjourned for lunch at 12 p.m.

AFTERNOON SESSION 1.30 p.m. May 8th

Discussion on classification (cont.)

MR. STOBBE suggested that the chairman call on the representatives from each province to express their opinions. As the report has been distributed to the members several years ago the members must have studied it and they must have a good idea whether the suggestions made are feasible.

MR. MOSS stated that in Saskatchewan a revision of their old classification, using series, had become necessary. This was partly due to the fact that their first survey was very broad and the series were wide and too inclusive. In their new classification they have done away with the series and introduced the association concept. However, their association does not agree entirely in all cases with the definition of the association in the committee report. Thus in the black zone a soil association of the black soils does not include the degraded black or the ground water podsols. The latter two are considered to be members of another zone.

MR. WICKLUND stated that the association concept has been used in Nova Scotia for the last three years and it has worked very satisfactory for reconnaissance work. For detailed surveys it may perhaps not work quite so satisfactorily and some modifications may have to be introduced. Difficulties may arise due to the similarity of many of the poorer drained members of the different associations.

MR. BARIL - The soil series, as defined by the U.S. Soil Survey are used by the provincial survey parties in Quebec and he believed that this method is superior to the proposed system. The greatest objection to using the proposed system is the lack of information regarding the different zones and sub-zones.

MR. FARSTAD can see no objections to the proposed system and he believes that it will work in B.C. although they are using the old series definitions because the work was started that way. Their biggest difficulty in British Columbia is the establishment of soil zones. Some of the soils on the Western Coast do not seem to fit into any of the recognized zones in Canada and sufficient information is not available in order to create new zones.

MR. WHITESIDE thinks that the association idea will meet the needs in P.E.I.

MR. AALUND - We have been using the association concept in N.B. for a long time, although we are calling the individual members of the association soil series. Although this system works generally quite well, it also has its difficulties. For example we have a soil which has been formed on a brown clay to clay loam till which has been derived from carboniferous sandstone. Generally the soils (Queens Association) on this material are gently undulating and are imperfectly drained. However in one area this same type of till covers strongly rolling and stony land, at a much higher elevation. The soil profile characteristics do not vary very markedly nor very consistently between the two sites. From an agricultural point of view these two soils differ greatly and they must be mapped separately. If these soils are classified according to the association concept they both should probably be members of the same association. They probably could be shown as different topographic or stony phases but the agricultural value of the soils differs so greatly that one would be hardly justified to place the soils in the same association. This is just an example of some of the difficulties that one may encounter with the association concept and I would be glad of any suggestions how to solve them.

PROF. ELLIS - The soils probably could be separated as different associates of the same association. The hilly land is probably an oromorphic member.

DR. KELLOGG - If the soils differ that much they would be shown as separate series by the U.S. Soil Survey.

THE CHAIRMAN closed the discussion on the report on Soil Classification and asked the sub-committee to reconsider their report in light of the discussion that has taken place and to prepare a summarized statement for Friday.

THE REPORT OF THE SUB-COMMITTEE
ON
LAND SETTLEMENT

Was presented by:-
DR. F.A. WYATT

Members of the Sub-Committee:-

Dr. F.A. Wyatt (Chairman)
Mr. J.E. Thériault
Dr. D.G. Laird

The revised report is reproduced below:

The following summary contains the information secured to date by the sub-committee on Land Settlement, and is arranged under the following headings: Value of Soil Survey for Land Settlement, Present Use of Soil Surveys in Directing Land Settlement, Types of Survey for Land Settlement, Form of Map and Report, and Possible Areas where Settlement Might Take Place.

A. Value of Soil Surveys for Land Settlement

(1) Virgin Lands - In the west these are principally wooded areas of gray soils.

(a) Delineates the poor land from the good, i.e., sets out the land that is possible of economic cultivation.

(b) Makes possible the blocking off of tracts in which there is sufficient arable land to warrant providing transportation, urban, and social facilities to a settlement. That is, it prevents sparse settlement which is costly to the state.

(c) Determines beforehand some of the possibilities of the land so that farm practices can become established in as little time as possible.

(d) Determines the adequate size of farm unit necessary to maintain a family over a reasonable period, that is, of sufficient size to allow for a farm practice that does not induce unnecessary deterioration.

(e) Determines the assistance that may be necessary to put prospective settlers on land so that they will reach a self-sustaining basis as soon as possible.

(2) Value of survey in abandoned land

(a) Determines best use of abandoned land, i.e., pasture, woodlot, recreation, or modified cropping.

(b) Helps determine how best the abandoned areas fit into a rehabilitation scheme, considering the social, etc. facilities already established.

(c) To prevent a recultivation of non-arable lands during favorable cycles (climatic and economic). Such cycles are costly and these areas should be relegated to a use that has in it a note of permanency.

B. Present Use of Soil Surveys in Directing Land Settlement

(1) P.F.R.A. drought area for relocation of settlement and readjustment in land use.

(2) Use of northern surveys in Alberta (and Saskatchewan) in withholding certain submarginal lands from homesteads.

(3) Present working of the Alberta Land Act requiring a soil report prior to granting a lease.

(4) Use of soil survey maps and land rating map by the economic land survey and farm management survey.

C. Types of Survey for Land Settlement

(1) In Virgin Areas -

(a) General reconnaissance to delineate broad areas in which a settlement could be placed. In this survey aerial photos would be of great value. Travelling in unoccupied timber-lands by pack train is extremely slow and expensive. Aerial photos could be used to eliminate obvious sub-marginal areas; such areas would be difficult to traverse on foot.

(b) Detailed reconnaissance of the better general areas to delineate the arable portions and to determine the soil characters and their potentialities in more detail.

(c) In such surveys items as the leaving of wood lots and the preventing of wholesale draining of muskegs would be valuable.

The object of this latter survey would be to determine adequate farm units with the arable portions delineated.

(2) In Abandoned Areas -

(a) A series type map.

(b) Conditions of abandoned soil; extent of deterioration, etc.

(c) Approximate rating of land on basis of past performance.

D. Form of Map and Report

(1) Map

(a) Series type map - showing phases that affect arability.

(b) Estimate of arable acres.

(c) Show topography, tree cover, drainage.

(2) Reports

(a) Description of soil type and its variations.

(b) Probable agricultural practice.

(c) Average climatic factors, if available, including temperature, rainfall and frost free period.

(d) Soil rating.

(e) Estimated cost of clearing, drainage.

(f) Social services available and any known facts regarding their establishment.

E. Possible Areas Where Settlement Might Take Place

No doubt there is the possibility of increased settlement in every province. The amount must be small in the maritime provinces. New lands which might be settled in the other provinces will require expensive improvements for clearing, breaking, providing irrigation waters, etc. Such preparation costs will vary from $40.00 to possibly $100.00 per acre, and will exert an influence upon the rate at which these lands will be brought under cultivation. Most of the remaining unsettled lands are to be found to the north of the present settled portions of Canada, and constitute a part of the podsol soil zones.

The latest estimates seem to be about as follows:

(1) B.C. interior and north of Prince George - $1\frac{3}{4}$ million acres; Peace River Block - $1\frac{1}{4}$ million acres; Total, 3 million (Dr. Hurd's figures).

(2) Alberta - 12 million acres of gray wooded soils (this is thought to be conservative).

(3) Saskatchewan - 3 million acres of gray wooded soils (this is less than 10% of the area of this wooded soil zone, exclusive of the Precambrian shield - this may be conservative).

(4) Manitoba - much less than Saskatchewan, probably below the one million mark.

(5) Ontario - chiefly in the Clay Belts (designated A and B grade lands suitable for full-time agriculture) - 4,450,000 acres (Dr. Hurd's figures).

(6) Quebec - estimates vary from 12 million acres downward. Dr. Hurd uses tentatively the figure of 7,500,000 acres. Much of this is in the northern clay belts.

(7) Maritime Provinces - $\frac{1}{2}$ million acres

(8) The Yukon and Northwest Territories - possibly about one million acres but further surveys and experimental work may considerably enlarge or reduce this estimate.

DISCUSSION OF THE REPORT ON LAND SETTLEMENT

DR. HOPKINS was pleased in the manner in which the report had been presented and was glad that Dr. Wyatt had suggested a certain amount of caution in opening new virgin areas. Dr. Hopkins felt that in many instances it was more economical and generally better for the settler to buy cleared land on already established farms than to settle in virgin bush areas.

Dr. Hopkins also felt that it was very important to find out first if crops could be grown satisfactorily in new virgin areas before the land is opened up for settlement.

DR. KELLOGG was glad to see that some consideration was given to the investigation of the soils in new areas before settlement was recommended. He stated that the history of land settlement in the U.S. is not too good as far as the investigation of the land is concerned. Much of the present difficulty with resettlement schemes is due to the fact that the land had not been thoroughly examined prior to settlement.

He was interested to know how the settlement in Quebec was proceeding, whether by gradual infiltration or by group settlement in virgin territory.

MR. BARIL said that he had not been in close touch with the land settlement in Quebec as it was carried out by a different department. However he was sure that most of the settlement conducted in Quebec was by groups in new territories and very little by infiltration into already established communities.

DR. LAIRD stated that in B.C. the survey work for settlement has been mainly confined to Rail Road belts in Central B.C. and is closely connected with the already established transportation system. This, he thought, is very important in establishing new settlements as supplies can be easier obtained and the produce can be easier marketed if the settlement is close to transportation routes.

He also pointed out that it is very important to estimate the amount of clearing that has to be done on new land. As the clearing can be very costly and recently the costs have gone up very rapidly. It is difficult to estimate the cost of clearing as it depends on a number of factors, such as, the size of trees, the species present, the density of growth and the type of machinery available for the purpose.

Other factors which must be considered in this type of survey are the roads, schools, churches and other social factors which have already been established in the area.

Accurate information on the climate and climatic variation should also be obtained for areas which are to be opened up for settlement.

Before land settlement is undertaken on a large scale in a new area the best use that the land is suitable for should be determined as best as possible, i.e. whether the land is best suited for forests and forest products, recreation, game, or for agricultural development. An attempt should also be made to establish what crops are best adapted to the soils and climatic conditions. This determines the type of farming that should be established and consequently the size of the farming unit. In planning new settlement districts the final landscape which will be the result of the final development should be kept in mind. That is, the proportion of land which should remain under forest in order to conserve the soil and in order to provide the necessary forest produce for the settler should be determined. Land also should be set aside for recreational purposes, etc.

Much of this work can not be considered as regular soil survey work, however, it is very important that it should be done. The surveyors are in a position to collect much information that will contribute toward the general picture.

DR. LEAHEY - It is difficult to determine where soil surveys should stop. The difficulty is that there usually are no other organizations which would take over and carry on from where the soil survey leaves off.

MR. BOWSER - Who should look after the problem of drainage or who could determine the question of water supply?

DR. LEAHEY - The geologists have been dealing with water resources and they should have some information on the water supply. Such problems should be called to the geologists attention.

MR. CHAPMAN - All problems related to water resources in Canada have been transferred to the geological surveys.

PROF. ELLIS expressed the opinion that the soil surveyors could give considerable information regarding the water resources of an area after the completion of a survey.

DR. LEAHEY suggested that if such problems as the status of the water resources of an area arise with which the soil survey can not cope, these problems should be called to the attention of the departments concerned and definite requests should be made. Other departments are always making requests and unless we are making our own requests the work in which we are interested in will not be done.

The discussion of the report on LAND SETTLEMENT was terminated and the sub-committee was requested to reconsider the report in light of the discussion which had taken place and to present their final views on Friday.

The meeting adjourned at 5 p.m.

WEDNESDAY, MAY 9th

9 a.m.-12 a.m.

THE REPORT OF THE SUB-COMMITTEE

ON

LANDSCAPE TERMINOLOGY

Was presented by:-

MR. H. MOSS

Members of Sub-Committee:-

Mr. H. Moss (Chairman)
Mr. H. Aalund
Mr. N.R. Richards

The revised report is given in the following pages:-

INTRODUCTION

Scope of Report. This sub-committee was requested by the National Soil Survey Committee to prepare a report dealing with those physical features other than soils that may be measured or described during the course of the soil survey.

The National Committee suggested that information on the above subject should be secured from the various Canadian soil survey organizations, and possibly from the United States as well. Finally, the National Committee desired the sub-committee, wherever possible, to draw conclusions and make recommendations on the basis of the information contained in the report.

In accordance with the above suggestions, the various soil survey organizations represented on the National Committee were requested in 1941 to supply the following information:-

(1) List of features mapped in the field, including topography, external drainage, stoniness, erosion, vegetative cover, and any others that do not deal directly with the soil.
(2) Methods used to measure and describe these features.
(3) The degree to which these features are shown on maps of different scale- reconnaissance, detailed reconnaissance, detailed, etc.
(4) Any suggestions or recommendations for the final report regarding features which may be adopted by all Canadian Soil Survey organizations.

Plan of Report. The report submitted below is based upon information secured in 1941 from most of the Canadian provinces, together with some material taken from other sources. The general form of the report was discussed in the sub-committee by means of correspondence, but it is obvious that the work was handicapped by the impossibility of the members meeting together. The report was also delayed until all available information was received, and hence it was not possible for the sub-committee to discuss each section of the report in advance.

In preparing the report, the material received from the various provinces was assembled under the headings of topography, drainage, erosion, stoniness and vegetation. For purposes of comparison all information relating to the classification of topography as used by Canadian soil survey organizations was grouped together. This information is referred to as Table 1. While much of the material does not lend itself to arrangement in tabular form, the use of the Table number facilitates references and comparisons made during the ensuing discussion. A similar procedure was followed in assembling the data for the other factors.

Finally it was decided to group Tables 1 to 5 and place them in a separate section of the report. By this means it was felt that one of the main objectives of the report could be attained - that of presenting the data secured by this sub-committee in a concise form. As far as possible, the text of the various tables is that used in the original communications received. In a few cases, less important details have been omitted, but it is hoped that the important features of each system of classification have been covered.

The various tables are discussed from the standpoint of the similarities and differences that exist between mapping systems in Canada. It is not always feasible in the discussion to separate the features shown on the final map from those recorded in the field. The scale and type of survey determine the degree to which field information can be shown on the published map. It is considered that the presentation and discussion of the methods used in the field are the most important features of this section of the report. The final section of the report deals with suggestions and recommendations arising out of the information previously discussed.

Table 1 - Classification of Topography in Canadian Soil Surveys

Nova Scotia

For detailed reconnaissance and reconnaissance surveys, topography has been described in the broad terms of level, undulating, rolling and hilly. No attempt was made to show these separations on the map. During the past season the following slope classifications have been used.

A - 0-3%	
B - 4-8%	These separations have been very arbitrary and
C - 9-15%	broadly applied; they have been shown on the
D - 16-25%	map by A, B, etc.
E - 25 or over.	

New Brunswick

Detailed reconnaissance surveys conducted. Slope is indicated on the map by capital letters. No reference made to other topographic descriptions.

A - 0-2½%
B - 2½%-7½%
C - 7½-15%
D - 15-25%
E - above 25.

Quebec (Macdonald College)

Most of the mapping done on reconnaissance scale. Slope symbols not shown on map, but may be ascertained from contours. Topographic separations not shown on map except to indicate outwash soils. On detailed maps degree and direction of slope are indicated by arrows and letters.

A - Flat land
B - 2-5%
C - 5-10%
D - 10-20%
E - over 20.

Quebec (Laboratoire de Sols) Ste. Anne de la Pocatière.

Degree and direction of slope are recorded. Local relief is shown in field note-book by a sketch indicating height of land in feet; with horizontal distances marked in chains. This information is presumably gathered where the soil is sampled or not shown on maps.

Ontario

Surveys presumably of detailed reconnaissance type. The present topographic classification is given below.

1. Very hilly or steep - commonly shown as a phase (steep phase)

2. Hilly
Commonly occurs in areas of terminal moraine and in areas badly dissected by stream courses. Ordinary machinery used, but heavier types with difficulty. Commonly mapped as well-drained series in a catena.

3. Rolling
Occurs chiefly in morainic and water-laid areas dissected by stream courses. Commonly mapped as well drained series in a catena.

4. Undulating
Occurs chiefly in areas of water-laid soils. Associated external drainage is imperfect. Artificial drainage required for lower positions only. Commonly mapped as the imperfect drained series in a catena.

5. Nearly level (Smooth)

Occurs chiefly in areas of water laid soils. Includes depressional sections of morainic areas. Poor to imperfect associated external drainage. Systematic artificial drainage necessary. Commonly mapped as poorly drained series in a catena.

These topographic phases are not shown on map as such. Each soil has characteristic topography which is indicated on legend or report.

Manitoba

On the field sheets dunes, escarpments, sharp morainic hills and such features are shown by brown hatchering or symbols. These notations refer to the two-inch to the mile maps which we are using in the reconnaissance survey. These features are also shown on the soil map prepared from the field sheets. In the reconnaissance mapping which we are now doing, topography is described, not measured or expressed mathematically.

General configuration within each soil boundary should be marked on the township map. It should be descriped as

Flat, (as wet hydromorphic areas)
Level or plain
Undulating, (smoothly, gently, sharply, roughly)
Morainic, (knob and basin topography)
Rolling, (gently, smoothly, strongly)
Sloping, (gently, moderately or steeply)
Hilly
Pot holes, depressions, or basins

Escarpments, beaches, sharp hills, etc. should be shown by hatchering.

The above notations should be marked across the area enclosed by the soil boundary in a suitable place, or (if possible) at the point where they occur.

Saskatchewan

The following topographic classes may be shown separately on detailed - reconnaissance and detailed maps, and also recorded on field mapping sheets of reconnaissance surveys.

Class	Slope %	Frequency
A Level to depressional	0-1	0
B Gently undulating	1-2½	2 or less
C Moderately undulating	2½-6	2 " "
D Strongly undulating	above 6	1
F Very gently rolling	2-4	3 or more
G Gently rolling	5-8	3 " "
M Moderately rolling	8-15	3 " "
H Strongly rolling-hilly	(15 -	3) " "
	or	
	(25 +	1) " "

Er. Eroded land class - rough broken land, steep coulees, escarpments, etc. Sand dune areas.

Frequency refers to the number of complete rolls, from ridge to ridge, occurring per half mile. Class D (strongly undulating) has not been encountered very often. It is suggested that the steeper slopes of low frequency be mapped with gently to moderately rolling on account of the agricultural problems relating to water retention and erosion. Thus slopes of 7-9% with frequency 2 may be included in class G. Slopes above 10% with frequency 2 may be included in class M. In most cases, frequencies of rolling classes are above 3. It is planned to revive the topography classification in order to define lengths of slope.

In addition to the above classes, which are shown on detailed and detailed reconnaissance maps by letters placed in the 4 points mapping symbol, special symbols are used to indicate wind eroded pits, recent hummocks or small dunes, etc. (See Table 3).

For reconnaissance maps, it is necessary to combine a number of the above classes. On these maps, topography is shown by hatching, eroded land by special symbol and colour.

Topographic Classes for Reconnaissance Maps

Depressional - (A class). Shown by depression symbol or included under associated soils - notably saline (Alkaline), alluvium and poorly drained phases.

Undulating - Includes B and C topography.

Mixed undulating and rolling - Includes areas composed of small belts of undulating and rolling topography which cannot be shown separately on small scale maps. Also used for areas of F topography, representing best rolling land from standpoint of agriculture.

Gently to moderately rolling - Includes G to M topography and also D if present.

Strongly rolling to hilly - H topography
Eroded (Er.) as defined above.
Sand dunes

Alberta

Topography applied to Reconnaissance Surveys.

Level - Flat to few gentle irregularities, irrigable topography.

Undulating - uniform low waves or undules, generally not over 5 per mile. Easily cultivated and no marked water erosion. (Level and undulating symbols are placed on field map, but areas of each type are not shown separately).

Gently rolling - Long uniform slopes or low frequent undules. Some possibility of water erosion.

Rolling - High hills with long uniform slopes, or more choppy gently rolling topography. As a guide hills are generally over 30-40 feet high and slopes greater than 5%. This topography regarded as arable.

Hilly - Average slope 10% or more. Slope erosion usually sufficient to produce truncated profile. In general considered as non-arable for cultivated crops. (The above classification may also be used for detailed surveys, but degree and direction of slope are also measured and shown on the final map.)

British Columbia

Relief is covered by the following factors, shown on the final map by base map symbols or by special symbols used by the soil survey.

Gently undulating land		1-3% slope
Morainal topography	(a) up to 15% slope.	Moderate (arable).
	(b) above 15%-20% slope.	Steep (non-arable).
Eroded		
Rough mountainous land		
Bluffs	(a) rocky (or contours)	
	(b) other than rocky (or contours)	
Washes		

The term morainal is suggested in place of rolling for certain B.C. topography formed by retreating ice. Morainal topography, particularly in boulder clay soils, is more or less common, while topography with wave-like rolls is rare. A variation of the morainal type is associated with kettle holes. To date no rolling topography has been mapped.

Table 2 - Classification of Drainage Features in Canadian Soil Surveys

Nova Scotia

External drainage is not shown on the map, but is referred to under soil series descriptions as rapid, adequate, or slow. No definite method used to measure external drainage. Rivers, lakes and other features shown on base maps, are of course included in the soil map. (This applies to all provinces.)

New Brunswick

No reference to classification of drainage. It is stated that external drainage is shown on the final map.

Quebec

Drainage covered in soil series descriptions.

Ontario

The following drainage classes are indicated on the map by series or phases.

1. Excessive, associated with hilly topography.
2. Good " " strongly undulating to rolling topography.
3. Imperfect " " undulating "
4. Poor (slow) " " almost level topography.
5. Very poor (very slow) " level and depressional "

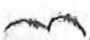
Manitoba

All water is shown in blue. All water detail as shown on the field maps is transferred to the final soil map.

Swamps, water courses, rivers, lakes, drainage channels should be shown in blue, either by continuous lines if perennial, or by broken lines if intermittent, as on former maps.

Saskatchewan

General drainage conditions are covered in descriptions of soil types. Drainage features shown on all maps, subject to limitations of the size of area, that can be separated.

 Flat-depressional land, poorly drained and liable to flooding.

 Marsh.

(M) Muskeg (Bog soil)

(◇) Slough or pot-hole.

In detailed maps of irrigation projects, local drainage is indicated in 4 point symbol and differentiated as follows:

(1) Well drained soil.
(2) Moderately well drained surface, poorly drained subsoil.
(3) Poorly drained throughout - lowland liable to flooding.

In addition to the above features, which are shown on the soil map whenever the scale permits, a rough estimate of the percentage of poorly drained land is sometimes entered on the field sheets. This poorly drained land is commonly associated with glacial soils, and consists of "sloughs" or depressions, marshy areas, etc., that are too small and often too numerous to be shown on the map.

sl 1 up to 25% of area consists of sloughs and other poorly drained areas that are chiefly non-arable and frequently saline.
sl 2 25 to 50% sloughs, etc.
sl 3 over 50% " "

Alberta

General drainage conditions are covered in descriptions of soil types. Non-permanent lakes, alkali and marshy areas are shown on the map by appropriate symbols and colours.

British Columbia

General drainage conditions covered in descriptions of soil types. No indication of the particular drainage features which may be shown on the map, other than those forming excessive and restricted drainage phases.

Table 3 - Classification of Erosion in Canadian Soil Surveys

Nova Scotia

Possibilities of erosion are discussed under soil descriptions, from standpoint of texture and slope. No attempt made so far to measure or to describe the degree of erosion.

New Brunswick

No reference to erosion.
Rock outcrops shown by usual symbol.
LI- lime outcrops.

Quebec

Erosion not mapped so far, since in areas surveyed to date erosion is not an important factor. Tendency of soil type to erode presumably covered in soil descriptions.

Rock outcrops shown by usual symbols, each representing certain acreage.

Ontario

Erosion classes shown on the map.

1. Very severe wind erosion.
All topsoil and 75% or more of subsoil removed. Commonly parent material has been eroded. Accumulations 1 to 6 feet or more.

Mapped as Bridgman series.

2. Large Dunes.
Six feet or more. If of recent formation indicated on map as Eastport series.

3. Very severe sheet erosion.
Sheet erosion of lower B and C-horizon or of lower horizons. Mapped as eroded or steep phase.

No other classes have been separated in the field. Soil type descriptions, however, indicate the other classes which may occur. Further field separations by additional classes does not seem advisable under Ontario conditions.

Manitoba

Erosion symbols, as shown in the accompanying notes, are placed on the field sheets, but they are not transferred to the completed map because the condition of erosion is not a constant but is subject to change. Thus, notations made on the field sheets give a record of the condition at the time of observation, and the condition and type of erosion is taken care of in the written report rather than on the map.

Soils which are injured by erosion should be noted.

Sheet erosion - E_1
Rill erosion - E_2
Gully erosion - E_3

Wind eroded soils, (I.E., soil removed by drifting), should be designated according to the degree of erosion as D_1, D_2, D_3, D_4, D_5.

These symbols refer to the amount of material removed. D_5 to be considered as removal of soil down to the parent material.

Saskatchewan

Erosion not shown on reconnaissance maps, other than eroded and dune lands described under topography. Tendency of soil type to be affected by wind erosion has been discussed in all survey reports. Considerable data is however, recorded on the field map sheets.

In more detailed survey, where the 4 point mapping symbol has been used, both wind and water erosion are indicated. In the first maps of this type only a partial classification was used. More recently the classification given below has been employed. This is largely a modification of the system used by the United States Soil Conservation Survey.

Wind Erosion

do - No accelerated erosion.
d1 - Slight erosion. Little damage to soil or crop. Patchy surface drifting but no serious or widespread loss of structure.
d2 - Moderate erosion. Definite damage to soil and crop. Part of A horizon removed or disturbed, with consequent loss of original surface structure. Fence accumulations 6" or more, some small field accumulations. Erosion control methods required.
d3 - Severe erosion. Most of A horizon removed for area as a whole, and in places B horizon exposed. Growing crop badly damaged. Accumulations up to 3 feet. Shallow "blow-pits" with B_1 horizon, eroded. Emergency control measures required.
d4 - Very severe erosion. Original profile largely destroyed and crop production impossible. C horizon penetrated in blow-pits. B_1 horizon removed from field as a whole or else buried under small dunes 3'-6' high.

Above symbols refer to active erosion at the time of mapping. Where stabilization has occurred through establishment of natural or seeded vegetation, the symbol is underscored thus: $\underline{d_2}$.

In cases of d_3 and d_4, where micro-relief of the area is affected by erosion, the following symbols may be placed on the map:

4 - Recent dune, - accumulation; number indicates height in feet.

5 - "Blow-pit", - removal; number indicates depth in feet.

Hummocky - mixed removals and accumulations, underscore if stabilized.

Water Erosion Modification of U.S. Conservation System.

Wo	No accelerated erosion.	
W1	Slight sheet or rill erosion.	In regard to effect on
W2	Moderate " " "	original profile, these
W3	Severe " " "	classes correspond
W4	Very severe " "	roughly to drifting (do-D4)

Gully Erosion, as defined in U.S. S.C.S., - eroded channels too large to be obliterated by normal tillage.

Class	Symbol	
A	E	Gully which cannot be obliterated by normal tillage but which may be crossed by implements.
B	(E)	Gully which cannot be crossed by implements, and which has penetrated compact B or C horizon.
C	E	Gully which cannot be crossed by implements, and which has penetrated a loose, friable C horizon.
	E	Example of gully and class symbol used on map.

Alberta

Soil Drifting is coded and shown on field sheet on a quarter-section basis, as d_1 to d_4.

D1 - slight surface removal, but considerable part of A horizon still present.

D4 - blown out to subsoil - at present unfit for normal crop production. Above information expressed on final map only in an indirect way, but is discussed in the report. Eroded lands indicated on map by colour. It includes eroded grass-covered banks or escarpments and exposed bedrock (bad lands). In general such land is non-arable.

Rock outcrop symbol is used to indicate protruding bed-rock.

British Columbia

Eroded land indicated on map, presumably by colour. Sand spots indicated by dots.

Rock outcrops shown by usual symbol.

Table 4 - Classification of Stoniness in Canadian Soil Surveys

Nova Scotia

Stoniness or presence of rock material on the surface has been covered in soil descriptions. On earlier maps the following symbols were used:

X	Gravelly
R	Large stones or boulders - sufficient to restrict clearing or make the land unsuitable for agricultural use.

At the present time the following system is being used and shown on the map.

St_1	Comparatively stone free or only a few large stones.
St_2	Stones common, could be cleared profitably.
St_3	Stones plentiful, doubtful as to advisability of clearing.
St_4	Very stony, unfit for agricultural use.

New Brunswick

The following stony classes appear on the map:

St_0	Stone free.
St_1	Occasional stones.
St_2	Moderately stony.
St_3	Very stony- serious handicap to farming
St_4	Stony phase - non arable

Quebec

St_0	Stone free.
St_1	Occasional stones.
St_2	Moderately stony - requiring removal.
St_3	Very stony - serious handicap to cultivation.
St_4	Excessively stony - non-arable.

Above degrees of stoniness mapped in field, but not shown on final map.

Ontario

List of stony factors recorded in field.

Quantity of stone

1. Stone-free - indicated on maps by soil developed on lacustrine marine and outwash materials.

2. Few - (visible effect on soil mass and its utilization is negligible). Indicated on maps by soil series developed on ground moraine covered by lacustrine deposit, and by water-laid moraines.

3. Frequent - (visible effects in soil mass, and sufficient to affect utilization). Indicated by series developed on rougher moraines.

4. Stony or bouldery - (Enough boulders over 8" diameter to interfere with cultivation. Mapped as boulder phase.

Degree of Stoniness of Surface Soil

1. Gravelly soil - 30% or more of stones 2 mm. - 2 inches diameter. Indicated on map by types developed on outwash.

2. Pebbly soil - 30% or more of rounded stones up to 4" diameter. Sufficient stones to affect utilization.

3. Shingly soil - 30% or more of angular fragments up to 4" diameter.

4. Cobbly soil - 30% or more of rounded stones from gravel size up to 8" diameter. Sufficient larger stones to materially influence tillage practice.

5. Rubbly soil - 30% or more of angular limestone fragments up to 8" in length.

6. Cherty soil - 30% or more of angular fragments of siliceous stones up to 8" in length.

Size of stones	Rounded	Angular
Up to 2"	Gravel	Gravel (coarse grit)
2" - 4"	Pebbles	Shingles
4" - 8"	Cobbles	Rubbles
Above 8"	Boulders	Boulders (large fragments).

Manitoba

In reconnaissance mapping the symbol for stone is put in where the stones are observed. The degree of stoniness is shown by the symbols in the accompanying notes. However, in the final map, the symbol for stones is only shown where stones are sufficiently numerous to seriously interfere with cultivation.

Local gravelly areas should be marked Gr. Gravel beaches should be outlined by herring-bone shading.

Land containing stones should be marked:-

St - slightly stony,
St sufficiently stony to interfere with cultivation.
St + very stony; stones responsible for the land not being broken.

Saskatchewan

On reconnaissance maps, only stony phases corresponding to St_4 and gravelly phases are shown. On detailed maps and on field sheets in all surveys the following classification is shown on each 1/4 section.

St_0	Stone free.
St_1	Occasional stones.
St_2	Moderately stony - requiring removal.
St_3	Very stony - serious handicap to cultivation.
St_4	Excessively stony - non-arable. On map shown as (St) following series symbol, and indicating stony phase.
Gr.	Gravel - where continuous gravel subsoil occurs, mapped by (Gr) after series symbol, indicating gravelly phase.
St(a) 1 etc.	Pebble size - removed by wagon.
St(b) 1 etc.	Chiefly boulders - too large for wagon.
Q	Quartzite pebbles.

Alberta

Gr (gravelly) and St (stony) on map as prefixes to series type notation. Otherwise stoniness discussed in report.

On field township plans stones are mapped per 1/4 section.

S_0	practically stone free.
S_1	
S_2	
S_3	
S_4	unfit for cultivation.

British Columbia

Stony and gravelly phases mapped.

Table 5 - Classification of Vegetative Cover in Canadian Soil Survey

Nova Scotia

Observations and notes are taken describing the general character of the forest cover as shown by the general plant associations, the predominant species being recognized. Where possible the ground cover is described. Observations of the dominant weeds and grasses in clearings and pasture fields. Presumably vegetative cover is not shown on the map.

New Brunswick

Woods and cleared land were differentiated in the first two years of survey, but this feature was later omitted owing to the expense of printing.

Quebec

Native vegetation of each soil type, and pasture plants are described in the report.

Ontario

Vegetative cover not indicated on the map. Records are made of the botanical composition of forests and natural pastures. Common cultivated crops are also noted. Correlations between tree associations and soil series have been made. Original tree cover recorded where possible. Correlations have also been recorded between dominant grass associations in permanent pastures. Sometimes the vegetation is checked by the quadrat where soil samples are taken. The pasture is traversed and the plants are checked off at each sampling point. Plants representing 5% or more of the ground cover are recorded. The following classification is made when summarizing pastures on a given type.

Dominant - species constituting a plant association; e.g. Kentucky blue-grass association.

Abundant - Found on almost every pasture, often may be reported as per cent.

Common - Found in fairly large numbers in at least one half of the pastures.

Occasional - Noted in small quantities in few pastures.

The percentage cover of a group (e.g. Weeds) as a whole is also generally recorded.

Manitoba

The only notes on the field sheets of vegetative cover are for swamp areas. The vegetation on the respective soil types mapped is taken care of separately in the report and shown by tabulation of the species occurring on the different soil types. The reason for not making notations on the map up to the present time has been that we have been working over the occupied portion of the province. In the virgin areas a different policy may be required.

Saskatchewan

Vegetative cover not shown on ordinary survey maps. Information regarding native vegetation and land use is recorded on the township plans in the field. In particular cultivated, abandoned and wooded features are noted.

K cultivated (K_{10} estimated 100 acres cultivated etc.)
Ab abandoned cultivated land.

H hayland, chiefly native hay in non-arable lowlands.
gs grass cover, undifferentiated.
sc scrub.
T Trees (various symbols are used to denote dominant as Ta-aspen, etc.)
wd weeds.
M Muskeg (bog), with 18 inches of raw peat surface.
18 Muskeg with tamerack cover. (Other symbol used for black spruce, etc.)
(t) A tentative classification of the size of trees has been suggested for use in the soil survey of northern Saskatchewan. The basis for this system is not yet fully established.

In detailed surveys of irrigation projects, vegetation and land use are shown as one of the main factors of the 4 point mapping symbol. Since these surveys are of a special nature and are not applicable to the country as a whole, the details regarding vegetation and land use are not included here.

Alberta

Vegetable cover noted occasionally on township plans, but more often in field note-books. Information includes native vegetation, weeds and cultivated crops. The information on the above features and tree cover also are secured by a rapid traverse of an area after it has been covered by the soil survey. Type samples of the vegetative cover are collected.

Details regarding cultivation are placed on the township plans, and refer to individual quarter-section units.

Examples:	C	120 acres or more cultivated.
	Cp3	80 to 120 acres cultivated.
	Cp2	40-80 " "
	Cp1	below 40 " "
	A C	abandoned cultivation.
	A Cp	" " (patchy)
	I	irrigated field.

A small map showing distribution of cultivated lands is included with the report.

British Columbia

Vegetative features which apply to forested areas, intended to be shown on a land classification map:

Light clearing (sub-climax growth)
Heavy clearing (climax growth)

Examples of the above types of cover as they occur in the province are given. In general, the climax forest (sub-alpine type) is regarded as too heavy for clearing and settlement.

DISCUSSION OF CLASSIFICATION SYSTEMS LISTED IN TABLES 1 to 5

Topography - From the information assembled under Table I, it is evident that two main systems of classifying topography are in use in this country. They are: (1) slope classes based upon defined ranges of slope as expressed in percentage; (2) descriptive topographical terms, such as undulating, rolling, etc. In several provinces these two systems are partly combined and in one topography is defined by a combination of slope, frequency and descriptive terminology.

It will be noted that in some provinces topography is not shown on the map, but is covered in soil type descriptions. Where topography is shown, it is evident that the number of classes that can be indicated on small scale maps is limited. However, subject to the scale of mapping used in the field, any number of topographic classes may be shown on the field sheets.

In several provinces topographic classes are described partly in relation to the potential erosion, and partly to soil drainage and tillage difficulties associated with specific topographic conditions.

It is evident that local conditions of relief, type of survey conducted, and form of base map available, have all influenced the methods used to classify topography. But making full allowance for these modifying factors, it is plain that widely differing systems of topographic classification are in use throughout Canada. However, considerable information has been assembled, and it is evident too that the various Canadian soil survey organizations are keenly interested in this important soil mapping factor. It may be assumed that relief is discussed in all soil reports.

External drainage. In many instances the information secured on drainage included a list of such features as rivers, lakes, etc. It was felt that these features belong to the base map and as such may form part of the work of the sub-committee on soil maps and reports. In any event, for reconnaissance surveys at least, prominent external drainage features are generally accepted as shown on the base maps.

A glance at Table 2 will indicate that in most cases soil drainage classes are shown separately on the soil map. They are usually covered in soil type descriptions. In one province a range of drainage conditions from excessive to very poor is indicated on the map by soil series or phases. In another province soil phases described as "excessively drained", and "drainage restricted" are shown on the map. In provinces where saline (alkali) areas are frequently encountered, such areas are indicated on the map by appropriate symbols and colours. Marshy areas are indicated in most cases by the conventional symbol. Alluvial soils of depressional topography and muskeg areas or bog soils are mapped in one case, while rough estimations of the percentage of poorly drained local areas are recorded on the field sheets.

It would appear from the information assembled in Table 2 that drainage features are not mapped to the same extent as topography. This is partly due to the fact that drainage is covered to a considerable extent in soil type descriptions and in topographic descriptions or phases. Furthermore, in some cases poorly drained areas are too small to be shown separately on the reconnaissance map. The internal drainage of the soil profile has to be taken into account in classifying and mapping soils, and this feature is also related to external drainage conditions. Hence it would seem that drainage features must be discussed along with soil type characters, irrespective of whether or not drainage classes are shown on the map.

Erosion - The information presented in Table 3 indicates that where soil erosion is mapped, two methods are in use. In the first, erosion is covered on the map by the soil series and phase. The second method consists of indicating erosion by symbols on the field sheets, and where the scale of mapping permits, on the final map also. The tendency of the soil type to erode is also discussed under soil descriptions, and where erosion is not mapped, this is the method used to cover this factor.

In several instances the information shows that wind and water erosion are recognized as separate parts of the erosion factor. In other cases, however, no intimation is given as to the form of erosion.

The above remarks apply to accelerated erosion. In several provinces eroded land is shown on the map by a special symbol and colour. This feature may include recent erosion, but in the main applies to rough, broken topography formed by geological erosion. Hence such areas may be regarded as relief or topographic features. A similar condition exists in the case of old sand dune areas, which are usually shown on the map by a standard symbol.

It is evident that considerable variation exists across Canada in the methods of mapping erosion and in the degree to which erosion is classified. However, it is obvious that the kind and degree of erosion encountered in any area will largely determine the extent to which this factor is recognized. It is unlikely that erosion can be satisfactorily classified until it is encountered in the field. It is evident too that a comprehensive system of classifying erosion requires the detailed or detailed reconnaissance soil survey if the system is to be expressed on the final map. On the other hand the establishment of erosion classes enables the soil survey party to record a considerable amount of valuable information on the field mapping sheets in any type of survey.

Stoniness - A glance at Table 4 will suggest that a greater measure of uniformity exists in regard to the classification of stoniness than in regard to any other factor. Five provinces follow essentially the same method - using five classes, ranging from stone-free to non-arable on account of stoniness. The feature of this classification is that the degrees of stoniness are related to their effect upon the agricultural use of the land.

The above stony classes are shown on the map in two provinces. Otherwise, they are not shown on the reconnaissance map, but are recorded on the field mapping sheets. They may be shown, however, on more detailed maps. In nearly all surveys stony and gravelly phases of soil types are shown on the reconnaissance map.

In one province stoniness is shown partly by soil series and partly by phases. In this system the stones encountered in the field have been classified according to size and shape. A less detailed method indicating variations in size is used in another province. Otherwise, no reference is made to the size of the stones. It may be assumed that the factor of stoniness is discussed in the soil survey reports of all provinces.

Vegetative Cover - As indicated in Table 5, the vegetative cover is not shown on the ordinary soil maps. But it is evident that considerable information regarding vegetation is secured in the field. In several provinces a partial classification of the vegetative cover is made, and is recorded on the field mapping sheets. In at least two provinces field notes covering native vegetation, cultivated land, abandonment, weeds, etc. are recorded. Such information is more strictly a classification of land use than of vegetation. However, it is information that can be secured by the soil survey and hence may logically be discussed in the present section.

It will also be noted that in one system vegetation and land use are shown on the detailed maps of irrigation projects. In another instance records and data are secured of the botanical composition of forests and natural pastures during the course of the ordinary soil survey.

SUGGESTIONS AND RECOMMENDATIONS RECEIVED BY THE SUB-COMMITTEE

The various Canadian soil survey organizations approached by the sub-committee in 1941 were requested to forward suggestions or recommendations covering physical features which might be adopted by all Canadian soil surveys. This request was not compiled with in all cases, but those answers received are given below.

(1) Lack of uniformity both in field and laboratory investigations is one of the greatest weaknesses in soil survey work. The interpretation or application of terminology to practical use is in a large measure a case of individual estimation and judgment. Nevertheless, the simpler and more uniform the soil terms are, the better it will be for agriculture and our own progress.

This correspondent also suggests that topography should be defined by terms such as level, rolling, etc. rather than by attempting to assign measurable limits which in the nature of the survey are uncertain in their application. Furthermore, all measurable changes in topography cannot be shown on the reconnaissance scale map.

It is recommended that the terminology for stoniness should be simple and flexible, and that it should recognize size of rock material as well as quantity. The system should provide for the separation of large surface boulders from rock material of smaller dimension. He notes that farmers will often remove a few large boulders, but will not clear a mass of smaller stones.

(2) In another case, reference is made to the mapping fraction as providing an easier method of carrying information and this system is recommended for use by Canadian soil surveys.

(3) From another correspondent comes the suggestion that terms used by the soil surveyors, and borrowed from the geologist, should be defined. Examples given include outwash, alluvium, deluvium, hummock, bluff, kame, plateau.

(4) Another source points out that the features covered in this report are in many cases local problems, or at least they have been treated with regard to local conditions. Thus land mapped as hilly and hence regarded as non-arable by one province may not be so considered by another. Furthermore, a system that would take in all requirements of all the provinces might be cumbersome and unwieldy to the individual province. These statements are not made to discourage uniformity, but rather to suggest caution in implementing it. It is certain that some standards can be set.

(5) In another case, it is recommended that soil surveys should be based on aerial photography; that morainal topography might be distinguished in most glaciated areas, and that in some cases the grading of forest cover is important.

CONCLUSIONS AND RECOMMENDATIONS OF THE SUB-COMMITTEE

Final recommendations of the Sub-Committee cannot be submitted at this stage, since the members have not yet had the opportunity of reviewing all the material assembled in the report. Suggestions embodied in the following discussion are, therefore, of a tentative nature, and are subject to the approval of the Sub-Committee as a whole.

1. It is suggested that final recommendations cannot be made by the sub-committee in a preliminary report. Such a report may form the basis for a discussion of the whole subject by the National Soil Survey Committee. We may, therefore, express the hope that a meeting of the National Committee will be held this year. If the basis of a uniform system can be adopted at the meeting, the details may be left to a special committee.

2. In attempting to achieve standardization of soil survey methods, it is important to differentiate between features shown on the published map and those recorded on field mapping sheets or described in note books.

3. In connection with the above statement, it may be pointed out that in ordinary soil surveys, much more information is secured in the field than can be shown on the final map. This material is extremely useful to the province in which it is secured. In many cases specific information requested on individual land parcels or on land areas may be obtained from the soil survey field sheets and notes. It is suggested that in regard to this type of information, uniformity of methods is not required and may not even be desirable. Local physical features may require special classification and special methods of recording data in the field. In each province additions are constantly being made to the field mapping symbols and descriptions. It is of course desirable that as much as possible of this field data should be shown on the published map.

4. It is, therefore, suggested that those physical features that are to be shown on the published map constitute the chief problem in the adoption of standard survey methods for Canada.

5. It is suggested that one of the first objectives is the standardization of terms and symbols already in use. To give an example, topography may be classified as gently rolling by a number of soil survey organizations. The descriptions of this topographic class, the methods of defining it, and the means of expressing it on maps may all differ between the various soil surveys. The material listed in Tables 1 to 5 will suggest other examples illustrating this point.

6. In connection with the above statement it is suggested that while complete standardization is desirable, it is most important to reach agreement on the definition of the physical factor involved. Using the above example again, it is more important to agree that the term "gently rolling" will have the same meaning in all soil surveys, than merely to reach uniformity in the method of expressing it on the map.

7. Whatever mapping factors may be adopted, it will be necessary to decide the degree to which they can be shown on different types of soil maps. Reconnaissance, detailed reconnaissance, and detailed soil maps represent not only differences in scale of mapping, but also differences in methods and objectives of the soil survey. Furthermore, in the case of special surveys, such as those of irrigation projects, it may be necessary to show on the map certain features not usually included in ordinary soil surveys.

8. Finally, it is suggested that one of the most important requirements for the establishment of uniformity in soil survey methods is the existence of a permanent staff of highly trained soil scientists or pedologists. Factors of permanency of employment, salary, title, promotion, etc. among pedologists vary throughout Canada, both within the Dominion service and as between Dominion and Provincial soil survey staffs. In addition the lack of adequate room and other facilities is frequently a serious handicap to efficient work. While this subject is not within the scope of this sub-committee's activities, it is presented here because the members of the sub-committee feel it is of vital importance to the future development of soil survey work in Canada. Furthermore, the question of personnel has not been raised by any other sub-committee.

DISCUSSION OF REPORT ON LANDSCAPE TERMINOLOGY

Mr. STOBBE - The question of landscape and the terminology which is used to describe it is very important and it can not be entirely divorced from soil mapping. Every soil type or series has a particular characteristic type of landscape and unless the landscape of each soil unit is fully described the job of mapping is not done properly.

The question is how much of the landscape variations should be shown in the maps and what should be described in the reports? In many provinces all references to landscapes are found in the reports, while in other provinces some landscape features are shown on the map. If these features are described in the report they should be presented in an orderly fashion so that they can be referred to with ease. However, in view of the fact that many users of the map do not read their reports carefully enough, as many landscape features as possible should be indicated on the map as well as described in the report.

Difficulty often arises in the field in determining significant differences in degree, such as differences in slope, or stoniness, etc., which should be indicated on the map.

Differences which are indicated must be clearly defined in order to prevent confusion and also in order to bring about as much uniformity between various survey organizations as is practical. Final agreement can only be brought about by correlation in the field.

It is also very important to define clearly the terminology which is used in describing the landscape and some closer agreement should be obtained in terminology. The use of the wrong terminology often exaggerates comparatively small differences in the field.

MR. LAJOIE - Would like further information in regard to descriptive versus measurable terminology.

MR. MOSS - It is often hard to describe differences in landscape sufficiently so that the soils can be separated according to the descriptions and some quantitative measure should be introduced where possible. As an example in Saskatchewan they have tried to measure topography by the degree of the average slope and the number of rolls within a mile. This is easier in Saskatchewan than in some other provinces in view of the existing civil land divisions.

MR. LAJOIE - Would it be possible to measure topographic differences from topographic maps?

MR. MOSS - Although topographic maps do indicate the general lay of land, they usually do not indicate topographic differences which have to be shown on soil maps and they are, therefore, of very limited value for this purpose.

PROF. ELLIS - In establishing topographic differences one must start off with the principle that everything deviates from a level plain in form and in degree. These differences, at least in form, can not be measured in degrees of slope nor in the number of rolls in a given distance, they must be described.

MR. MOSS - In the early surveys in Saskatchewan topographic differences were defined in descriptive terms in order to present a picture of the landscape and to indicate any possible effect on land use. They worked fine as long as one considered such broad areas as the Regina plains, the Missouri Coteau, etc., they gave a broad picture of the landscape and coincided roughly with land use. In these reconnaissance surveys the topographic terms which were assigned to an area usually depended on the experience of the individual and on the type of country which had been surveyed last, because no definite measurements were used to check the topography.

MR. AALUND - External topographic features are problems of geometry and a universal system of measuring same should be devisable for Canada.

DR. KELLOGG - The U.S. Soil Survey has had five technical committees working on the subject matter of this one report for three years.

Every soil scientist must decide what should go into the note book and what should be shown on the map. This is often most difficult. Only features which are relevant should be shown on the map. As far as slopes are concerned this differs in different areas. In some cases a small slope difference is very important, while in other areas it has no significance. For example, some

Rendzina soils do not erode at $\frac{1}{2}$% slope but erode severely at a 1% slope while most soils do not erode to any marked degree at a 1% slope. It would be foolish to indicate such small differences in ordinary soils. It is hard to get all relevant differences, and only these, indicated by the soil map.

In soil survey work the legends should be controlled and the necessary revisions in them should be made as the occasion arises. The fractional system of symbols, uncontrolled, is not used in the U.S. Soil Survey. It has two very serious faults: (1) It has the implied assumption that every combination is possible which is not the case and (2) it provides an uncontrolled legend, allowing the individual mappers to set up, unconsciously, all sorts of units. Experiences in the U.S. with the fractional symbols have not been satisfactory. In some cases as many as 10,000 separations are shown, where as only about 150 are relevant. In such an instance it is obvious that the mapper tried to put on the map many things that should have gone only in his notebook. The landscape was analysed, but the task of classification, a prime responsibility of the soil survey party - was neatly avoided.

In mapping individual features two things have to be considered (1) Establishment of classes of individual features, such as, slope, pH, texture, and structure, and (2) combinations of differences of all soil features. Often differences in some one feature coincides with differences in other features.

In the case of stoniness - if all other soil characteristics are suitable for crop production except stoniness, then the degree of stoniness should be shown in detail, but, on the other hand, it is useless to show the degree of a stoniness with some detail on otherwise poor and unsuitable land.

In the case of erosion one must distinguish between susceptibility to erosion and the effect of erosion that has already taken place on the nature and productivity of the land. It is not sufficient to show that the land has eroded 1" to 2" without reference to the soil characteristics. If the change in the soil due to erosion, or the evidence of erosional effect, are such that changes in land use recommendations should be made, the erosion damage should be shown on the map. If on the other hand, the evidencos of erosion do not warrant changes in land use, they are not relevant to the map but may be to the notebook. In some cases even several inches of erosion may not be serious. It is, therefore, essential to define erosion in reference to each soil unit.

The establishment of slope classes is exceptionally difficult and the systems in use are not very good. The present slope classes are usually biased entirely on degree because it is easy to measure. We know that the shape of slopes and their general pattern, as well as the length of slope, have important influences on the suitability of the land and on susceptibility to erosion. In the establishment of topographic classes the geomorphologist can provide valuable information and assistance.

In the U.S. Soil Survey at present 5 main slope classes are in use which are approximately as follows:

1. Level to nearly level
2. Sloping to undulating
3. Strongly sloping or gently rolling.
4. Strongly, or steeply rolling
5. Hilly.

N.B. (A report by the U.S. Committee on slopes giving exact definitions will be made available at a later date).

The range in the degree of slope permitted for each of the classes overlaps somewhat from one class to the next to permit adjustments in relation to land use potentiality. In establishing the slope classes such factors as rapidity of external drainage, and the use of farm machinery are also important, although the latter differs in different areas and depends to some extent on custom. The slope also has an important bearing on erosion, although there is obviously not a straight line function between slope and erosion for all soils.

PROF. ELLIS - Are your slope classes such as undulating and rolling based on form or degree?

DR. KELLOGG - They are based on degree, although we attempt to distinguish between primarily simple slopes and primarily complex slopes. The range of slope is generally shown in parenthesis.

Would suggest that the committee on landscape be broken up into a number of smaller sub-committees dealing with, topography or slope, erosion, stoniness, drainage, salts and silting, parent materials and rocks, land forms, and land use terms. The geological definitions and terms should be as nearly as possible like those used by geologists and geological authorities should be referred to.

DR. LEAHEY - We have only very few surface geologists in Canada who could assist us in this work.

MR. MOSS - We are fortunate in Saskatchewan in having the services of Dr. Edmunds, professor of geology, who has spent 5 years on soil surveys and is familiar with our views.

DR. KELLOGG - If uniformity is desired in the Dominion, the definitions must be worked out at a rather high level of abstraction to permit more narrow local definitions within the broad classes. The gently rolling land in Quebec probably will have a different definition in fugures and a different significance than that in southern Saskatchewan.

MR. AALUND - Would it not be possible to delineate the different topographic classes first and then study and explain their relevance afterward and describe them in the report? In many cases we do not know the relevance of the differences at the time of survey.

DR. KELLOGG - In that case it would be necessary to map every degree of variation which occurs! If erosion on some soils does not occur below a 10% or 60% slope why show lines below the critical one? Relevance of facts is very important. We can't possibly map all differences in all characteristics but only those which are relevant and this varies with different areas and even among different soils in the same area.

MR. BOWSER - In the case of the 60% slope which is still farmed would it be shown as hilly land.

DR. KELLOGG - Yes.

MR. AALUND - We have used fractional symbols with satisfaction.

DR. KELLOGG - In hands of competent men the fractional symbols can be used, but where the surveyor is not so competent there is always the tendency to create too many combinations. In fact, you may be sure, the ordinary surveyor will create a lot of unnecessary and some impossible combinations. If the fractional notation is used it is initially important to have a complete and controlled legend.

Nearly every soil scientist wants to hedge from making definite statements. For example, some land may be farmed which is shown on the maps as too stony for use. It is difficult for the surveyors to act definitely regardless of such anomalies.

The soil maps are not being made for all times. Some former "useless" soil is now used because of advances in agricultural science. We can change interpretations with supplemental publications and recommendations.

Unusual circumstances in land management do not alter land types. There is often a tendency to stress the unusual features and to take the obvious for granted. The usual, obvious things are often hardest to describe, but they should be stressed and the unusual things should be mentioned in comparison. In order to overcome the neglect of the obvious, it is the usual thing in the U.S. Soil Survey for men to be assigned areas unlike those in which they grew up.

Mr. BARIL - It is important to differentiate between a level "plain" such as the Champlain plain and a level plateau and should they be defined according to their origin?

DR. KELLOGG - The topography or relief is a characteristic of the soil type. A topographic map is important and of great assistance in explaining the relative position of the land. A supplementary map to show the land forms is also often valuable and land form descriptions should be a part of soil unit definitions. The determination and definition of exact land forms often involves the specialized nomenclature used in geomorphology.

MR. LAJOIE - In Quebec they have found that the ordinary contour maps (25' interval) are very useful on the upland in the Eastern Townships but on the plain of Montreal they are of very little or no value. In order to be of any real value the contours would have to be at a 5' or 6' interval.

MR. WEBBER - Are plain tables still in use by the U.S. Soil Survey?

DR. KELLOGG - Only on small special projects. The present surveys are almost entirely based on air photographs which are 3.6" - 4" to the mile.

MR. STOBBE - Are the photographs compiled into mosaics?

DR. KELLOGG - That is the least satisfactory way of preparing a map. The slotted template method is generally used. The Geological Survey in the U.S. has used aerial photographs for the preparation of topographic maps which are exceedingly accurate. This can not be done by amateurs. The U.S. Soil Survey likes to use the photographs or overlays, for field sheets and then transfer the information to the topographic maps prepared by the Geological Survey. In soil survey work geodetic accuracy is not very important, so long as the right relationship among features is maintained. The average soil surveyor can get by with rather poor geodetics. If he were required to make highly accurate base maps he would soon forget what he is out for.

This concluded the discussion on Landscape terminology and the sub-committee was requested to reconsider their report in light of the discussions and report back to the meeting on Friday.

The meeting adjourned at 12 a.m.

WEDNESDAY, May 9th, 1945
AFTERNOON SESSION - 1.30 p.m. - 5.30 p.m.

REPORT OF THE SUB-COMMITTEE ON CHEMICAL AND PHYSICAL ANALYSES

Was presented in three parts:-

Prof. Ellis presented an outline of the kind of analyses which are required by the surveyors in order to get a more accurate interpretation of the qualities of the soil.

Mr. Wright presented a summary of the available information on the methods of analyses which are in use in the various provinces.

Dr. Delong gave a brief summary on the type of work which has been conducted in foreign countries, chiefly the British Empire and the U.S.

Members of Sub-Committee

Prof. J.H. Ellis, Winnipeg, Manitoba - Chairman
Dr. W.A. Delong, Macdonald College, P.Q.
Mr. L.E. Wright, Science Service, Ottawa.
Dr. G.R. Smith, Truro, Nova Scotia.

The revised reports are given on following pages.

Introduction

The Sub-committee on Chemical and Physical Analyses hereby presents its initial submission to the first meeting of "The National Soil Survey Committee".

The purpose of this initial report is to provoke discussion by the committee as a whole on the subject of laboratory analyses, with the hope that this will develop a uniform concept of the objects and purposes of undertaking laboratory analyses of soil materials, that information in respect to the procedures followed in the various soils laboratories will be forthcoming, and that the various problems encountered by Canadian soil laboratory workers in dealing with the respective regional and local soils may be brought to the attention of the membership.

The members of the Sub-committee did not consider it advisable to recommend or to indorse specific laboratory procedures until the views of the membership were expressed and the respective needs and problems in different parts of the Dominion were studied more in detail.

In order to direct the discussion to the desired ends, a number of questions are presented.

1. What is the purpose or object of making laboratory determinations in connection with the soil survey in Canada?

A general statement may be given in answer to this question as follows: The object of undertaking laboratory determinations by Canadian soil survey workers is to acquire a fuller knowledge and a better understanding of the soils in the areas surveyed, and to give data, (supplementary to field data), that will aid in solving or simplifying the problems of classification, utilization, amelioration and reclamation of such soils.

If this statement answers the first question, then the following additional questions may be presented for consideration.

2. What is the nature of the objects, (i.e., soils), about which we are to acquire knowledge and a better understanding?

3. What information about soils is desired, and what information can laboratory determinations contribute? and

4. What are the means or methods of analyses by which the required information can be obtained?

2. What is the nature of the objects (i.e., soils), about which we are to acquire fuller knowledge?

Soils are complex natural bodies or objects. Like two other great groups of natural objects, (i.e., plants and animals), their characteristics are determined by the characteristics and morphology of the various component parts. Plants and animals are classified on the basis of their morphological characteristics and anatomy, not on complete chemical analyses of individual species. Soils also have characteristics and component parts that cannot be expressed or explained merely by a statement of chemical analyses of the whole. To attempt to express complex natural bodies with too much simplicity only leads to confusion, and to erroneous conceptions.

The morphological characteristics and conditions of color, texture, structure, consistency, constitution, concretions, intrusions and reaction of the different horizons of a soil profile are (or should be) invariably noted and described in the field observations of a soil by the soil surveyor. However, laboratory determinations are often required to supplement the field observations and to give information about the components, but before undertaking any analytical determinations of a soil, it is important to remember that the observed characteristics or conditions expressed in the soil profile, are but the expression of the sum total of the contributions made by the various and varying component parts. These soil components include (1) the skeleton or mineral reserve; (2) the organic reserve; (3) the absorption complex; (4) the concretions and intrusions; (5) the soil solution; (6) the soil air; and (7) the soil organisms. Therefore, to find out what a soil really is, the logical approach would appear to be either:-

(a) The separation of the components so that they may be studied independently;

or (b) The examination of the components as an association of parts that are built up into a pattern or fabric.

The common component parts of a soil and their derivation are reviewed in Figure No. 1.

3. What information about soils is desired, and what laboratory determinations are indicated?

Different information is required by different workers, depending upon their interests and the purposes for which the information is to be used.

(a) There is the information required by those who are interested in soils as natural objects, i.e., soil scientists, who require information that will contribute to their knowledge of soils, and that will aid in the logical classification of soils.

(b) There is the information required by those who are interested in soils as the medium for the production of plants, i.e., plant scientists, agronomists and farmers; horticulturists and gardeners; botanists and foresters, etc., and all those who are interested in soils as the medium which supports plants, animals and men.

(c) There is the information required by those who are interested in soils as earth material, i.e., technicians, engineers, highway officials, builders, etc., who require information about soils as base and foundation materials, or as material for the construction of earthworks, highways and structure.

(a) <u>Information about soils required by soil scientists, etc:</u>

The information required by soil scientists, soil surveyors, etc., and the laboratory determinations that may be needed to give the required information in respect to the soil components are outlined in Table No. 1.

The observations made in the field, supplemented with the minimal routine laboratory determinations listed in Table No.1, may give all the information immediately required by the soil surveyor for mapping and classifying the soils in a particular area. Where this is the case, and the necessary understanding of the soils and of the soil forming processes involved are obtained, there is little point in embarking further on tedious and time consuming analytical determinations. On the other hand, where the soil scientists has to compare criteria of representative soils from different regions, or where specific soils are to be studied, more detailed quantitative chemical data may be essential.

The chemical characteristics of soils that are of most value in throwing light on the soil forming processes, and about which quantitative data may be needed when full information is required can be listed in groups as follows:

1 The mineral-chemical composition of the soil,

i.e., (a) The alkalies,
(b) The alkali-earths,
(c) The sesquioxides,
(d) The silica.

2 The compounds that are precipitated naturally in certain soils, such as -

Alkali-earth carbonates,
Gypsum,
Iron concretions, etc.

3 The nature and characteristics of the soil adsorption complex, (mineralogy and base status, etc.)

4 The characteristics of the soil solution as revealed by a water extract. (Soluble salts and soluble humus).

5 The nature and characteristics of the soil organic matter (humus), and

6 The oxidation and reduction potentials.

The evaluation of these groups by horizons points to the processes involved, and indicates what is removed and what accumulates in the respective soil horizons. (See Figure No. 2). However, all these data are not needed in every case. The procedure will depend upon whether the soil is well or poorly drained, and whether the soil has been subject to weathering (or leaching) in an arid medium; in a medium that is neutral or slightly alkaline; or in a medium that is alkaline in reaction.

To permit easier comparison of the mineral-chemical condition of the respective soil horizons, the analytical data are often expressed in molecular value ratios as:-

$$\frac{SiO_2}{Al_2O_3 + Fe_2O_3} = \text{Silica/sesquioxide ratio.}$$

$$\frac{SiO_2}{Al_2O_3} = sa \text{ Silica/alumina ratio}$$

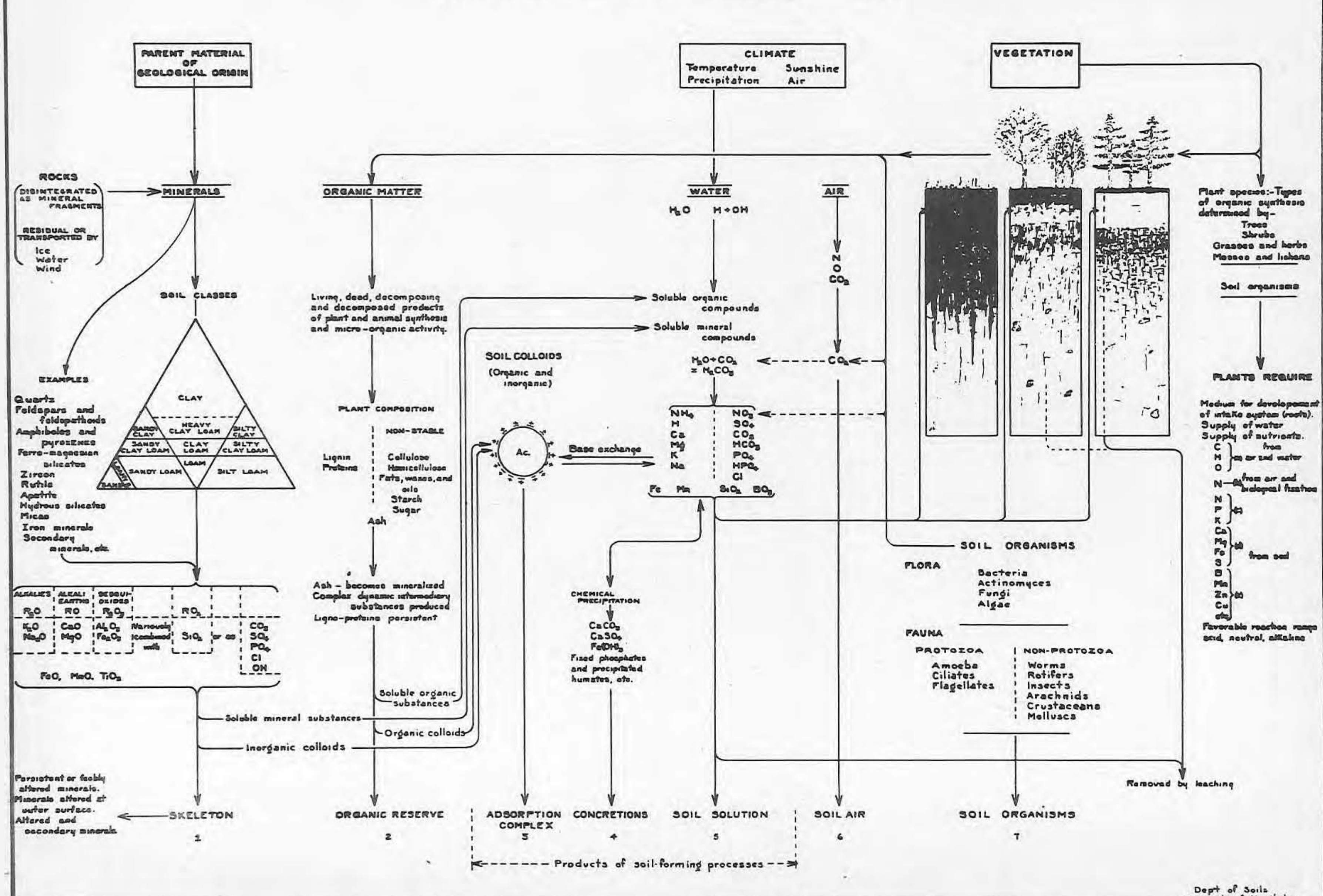
$$\frac{SiO_2}{Fe_2O_3} = sf. \text{ Silica/iron ratio.}$$

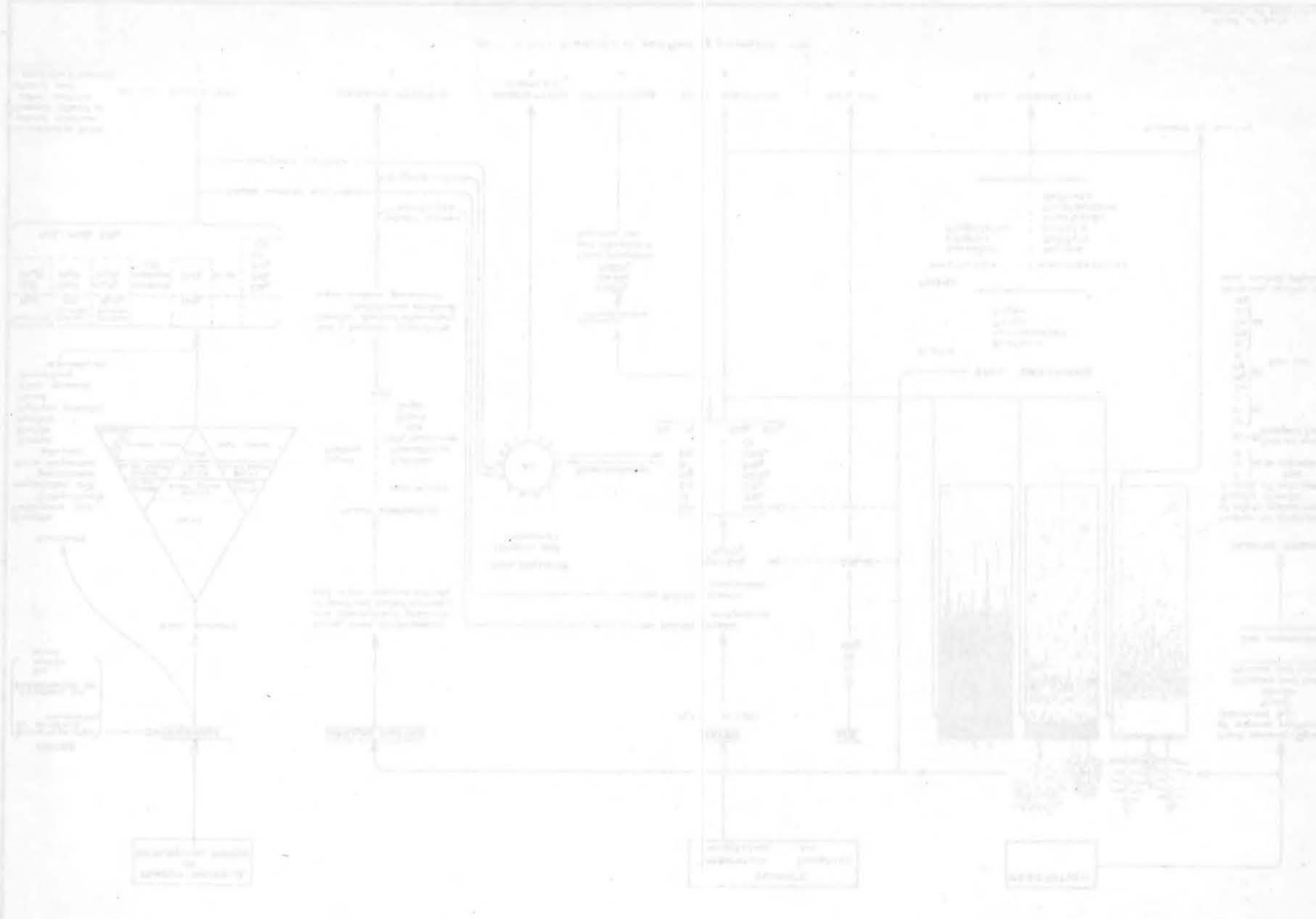
$$\frac{K_2O + Na_2O}{Al_2O_3} = ba_1 \text{ Alkali/alumina ratio.}$$

$$\frac{CaO + MgO}{Al_2O_3} = ba_2 \text{ Alkali earth/alumina ratio.}$$

The value of such quantitative determinations to the soil scientist is obvious, but are they necessary to the soil surveyor?

THE COMPONENT PARTS OF SOIL





THE COMPONENT PARTS OF SOIL

TABLE NO. 1

The component parts of soil, the information required, and laboratory determinations that may be undertaken, supplementary to field observations, to give a better understanding of the soil components.

Component parts of soil	Information desired	Determinations to give information required: Minimal routine determinations	Determinations to give information required: Other determinations (only where possible or required)
1) Skeleton or mineral reserve	(a) Texture or diameter size	(a) Mechanical analyses & moisture equivalent	
	(b) Mineralogy or variety of minerals (c) Condition or degree of alteration	(b) Examination by lens) or microscope (c))	(b) Petrographic analysis of sand and silt (c) fraction)
2) Organic matter or organic reserve	(a) Amount of organic matter	(a) Organic carbon and total nitrogen, C/N Ratios	
(Dead organisms)	(b) Condition of organic matter	(b)	(b) Fractionation of organic matter - (Waksman, etc.)
3) Adsorption Complex	(a) Base exchange capacity (or T value)	pH	(a) T value
	(b) Base status:- Cations present in M.E. and per cent Degree of saturation - (S value)		(b) (S value ((M.E. of bases present
	(c) Amount of I mineral colloid II organic colloid		(c) Determination of the colloids
	(d) Characteristics or mineralogy of mineral colloids		(d) Mineralogical composition of clay minerals and colloids. Optical examination Chemical analysis X-ray patterns (or)

Continued

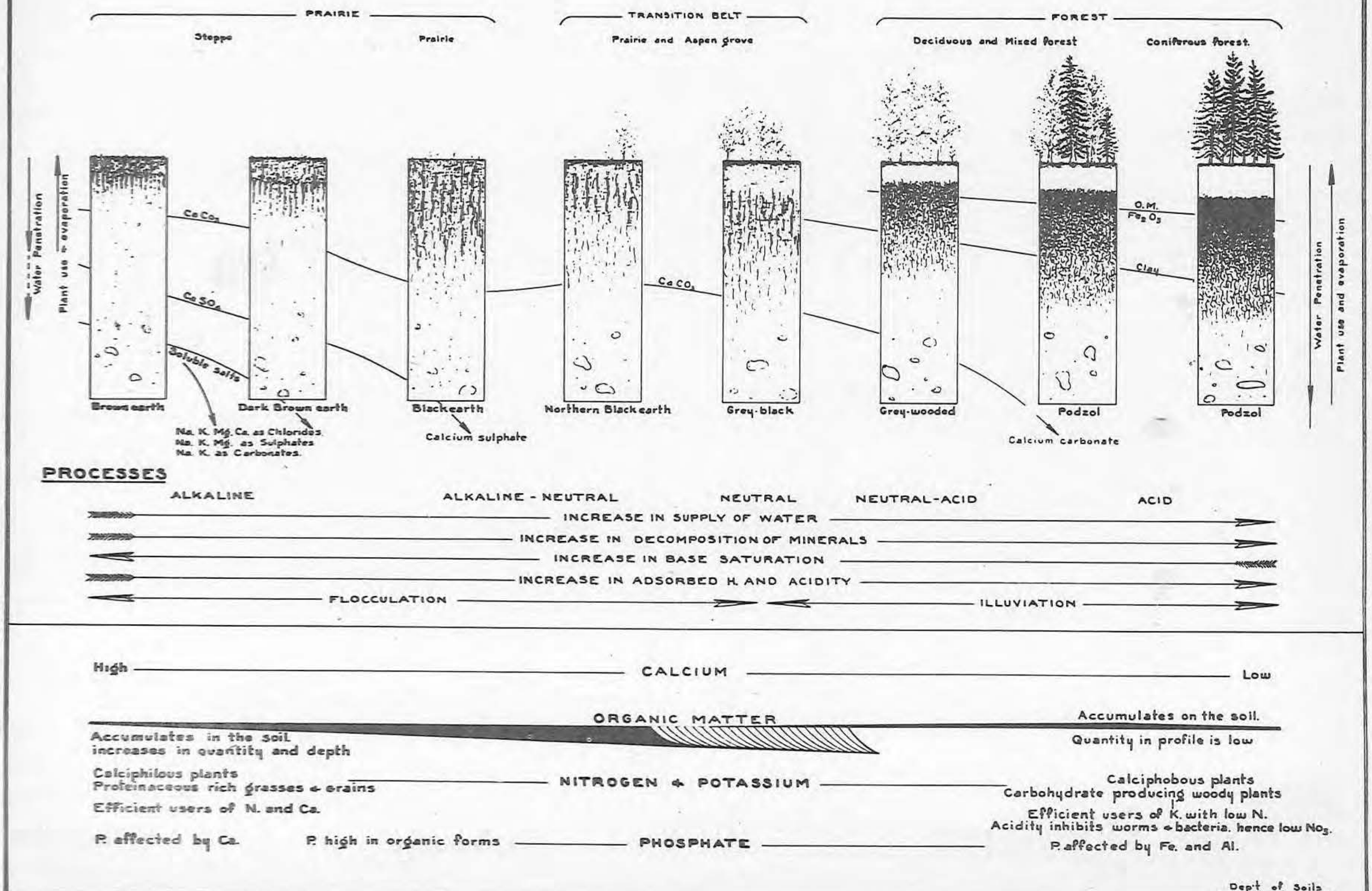
TABLE NO. 1 (Continued)

Component parts of soil	Information desired	Determinations to give information required: Minimal routine determinations	Other determinations (only where possible or required)
4) Concretions and intrusions	Variety, form and chemical composition	(a) Optical examination (b) Qualitative chemical and physical tests of specimens as required	Chemical analysis as required
5) Soil solution	(a) Reaction (b) Amount and kind of soluble salts (c) Amount and color of soluble organic matter	(a) pH (b) Amount of soluble salts (where present): Cations and anions	(c) Amount and color of soluble humus
6) Soil air	Porosity, drainage, and size of air cavities	Field observation	Field determinations of porosity, etc. Examination of structural aggregation and pore spaces
7) Soil organisms Flora and fauna	(a) Species (b) Activities	Visible evidence of condition of organic deposits	Where facilities are available. Determination of species by horizon depths on typical soils - Activities as a special program

General determinations frequently required of the soil as a whole in each horizon of the soil profile

Color; texture; structure; consistency and constitution; pH.

SOIL FORMING PROCESSES



(b) Information about soils required by those who are interested in soils as a medium in which to grow plants:

In this connection the essential or fundamental relationship of soils to plants may be enumerated as follows:

(1) Soils are the medium in which plants germinate and develop their intake system, hence the physical conditions of the soil are of prime importance.

(2) Soils must supply the plants with water, but the water must not be in excess.

(3) Soils must supply the plants with all the nutrients required, except those obtained from air.

(4) The soil reaction must be favorable for the plants produced.

(5) The soil must be reasonably free from toxic substances and reasonably free from soil borne diseases.

If these conditions are satisfactory, the soil will be favorable for the specific type of plant or crop production in which the users of the soil are interested.

The information required by soil users therefore may be outlined in Table No. 2.

(c) Information about soil and earth materials required by engineers, technicians, etc.:

The information required by technicians, engineers, highway officials, etc., is more or less concerned with physical properties. They are interested in soils as earth materials rather than in soils as natural objects, or as the medium for the production of plants and other organisms.

Examples:

Examples of the physical or mechanical data required by these workers include:

Mechanical analysis
Density (actual and apparent)
Water relationships and moisture tests
Structure
Plasticity and consistency
Cohesion
Permeability
Shrinkage and swelling
Compression tests
Behaviour under loads
Bearing and loading tests
Shearing resistance
Stability of slopes, and erodability
Trial mixes for aggregate-binder base construction, etc.

TABLE NO. 2

Soil information required	Routine and specific or special determinations to give information required
Texture and soil class	Mechanical analysis, and organic matter
Water relationship	(a) Moisture equivalent, or (b) Hygroscopic coefficient
Workability (Structure	Observation + aggregate analysis and strength of aggregation, (where required or necessary)
Workability (Consistency	Upper and lower plastic limits - (Atterberg (Constants where needed)
Workability (Permeability	Field observations and tests
Drainage (External - Topography	Field observations and data
Drainage (Internal - (Porosity	Pore space determinations and rate of percolation tests. (Where required)
Drainage (Internal - (Constitution	Field observations with laboratory tests as required
Drainage (Internal - (Substrata	Field observations
Fertility (Organic matter	Organic carbon (Condition of organic matter and (degree of disintegration of organic (matter
Fertility (Nitrogen	Total nitrogen
Fertility (Availability and reserve of (mineral nutrient elements	(Determinations as required for local conditions:- (Soil analysis - Plant analysis - Biological assay.
Reaction (pH)	pH. (Colorimetric in field. (Approximate). (Electrometer in laboratory)
Lime requirement, if acid	Lime requirement determinations
Depth of lime layer, if alkaline	Field observations and tests with dilute HCl.
Lime excess	Inorganic carbonate determination
Toxicity, etc:- Soluble salts	Analysis of 1:5 water extract.
Other harmful substances	Determinations as required
Soil borne diseases	Determinations as biological laboratory facilities are available.

Some of the physical information about soils required by engineers and construction workers can be obtained from the data normally compiled by the soil survey. The additional data required in construction projects, etc., should normally be obtained in the mechanics laboratories of the technicians concerned.

4. What are the means or methods of analyses by which the information required can be obtained?

As the soil survey started independently in most of the provinces, each laboratory had to work out and adopt analytical methods that appeared to suit the local requirements, or as facilities permitted.

When the National Soil Survey Committee was organized, a survey by questionnaire was made of the laboratory methods followed in the co-operating soils laboratories in Canada. It has been reviewed by a member of the Sub-committee*. The data obtained from the questionnaires have proved to be incomplete or are now out-of-date, hence it is not thought advisable to record an incomplete or misleading tabulation of the methods now in use. As this is the first time the members of the National Soil Survey Committee have been brought together, this Sub-committee invites free discussion of the questions here presented, and urges that each laboratory co-operate by submitting for general information, an outline of (1) method of soil sampling, and (2) methods of laboratory analyses followed, together with notation of the special problems encountered. As this information is not at present available, the Sub-committee is not prepared to recommend the general adoption of specific methods.

As a contribution to the subject under discussion, a member** of this Sub-committee has reviewed a survey of laboratory methods made by "The committee on Laboratory Studies supplementary to Soil Classification" of the "Soil Science Society of America". This summary is presented in tabular form as follows:

Analytical data which the Committee on Laboratory Studies Supplementary to Soil Classification of the Soil Science Society of America suggested (at the 1938 meeting of the society) should be obtained in order adequately to describe soils. This committee subsequently reported a substantial measure of agreement among the soils workers of the United States with regard to the need for these determinations.

Determinations Primarily Related to Soil Classification	Determinations Primarily Related to Soil Management and Land Use
1. Mechanical analysis with increased emphasis on fractions of 50 microns and less in diameter	1. Mechanical analysis
2. Structural analysis Volume weight Capillary and non-capillary porosity probably at field moisture capacity Extent and stability of aggregation	2. Structural analysis Volume weight - - - - - - - - - - - - - - - - - - - - - -

* L. E. Wright - ** W. A. Delong

	Determinations Primarily Related to Soil Classification		Determinations Primarily Related to Soil Management and Land Use
3.	Water relationships Infiltration Moisture equivalent pF measurements	3.	Water relationships Possibility of infiltration Air and water capacity
4.	Soil consistency of various horizons	4.	- - - - - - - - - - - - - -
5.	Soil colour	5.	Soil colour

1.	pH	1.	pH
2.	Carbonates	2.	- - - - - - - - - - - - - -
3.	Base exchange capacity, exchangeable bases, base saturation, exchangeable calcium, magnesium, potassium and perhaps sodium (western soils).	3.	- - - - - - - - - - - - - -
4.	Organic matter	4.	Organic matter
5.	Nitrogen	5.	Nitrogen
6.	Phosphorus (probably determined at two pH values).	6.	Available phosphorus
7.	Salt content (western soils) carbonates, calcium, magnesium and sodium	7.	Salt content (western soils)
8.	Analysis of colloidal fraction Exchange capacity Complete accurate chemical analysis, mineralogical analysis - including the entire soil	8.	Available calcium and potassium
		9.	Field responses
		10.	Greenhouse responses

Summary of replies to questionnaire prepared by the Committee on Laboratory Studies Supplementary to Soil Classification of the Soil Science Society of America and reported upon at the 1938 meeting of that society. Analytical Choices of the soils workers of twenty-four states in respect of analytical data supplementary to mechanical analysis, ranked in order of percentage choosing a given determination.

	Data Desired	Per Cent Desiring
1.	pH	83.3
2.	Available phosphorus	58.3
3.	Organic matter	58.3
4.	Nitrogen	54.2
5.	Available potassium	50.0

Data Desired	Per Cent Desiring
6. Exchange capacity	37.5
7. Greenhouse responses	29.1
8. Exchangeable calcium	25.0
9. Volume weight	25.0
10. Salt content	20.8
11. Field responses	20.8
12. Permeability (infiltration)	20.8
13. Aggregation	20.8
14. Colloidal properties	16.7
15. Moisture equivalent	16.7
16. Colour	16.7
17. Total analysis	12.5
18. Exchangeable magnesium	12.5
19. Plasticity	8.3
20. Carbonates	8.3
21. Exchangeable hydrogen	4.1

In conclusion the members of this Sub-committee on Chemical and Physical Analyses of the National Soil Survey Committee suggest that the first essential to be dealt with is a common concept of the purpose and object of laboratory methods. "The why" and "The where" should be agreed upon by the committee as a whole before the Sub-committee are in a position to suggest "the how."

Recommendations

1. We would recommend that the soil survey unit in each province attempt to make the minimal routine physical and chemical determinations, as outlined in Table No. 1 on routine soil samples as required by the respective soil survey units; and we recommend that each soils laboratory, wherever possible, undertake to select representative regional soil profiles and to conduct complete chemical analysis of same for the purposes of interpreting the soil-forming processes involved. It is further recommended, where questions arise respecting soils which are of doubtful category, that complete chemical analytical data also be obtained.

2. It is the opinion of this Sub-committee that where analyses for the assessment of fertility status are being used, an effort be made to obtain definite information concerning the relationship of the results secured by laboratory determinations to the results of crop response in the field.

3. We recommend that, where possible, soil survey laboratories attempt to secure the information about soils as outlined in Table No. 2, with the exception of the fertility determinations. No recommendations of method to use is made in respect to the latter at this time, pending further study. (See recommendation No. 2)

4. This Sub-committee draws attention to the fact, that it is highly desirable for all laboratory determinations to conform to approved standard procedure. With this in view, we request that each soils laboratory outline

in detail the methods used in taking and preparing samples for laboratory analysis, and request that such outlines be submitted to the Chairman of this Sub-committee for study, and for guidance in drafting procedures that may be recommended. Further, in view of the discussions at this conference, and the changes in methods of analysis which have come into use since the survey of methods was made in 1941, this Sub-committee requests that each soils laboratory, including the Soils Laboratory at Swift Current, prepare an outline of the methods of analysis, (with references), now in use in the respective laboratories for the information of this Sub-committee.

5. In order to avoid confusion and duplication in collaboration, we recommend that the secretary of the National Soil Survey Committee, because of his official capacity, obtain the information promised by Dr. Kellogg in respect to the technique of analysis, and to make same available for the guidance of the Sub-committee on Physical and Chemical Analyses.

DISCUSSION OF THE REPORT ON CHEMICAL AND PHYSICAL ANALYSES

Dr. Laird - In British Columbia no routine chemical analyses have been conducted to date on soil survey samples. Such chemical information as has been obtained has been performed by the Department of Chemistry, Ottawa, through the kind co-operation of Science Services, Ottawa. Arrangements are being made to start some chemical analyses in B.C. for the future.

Some chemical work has been done in relation to fertility problems on some soils also some comparative chemical-biological studies have been made of some soil profiles. The biological studies of the profile horizons of Pineview, Vanderhoof and Nulki soils have yielded some very interesting results. The distribution of the organic fractions differed in the various horizons. This information, indicating the breakdown of the proteins by the various micro-organisms, showed great differences in the number of actinomyces in the B horizons of the different soils.

Dr. Wyatt said that they have been doing considerable work on soils from the biological point of view. Most of the studies have been devoted to the examination of the end products of biological actions which together with the chemical work helps in interpreting soil conditions.

Mr. Moss stated that in Saskatchewan they would like to have full information on the main soil associations which they have mapped and especially on the major new associations which will be encountered. This would include complete chemical analyses, as well as some data on the mineral make-up and the physical conditions of the soil. To-date their data on the last two points is too limited. They would also like to have comparative studies on composite virgin and cultivated soils.

Prof. Ruhnke - The amount and kind of work that has been conducted in Ontario has been largely dictated by the funds and staff which were available. Most of the analytical information which has been collected in Ontario is largely of utilitarian nature and the fertility aspect has been mainly concerned with. The simpler methods of analyses have been mainly used because facilities were not available for more complete analyses. It is felt that a larger number of simple tests would show the general trend of requirements better than a few more accurate results.

Mr. Baril stated that in Quebec they are doing a considerable amount of analytical work on the regular soil survey samples. Their analysis consist mainly of complete totals and of exchangeable bases. He felt that some inquiry should be made into what work should be done and what the value of some of the determinations is. A closer examination should also be made of some of the methods which are in use and such methods as are unsatisfactory and which are used mainly for convenience should be discarded. Mr. Baril felt that they should have information on the nature of the clay fraction and that they should also do some work on the fractionation of organic matter.

Mr. Aalund stated that in N.B. complete chemical analysis were performed on the main soils mapped. The amount of work done was limited due to lack of available time. He would like to have some suggestions from the committee as to what type of analysis should be performed. He was not sure that at the present time the chemical information which was obtained did give them the information desired.

Dr. Smith thought that total chemical analysis were important and should be performed on all soil series. If this information could not be used at present it should be kept for historical records. Only in this manner can we gradually accumulate the necessary information regarding our soils.

Mr. Stobbe stated that he considered chemical analysis as a very important phase of the soil survey work. In the classification and the interpretation of the behaviour of the soil we need more accurate measurements of the chemical and physical characteristics of the soil than mere visual observation. What would give the best measure of the inherent soil characteristics we do not know. Prof. Ellis has suggested a number of tests and various analysis, which might be made. With the exception of the more simple tests, the more elaborate mineralogical, xrays and chemical tests are out of the reach of our average soil surveyor, because they require special equipment, specially trained personnel and they are very time consuming.

Up to-date we have been performing complete chemical analysis in many provinces, not, as far as I am concerned at least, for historical records but to obtain as good a picture, as we know how, of the chemical status of the soil. Outside of the complete chemical analysis I do not know of any other measure that we could use to-day with our present staff and equipment which would give us a picture of the movement and accumulation of the various elements and organic matter in the soil. This information is very important, especially in the classification of the woodland soils such as they grey-brown podsolic, brown podsolic and podsol soils. The total analysis also give us some information on the reserve of nitrogen, lime, magensium, phosphorous, potash, etc., in the soil. This information together with the analysis of the exchangeable bases go a long way in interpreting the fertility status of the soil.

I fully agree that we need more information to get a complete picture regarding the make-up and behaviour of our soils and I am fully in accord with the suggestions which Prof. Ellis has made. Perhaps some of the analytical work suggested by him will give us the information we need, but I do think at the same time that we should at the present not neglect our total analysis of the major genetic soil units. This work does provide us with some definite information now which we otherwise would not have.

Dr. Kellogg - The series of analytical determinations which should be made may depend to a large extent on the problems at hand and on special circumstances. Thus in some soils, information on exchangeable calcium and magnesium may be very important, while in other soils these determinations are unnecessary as the soil is known to be well supplied with these elements. Again information on the amount of soluble salts present in "alkali" and Solonetz soils is very important, while in many other soils it would be a waste of time to run these analyses.

Concerning the methods of analysis which are being used in the U.S. he referred the committee to Dr. L.T. Alexander of the Plant Industry Station, Beltsville, Maryland for total analysis and to Dr. Michael Peech of Cornell University for methods on available plant nutrients and quick tests. He also recommended the methods outlined in the January issue of Soil Science.

The mechanical analyses are mainly used for the determinations of textures and the size distribution of soil particles. For the definition of the soil classes the field texturing by trained surveyors has become more or less standard. Variations of the soil class in the field texturing have been less over a period of years than the variation in the percentage of separates obtained by mechanical analyses. The latter variation has been due to improvements in methods and more complete dispersion which has been obtained by the improved methods. As a result, it has become necessary to change the limits of the soil classes in order that the mechanical analysis will fall in line with the field texturing. By changing the limits it is relatively easy to get correlation within the same soil zone but trouble often arises if the correlation is carried through from one zone to another. The difficulty is due to the fact that field soil textures depend to a large extent on the nature of the colloids present and this is not shown by mechanical analysis.

The Bouyoucous method of analysis is cheap and quick, but it is not very accurate. Modifications of it are widely used by the public roads departments and in many soils laboratories. This method can be used as a comparison between different soils but it is not suitable for fitting the soils into the respective soil classes. Whenever it is employed the 0.002 m.m. fraction should be used for the clay.

The total chemical analyses of the soil are in many cases needed as a background for the interpretation of quick tests, base exchange, etc. In many instances information on total analysis can not be made use of until more information regarding the soil is obtained.

The determination of the clay minerals of the soil is very important as they often determine the physical and chemical behaviour of the soil; but this work is expensive and highly technical. It can only be used to-day for special studies. Some rapid methods have recently been developed, based on heating curves, which have considerable promise. Portable sets are now available which make it possible to perform this work as routine analysis.

The importance of base exchange determinations is taken for granted by everyone and this information should be obtained for the important soil series.

The fractionation of organic matter probably will give us considerable information regarding the development and the productivity of our soils, but here again it is difficult to say where to draw the line between the different fractions.

The methods of analysis for available plant nutrients are likely to give misleading results unless expertly interpreted, yet they are going to be used. They are of value in making recommendations regarding the use of fertilizers if they are in competent hands. However, in this work too we should not limit ourselves to surface soils. In some cases the success or failure of a soil to produce crops depends on the fertility status of the subsoil.

The range within a soil is a very important factor to consider in doing analytical work. It becomes very costly to study the entire range by the standard methods.

Usually 2,000,000 pounds are considered as the weight of plow depth per acre. This is very misleading and the determination of the simple weight of all our important soils would be helpful.

Dr. Atkinson - What effect has organic matter on the texture and is this considered in determining textures?

Dr. Kellogg - In some cases the organic matter makes the soil appear heavier and in other cases lighter. In the U.S. Soil Survey mechanical analysis are performed on most surface samples and the results obtained carry the most weight in deciding on the soil class. By using the modified pipette method the organic matter is destroyed.

Dr. DeLong - Suggested that if the committee is to continue with physical analysis a physicist should be added to the committee.

Dr. Leahey - Stated that there is a considerable disagreement in the expression of analytical data and the committee should bring forth some suggestions in this regard.

Prof. Ruhnke - How fixed are mapping units or soil types? Frequently it is impossible or impractical to define or fix these units very closely. In a similar manner it may not be desirable to have the methods fixed too rigidly as some modifications may work more satisfactory on some soils than on others. In any event the results obtained from the modified methods may not vary so widely as the variations within the same mapping unit.

Mr. Stobbe - If it becomes necessary or desirable to use different modifications of the same method there must be reasons for this. If such is the case they should be clearly stated when a survey of the methods, which are in use, is made.

Dr. Kellogg - The characteristics on which the soil is mapped or classified are usually constant. In such units closer correlation is usually obtained in such determinations as pH, exchangeable calcium, etc., which are definitely related to observable features, than with available phosphorous, for example, which can vary a great deal independently of the characteristics used in classification. On the other hand, such elements as cobalt are usually more closely related to the parent material of the soil than to the genetic soil type.

Two things must be considered in a soil type as far as its productivity is concerned. One is the present nutrient status and the other is the responsiveness to management. The responsiveness does not depend entirely on the lack of fertilizer ingredients in the soil but to a great extent on the physical conditions of the soil.

The standardization of all the methods of analysis is difficult because different types of soils require different types of analysis and often also different methods.

Prof. Ellis - In the prairie regions we are generally more concerned with physical features of the soil, while in the east we are more concerned with fertility problems. The question of how fine a method should be used to measure differences is difficult to answer. We have considerable evidence that there are many variations in small plots which can not be mapped out. In addition there is a considerable variation in the amount of available nutrients present in the soil during different periods of the season.

Dr. Smith - Believed that it would be of great value to exchange soil samples between the different laboratories for analysis even if the methods were not exactly the same. Such exchange would greatly contribute towards more accurate work and it would also be of great value in training young men.

Prof. Ruhnke - Thought that it would perhaps be impossible to use the same methods on soils of the different zones. However, the actual methods or modifications which are to be used must be theoretically sound and accurate.

The discussion was discontinued and the chairman asked the committee to consider the various points which had been brought up during the discussion in preparing the final revision of the report and in bringing forth the final suggestionsof the committee.

The meeting adjourned at 5.30 p.m.

THURSDAY, MAY 10th, 1945
MORNING SESSION - 9 a.m. - 12 a.m.

REPORT OF THE SUB-COMMITTEE ON SOIL RATINGS FOR LAND CLASSIFICATION

Was presented by Mr. L. J. Chapman in the absence of the regular sub-committee chairman.

Members of Sub-Committee

Dr. J. Mitchell, Saskatoon, Sask. (Chairman)
Mr. L.J. Chapman, Toronto, Ont.
Mr. R.E. Wicklund, Truro, N.S.

The report was presented in two parts. The first section dealt with soil rating and the second part discussed follow-up programs which are desired in order to provide information for a satisfactory soil rating.

The original report with some revisions is presented in the following pages:-

Title:

The committee feels that the above title might be shortened to "Sub-Committee on Soil Ratings". There are several reasons for suggesting this. In the first place the question of a definition of the term Land Classification was immediately raised by a member of the Committee. This undoubtedly presents a difficulty. There are many ways in which land may be classified. For instance, one might classify land on physical features such as topography, or stoniness. On the other hand it may be classified on the basis of suitability for producing certain crops. On this basis such considerations as cost of production, possibility of finding suitably accessible markets, and a satisfactory price need to be taken into account. Even climate affects the result since it may limit the choice of crops in an area, and the quality obtained, as well as the quantity. Also any rating or grouping of soils must to a degree connote a relative economic value. To be interested in the relative productivity of soil means that the interest relates eventually to variation in ability to support a population.

Nevertheless, to seek an exact definition for Land Classification would seem to be a quest after a rather elusive idea. In "The Classification of Land", Bull. 421, Columbia, Missouri, 1940, Kelso and Kellogg discuss the matter in a summarized introduction to these proceedings of the First National Conference on Land Classification. The difficulty of deciding whether land classification should be based on physical facts only, or on other factors (economic) which might likewise influence the usefulness of land is mentioned. It was apparently generally agreed that there are many different kinds of land classification "which vary according to the objective for which they are undertaken". It is further pointed out that lands classified in one group for use purposes may not remain in that group; and that there is danger in the conception of a rigid finality of classification of lands into any form whatever.

Such opinions representing as they do the thoughts of leaders in land economics, appraisal methods and soil sruveying in the United States, emphasize the difficulty of introducing the subject of land classification, without first defining the term. For the present this committee would confine their activities more particularly to the subject of soil rating.

It may be further stated that soil ratings are useful for other purposes than in land classification. They may be useful in carrying out assessments; as a guide in appraising land; and perhaps may have some use to the soil surveyor inasmuch as it forces him to organize his opinions and data concerning a particular soil type.

Soil Rating:

It must be remembered at all times that the sound basic information for rating soils is obtained from the soil survey. The first purpose of a soil survey is to classify and map soils. The classification is scientific and independent of elusive economic considerations. Obviously, whatever form of rating is attempted, it can be no better than the basic information provided for the soil survey. This is true of almost any attempt to deal with land problems, either administrative, in research activities, or in advising the farmer when he is in need of advice. As soils men we should, therefore, be alert to the possibilities of improving and perfecting soil survey methods, and to making the results as fully usable and available to those concerned with the land and its problems, as possible.

Methods of rating soils:

There appears to be only two general methods of rating soils in use at present. The first is that of Storie or modifications of it, (An index for Rating the Agricultural Value of Soils - R.L. Storie, Bull. 556, Univ. of California, Berkeley) in which the physical and chemical nature of the soil profile and the physical features of the land are basic; and the method used by the American Soil Survey in which a productivity rating based on yield data is used. (J.K. Ableiter in Soils and Men, p.1011 et seq.; U.S.D.A. Yearbook 1938). See also productivity ratings in the Soil Survey Report Proc. Soil Sci. Soc. of America Vol. 11, 415-422, 1937 and Productivity ratings of Soil Types. The Classification of the Land, Bull. 421, Columbia, Missouri, December, 1940.

These systems have a common objective but are quite different in their approach. The system used by the U.S. Soil Survey appears to be soundly based, since yield must indicate the productive capacity of the soil at least insafar as past performance is indicative. However, it is difficult, in some regions at least, to obtain accurate data over a long enough period, and during a period of years economic factors may affect the choice of crops. New varieties with new biological characteristics may even become a factor influencing the trend and accuracy of yield data.

The Storie system of rating soils:

Storie system attempts to evaluate the effect on production of inherent physical and chemical conditions of the land. It is based on the degree to which the various soil factors represent conditions favorable to plant growth. These factors have a degree of permanence, independent of people, insects, disease and economic disturbances of a passing nature on the face of the earth. The inherent physical and chemical conditions of the soil are all the conditions giving distinctive character to the soil profile, as texture, depth, structure, reaction, organic matter, general fertility and surface features, such as topography or stoniness. The soil surveyor can evaluate the effect of such factors better than those less familiar with soils, and in spite of any deficiencies on his part we think that he should do it. However, it should be made clear that the system is not strictly an inductive method of estimating soil productivity.

The U. S. Soil Survey System of Rating

The method is based on comparative yields. All economic crops are given a rating for each soil type covered in the survey report. A standard yield represented as 100 is obtained for each crop; this standard represents the approximate average yield obtained in larger areas of the U.S. where the crop is a principal product. For instance, in a crop such as corn the corn belt would be the representative area, and 50 bu. per acre an average yield, so that 100 in the case of corn represents 50 bu. per acre. For wheat the standard is 25 bu. per acre (apparently soft wheat) for clover and timothy hay, 2 tons, and for alfalfa 4 tons per acre. In some other crops the standard would represent pounds per acre rather than bushels or tons.

Having tabulated appropriate indexes for each crop of economic importance in the area by soil types, a productivity grade is obtained by weighting the individual crop indexes into a final index number. This weighting is according to the relative importance of the crop concerned. Soils rating between 90-100 are graded 1, 80-90 - 2, and so forth.

Some concession is given to the effect of management in that indexes are given based on "inherent productivity" and "under current practice". The principle crops and type of farming is also indicated.

According to Ableiter in the Classification of Land (cited above) certain changes of this rating are found in recent survey reports.

These are listed as
(1) Inclusion of estimated yields
(2) Discontinuance of term natural productivity
(3) Reporting yields as by current management practices
(4) Retaining of standard yields as a reference
(5) Use of indices from 1 - 100 instead of 1 - 10
(6) Assigning index numbers to soil individuals rather than groups
(7) List of percentage weightings used in obtaining productivity grade number
(8) Addition of remarks regarding principle crops, land use, fertility, erodibility, etc.
(9) A simple grouping of soils in terms of general productivity.

Desirability of Including Ratings or Groupings in Soil Survey Reports

There is little need to raise points in favor of the inclusion of some form of rating or grouping of soil in the soil survey report. In the U.S. the Soil Survey has adopted such a practice as a standard procedure in preparing reports. The need for some form of soil grouping has been recognized for some time and mentioned by many workers.

The soil descriptions usually include some information of general productivity and agricultural adaptation, but this information has been scattered throughout the report and is not readily accessible.

A useful step to take would seem to be a simple tabulation of the soils into a general grouping such as best, good, fair, poor, etc. It is desirable that a systematic method of rating soils be used in placing them in such groups in order to reduce bias of judgment if for no other reason. All known data regarding yields should be consulted as supplementary information to any form of rating. However, yield data must be carefully interpreted.

The yield of any crop represents the culminating effect of all natural processes working in a particular environment. Some of these processes may affect plant growth favorably and some unfavorably. Changes in the biological nature of a plant variety may greatly alter its relationship to environment. For instance, a heavy clay soil of a highly fertile nature has produced a certain average yield of wheat over the past 25 years. In three seasons of the 25, severe rust damage occurred. Such seasons are always favorable as far as moisture is concerned and normally yields in the three rust years would have been high, bringing the average higher than the records actually show. The rust problem has been overcome, and rust infection will not detrimentally affect future yields, therefore, the average obtained at the present is in error if applied to the future. Furthermore, if one attempts to translate yields into value of production than the question of quality becomes of great importance, and quality often decreases with increasing quantity of yield. The above examples may serve to emphasize the possibility of yield data giving misleading information unless carefully studied.

On the other hand, the inherent, and more or less permanent characteristics of the soil affecting plant growth are difficult to evaluate numerically. The heaviest texture is most desirable in the drier area, but becomes less desirable in a moist one. An open porous structure may be decidedly unfavorable in one locality, and quite desirable in another. Good judgment and considerable experience and knowledge of the soil area would appear to be required in order to properly balance the various factors concerned in rating or grouping soils.

As a tentative suggestion, the committee might advise that a grouping of soils into probably five or six categories reflecting their comparative productivity and suitability for agriculture in the particular region, be a first requirement.

The grouping should be based on some system of rating the soils of the area. This rating might vary somewhat in detail but the general approach used by Storie appears to have much to recommend it. The addition of a factor reflecting the influence of climate may be desirable. It is debatable whether numerical indexes should be included in the soil survey report, or whether they should simply be mentioned and made available in mimeographed form to those particularly interested.

As a further suggestion, it would seem advisable to include a table of average yields, or perhaps a range of yields, for all economic crops if such data were available.

The bulk of the users of soil survey reports would not require further detail than that supplied by the tabulated grouping of soils. Others would be particularly interested in yield data as well. This information could be tabulated with the grouping perhaps.

Actual indexes by soil types are required for special purposes. The information should be on hand, since it is advisable to start from a formal type of rating, before arriving at a grouping.

Nature of a follow-up program

Investigations into the potentialities of a soil type for crop production rests largely with those concerned with field and plot experiments. The results of such experiments are made known through bulletins, reports and other published material. The soil surveyor may, or may not, have direct contact with such investigations depending upon the organization and scope of work undertaken by the department of which he is a member. If the soil surveyor is not in direct contact with experimental work, he at least has a direct interest in following the results obtained, and in seeing that experimental fields and plots are well located. In many cases very little regard has been paid to soil conditions when selecting sites for experiments. The area selected often represents only a limited, unrepresentative area of soil in the district. The experimenter may need assistance in classifying the particular type or types of soil with which he had to deal, and it becomes a duty of the soil surveyor in his own interest to give such assistance.

The soil surveyor may discover problems which require experimental work for their solution, and he may well encourage the carrying out of such work. Indeed the soil surveyor has only partly completed his job unless he points out the soil problems he may discover and suggests their solution, or encourages investigation directed towards obtaining necessary information. The results of a proper soil survey are first of all a cartographical representation of the soils of an area and a report describing the soils, together with other pertinent information. It is an inventory of the soils of the area concerned, and serves as a basis for further research on these soils. Classification is a first and vital step towards investigating any group of natural objects, but classification is only a foundation for further research on such objects.

Plant growth is conditioned by climate as well as by soil and it is well that our information about climate keep up with that provided by soil surveyors. We therefore suggest that climatic studies should be promoted as part of the follow-up programme.

The soil surveyor should furthermore encourage a more comprehensive and accurate system of gathering crop yield statistics than is commonly followed. In some cases statistics are entirely inadequate. At best, they do not seem to be either complete enough or perhaps accurate enough. They are generally taken by political units, rather than to represent soil areas. It should be quite possible to overcome the latter detriment in areas where soil maps are available.

Finally the soil surveyor should constantly check his soil groupings and classification with new information, as it becomes available. Where errors in judgment occur, it is better for the soil surveyor to make the revision necessary than have others point it out. By this procedure he is most likely to gain and retain the confidence of those using the information gathered by the soil survey.

AGRONOMIC EXPERIMENTS TO DETERMINE CROP ADAPTATION AND FERTILITY REQUIREMENTS OF SOIL TYPES

By

E.S. Hopkins, C.E.F., Ottawa

I. The Need for Agronomic Experiments

Soil survey work has been in progress in Canada for many years and many areas have now been surveyed, classified and mapped. Each year more land is being surveyed and ultimately, it is hoped, all the land suitable for agricultural settlement will be surveyed. These soil surveys are of great value in providing a reliable inventory of the soil resources of the country. They are particularly valuable to prospective purchasers of farm land, for municipal authorities making assessments of farm land, and to financial companies loaning money on farms. These surveys are of great value, also, to technical agriculturists in that the results of experiments may be used on areas to which it is thought they may be applicable.

Unfortunately, the soil survey has not yet provided as much information as it is hoped it may ultimately provide to the individual farmer. It has not been used very extensively by agronomists to study the requirements of various soil types. Some work, it is true, has been done in this field, but in comparison with the great number of soil types mapped by the soil survey this phase of agronomic work is as yet in its infancy. It is clear that extensive work will be necessary if the agricultural possibilities of these types are to be known.

Farmers acquire considerable information over a period of years in regard to the characteristics of the soils they cultivate. They do not learn everything in regard to their land and their observations are particularly concerned with the physical characteristics. For example, in Carleton County, Ontario, there are two soils, mapped by the soil survey, one being known as the Rideau Clay and the other, the North Gower Clay Loam. The Rideau Clay is much heavier and contains less organic matter. An elderly farmer described the difference in these two soil types by referring to the North Gower Clay Loam as black clay which does not bake, while the Rideau Clay was described as grey clay which baked after heavy rains. These descriptions are very accurate in indicating the characteristics of those two soil types and show that the observant farmer has considerable information, particularly in regard to the physical characteristics of the land.

Some authorities have expressed certain limitations in regard to the value of the soil survey for certain important uses. While conceding its value in the early years of the development of a country and especially if made before settlement commences, and that it is useful to the experiment station worker and others having dealings with farmers, it is contended that ultimately the farmer learns to know his own soils and how to handle them. It is claimed that both the physical and chemical properties of the soil can be changed to suit the needs of the crop desired to be grown. Fertility, organic matter, favorable reaction, irrigation and drainage may be provided. In other words, with proper management many soil types would give about the same crop growth.

However, while soil characteristics can be changed very considerably by various management practices, and in fact crops can be grown in solution even without soil, it is obvious that if nature has taken many thousands of years to develop soils as they exist today, it would seem desirable to utilize their qualities for the most successful crop production. Under most conditions it would be much more economical to take advantage of existing qualities than to attempt to build these by expensive practices. Certainly in semi-arid regions the great value of heavy clay soils over sandy soils in conserving moisture and in producing much larger crop yields is well recognized. However, in some regions, especially in humid regions near large cities, no choice is available, making it necessary to modify the soil to suit the crop to be grown.

In view of the great variations among soil types, the extensive areas surveyed from year to year, the expenditures involved in making these surveys, and the need for more information for successful crop production, it would seem very desirable to undertake more agronomic experiments to determine the crop adaptation and fertility requirements of these soils. The soil survey like other phases of edaphology, can become a very interesting study in itself in developing as a special science. Agriculture, however, is a very practical subject and the usefulness of the soil survey should never be overlooked. Agronomic experiments should be conducted to follow the soil survey and these experiments might relate, according to one definition of agronomy, to experiments dealing with "The theory and practice of crop production - the scientific management of land".

Many factors in addition to the type of the soil, have a profound effect upon crop production. The selection of the crop grown, variety used, quality and treatment of the seed, rotation followed, how much and what kind of legumes grown, amount of farm manure used and place in the rotation it is applied, acreage pastured, quantity and formulae of commercial fertilizer used, extent of drainage provided, weed control and tillage practices - all these and other factors have such a dominating affect upon crop production that in some regions the influence of the soil type has not yet been seriously considered. A popular author has recently emphasized that the all important point was simply the incorporation of an adequate quantity of the right kind of organic matter in the surface soil and the abolition of the mouldboard plow. Those connected with the soil survey must constantly consider the usefulness of the soil survey and how to utilize the information, especially for the farmer.

II. Climatic Zones

Major and Minor Climatic Zones

In Canada there are two very extensive climatic zones, the humid climate of Eastern Canada, and the semi-arid to sub-humid climate of the Prairie Provinces. In addition, in British Columbia there are many widely varying climatic conditions, ranging from areas where the precipitation is so small that irrigation is an absolute necessity, to very humid regions along the Pacific coast where precipitation is double that received in Eastern Canada. Crop growth is influenced more, perhaps, by temperature and precipitation than by variations in the soil. It is necessary, therefor, to undertake agronomic experiments in the light of climatic zones as well as in relation to soil types.

The Counties of Essex and Kent in Ontario have the hottest summers in Canada, with July temperatures at Harrow averaging 72.9°F. This region is the corn belt of Canada. Vancouver Island has the mildest winters with a January mean temperature at Saanichton of 34.9°F., as compared with Ottawa 11.9°F., Brandon at 1.5° below zero, and Fort Vermilion at 12.1° below zero.

Precipitation varies widely in Canada. In the Lower Fraser River Valley in British Columbia, at Agassiz, there is very heavy precipitation, averaging 63.05 inches; but at Summerland in the Okanagan Valley, also in British Columbia, there is an annual precipitation of only 9.88 inches. In some regions the precipitation comes mostly in the winter, as along the Pacific Coast, in others in the summer, as in the Prairie Provinces, while in Eastern Canada it is distributed fairly uniformly throughout the year. Snowfall in some regions is quite heavy, while in others there is scarcely any at all.

It should not be assumed that there are only a few climatic zones in Canada. In reality, there are many zones. Even in the territory known as "old" Ontario, that is the portion lying south of North Bay, the district has been divided by the Ontario Research Foundation into 15 climatic zones. For corn production 5 climatic zones have been recognized. In British Columbia greater variations occur within smaller distances on account of the influence of the mountains. In the Prairie Provinces it should not be assumed that the region has only one climatic zone, because in reality there is a great range in climate from semi-arid to sub-humid conditions.

Climatic conditions have a very profound effect on the growth of certain crops. Thus, the Prairie Provinces are eminently suited to grain but in most regions they are too dry for good hay or pasture production. Eastern Canada is fairly well suited to general crop conditions, especially to hay. The Maritime Provinces are well adapted to the production of permanent pasture.

Small differences in temperature affect the growth of corn

Corn grows successfully at Ottawa, especially for silage, but it is rather poor in Eastern Quebec and the Maritime Provinces. The temperature in those regions is too cool for corn and although the differences are not great they are sufficient to eliminate it as a satisfactory crop. Thus, for the three summer months of June, July and August, the mean temperature at Ottawa is 66.6°F., while that at Nappan, N.S. is 60.9°F. At Harrow, in southwestern Ontario, where corn is grown for grain, the mean temperature for the three summer months is 70.3°F., and at Morden, Manitoba, where corn is being promoted as a substitute crop for summerfallow, the temperature is 65.5°.

According to M. T. Jenkins in the 1941 U.S.D.A. Year Book on "Climate and Man", in his article "Influence of Climate and Weather on Growth of Corn", he quotes Finch and Baker to the effect that "practically no corn is grown where the mean summer temperature is less than 66°F. or where the average night temperature during the three summer months falls below 55°".

Strange to say, at Lacombe, Alberta, the mean temperature for the three summer months is only 58.2 , but corn grows much better than might be expected, giving an average yield of 9.55 tons of silage. The only explanation for this peculiar situation may be found in the somewhat sandy loam character of the soil, which gives perhaps a higher soil temperature and no doubt the dry matter content of the silage is not high.

Climate Exerts a Dominant Effect on Crop Growth

Variations in climate exert a profound effect upon crop production. Some crops cannot be grown at all in certain climatic regions quite irrespective of the soil. Corn, hay, pasture, fruit, vegetables, and other special crops, require particular climatic conditions for satisfactory growth. Accordingly, in any consideration of agronomic experiments to determine the crop adaptation and fertility requirements of various soil types it is absolutely necessary to consider such experiments with respect to climatic zones. The next point to determine is the amount of variation which should be allowed in any one zone. Additional studies will be necessary to learn the various climatic zones throughout Canada and undoubtedly more meteorological records will be required before such zones can be established. Meteorological Stations will have to be located more frequently throughout the country in order to secure additional data in regard to temperature, precipitation, sunshine and evaporation.

III. Soil Type, Soil Class and Land Type

Soil type is the final unit of classification mapped by the soil survey. It is based on profile characteristics and is further qualified into phases, depending upon erosion, slope, stoniness, drainage and other characteristics. No doubt, if desired, it could be subdivided further depending upon variations within the soil type based upon the fineness of the textural constituents.

The number of soil types, however, not even considering soil phases or other refinements, is now so large that over 8,000 have already been mapped by the U.S.D.A. Soil Survey. The number has become so large that it is almost impossible to consider agronomic experiments for all of them. It might take so many years to complete such investigations that the soils themselves might alter sufficiently, or cropping conditions might change so much, that it would be necessary to repeat the experiments before all the entire area of the country would be covered. Accordingly, the agronomist desires to find some simpler classification in the hope that his work might be successfully undertaken.

One simple classification would be to divide the soils into soil classes, consisting of about a dozen classes, ranging from sand through various kinds of loam, to clay and heavy clay. Such a system would be simple and would provide considerable information, but unfortunately it would be misleading. Even within the same soil class other characteristics would vary so markedly that agronomic experiments based on soil class would have very little application.

Land types might prove useful and workable as an intermediate system of classification. Land types would group together a number of somewhat similar soil types. They would include similar soil classes and should be qualified in regard to reaction and drainage. Possibly soil horizons and topography should also be considered but it would be necessary to avoid too many qualifications or the ultimate end would be to again have soil types. It would be a matter of judgment how many soil types should be included in any land type. If too many were included the variations within the land type would be so great that it would be impossible to apply any experimental results, even within the same land type.

The land types have already been used to some extent. Chapman and Putman have grouped 30 and 40 soil types into 13 major land types in their article on "The Soils of South Central Ontario", in the December 1937 issue of Scientific Agriculture. These land types carry soil class names prefixed with some qualifying word such as acid, neutral, poorly drained, well drained, and on certain other designations.

This method of using land types is a compromise between the relatively few soil classes and the extremely numerous soil types. However, when agonomic experiments are conducted they will have to be located on some specific soil type and, in fact, on some phase of this soil type. The results from such experiments will be assumed to apply to other soil types included in the land type. To what extent this assumption will be true or will vary for other soil types, will be unknown factors. However, this method would seem to offer perhaps the best means of making a start. If the experimental work were located on a fairly extensive soil type that was somewhat mid-way in regard to its characteristics among the soil types included in the land type, the results might be expected to apply as closely as would be possible under such a system. Nevertheless, it would be necessary to realize that the results of such experiments might not apply on some soils within the land type.

What Constitutes Major and Minor Soil Characteristics

One important problem to investigate is whether small differences in soil characteristics have much real significance. What does it matter if certain soil types possess certain minor characteristics in regard to various points used in soil classification? Another problem would arise, however, in that it would be necessary to learn what constituted a minor and a major characteristic. Black soil is usually regarded as a rich soil, but grey soil also may be rich. The black soil on our Dominion Experimental Station at Lacombe, Alberta, grows wonderful crops, but so does the grey coloured clay at Ste. Anne de la Pocatiere, Quebec.

Is it possible that some characteristics used by soil surveyors are of minor importance and may be similar to the small points used in judging cattle? Cattle may be classified into dairy, beef and dual purpose types with each of these being grouped into sub-divisions or breeds especially developed for milk, butter fat or some other quality. The main classes of cattle might correspond to the main sub-divisions of the soil. However, the length, shape, or even the presence or absence of horns on cattle, the amount of red, white or black colour on the body, and certain other appearances, have no real significance in production. Possibly in soil survey work some characteristics have major significance while others are of little value, and it is desirable to try to learn the value of the various characteristics. It is impossible, of course, to get perfection immediately, but we should commence in the hope that ultimately some system of classification can be developed which will be helpful in arranging agronomic experiments.

Investigational work relating to land use, agricultural zones, or crop zonation, should be undertaken by soil surveyors in association with agronomists, horticulturists, and other crop specialists. These groups of specialists have special knowledge in relation to soils and crops and should be in the best position to rate agricultural land. Sometimes other technical agriculturists enter this field with or without association with soil surveyors, agronomists or other crop specialists, but it would seem that this field of work should be handled by officials who have specialized in these sciences.

IV. Soil Fertility Requirements

Virgin soils contain widely varying levels of fertility. Some soils, especially those developed under grass vegetation are quite rich, while others developed in humid regions may be very infertile. Such soils never were rich, even immediately after breaking, so that unless suitable methods of management are used they are very unproductive.

Commercial Fertilizer Sales in the United States and Canada

Soil fertility is maintained or improved in many regions by the use of suitable crop rotations, including the growth of legume crops, the application of farm manure and the use of commercial fertilizers and limestone. All of these methods are very important and probably have a different significance on different soil types. The amount and cost of commercial fertilizers used in the United States and Canada is very considerable and is increasing.

The total fertilizer consumption in the United States in 1944 (according to the "Fertilizer Review", Jan. Feb. March, 1945 issue), was 12,072,000 short tons. Fertilizer consumption has increased from 4,385,000 tons in 1932, but in 1930 it was up to 8,222,000 tons. While it is impossible to estimate the exact financial cost of this fertilizer to farmers, if it is assumed to cost approximately $30.00 per ton in 1944, the cost would have been about $360,000,000.

In Canada, fertilizer consumption in 1944 amounted to 455,875 tons of mixed goods, and 79,100 of materials or a total of 534,975 short tons. If estimated at $30.00 a ton, the cost of this fertilizer to farmers would total $16,049,250.

In view of these very large expenditures made every year by farmers for commercial fertilizers, it is imperative that impartial agencies should undertake adequate experimental work in order to be able to give reliable information on their most efficient and economical use.

Varying Response to Commercial Fertilizers

One of the interesting findings of agronomic experiments is the striking difference in the response to fertilizers in different soils. Some soils give a remarkable response, while others give only a very small increase. One of the most infertile soils in Eastern Canada is on our Dominion Experimental Station at Kentville, Nova Scotia. Yet, when suitable commercial fertilizers are applied this soil has become one of the most productive soils for pasture. Thus, as an average of four years' results, an untreated check yielded only 3,368 pounds per acre of green weight pasture clippings, while fertilized pasture, on the other hand, gave 16,836 pounds, which is about five times that secured on the check plot. Moreover, where a heavier application of fertilizer was used the yields increased again to 27,806 pounds of green weight per acre, and in one year reached 40,011 pounds. Considering that this soil in its virgin condition could be rated as extremely poor, it is remarkable the improvement which may be obtained from the use of fertilizers.

On the other hand, as an example of a condition in which commercial fertilizers have not given such striking increases, average yields at Ottawa over a period of several years on a rather good North Gower clay loam averaged 9,407 pounds per acre of green matter, as compared with 20,030 pounds for phosphorus fertilizer and 19,334 pounds for complete fertilizer. These increases are about double those secured on the check, while at Kentville they were about five times.

Excellent pasture yields have been obtained on the Dominion Experimental Farm at Nappan, N.S. under favorable climatic conditions, of course, for pasture but on unfertilized land. As an average of seven years' experiments, the untreated check yielded 3,012 pounds per acre of dry matter, as compared with 5,122 pounds on the complete fertilizer. At Nappan the yields on the untreated check have been much higher than at Ottawa or especially at Kentville. At Ottawa pasture yields over a period of seven years were only 2,215 pounds of dry matter per acre on the check and 3,949 pounds on the phosphorous plot, the best fertilizer treatment. The yields of pasture on the untreated plot at Nappan have tended to approach the yields on the fertilized land at Ottawa, although the soil at Ottawa is naturally richer than that at Nappan.

These pasture experiments are mentioned to indicate the possibility and perhaps the probability of soil ratings based on some poor virgin soils as at Kentville giving misleading information as to the real value of the soil when properly handled. It points to the need, also, of learning what characteristic of the soil or correlation between the climate and crop may indicate where fertilizers will give large responses.

All too frequently great publicity is given to certain experiments where increased yields have followed the use of fertilizers. Rarely are negative results reported. Really, this misrepresents the situation because in many cases under certain conditions only insignificant increases are obtained.

In many parts of the Prairie Provinces soil fertility is not as important a factor as in the humid regions of Canada. In the brown and dark brown soil zones fertility deficiencies are not liable to occur for many years. Experiments conducted on the Dominion Experimental Stations at Lethbridge and Swift Current give no significant increases from fertilizers. In the black and gray soil zones, on the other hand, fertility problems are liable to warrant serious consideration. Similar responses have not been obtained throughout these zones, but it would be too much to expect that all the soil types in these zones would respond in a similar manner. Even on some very rich, black soils, as at Lacombe, Alberta, considerable response is obtained from commercial fertilizers, and mixed farming rotations have given better results than straight grain rotations. Soil erosion and moisture conservation are much more important problems than soil fertility in the brown and dark brown zones, but in the black and gray zones all of these problems are important.

Unfortunately, there is entirely insufficient experimental evidence on which to base commercial fertilizer recommendations. Custom, the advice of fertilizer manufacturers or other agents, and the experience of farmers have been the main guides to fertilizer use. Experimental results for various conditions, except for a few special crops, have been entirely inadequate.

Is Fertilizer Response Influenced More by the Crop, by the Soil Type or by the Climate?

Soil types might be expected to show a considerable difference to various fertilizer treatments and it would seem necessary to arrange experiments in order to learn what recommendations should be made for each important soil type. Will these different types respond differently to various fertilizers? Will the type of crop grown exert a dominant influence over that of the soil type on which it is grown? Will the soil type and the kind of crop both exert a considerable influence and if so, will they be equal or will one exert a considerable influence and if so, will they be equal or will one exert a greater effect, and if so how much? Will the previous management of the land, that is, whether it has been well handled or not, over-shadow the effect of the soil type? If legume hay has been grown on the land for many years, livestock kept, and the manure returned to the soil, will any fertilizers be required? Climate also, as well as the crop and the soil, profoundly affects the response from commercial fertilizers.

V. Crop Adaptation

In the Prairie Provinces grain production, especially wheat, is the main type of crop grown. Hay and pasture are not very successful on account of the dry weather. In Eastern Canada, on the other hand, hay and pasture are more important than grain, while in the Maritime Provinces conditions for permanent pasture are very satisfactory. In certain areas conditions are favourable for special fruit, vegetable and other crops. It would be very desirable to learn what soil types and climatic zones would be most suitable for various economic crops. Many different species of weeds thrive only under certain specific soil and especially climatic conditions, so that different crops, also, might be expected to respond very differently to different conditions.

Variations in Crop Yields in Different Crop Districts on the Prairie

In the Prairie Provinces there is a very considerable variation in the average yield of crops from one crop district to another. Thus, over a period of 22 years in Alberta, the average yield of wheat has ranged from 12.9 bushels in crop district No. 5 to 22.5 bushels in the Edmonton crop district No. 11. In the other Prairie Provinces of Manitoba, and Saskatchewan somewhat similar differences in yield occur. Hay yields vary even more than wheat as limited moisture supplied, particularly in the early part of the season, make conditions more unfavourable for hay production. Moisture is the most dominant factor influencing crop yields in the Prairie Provinces. It is not alone the amount of precipitation, but its distribution, the amount of evaporation, and hence the effectiveness of the precipitation.

Uniformity of Yields in Various Counties in Ontario

In Eastern Canada variations in the yields of general farm crops from one district to another, do not seem to be as great as in the Prairie Provinces. It is surprising to observe the uniformity of the yields from selected Counties in the Province of Ontario located in various climatic zones. The following table gives the average yields per acre of five important farm crops over a period of 10 years, from 1934 to 1943, in seven widely separated counties in Ontario.

Crop Yields in Selected Counties in Ontario
Located in Various Climatic Zones
(Ten Year Average, 1934-1943)

County	Zone	Oats bu.	Corn Silage Tons	Potatoes Bu.	Hay & Clover Tons	Alfalfa
Essex	C	38.4	8.98	111.6	1.81	2.64 tons
Haldimand	D	33.6	9.23	85.6	1.59	2.34
York	E	38.9	10.70	92.7	1.81	2.53
Bruce	G	36.5	9.55	100.7	1.64	2.30
Prince Edward	F	30.8	9.16	89.9	1.55	2.27
Carleton	K	34.9	10.28	100.6	1.71	2.48
Cochrane	X	29.1	7.72	119.8	1.18	1.85

X - Northern Ontario.

Crop yields, it would seem from this table, are very similar in all parts of Ontario, especially in all parts of "old" Ontario. Even yields in the Cochrane district in Northern Ontario are not very much different from those in Southern Ontario, although they are somewhat better for potatoes and poorer for oats, corn silage and hay.

When the great variations in both climate and soil are considered, the small differences in the yields of these crops appear relatively unimportant. It would seem that for these crops fairly uniform crop yields may be expected throughout Ontario. Possibly for such general farm crops as oats, corn silage, potatoes and hay these climatic zones in Ontario have very little effect. Corn for silage, however, it would be thought, would have shown a marked difference, and possibly the dry matter content of the more southernly grown corn would be much higher than that grown in cooler regions. Special crops would no doubt show a greater response to climate. Corn for grain, peaches, grapes and certain varieties of special crops would require a longer frost-free period and a higher temperature than general farm crops.

Crop Yields on Different Soils at C.E.F., Ottawa.

A comparison is available at the Central Experimental Farm, Ottawa, of crop yields on different soils. Crops have been grown on sandy loam soils and on heavy clay soil for a long number of years. The comparison is not as accurate as it should be in that the sandy loam soils have received farm manure, while the heavy clay land, being rented and located at some distance from the buildings, receives only commercial fertilizers. Undoubtedly this is a serious weakness, but considering the fact that in other experiments commercial fertilizers used in crop rotations have given results almost equal to those secured with farm manure this comparison may afford an approximate guide as to the adaptation of the two classes of soil for various crops. The following table shows the yields per acre which have been obtained over a long period of years:

Comparison of Crop Yields on
Sandy Loam Soils Versus on Heavy Clay
At the Central Experimental Farm, Ottawa

Crop	Average No. of Years	C.E.F. Sandy Loam Soils	Rideau Heavy Clay
Corn Silage (tons)	19	17.32	10.16
Sunflowers (tons)	10	20.83	11.51
Potatoes (bus.)	14	244.3	128.8
Turnips (tongs)	12	17.77	8.03
Mangels(tons)	13	24.50	10.56
Sweet Clover (tons)	7	1.96	1.75
Hay, Alfalfa & Red Clover (tons)	14	3.41	2.67
Alfalfa (tons)	7	2.85	3.20
Oats	17	56.0	57.3

These results show the sandy loam soils to be definitely superior to the heavy clay for corn, sunflowers, potatoes, turnips and mangels. For hay and oats, on the other hand, there is very little if any significant differences. From these results it would seem that the Rideau heavy clay soil would be distinctily inferior to the lighter soils except for hay and grain. For these latter crops the clay would be superior as it would contain more fertility and would produce better yields under inferior systems of management.

A deep sandy soil, known as Upland sand, and rated low in the soil survey, has given, under a good system of management, excellent yields of alfalfa and corn, and fair yields of hay. Throughout the country, however, the yields are poor and amply warrant the low rating this soil type has been given.

Comparisons have been made at the Central Experimental Farm, Ottawa, on soil types as mapped in a detailed soil survey. However, the results have not yet been secured over a sufficient period of years to enable reliable conclusions to be drawn. The indications would seem to be that under good management the differences in yield may be less than might be expected for general crops. For special crops there may be greater differences.

Considerable variability has occurred in crop yields at the Central Experimental Farm within a soil type even when mapped in a detailed soil survey. This variation appeared to be due to the texture of the sand, in one case being much coarser than in another. However, even after 50 years of good management the yields were not uniform within this soil type, indicating perhaps a greater importance for texture than was given in the soil survey.

VI. Tentative Plan for Agronomic Experiments to Study Soil Types

Some problems to Solve in regard to the Capabilities of Each Soil Type or Land Type in Each Climatic Zone Throughout Canada

1. What species of crops will grow best?
2. What varieties of each crop - especially insofar as these studies are concerned - early, late, or varieties with special growth characteristics?
3. What additional fertilizer elements are required, such as NPK, and how much and in what proportion should they be added. What trace and other elements are necessary?
4. Are these elements needed when the crops are fed to livestock and the farm manure returned to the soil?
5. Are legume hay crops required to maintain the nitrogen supply of the soil, and if so how frequently should they be included in the rotation? Are legumes essential for permanent pasture in humid regions?
6. At what point should the soil reaction be maintained?
7. What is the most suitable soil nutrient level and ratio for all important field and horticultural crops?

8. Is the soil fertility under different treatments on an upward or downward trend, and if so at what rate? This would indicate when changes in management should be made.
9. What tillage practices are necessary to maintain the best tilth?
10. How should soil moisture be maintained to best advantage under semiarid, sub-humid and humid conditions?
11. What amount of organic matter should be maintained in the soil and at what depth should it be located?
12. What are the maximum possible yields and also the most economical optimum yields which may be obtained, assuming different rotation, manurial, fertilizer and irrigation treatments?

Methods of Solving these Problems

The following methods may be used to study these problems:

A. Field and plot experiments.
B. Greenhouse experiments.
C. Chemical Analyses, based on total, partial or short test methods.

While field experiments, including also those conducted on plots, have some limitations, they are undoubtedly the most reliable method of determining soil fertility deficiencies, and the only method of learning in regard to crop adaptation. Careful technique is necessary, however, in conducting field and plot experiments if a proper interpretation is to be made of the results. Heterogeneity of the soil, even within a single soil type, varying phases of a given type, including slope, topography and drainage, make it almost impossible in some regions to locate field experiments on very uniform land. Extreme care is necessary in all cases to arrange the experiments so that the ultimate results will be reliable and will apply to some definite situation.

Variable weather conditions from year to year and from season to season make it unsafe to rely on results covering too brief a period of years? Cumulative changes in the soil over a long period of years may give rise to conditions considerably different from those prevailing at the commencement of any experiments. Nevertheless, notwithstanding these weaknesses, field and plot experiments seem to be the most reliable means of securing information which will apply to field conditions. The difficulty which presents itself with this type of experiment is the problem of being able to undertake a sufficient number of field or plot experiments to study the thousands of soil types mapped by the soil survey.

In an effort to overcome this difficulty with field and plot experiments, greenhouse experiments and various kinds of chemical analyses are undertaken to simplify the procedure and secure results in a shorter period of time. Unfortunately, there is no assurance that the results of such experiments will apply to field conditions, and it is necessary to check these methods constantly against field results.

Procedure to Employ

1. An extensive study should be made of the meteorological records throughout Canada with the object of establishing climatic zones of somewhat similar climatic conditions. To perfect this study, many additional records will be necessary at new locations so that climiatic conditions in smaller territorial regions may be known.

2. When soil surveyors complete the survey of a region they might show, in addition to the location of soil types, a grouping of similar soil types into land types. They might indicate to agronomists the location of these land types as well as the more important soil types, and mention any special soil problems they have observed in the area surveyed.

3. A study of crop adaptation should be made on the Experimental Stations and substations in order to learn what crops will grow best on as many soils and climatic zones throughout Canada as possible.

4. Experiments should be undertaken to determine the nutrient requirements of each field and horticultural crop, as well as nutrient losses and gains in the soil. Such experiments should be conducted at the Experimental Stations.

5. Field and plot experiments should be conducted on Experimental Stations, Substations, and also on a large number of private farms to determine the fertility requirements for N.P.K., Ca., etc. on the various land types and principal soil types.
Field experiments should be conducted at Experimental Farms in which varying amounts and ratios of commercial fertilizers would be applied, with and without manure and in crop rotations without legumes and with legumes included, say 25% and 50% of the time. These experiments should be arranged so that a study of the increase or decrease in the nutrients could be measured at 10 or 20 year intervals and on an area sufficient to allow changes to be made in later years in some of the treatments in accordance with the changes which have occurred in the fertility level of the soil.

6. Greenhouse experiments should be conducted at Experimental Stations with soil samples taken from land and soil types on which it would not be possible to conduct field experiments in the near future.

7. Various chemical methods should be used to analyse soil samples from soil types which would be impossible to use during the next few years either in field or greenhouse experiments.

8. Correlation studies should be undertaken constantly at the Experimental Stations to check the agreement among field, greenhouse and chemical analyses experiments. The technique of these experiments should be improved from time to time as better methods became available.

9. The soil surveyor should return to the area every few years to consult with the agronomist on the results of the agronomic experiments.

10. About 10 to 15 years after each area has been surveyed and the report and map issued, a new report and map might be prepared giving the results of the agronomic experiments and embodying any changes or refinements in the report and map which the soil surveyors might think desirable.

Discussion on Soil Rating

Dr. Leahey - We must give the soils some rating as to their general value. In most cases yield data are not always available in sufficient quantity and in virgin areas there often is no data at all. Under such circumstances some other deductive reasoning has to be used to rate the soils.

Mr. Aalund - In New Brunswick some deductive system will be necessary as it is almost impossible to obtain accurate yield data and of course in virgin areas there is no data.

Dr. Hopkins - The rating of the soils by the surveyors gives the benefit of the experience of the most competent men to rate the soils. What system is used and what figures should serve as 100% is difficult to say, but some such figures should be defined and used.

Mr. Lajoie - Information regarding the yields has to come from farmers. What type of farmers should one choose? The results that will be obtained depend largely on the type of farmer that one gets in contact with.

Mr. Bowser - In Alberta we use the "typical farmer" as defined by the appraisal institute.

Dr. Kellogg - The productivity ratings of soils form the bridge between soil science and the other agricultural sciences.

In the old reports the soil was described generally according to its appearances and its inherent characteristics. This information is not sufficient for other people, who are not soil scientists, to evaluate the soil. The surveyors who know the soils and have observed their performance, together with the soil fertility specialists, are in the best position to evaluate the soil. The rating of the soils forms a particularly valuable and necessary bridge for the farm economist because the latter must have some assumptions regarding yields before he can utilize the soil information in developing farm budgets.

Only a few of the yield data included in the U.S. Soil Survey Reports are accurate measurements. They are based mainly on estimates and represent a figure which is reasonable if tested deductively from farm experience and inductively from a knowledge of soil characteristics and crop requirements.

Many of the early ratings were based on the "natural" productivity of the soil. Actually there is no such thing as natural productivity. Man has to do something to produce crops, i.e. he must cultivate, seed and often fertilize. The productivity of the soil, therefore, must be considered as the excess of out-put over input. In rating the soil the management must be stated and interpreted very carefully; and we can not expect to do our job until this is done. One set of ratings is based on current practices, which are used by farmers who are making a go of it, and other sets on more intensive but tested practices, physically defined.

In collecting the necessary data we must co-operate with other scientists since the soil surveyor is not in a position to know all the details pertaining to crops, varieties, cultural practices and fertilizers. The experts in these lines must be consulted. The best sources of information for the U.S. Soil Survey have been the farm management studies and the district experiment stations. In some cases, where accurate farm management studies have been made, significant differences for different soils have been obtained between 55 and 60 bushel corn land under specified management.

In the U.S. Soil Survey Reports the yields are considered as the main information on which ratings are based and the yields are stated. The final ratings in percentages are not so important, although they are usually included to allow easy comparison. The final rating, or general weighting, is not so important and in some cases it may be misleading. We should not worry too much about them, perhaps, although land appraisers are anxious to have these general ratings. The final ratings can only be made by weighting the ratings of individual crops according to relative acreages where it can be assumed that farmers have free, or reasonable free, choice. Actually many do not have really free choice. An example of this are the soils very good for flue cured tobacco. These soil, although they are highly rated for tobacco are poor soils for general farming purposes. On a 100 acre farm perhaps, only 5 acres are devoted to tobacco, and the remainder to other crops. It is not fair to rate all 100 acres on the basis of its suitability for tobacco production. In such cases the rating for tobacco must be given a higher weight in the general rating than simply 5/100, according to the intensity of use in man-acre-days of labour.

The alternative of the rating on yield data is the evaluation on soil characteristics. The Storie Index is such an attempt. Although very little fault can be found with the final ratings obtained by Storie, the assumptions used in the index system are questionable. This system assumes a straight line relationship between certain selected groups of soil characteristics and the final value of the soil, which is scarcely true. Eventually perhaps a differential equation of the second or third order may be devised which will permit the evaluation of the soil by its characteristics alone. However, at the present time we have not the information at hand which would permit us to do that.

It appears that Storie has in mind the final rating which would be reasonable and then selects figures under the respective headings to give this reasonable result.

<u>Mr. Webber</u> stated that in Ontario they have tried to interprete such soil characteristics that do not change readily and applied them to soil ratings. They have used:-

A. Internal soil characteristics
B. External characteristics
C. Climatic factors for crop growth

By the use of a system the surveyor gets away from personal bias. The final rating which is obtained is then compared to such yield data as are available.

Dr. Kellogg - What would you do about such items as stoniness?

Mr. Webber - Surface stones are taken care of by external characteristics. However, some difficulty was encountered in the case of shallow soils over bed rock, such as Farmington. In the case of these soils special deductions were made for shallowness to bed rock.

Mr. Stobbe - Does this system of rating apply to individual crops or is it a general rating?

Mr. Webber - It is based on the common crops used for general farming in Ontario, such as fall wheat, oats, alfalfa, clover and fodder corn. It does not taken into account special crops.

Mr. Richards - After the completion of the soil survey in Carleton County the soils were rated for the different crops as good, fair, poor, etc. due to the lack of more specific information regarding yields. This rating was based on field observations of the different crops, on information obtained by talks with farmers and on knowledge of the internal and external soil conditions. This rating, although it is not so specific as the ratings based on yield data, as suggested by Dr. Kellogg, never the less it has served a good purpose.

Dr. Leahey - What does a particular farmer mean by good? Good in one area may not mean the same as in another area. The terms good, fair, etc. must be defined more closely and this brings us back again to the question of yields.

Dr. Kellogg - In the U.S. Soil Survey the party chief is required to rate the soils in terms of yield data. In order to do this with any degree of accuracy he has to have some help. The county agents and the crop specialists are asked to co-operate with the party chief and any yield data which have been obtained from experimental work or by farm management studies are made available to him. A table with the preliminary ratings then comes to the chief soil analyst (Dr. C.P. Barnes) who goes over the work and then distributes the ratings to the experiment stations and agricultural agents, etc., for further comments and corrections. In this manner a number of people have a chance to express their approval or disapproval several times. The final rating which is obtained in this manner is usually fairly accurate and reliable.

Mr. Bowser - In the rating of new soils it is necessary to carry over some information from other somewhat similar soils which have been studied earlier. This often brings in too much personal judgment unless some particular system is followed.

Dr. Ripley doubted if we were in a position to rate the soils very closely on the basis of yields. If such close rating were to mean anything, so that people could have confidence in it, we must have very much more information than we now have. He thought that the general type of rating that Mr. Richards had mentioned such as fair, good, etc. for the different crops, is very desirable and that is about all we could expect the surveyors to do at present. After several years of work with the main soils in Carleton County we are not in a position to rate the soils very much closer than the surveyors did at the time of survey.

Mr. Aalund - How would one rate apparently good virgin land where no yield data are available?

Dr. Kellogg - In such cases the soils would have to be rated by judgment based on careful morphological studies of the soil and on a study of the environment, including especially the native vegetation, in relation to soils of known crop adaptability and response to management.

Mr. Moss - Soil ratings in Saskatchewan are now in common use. The rating has been forced on the soil survey in Saskatchewan over a period of years. First one of the larger commercial concerns desired a rating of their lands and was willing to pay for it. Then the agricultural economists and farm management people demanded a soil rating for their studies. Later the land assessors demanded additional information in order to enable them to evaluate the land more accurately.

The rating which is presently in use is based on a modification of the Storie Index and works quite satisfactorily. Yield data which have been recently collected agree fairly closely with the earlier ratings.

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THURSDAY, MAY 10th, 1945.
1.30 p.m. - 5.30 p.m.

DISCUSSIONS ON THE FOLLOW-UP PROGRAMS

Dr. Ripley stated that the Field Husbandry Division of the Central Experimental Farm has tried to tie in agronomic work with the Soil Surveys. In order to work out their procedure they have made a survey of the type of work which has been done in other places. A questionnaire was sent to 51 stations in the U.S. and Canada.

A summary of the results of this survey is reproduced on the following pages for the benefit of the committee.

METHODS USED BY VARIOUS AGRICULTURAL EXPERIMENT

STATIONS TO DETERMINE SOIL FERTILITY REQUIREMENTS

In order to learn at first hand what methods are being used by various agricultural institutions on the North American continent to determine soil fertility requirements, information was solicited in 1941 by letter and questionnaire from a number of prominent soils workers and agronomists in Canada and United States. Questionnaires were sent to 51 Agricultural Experiment Stations in United States and 7 Provincial Institutions in Canada. Replies to the questionnaire were received from 46 United States stations and 6 Canadian stations.

The information requested in the questionnaire was as follows:

1. To what extent are the following methods used at your Station to determine soil fertility requirements?
   - (a) Field experiments on the station farm.
   - (b) Field experiments at substations.
   - (c) Field experiments on private farms.
   - (d) Total chemical analysis.
   - (e) Rapid chemical tests.
   - (f) Greenhouse experiments.

2. What experimental work is being done by your station to determine the response of various soil types as mapped by the soil survey:
   - (a) To crop adaptation?
   - (b) To soil fertility treatments?
   - (c) To different methods of soil management?

3. Which of the following tests are being used at your station? Spurway, Morgan, Truog, Thornton, Metscherlich, Wiessmann, Neubauer, other tests.

4. On what basis do you make commercial fertilizer rate and formulae recommendations?

5. To what extent can rapid chemical tests be relied upon to diagnose soil fertility needs?

6. Do field experiments conducted on specific soil types provide a reliable method on which to base soil fertility recommendations?

7. Owing to the variation in the level of fertility of farm lands within a soil type what methods will provide information for recommendations for the individual farmer?

In addition to the questionnaire sent to various institutions an expression of opinion was obtained in regard to the questions asked, from Dr. Oswald Schreiner, Principal Biochemist in charge of the Division of Soil Fertility Investigations, Bureau of Plant Industry, U.S.D.A., and also from Dr. Charles E. Kellogg, Chief, Division of Soil Survey, Bureau of Plant Industry, U.S.D.A.

Dr. Schreiner replied as follows:-

"In the past we have, as far as practicable, conducted soil fertility studies on prominent soil types and crop regions and thus contributed to the proper use of the land. Mechanical analysis and chemical analysis of the soil types have been under way for years and agronomic tests are made by our state agricultural experiment stations, as well as by the Department.

The so-called quick tests are now pretty generally used for acidity and lime requirement determinations and the tests for the principal plant foods are increasingly meeting with favor in the newer work. For definite information, however, on questions of relative fertility or fertilizer requirement the agronomic field tests still remain the basis of accurate comparison.

In the making of soil surveys there lies the opportunity for a very happy blending of field soil information and the agronomic experimentation on specific soil types or agricultural regions with soil analysis and testing properly evaluated as contributing factors to the land use value of the soils."

Dr. Kellogg commented as follows:

"I would stress some of the following points in regard to the relationship between agricultural research and soil classification and mappings:

1. In the first place, we must realize that some kind of classification of soils is essential for the proper planning, interpretation, and extension of research and the results of research dealing with the land, whether these classifications are clearly and definitely developed or more or less uncon sciously and loosely conceived. We think of soil classification as an immediate necessity to the soil mapper, and it is, but in the long run it is just as essential to all other research workers dealing with soils.

2. I believe there is an advantage in having research work in all phases of soil and agronomic investigations conducted on definite, defined soil types.

3. I think it is important for soil investigators to co-operate with farmers in order to develop as accurately as possible yield data under alternative physically defined systems of management on specific soil types.

4. I think the concept of productivity ratings for soil types is a very useful one as a sort of final practical synthesis of the results of research and of farmer experience in such a way that these findings may be made available to other farmers, in order to make predictions regarding the yield expectancy of different soil types under different management practices.

In regard to some of the points on your questionnaire: Of course, by inference I have answered some of these. I think total chemical analysis is helpful as good background material where good morphological samples have been used. I think total chemical analysis of composite samples or of surface soils only are not worth the time and expense.

I think rapid chemical tests can be useful if one has found or developed a test that will work on theparticular soils involved satisfactorily, and has sufficient checks against controlled experiments and farmer experiense to standarize it. I think also that these tests can only be useful where one has a lot of additional data, including especially the soil type, the character of the previous vegetation, the previous use, and a knowledge of the physiological requirements of the plants to be grown. The results of the tests must be interpreted by competent agronomists who are familiar with soil classification and soil chemistry. In the hands of unskilled people they may give very misleading results. I am convinced that there are no rapid chemical tests that will work on all soils. For example, I doubt if there is one that will work on both the Podzol and the Chernozem, and one that will work on either will doubtless not work on the Laterite."

A general summary of answers from Experimental Stations to the questions in the questionnaire is shown briefly in Table 1.

Table 1 GENERAL SUMMARY OF ANSWERS

Question	Extensive	Limited	None			
1. To what extent are the following methods used to determine soil fertility needs?						
a. Field experiments on station Farms	28	19	5			
b. Field experiments on substations	26	15	11			
c. Field experiments on private farms	63.57 39	8	5			
d. Total chemical analysis	3	17	32			
e. Rapid chemical tests	22	25	5			
f. Greenhouse Exp.	11	33	8			
2. Experiments related to soil type						
a. Crop adaptation	19	7	26			
b. Fertility treat.	35	4	11			
c. Methods of soil management	27	-	25			

Table 1 continued

Question	Extensive	Limited	None			
3. Rapid soil tests used	Morgan 18	Truog 17	Neubauer 11	Spurway 8	Thornton 6	Other tests 24 kinds
4. Basis of fertilizer recommendations	Field tests 40	Rapid or greenhouse 22	Knowledge of conditions 27			
5. Reliability of rapid tests	Reliable 4	Limited 12	Reliable with qualifications 22	Not reliable 0		
6. Reliability of field experiments on soil types	18	3	21	3		
7. Method of recommendation for each farm	Field tests 17	Rapid or greenhouse 21	Knowledge of conditions 17			

A more detailed discussion of the answers reveal the following points:

Question 1. <u>To what extent are the following methods used at your station to determine soil fertility requirements?</u>

(a) Field experiments on the station farm?

Twenty eight of the 52 stations reported extensive experiments. These include the Morrow plots at Urbana, Illinois, the oldest fertility experiments in United States, begun in 1879, the Jordan plots at Pennsylvania, established in 1881 and experiments at Columbus, Ohio, since 1893. Other stations reported varying amounts of work being done, as, for example, 600 acres in experiments at one station, some 3000 plots at another and extensive experiments at many of these stations.

Nineteen stations reported a limited amount of work.

Two stations reported some work but the soil on the station was not representative of large areas of soil in the state.

Five stations reported no fertility experiments on the station farm.

(b) Field Experiments on Substations

Twenty-six stations reported more or less extensive use of substations ranging from 1 substation to 15. The average number of substations used by 20 stations which reported a specific number was 6.7.

Fifteen stations reported a limited use of substations.

Eleven stations reported that no substations were used.

(c) Field Experiments on Private Farms

Thirty-nine stations reported more or less extensive work on private farms. These ranged from two or three farms at some stations to as many as 500 in one state. The average number of private farms used in thirty-six states or provinces was 63.57.

Eight stations reported very little work on private farms and five had no work at all.

One station had previously done experimental work on private farms but found it unsatisfactory and the work is now done on 10 substations on representative soil types.

(d) Total chemical Analyses

Thirty-two stations reported no use of total chemical analyses to determine soil fertility needs.

Seventeen stations used total analyses to only a limited extent and some of these for special problems only.

Only 3 stations reported extensive use of total chemical analyses.

(e) The Use of Rapid Chemical Tests

Five stations reported no use of rapid chemical tests for soil fertility diagnosis.

Twenty-five stations reported a limited use of the tests and twenty-two used the tests quite extensively. One station tested 100,000 soil samples annually, another 14,000 and another 10 to 15,000 samples annually.

A survey in regard to the use of rapid chemical tests in various states was made by R.P. Thomas in 1935 and the results were published in Journal of the American Society of Agronomy, May 1936, page 411. The results of this survey as compared with those obtained by the Dominion Experimental Farm, Ottawa in 1940 is shown in Table 2.

Extent to Which Rapid Chemical Tests
Were Used in 1935 & 1940

Table 2

State or Province	Thomas Survey 1935	Ottawa Survey 1940
Alabama	50	0
Arkansas	0	Limited
California	0	0
Colorado	6,000	200-300
Connecticut	3,000	12,000
Delaware	200	General
Florida	0	Moderate
Georgia	100	Large extent
Idaho	50	Some
Illinois	(25,000 P) (10,000 pH)	Considerable
Indiana	40,000	Considerable
Iowa	2,000	2,000
Kansas	600	Indicator only
Kentucky	10,000	pH and P only
Maine	600	Considerable
Maryland	10,000	Considerable
Michigan	10,000	Extensively
Minnesota	2,000	Slight
Mississippi	Limited	500
Missouri	4,000	Used by country agents
Montana	500	P and pH
Nebraska	300	Litte used
Nevada	0	0
New Hampshire	600	Considerable
New Jersey	Extensive	8,000
New Mexico	150	Some
New York	Extensive	Limited
North Carolina	2,000	Correlating with crop yields
Ohio	10,000	14,000
Oklahoma	2,000	over 2,000
Pennsylvania	1,000	Some
Rhode Island	500	Extension Service
South Carolina	500,000 pH	for Calibrating recommendations
Tennessee	10,000	Occasionally
Texas	500	Limited
Utah	100	P pH Soluble Salt
Vermont	1,000	8,000 - 10,000
Virginia	10,000	10,000 - 15,000
Washington	1,100	1,000
West Virginia	500	General use
Wisconsin	15,000	100,000
Wyoming	100	300 - 400

Table 2 continued

State or Province	Thomas Survey 1935	Ottawa Survey 1940
Canada		
Nova Scotia		Considerable
Quebec		Very little
Ontario		Extensively
Manitoba		Limited
Saskatchewan		Limited
Alberta		Limited

Several state institutions which sent in a report in 1935 did not report in 1940 and were omitted from Table 2. There appears to be a definite trend toward increased use of rapid tests over the five year period. Of the stations replying to both the 1935 and 1940 questionnaires 10 showed an increase in the use of the tests, 17 showed no change. With 12 the information supplied was on a different basis in the two reports and no comparison could be made. Only 3 showed a decrease in the number of samples handled and in most cases the difference was small.

(f) The use of a greenhouse in determining soil fertility needs

Eleven stations reported extensive use of the greenhouse in connection with soil fertility work.

Thirty-three used a greenhouse to only a limited extent.

Eight stations did not use a greenhouse at all.

Question 2. What experimental work is being done by your station to determine the response of various soil types as mapped by the soil survey?

(a) to crop adaptation?

Twenty-six stations reported no attempt to correlate soil type with crop adaptation. Two of these reported no adequate soil survey to make this possible.

At nineteen stations experiments of various kinds were attempted relating crop adaptation to soil type. These included crop variety tests in most cases.

Seven stations attempted to relate soil types to crop adaptation and production by field records or observations. In some cases these observations were made by soil surveyors.

(b) Soil types as related to fertility treatments

Eleven stations reported no correlation between fertility experiments and soil type.

Thirty-five stations conducted experiments on substations or private farms located on definite soil types.

Two stations related soil fertility to soil type by observation and two conducted greenhouse and laboratory experiments on soil types in relation to fertility.

(c) Soil types related to soil management

Twenty-five stations reported no correlation between soil type and soil management experiments while twenty-five conducted soil management investigations in some way related to soil type.

3. In answer to the question "Which of the following tests are used at your station", the replies are listed as follows:

Table 3

Test used	No. of Stations	Test used	No. of Stations	Test used	No. of Stations
Morgan	18	Acetate Borate	2	Missouri	1
Truog	17	No test named	2	Winogradsky	1
Neubauer	11	Wiessmann	1	Nebraska	1
Spurway	7	CO 2	1	O.A.C.	1
Thornton	6	Hoshensmith	1	Fungus	1
Bray	3	Georgia test	1	Hi-lo-phos	1
Mitscherlich	3	Combination	1	O.K. (Acidity)	1
Hester & Miles	3	Niklas	1	Fraps	1
Dahlborg & Brown	2	Illinois	1		
La Motte	2	Potassium Thiocyanate	1		

Question 4. On What Basis do you make Commercial Fertilizer Rate and Formula Recommendations?

Forty stations used field experiments as a basis for commercial fertilizer recommendations.

Eighteen stations reported the use of laboratory soil tests; most of these refer to quick tests.

Eleven stations base recommendations on soil characteristics.

Nine base recommendations on farm experience and seven stations on observations, while three use greenhouse tests.

Four stations recommend only the use of phosphate.

At one station recommendations are based on tissue tests, at one on the farmers ability to buy, at one on crops grown with no particular relation to soil.

One station does not attempt to make recommendations since they have no field tests.

Although the individual basis of recommendation listed above are used by the different stations a combination of methods are used by most of the institutions.

Ten stations report the use of a combination of field experiments and soil characteristics as determined by the soil survey.

Fourteen stations use a combination of field experiments and laboratory tests.

Eleven stations combine the use of field experiments with farm experience.

Four stations use laboratory tests in conjunction with field observations while two stations combine field and greenhouse experiments.

Eleven stations use field tests alone and one station uses as a basis for fertilizer recommendations 90 per cent experience and 10 per cent tests.

Question 5. To what extent can rapid tests be relied upon to diagnose soil fertility needs?

Four stations expressed the opinion without reservation that rapid tests are reliable to a large extent.

Twelve stations suggested that such tests have a rather limited value and eight reported that very little value could be placed on the reliability of these tests.

Ten stations reported the tests reliable when used in conjunction with other information.

Four stations find the test for phosphorus very reliable and one finds the test reliable for potash and lime, fair for nitrogen and indicative for phosphorus.

Three stations suggest the tests are fairly reliable if interpreted by a skilled operator and two report that caution is necessary in interpreting the tests.

One station finds the tests unreliable alone but useful as an indicator. One station found the tests unreliable on high lime soils, and one claimed reliability at high and low fertility levels.

Question 6. Do field experiments conducted on specific soil types provide a reliable method on which to base soil fertility recommendations?

Fifteen stations replied definitely in the affirmative in answer to question six.

Seventeen stations suggested that the method is reliable with certain reservations: of these,

4 reported them valuable if correlated with other data.
4 reported them valuable if carried on for a sufficient number of years, and with sufficient tests.
5 reported them valuable but there is considerable variation within soil types which must be considered.
6 agreed that they were useful but soil management was an important factor.
3 suggested they were useful for general recommendations but not for specific cases.
1 station found the method fair but it does not take into consideration climatic differences such as drought, within a soil type.
1 station thought of it as only an approximate guide.
2 stations found little correlation between soil type and fertility recommendations.
3 stations said definitely "no relationship" and one said no because variations due to soil management were greater than differences in soil type.

Question 7. Owing to the variation in the level of fertility of farm lands within a soil type, what methods will provide information for recommendations for the individual farmer?

Eighteen stations suggested rapid chemical tests might be used wholly or in part as a basis for recommendations for the individual farm.

Seventeen use a knowledge of conditions such as yields, soil character, previous management as a guide in making recommendations.

Eight stations suggest dependence in field tests on farms or stations.

Eight stations maintain tests are required on each individual farm.

Three stations use greenhouse tests, one fungus tests and two suggest the possible use of tissue tests.

One station suggests the simple method of applying minerals and building up the soil by good management.

Four stations report the necessity of a combination of rapid tests and a knowledge of conditions. Five suggest a combination of field tests and rapid chemical tests. Three others favor a combination of a knowledge of conditions and individual tests on each farm. Three would combine rapid tests and greenhouse experiments with a knowledge of conditions and with field tests.

One station replied "We are still looking for such a method" and another "This question still remains to be answered".

General Conclusions Based on Answers to Questionnaire

1. There appears to be a definite trend away from large scale fertility experiments on State Agricultural Experiment Station Farms toward a larger number of perhaps more simple tests on a large number of private farms.

2. Due to the impossibility of conducting tests on every individual farm in a state or province, which might be desirable if possible, the tendency is toward tests on a few private farms located on definite soil types as mapped by the soil survey.

3. At the same time as there is a tendency for soil fertility workers or agronomists to use the information of the soil surveyor as a basis of soil fertility research, the soil surveyors are accumulating more information of an agronomic nature and the more recent soil survey bulletins deal with both phases of soil investigations. This is a very promising development.

4. While many institutions are using rapid chemical tests very extensively, nearly all of the investigators agree that the tests in themselves do not provide a final solution to the proper diagnosing of soil fertility needs. It is fairly generally accepted that, if the tests are carefully done and properly interpreted, and if a suitable extractant is used for the particular soil types or conditions, rapid chemical tests can be used as a guide along with other related information in determining the relative fertility of soils.

5. The use of rapid chemical tests is on the increase.

6. There still remains considerable confusion of methods and ideas in formulating commercial fertilizer recommendations in various states and provinces. Field experiments continue to be the most widely used basis of fertilizer recommendations. Rapid chemical tests, field observation and experience and in a few cases greenhouse tests are also used to a considerable extent.

Discussion continued

Dr. Ripley - After this survey the Field Husbandry selected 11 of the major soil types in Carleton County for further investigations. Fertilizer tests were conducted on these soils in the greenhouse and some fertilizer tests were also conducted in the field, although the number of field tests had to be limited due to lack of help. The Department of Chemistry, Science Service, is co-operating in this work and is performing quick tests on the various soils. Similar work has been started on some of the Branch Farms during the last year. It is hoped that this work will bring the soil survey and soil fertility work closer in line and will also help in the rating of the soils.

Dr. Kellogg - Questioned the use of the term "Follow-Up"? He did not think it was a good term and would rather like to think in terms of "co-operation", as the agronomist could not get far without the surveyor and visa versa. The basic excuse for the money spent on soil survey work is the implementation of a sound research program and extending the results to farmers. The soil survey furnishes the base for such programs.

The question of the large number of soil types established by the surveyor is frequently raised by some agronomists. The surveyor does not create the soil types but indicates the significant difference in the landscape. The nutrient requirements and many physical conditions are directly tied up with soil type. In the classification similar units are grouped by a logical process into higher categories on the basis of soil characteristics. If this grouping is not performed unsatisfactory developments may take place in the established research programs. It is not possible to conduct experimental work on each individual farm yet farmers will, in the future, demand much more accurate information spetificially applicable to their particular fields.

In the research programs the greenhouse has a place and it could be used more widely. Unfortunately, frequently in greenhouse work only surface soils are dealt with. This is a mistake. Soils from dry land are often placed in the greenhouse and tested under humid environment. Such results are not relevant.

Prof. Ellis - We are fortunate in Canada that soil survey work is tied up with provincial institutions. Fertilizer tests and other experimental work which has been conducted by these institutions for years is now used in connection with soil surveys. Soil survey is the initial step in soil science research.

The greenhouse work is not very satisfactory as we can not expect to get the same results as in the field. In the fertilization of a crop it is possible that micro-organisms and climatic conditions have a great influence on the behaviour and action of the crop. The dates of application of phosphates also has varying effects on the yield. These factors may react differently in the greenhouse than in the field and for that reason it is absolutely essential that fertilizer experiments be conducted in the field.

There are also a large number of factors affecting the soil type, of these the human factor may be very powerful. Some work should be done in connection with long time cultivation as compared with short time cultivation experiments.

Dr. Leahey - Not quite prepared to agree with Prof. Ellis in condemning greenhouse soil work. It may be interesting to note that the results obtained in the greenhouse at Ottawa check with Prof. Ellis's results in the field over a considerable period of time.

Prof. Ellis - The greenhouse work is useful as a preliminary approach to the problem.

Dr. Kellogg - One of the main drawbacks of the greenhouse is that the work is usually done on surface soils only, whereas the plants extract a considerable amount of nutrients from the subsoil, and subsoils have a vital influence on water relations and root penetrations.

Dr. Ripley - We have a good example of this in the case of the Farmington soil. It is a shallow soil over bedrock and not much good in the field, whereas in the greenhouse it produces good crops. One must use sound judgment in this work.

Dr. Kellogg - The greenhouse offers good possibilities for exploratory work.

Dr. Hopkins - The greenhouse results have to be compared with field results. Considerable work has to be done in greenhouse technique in order to obtain comparable results.

The discussion was brought to a conclusion and the chairman requested the sub-committee to consider the points which had been discussed while preparing a summarized statement for the consideration of the committee on Friday.

REPORT OF THE SUB-COMMITTEE ON MAPS AND REPORTS

Was presented by Prof. F. F. Morwick

Members of Sub-Committee

Prof. F.F. Morwick, Ontario Agricultural College, Guelph, Ontario. (Chairman)
Mr. W. Odynsky, Edmonton, Alberta.
Mr. G.B. Whiteside, Charlottetown, P.E.I.
Mr. W.H. Shaefer, Winnipeg, Manitoba.

The revised report is presented in the following pages.

Soil maps and reports will vary greatly, depending upon the type of survey, scale of mapping and the total amount of land described by one map or report. Surveys may vary from a broad regional or reconnaissance type, to a survey of an individual farm or plot. For present purposes we will strike a middle road and deal primarily with the detailed-reconnaissance type of surveys such as are being carried out in most of the Provinces.

In preparing this report on Soil Maps and Reports, which must necessarily take the form of a recommendation for the guidance of those preparing Soil Maps and Reports, we must first answer two questions. The first is "On what are we reporting?" and the second "To whom are we reporting?"

To answer the first question briefly we would say that we are primarily setting up an inventory of the soil resources of the area in question and describing them in such a way as to clearly convey to others their natural and associated characteristics. Similarly for the second, the answer would be "Any persons who are interested in learning about the soils in the area."

It is obvious that unless the soils are very uniform in nature, there is a very definite limit to the amount of detail that can be given in either the map or the report on any given small parcel of land which may represent one man's farm. Consequently for a person interested primarily in his own farm the report will likely be far too general. On the other hand there are many persons engaged in cropping and correlation studies covering broad regions, who do not want too much detail and desire a broad-grouping of the soils for their own particular purpose.

Let us conclude then that some of the persons who will be most interested in the maps and reports will be:

1. Persons or groups wanting to locate land for specific purposes.
2. Municipal bodies or other groups, interested in land-use planning.
3. Assessors.
4. Agricultural extension workers.
5. Banks and loan companies in the business of loaning money on agricultural land.
6. Highway and construction engineers. (the term "Soil" has a more inclusive meaning with many of this group).
7. Teachers of agriculture.
8. Soil Scientists.
9. Other agricultural Scientists.
10. Etc. Etc.

It is obvious that the report can neither be a simply written "Farmers bulletin" type of report nor a highly technical treatise intended mainly for other soil scientists. Owing to the fact that the soils occurring over a fairly large area are to be represented on a comparatively small sheet of paper (the map) and are to be described so that an interested person may learn the nature of the soil in all or any part of the area, it is necessary to use many technical terms relating specifically to soils. These should be kept to a minimum and their meaning can be given in a glossary of terms in the appendix.

<u>Subject matter and Its Arrangement in the Report</u>

One of the best guides for the preparation of a soil report is a critical study of the reports already written. A review of some of the published soil reports would indicate that the following information is generally considered essential to the report.

1. GENERAL INFORMATION NOT SPECIFICALLY RELATED TO THE SOIL.

(a) Location and extent of the area.
(b) Population and racial extraction.
(c) Transportation and markets.
(d) Non-agricultural industries and natural resources.

This section of the report should be fairly brief, just sufficient to put the reader in the picture with regard to general conditions associated with the area to be described.

2. INFORMATION RELATED SPECIFICALLY TO THE GENESIS AND MORPHOLOGY OF SOILS.

(a) Parent materials and their age (surface geology).
(b) Topography and drainage.
(c) Climate.
(d) Native vegetation.
(e) Cultivation.
(f) Erosion.

This section should contain more detail than the first but should be confined mainly to information pertinent to soil formation. This same information, particularly climate, is also of direct interest in land-use studies. It should be related largely to the area as a whole.

3. CLASSIFICATION AND DESCRIPTION OF THE SOILS.

(a) Relationship to broad Soil Zones or Great Soil Groups and to adjoining areas.
(b) Relationship of soils within the area, detailed descriptions of the soils and their agricultural importance.

This section should constitute the main body of the report, particularly the (b) part. The (a) part may be written in more technical terms and should be of particular interest to other soil scientists. In the (b) part the soils should be described by groups and units so that a minimum of repitition is necessary. Some uniform system or sequence should be followed so that a minimum amount of time will be required to look up certain information regarding any individual soil or group of soils. The following sequence is suggested:

1. Subdivision of soils into various categories down to the smallest mapping units, thus showing the relationship of one soil unit to the rest. A table along with some explanatory discussion is the best means of doing this.

2. A brief discussion of each group of soil materials in turn followed by a detailed description of each Series (or Associate) developed on that material.

3. Each series description might include:

i. General description.
ii. Extent and location.
iii. Topography and drainage. (Internal & External)
iv. Stoniness.
v. Natural vegetation.
vi. Detailed typical or generalized profile description, preferably in graphic or tabular form.
vii. Condition of cultivated soil, fertility, erosion, etc.
viii. Utilization.

4. Description of types and phases.

4. THE UTILIZATION OF SOILS, PARTICULARLY IN AGRICULTURE.

(a) History of the clearing of the land and the development of agriculture.
(b) Present land use and future possibilities.
(c) Management and development.
* (d) Comparative suitability for the production of locally important farm crops, including a soil rating.

* Soil ratings and crop adaptability ratings should be checked with regional agronomists during the preparation of the report and be generally approved by them.

This section should be written in as practical a form as possible. Some general recommendations can be included in the discussion of management and development. The sub-section on Land Use Capability and Soil Rating is one of increasing interest. This is considered by some to be the job of economists or geographers but their approach to this problem is through a somewhat different channel. The soil scientist must approach it through a study of the inherent capacity of the soil to produce crops satisfactorily, without serious deterioration. He must keep in mind, of course, modern agronomic methods and the suitability of the climate. In all cases where material included in the report overlaps on the work of other scientists, specialists in these fields should be consulted during the preparation of the report.

5. ADDED INFORMATION WHICH MAY BE HELPFUL IN THE INTERPRETATION OF THE REPORT. (APPENDIX).

(a) Analytical data.
(b) Survey methods.
(c) System of classification.
(d) Textural, structural, topographical classes, etc.
(e) Glossary of terms.

In some reports it may be desirable to include other topics than those mentioned in the above outline but it includes most of the essential ones and probably some non-essential. This arrangement of material is arbitrary but seems logical. This may give rise to some discussion.

Some authors have greatly expanded certain sections of the report. For example the section on geology is written up in considerable detail in some reports. This may be desirable where the material is available in unpublished or scattered published form. In other cases it may reflect the early training or interest of the workers. The most essential portion is that pertaining to the nature and deposition of the soil-forming materials and the approximate length of time since their deposition.

In some reports a considerable amount of "Textbook" type of material is included. This seems to be more suitable for a broad scale report such as a report for a Province or large portion of a Province than for a county or other local area report which will be duplicated for other counties or areas in a series of reports.

The Use of Pictures, Tables, Charts, Single Characteristic Maps, etc.

One needs only to compare some of the earlier soil reports without pictures, with some of the later ones with pictures to quickly decide on the desirability of using some good pictures in the soil report. Well chosen pictures will convey ideas regarding the appearance of a soil profile or the landscape of an area much better than any verbal description. Their use increases the cost of publishing and that makes it still more important to select pictures that will "Tell a story".

Where a suitable quality of paper is available for the entire report, the pictures should accompany the associated text material. When there are definite limitations on high quality paper the pictures can be grouped together as has been done in a number of the recent reports. Poor pictures or poorly reproduced pictures are not much of an asset in any report.

Tables are essential for the more exacting types of data and serve as a convenient source of reference. They should be kept as simple as possible, in keeping with the inclusion of all the essential data. Many trends and comparisons can be most simply shown by means of charts. Considerable time is often required for their preparation but this is time well spent.

Single characteristic maps in either black and white or color can be used to very good advantage but they should not be cluttered up with so much detail that it introduces confusion rather than putting across a general idea. The amount of detail should be adjusted to the scale.

The carefully planned use of pictures, tables, charts, and single characteristic maps make the report much more readable and gives the casual reader a general idea of what the report is all about.

References

The general opinion regarding references seems to be that they should be kept to a minimum for this type of report. There are however, some which are essential. These can be most simply handled as a footnote in small print at the bottom of the page.

<u>Legends and Symbols for the Soil Survey Map</u>

From information at hand it appears that soil surveyors in Canada seldom have to prepare their own base maps. For most areas there are some sort of base maps available which have been prepared by some other government agency.

These base maps vary greatly, depending on a number of factors such as scale, information available, purpose for which made, etc. The task of preparing them is a large one in itself.

When the final soil map is re-drafted for publication, any undesirable data on the base map can be deleted or other data added. On reconnaissance soil maps the main attention should be given to local boundaries and physical features with just sufficient of the cultural features shown to give location. The scale is likely to be small and there is danger of cluttering the map if all the roads, contour lines, etc, are shown. On detailed maps it may be desirable to show much more of the cultural data.

The legend of the map is normally in two parts, one part being a key to the base map data and the other a key to the soils data. The former is fairly well standardized and is usually taken from the original base map. The latter is variable and depends to a considerable degree on the system of classification used and consequently can best be outlined after the system of classification has been decided upon.

In general the legend or key to the soils data should be sufficiently complete so that the map can be used as a separate unit. (This does not mean that the report is unnecessary) If possible it should show the inter-relationship of the soils within the area. Some of the more recent maps published are greatly improved in this respect.

Symbols for the published map should be as simple as possible. Their essential use is to give direction to the proper unit in the legend. For field use a more extensive system of symbols is very desirable for the convenience of the surveyors. They are familiar with each part of the symbol and what it means but the average reader of the map, who is not familiar with the system, often becomes unnecessarily confused. Where the soils are classified on a series type and phase or comparable basis the system of using a capital letter and one or more small letters seems to be quite satisfactory.

The Use of Color on Maps.

Color adds greatly to the appearance of almost any map. On soil maps its chief use is to further establish a connection between the various soil units or groups and the key, and to show the distribution of each unit or group. Since there is a limitation on the number of clearly defined colors there cannot always be a separate color for each individual soil unit and some grouping of units is essential.

However there is a strong tendency on the part of most map readers to think that "Similar color means similar soil". Consequently in preparing a color scheme it is essential to make the groupings coincide with the greatest likenesses. Within a zone in an arid region texture is probably a fair basis for grouping although there are bound to be many misfits. In a humid region there is a greater difference between the well drained and poorly drained series on the same materials and a grouping on the basis of texture does not seem acceptable.

In most cases the coloring of the map is related to the categories in the classification used. For example on detailed maps of small areas separate colors can be used for each type or phase but when this involves too many separations a series basis is used.

On published maps there has been a tendency to use yellow colors for well drained sandy soils and darker colors for heavier and more poorly drained soils. Each provincial group of soil workers seem to have experienced difficulty in arranging a color scheme in such a way that adjoining maps will match up satisfactorily, except of course, where the color scheme is based upon a simple classification such as texture. The main objection is that it doesn't make the best use of color on individual maps and that has already been discussed.

Cross-hatching for topography.

This system serves a good purpose where it does not become too cumbersome. It serves best in showing the general topography over a broad area rather than on smaller and more variable areas. Where the cadastral (or legal survey) is on a uniform basis such as the square mile sections, started from a uniform base line and the road network is mainly on this basis there is no serious confliction on the maps other than increasing the load. However where the base lines vary within counties and even within townships as in Eastern Canada, the cross-hatching causes too much confliction with roads.

Scale of Map vs. Type of Survey.

Standarization of scale to type of survey or frequency of traverses is desirable. Too often the scale is reduced for the sake of economy to the point of losing too much detail or making the map too cumbersome. This meeting should set up the desirable standard to strive for.

DISCUSSION OF THE SUB-COMMITTEE ON MAPS AND REPORTS

Mr. Morwick stated that he would like to suggest that this group recommend that "A separate drafting office be set up in Ottawa to expedite the publication of soil survey maps".

He also suggested greater uniformity in titles used on reports and maps. Such as Soils of ------- or survey of ------; Soil survey maps of ---- or Soil Map of ------.

Mr. Lajoie - Suggested that greater uniformity should be established in the colour scheme used. Similar soils should have the same colour on different adjacent county maps so that the maps could be mounted together. He also suggested that the maps should be rectangular sheets rather than an irregular form by counties.

Mr. Morwick - It would be impossible to reserve one colour for each soil type as there is only a limited number of colours which can be used without confusion.

Mr. Stobbe - Mr. Lajoie has in mind the mounting of several small maps together in order to obtain one large map covering a large geographic unit. This does not work very satisfactorily as each base map in itself is set up separately and it is very difficult to get the different maps to fit due to differences in projection. If we want a map for a large geographic unit we have to use a different scale and this means some of the smaller detail has to be left out and an entirely new base map must be used.

Rectangular sheets are often more convenient to use than irregular county maps. In the Prairie provinces where the original surveys and the political units are laid out on the square, rectangular sheets are fine. However, in Eastern Canada all the statistical information, as well as the administrative units, are based on the county which is not laid out on the square. Rectangular sheets for this reason are not so satisfactory. However, in some areas, like in N.B. where the settlement is mainly confined to the river valleys and the main roads, large sections of the county are inaccessible, and very often no base maps are available for these inaccessible sections of the county in the interior of the province. In such circumstances it is often more convenient to publish on square or rectangular sheets.

Dr. Kellogg - It is not satisfactory to attempt to show all the information on the same scale. A map should not be cluttered up with too much information which covers up the main features that we wish to show. It is sometimes better to prepare several maps of the same area showing different kinds of information.

The meaning of detailed-reconnaissance surveys and maps in Canada is different from the detailed-reconnaissance in the U.S. In Canada you mean intermediate between detailed and reconnaissance, while in the U.S. we mean parts of the area are mapped in detail and other parts in reconnaissance. In the case of a detailed-reconnaissance survey in the U.S. usually two maps are prepared, one at about 2 miles to the inch of the entire county leaving the detailed area blank and one on a larger scale of the detailed area only. Where the pattern of contrasting soils is very complicated the whole survey may be shown on one sheet but it is indicated that only reconnaissance mapping was done within the areas of certain soil associations, complexes, or land types included in the legend.

Similar maps could be prepared for Quebec and other parts of Canada where parts of the county are very rough and inaccessible. A general reconnaissance map could be prepared for the entire county and a separate map could be prepared for the areas covered more intensively. A map of the entire county is very important as the people who administer the area and extension men, such as the district representative must have a picture of their entire territory.

In the U.S. the opinion is growing, that in order to include the required details for farm use the maps should be published on the scale of at least 2 inches to one mile. Very little attention should be paid to "piecing" maps together as maps are prepared by polygonic projections which apply to curved surfaces. In addition paper shrinks unevenly which makes it almost impossible to piece maps together. In a map covering larger areas much of the detail has to be left out and only the larger soil classes shown.

The descriptive legend as suggested by Mr. Morwick is very useful. In such cases the legend can be used without having to refer to the report constantly. The report might serve as a handbook of the county or area. It is a good policy to include in the report a guide for the reader showing where the several kinds of information can be found.

Mr. Aalund - Was of the opinion that the abbreviated soils names or the first letters of the soils names when used on the map often caused difficulties and confusion. He suggested that numbers instead of letters might be used on the soil maps like in the case of geological maps.

Mr. Baril - Numbers are being used on the soil maps in Quebec with satisfaction.

Prof. Ellis - Objected to numbers on the maps as they can not be universally used and referred to like soil names.

Mr. Chapman suggested that soil names should be listed on the map alphabetically so that it would not be necessary to look all over the legend for a certain soil.

Dr. Hopkins - In connection with the utilization of soils Dr. Hopkins questioned if the committee report had made it clear enough that the soil surveyors should consult more with other agricultural specialists such as the agronomists, horticulturists, etc. These men should have an opportunity to study the interpretations and suggestions made before the reports are printed.

Mr. Morwick agreed that the committee would reconsider this point and enlarge on it.

Mr. Stobbe - Does this not also apply to the geologist, forester and any other men whom the surveyor consultsand gets information from?

Dr. Hopkins - That is perfectly true to some extent. However in our own Department of Agriculture we must have closer unanimity in the recommendations made to the farmers and others. We can not have this if the surveyors on their own publish certain recommendations concerning certain matters without the knowledge of the experts in the field concerned. We must have a certain amount of supervision in this respect.

Dr. Kellogg - This is an administrative problem of clearance. The U.S. Soil Survey and the Directors of the Stations clear their publications with one another before they are published. The soil survey reports are read and O.K'd. by all relevant parties.

Dr. Leahey - There is no official clearing house for all reports in Canada.

Dr. Wyatt - We clear the reports within our own local groups.

Mr. Bowser stated that the section dealing with land utilization in their reports are submitted to the Experimental Farms and other agricultural officials concerned.

Mr. Morwick agreed that some difficulty is often experienced in this connection. In many cases there are no specialists in some of the areas concerned and then the surveyor must do his best and present a picture by himself but it would be impossible for the surveyor to be so specific as to include actual yields.

Mr. Aalund - It is often difficult to get the other specialists sufficiently interested in the work so that they will accompany the surveyor in the field on trips. Unless they come out and see the actual soil conditions it is often difficult for them to appreciate the surveyors point of view.

Mr. Stobbe - It is important that we attain closer co-operation with the other scientists and we must endeavor to obtain their interest.

Prof. Ruhnke - Dr. Hopkins has raised a good point and I think the authors should probably circulate drafts of their reports more to other authorities for comments and suggestions. It would be an asset to the authors as it relieves them of a certain amount of responsibility.

The chairman brought the discussion to a conclusion and requested the sub-committee to keep in mind the points raised in the discussion while preparing the final statement which will be presented to the committee on Friday.

PROGRESS REPORT OF THE SUB-COMMITTEE ON THE TRANSLITERATION OF SOIL TERMINOLOGY

The Chairman pointed out that in a bilingual country like Canada there is a great need for the proper transliteration of soils terminology. The French speaking members should know what we mean by certain English terms and the English speaking members should know what certain French terms stand for. There must be a certain amount of consistency in the terms used in translation.

The French speaking members have been asked to form a sub-committee on the transliteration of soil terms.

He then called on Mr. Lajoie to give a brief report on the activites of the sub-committee on transliteration.

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A letter received some weeks ago from the Secretary of the Committee, was suggesting that some work should be done on the French Soil Terminology while at the same time attempts would be made to reach more uniformity throughout Canada in the use of the English Terminology. I feel that we are in a great need of this work and I welcome this suggestion of the Committee.

In the Province of Quebec we have two different organizations engaged in Soil Surveys. We are, therefore, perhaps more anxious than most provinces to obtain uniformity in the terminology which is used in our reports. The maps and reports which are published by both organizations in our Province appear in French and English and it is important that the correct meaning be conveyed to the readers.

We want to base our French Terminology on the English Terminology which is used in the other Provinces of the Dominion. So you understand immediately that we need fist the main outline of the English Terminology together with all the details before we can translate it into French. Our work would be facilitated if copies of every report presented during this week were placed in the hands of the individuals charged with the task of translation.

As a beginning in the attempt to translate the English terminology into French, I have prepared a small vocabulary of terms used in connection with Soil Survey Work. This list gives us the French terms and their English equivalents and vice-versa. A great number of terms and words need to be added to this vocabulary. A considerable amount of material which will be useful in the translation has been accumulated by some Quebec soil surveyors especially by Mr. Mailloux and I would suggest that Mr. Mailloux be placed on the sub-committee on translation.

It will take a long time before the translation of a complete list of soil terms can be completed as there are many difficulties to be overcome.

There are two ways in which these terms can be presented; one is by alphabetical order and the other is to group them under certain general headings like texture, structure, etc., ----, I believe that the alphabetical order is the most practical. Such a vocabulary of soil terms would be useful to English Surveyors who want to understand some articles by French authors, like those published by the International Congress of Soil Science.

Among the difficulties experienced in the translation of terms, I may bring to your attention the following:

1. The English word may have a different meaning than its French equivalent or it may be differently interpreted in the various provinces, ex. of latter undulating, rolling.

2. Some English words have no equivalent in French and must be translated by an expression composed of two or more words, ex. loam --- terre franche; stoniness -- quantite de pierres; the same may be true of the French words, e.g. clay pit - glaissiere.

3. In some cases, terms or words used in France are not used in our Country e.g. loam in France is translated by limon (which means silt as well as loam). In Quebec the word "limon" is not used generally to translate "loam" but to translate "silt" only.

In our province the term "terre franche" or "sol franc" is used in the same sense as loam. In such cases the question may be raised as to whether we should adopt our local names or the names which appear in the publications issued from France.

5. The soil survey terminology contains some geological terms and, as Dr. Kellogg mentioned, we have to know the exact meaning of these terms and use them in their proper sense, in French as well as in English.

Discussion of Translations

Dr. Kellogg - Pointed out that the transliteration of soil terms is a very important problem. He recently attended a conference in Mexico and it was there agreed to make transliterations in English, French, Spanish and Portuguese. He should like to add Russian, Italian, and Chinese to these languages. It is very likely that much work will be published in those languages and we must know what their terms mean. It would be desirable if this sub-committee got in touch with any committee set up in Mexico.

There are many pitfalls in the transliteration of technical terms. Equivalent words are often absent in the other languages and it is often necessary to create new terms. Local folk terms are often used necessarily in material prepared for farmers, and frequently these get into the scientific literature. It would be advisable to include language scholars in this committee regardless of their knowledge of soils. Very often roots have been taken from languages and have been given conflicting infections.

This problem should really be organized on an international basis.

In the Belgian literature a considerable number of French soils terms may be found which would be of assistance to this committee.

The Chairman suggested that the committee should continue with this work and from time to time submit progress report.

OTHER BUSINESS

SOIL MAP OF CANADA

The Chairman took up the next question on the program - namely, The soil map of Canada. He pointed out that the Soils Group of the C.S.T.A. has a committee working on this problem, but very little has been done in recent years. It would seem desirable that the soil survey committee should take this matter up now.

Prof. Ellis - Gave a brief outline of the work done by the Committee of the C.S.T.A. A member from each province plus a federal member were instructed to collect information on soils in order to attempt the compilation of a Soils Map of Canada. However this was a very difficult assignment at that time

The Committee assumed that a relationship exists between soils, climate and vegetation. A vegetative map of Canada was obtained from the Forestry Department through the efforts of Mr. Halliday. Next the climatic data was collected and expressed on the basis of Thornthwait's values. The known soil data was superimposed over this information and a preliminary soils map was obtained in this manner.

The soil map was then sent to each province for criticism. The map was never published as it was felt it was not accurate enough but all the data is still available. However, some other people have used it from time to time.

He felt that the C.S.T.A. Committee can do nothing more on this project. This Committee should now take over and take some steps to collect further information in order to prepare a tentative map.

Dr. Leahey - This question should probably be taken up with the C.S.T.A. group.

Prof. Ellis - Did not think that this is necessary and that this Committee could just take over the project.

Mr. Moss - We should prepare as good a map as we can now with the object of improving it as we go along. This would promote uniformity in our classification. As time goes along the old maps will have to be adjusted and corrections will have to be made. The maps which will be prepared in progressive stages will form an interesting historical record.

Dr. Kellogg stated he would appreciate it very much if we would prepare our soil map of Canada as he will be called upon to prepare another soil map of the world and any information would be welcomed.

Prof. Ellis - It is still a difficult job as there are still many gaps but a start should be made.

Dr. Kellogg - Any information available plus the best guess on the part of all concerned would be much better than nothing at all.

The Chairman referred this question to the resolution committee for the creation of a sub-committee on this project.

AERIAL PHOTOGRAPHS AND BASE MAPS

The question of aerial photographs and base maps was next raised by the Chairman.

The Chairman pointed out that this Committee, as such, can not do anything in regard to aerial photographs and maps. However, the individual members and the Committee as such can support the Departments which prepare the photographs and maps.

He then proceeded to outline the set-up of the Inter-Departmental Committee and of the Sub-Committee in the Department of Agriculture on maps and photography. These Committees assign priorities to work which is to be done.

They require information on which areas should be surveyed and what aerial photographs are desired. This information is required two years in advance before the actual photos and maps can be obtained. The requests have to come through federal departments but all the members here can easily see that the requests are channelled through federal departments if they desire maps. The aerial photographs are usually on the scale of 4 inches to one mile and may be purchased at 15¢ a copy. The scale of the photographs should be specified in the requests.

Mr. Aalund - Asked for information regarding the preparation of base maps from aerial photographs.

Dr. Kellogg - Suggested that the preparation of base maps from aerial photographs be left to experts as this is an expensive job and requires special technic and training. The average surveyor is in no position to prepare a map from photographs and then transfer it to prepared base maps. Often the plotting is done on transparent material which is placed over the photographs. Up until recently the U.S. Soil Survey has used alternate photographs but now they prefer every photograph.

CLEARING OF SOIL NAMES

The Chairman Raised as the Next Topic For Discussion the Clearing of Soil Names

He pointed out that in some cases similar names were given to different soils and often different names were given to similar soils. Some attempts should be made to clear a name as soon as it is adopted in any one province.

Dr. Kellogg stated that he was interested in the nomenclature of the soils along the border. In cases where similar names are used on both sides we should make sure we are dealing with the same soil. If we cannot do this we shall be criticized by other scientists. We have similar soils on both sides that have different names. It would be desirable to have common names for these soils; however, if that is not possible we should at least know which soils correspond to which.

It would be desirable to have some arrangement whereby the border series could be checked. If practical, all the Canadian data concerning the series could be collected in Ottawa and then transferred to Washington. The U.S. Soil Survey Division would likewise, furnish their data to Ottawa. Perhaps it would also be possible to arrange for joint field trips through the border States.

Prof. Ellis - We would be glad to advise Dr. Kellogg when we are working in border areas.

Dr. Kellogg - The U.S. Survey has changed some of their soil names and they would not like to have names stated as correlatives with U.S. series unless this has been cleared through Mr. Ableiter, Chief Inspector in the Division of Soil Survey.

Prof. Ellis - The American Soil Science Society has a committee dealing with soil series names.

Dr. Kellogg - That committee deals with names only and not with definitions.

Dr. Leahey - We will inform Dr. Kellogg's office of any of our parties which will be within 50 miles or so of the border. If it is possible to get together with the American surveyors we will be pleased to do so.

Dr. Kellogg - The Canadians should contact the U.S. Soil Survey inspection staff which is the correlating agency, rather than work only with the individual soil surveyors.

In making these contacts, economy should be kept in mind. Difficulty has been experienced in bringing U.S. official cars into Canada and perhaps it would be possible to use Canadian cars in Canada and U.S. cars in the U.S.A.

Prof. Ruhnke - Do you depend on the inspectors for definitions, nomenclature, etc. in the U.S.?

Dr. Kellogg - Yes, the inspectors authorize the final definitions, descriptions, mapping practices, etc. and decide on the naming of the mapping units.

Mr. Morwick - Have you defined yet on what basis soils can be grouped into families in the U.S.?

Dr. Kellogg - Much work is still to be done. There are about 3000 official series for which the final descriptions and definitions are being prepared. When this is done all series will be grouped into families and catenas. Some progress toward this has already been made by the inspection staff. We are now working on the abstraction of data for regional keys. Later we have to obtain a higher level of abstraction for a national key.

Mr. Stobbe - We have been talking about the correlation of soils between Canada and the U.S. and we all agree that closer contact is desirable. However, this work is going to be complicated by the fact that we have not close enough correlation between the provinces and in some cases within a province.

We have not been fortunate in having inspectors available for correlation work and even now the amount of correlation done is limited. As a result we have many instances where similar soils are known by different names in different provinces and we have some instances where similar names are used for soils which are not identical in all respects.

In order to facilitate the correlation of our soils we must have complete and accurate descriptions of every mapping unit which has been established, whether it is a series, association or referred to by some other designations. These descriptions should be available here at Ottawa and copies should be supplied to those provinces which have or may have similar soils to deal with. Also we should have more contact between the adjacent provinces to facilitate the exchange of information. Our senior men from adjacent provinces should get together periodically and, together with a member of the staff from Ottawa, should check along the border lines and through areas where they may have soils in common.

Dr. Leahey - Suggested that the Canadian soils names should be cleared through Ottawa before they are put into print. He also suggested that the provinces forward descriptions of their soils to Ottawa in order to ease the correlation work. This is very important as in many cases considerable time elapses from the time the survey is completed until the information is available in print.

The Meeting adjourned at 5.30 p.m.

FRIDAY, MAY 11th, 1945.

MORNING SESSION - 9 a.m. - 12.00 a.m.

The Chairman called the meeting to order and then called on Prof. G.N. Ruhnke, to present a brief summarized statement regarding the revisions in the report on Ways and Means of Utilizing Soil Survey Information which the sub-committee would like to make.

Prof. Ruhnke - Stated that the committee had not been able to make a complete revision of the report, however, it had decided on a number of points which would be added to the report in light of the discussions which had taken place.

These additions are:

Under Utilization of Soil Surveys:

1 (i); 3 (h); 4 (a); 6 (e); 8 (h,i,j,k,l,m.)

Under the section: Selling of soil survey, a statement should be inserted regarding the preparation of preliminary mimeographed reports immediately after the survey is completed for the use of key men in the area. A second statement suggesting how the surveyors could assist the people of the surveyed area in becoming familiar with the different soils and in utilizing the information which the soil survey provides would also be worth while.

(These corrections and additions have been included in the revised report which has been presented earlier in the Proceedings)

Prof. Ruhnke - Moved and Mr. Farstad seconded that the original report with the enumerated additions be accepted by the Committee.

Carried.

The question of whether the sub-committee as such should continue to function or not was discussed. It was pointed out that for the present the work of the sub-committee was pretty well wound up and that if the Committee were to continue it would not be very active for some time. At the same time the members of this sub-committee will be required for work on other sub-committees.

It was then moved by Prof. Ruhnke and seconded by Mr. Farstad that the sub-committee be discharged.

Carried.

The Chairman then called on Mr. P.C. Stobbe, chairman of the Sub-Committee on Soil Classification for a summarized statement.

Mr. Stobbe stated that the sub-committee was not very clear on what changes they could make in the report as far as the actual grouping of the soils is concerned. However, the Committee agreed that it should be made clear in the report that the proposed classification scheme should not be considered as a final pedological classification but rather as a practical grouping of the soils which would be of immediate aid to the surveyors in the field and which would show the relationships between the different soils. It should also be pointed out that sight should not be lost of the eventual pedological classification and the information for this purpose should be collected as we proceed with our work.

The sub-committee feels that the suggested classification scheme does not differ very widely from the soil keys which are now being prepared in the U.S. At the present time we are not prepared in Canada, due to a lack of sufficient pedological studies, to decide into what introzonal groups many of our soils belong. We do not think that there are sufficient intrazonal groups established to take care of a large number of our soils. The Committee, therefore, feels that we should continue to map and describe our soils as they occur and group them on a practical basis as outlined in the report. The sub-committee is not prepared to ask this committee to adopt the report and the classification scheme at the present time. Instead the sub-committee would ask the members to try this classification system in the field and give it a fair chance. Official action on this problem should be delayed until all the members have had a chance to become more familiar with the application of the proposed classification system.

During the discussion of the original report the Committee according to the directions of the chairman has been dealing with principles and not with terminology. A number of the members of this Committee are at the present concerned with terminology as they are ready to issue publications. As the question of terminology has not been discussed the sub-committee can not be any more specific in this regard than has been outlined in the original report. Whatever terminology is being used should be clearly defined. The sub-committee hopes that this question will be settled at a later date by a sub-committee on terminology.

<u>Mr. Stobbe</u> then moved that the Committee receive the report with the above mentioned revisions. This was seconded by <u>Mr. Morwick</u>.

After some discussion the motion was <u>carried</u>.

<u>DISCUSSION</u>

<u>Prof. Ellis</u> - Referred to the report of South Central Manitoba which illustrates how simply the soils can be fitted into a key if they are classified and mapped according to the proposed system.

<u>Dr. Kellogg</u> - It is more important to be clear than to be uniform. It is important to distinguish between great soil groups and regions or zones of great soils groups. The zones of the higher categories are not taxonomic units. These differences should be brought out more clearly in sub-committee report.

<u>Mr. Stobbe</u> stated that the sub-committee agreed that the conception of zones and groups were not the same and they would attempt to make this clearer in the report. In the past the terms chernosem and chernosem zone have been used too loosely and have often been regarded to be synonymous. This can be said about the Canadian as well as about the American soil scientists.

<u>Dr. Kellogg</u> agreed that some of Marbut's papers are not quite clear in this respect.

In view of the fact that the sub-committee so far has only dealt with principles leading up to the actual classification, it was moved by <u>Mr. Stobbe</u> and seconded by Mr. Bowser that a sub-committee on soil classification continue to function under the National Soil Survey Committee.

Carried.

<u>The Chairman</u> called next on <u>Prof. Ellis</u>, chairman of the sub-committee on <u>Chemical and Physical Analyses</u> for a summarized statement on the report.

Prof. Ellis stated that the sub-committee felt that the first essential to be dealt with is the common concept of the purpose and object of laboratory methods. "The why" and "the where" should be agreed upon by the Committee as a whole before the sub-committee is in a position to suggest "the how".

The sub-committee has not received much information from the members regarding the need of different types of analysis, but it feels that some revisions of the original report are necessary.

The sub-committee would like to make the following recommendations.

1. That the soil survey unit in each province attempt to make the minimum routine physical and chemical determinations as outlined in Table 1. on routine soil samples as required by the respective soil survey units and, further, that each soils laboratory, wherever possible, undertake to select representative regional soil profiles and perform complete chemical analysis of some for the purpose of interpreting the soil-forming process involved. It is further recommended that where questions arise respecting soils which are of doubtful category, that complete chemical analytical data be obtained.

It was moved by Prof. Ellis and seconded by Mr. Wright that this recommendation be accepted.

Carried.

2. It is the opinion of the sub-committee that where analysis for the assessment of fertility status are being used, an effort be made to obtain definite information concerning the relationship of the results secured by laboratory determinations to the results of crop response in the field.

It was moved by Prof. Ellis and seconded by Mr. Wright that an attempt be made to secure such corroborative data - Carried.

3. The Committee recommends that, where possible, soil survey laboratories, attempt to secure the information about soils as outlined in Table 2 with the exception of the fertility determinations. No recommendations concerning the methods to be used in respect to the latter can be made at this time, pending further study.

It was moved by Prof. Ellis and seconded by Mr. Wright that the Committee adopt the recommendation - Carried.

4. The Sub-committee draws attention to the fact, that it is highly desirable for all laboratory determinations to conform to approved standard procedures. With this in view, we request that each soils laboratory outline in detail the methods used in taking and preparing samples for laboratory analysis, and request that such outlines be submitted to the chairman of this sub-committee for study and for drafting procedures that may be recommended. Further, in view of the discussions at this conference, and the changes in methods of analysis which have come into use since the survey of methods was made in 1941, this sub-committee requests that each soils laboratory including the Soils Laboratory at Swift Current, prepare an outline of the methods of analysis, (with references) now in use in the respective laboratories for the information of this sub-committee.

It was moved by Prof. Ellis and seconded by Mr. Wright that this Committee endorse the requests outlined above - Carried.

Mr. Ehrlich - Would this request also apply to plant analysis?

Prof. Ellis - No, not generally, but any laboratory which performs plant analysis in connection with the soils studies should include their methods.

5. In order to avoid confusion and duplication in collaboration, the Committee recommends that the secretary of the National Soil Survey Committee, because of his official capacity, obtain the information promised by Dr. Kellogg in respect to the technique of analysis, and to make same available for the guidance of the sub-committee.

Moved by Prof. Ellis and seconded by Mr. Wright - Carried.

Dr. Kellogg was not certain that there would be much unpublished information available.

It was moved by Prof. Ellis and seconded by Mr. Wright that the sub-committee on PHYSICAL AND CHEMICAL ANALYSIS be continued - Carried.

The Chairman called next on Mr. Moss for a summarized statement regarding the sub-committee on LANDSCAPE TERMINOLOGY.

Mr. Moss stated that the sub-committee had nothing specific to offer. Instead he would like to ask several questions for guidance.

First - What is the future of the sub-committee? If the Committee wishes to appoint several sub-committees, as had been suggested during the discussions, say, one on topography, another on erosion, etc., it may become very awkward if these sub-committees are not in very close touch, as some of these topics are inter-related. To avoid this he would suggest that an over all sub-committee on landscape terminology be established with a number of smaller sub-committees assigned to different subjects, such as erosion, topography, stoniness, etc.

Dr. Kellogg suggested an overall sub-committee chairman should probably be appointed who would assign topics to different ad hoc sub-committees.

He suggested the following topics:

1. Relief Classes
2. Erosion Classes
3. Drainage
4. Stoniness
5. Excess salts and silting
6. Definition of parent materials and rocks
7. Land forms
8. Land use terms (bushland, etc.)

In some cases one man could probably take over one or more of the above topics.

Dr. Leahey - The sub-committees have power to add to their members. It may perhaps be necessary to rearrange the personnel of some of the main sub-committees.

It was then moved by Mr. Moss and seconded by Mr. Aalund that the sub-committee be enlarged in order to provide for personnel to deal separately with such topics as will be assigned to the sub-committee - Carried.

It was further moved by Mr. Moss and seconded by Mr. Aalund that the sub-committee draw up schemes of classification for the various factors and submit these to the various organizations with a request to criticize same and attempt to apply the system. The opinions of the various organizations should be returned to the sub-committee in order to establish greater clarity - Carried.

Mr. Moss also requested that the provincial organizations should send in any changes and suggestions which they would like to have incorporated in the present report.

Mr. Chapman was next called upon to present a summarized statement for the sub-committee on SOIL RATING AND LAND CLASSIFICATION.

Mr. Chapman moved that the sub-committee on Soil Rating continue to function, this was seconded by Mr. Wicklund - Carried.

Mr. Chapman - After the discussions which have taken place it would seem that three points should be inserted into the original report. The discussions would indicate that the soil rating is not strictly based on inductive processes and this probably should be made clearer in the report.

He suggested that the nature of "follow-up" program be changed to "co-operative" program.

The sub-committee also suggests that this organization should help to promote the study of climate as it has a direct bearing on the soils and the crops that grow on it.

The Committee further suggests that this organization promote the gathering of yield data on specific soil types in order to facilitate a more accurate rating of the soils.

It was moved by Mr. Chapman and seconded by Mr. Wicklund that the report with the above stated revisions be adopted.

After some discussion the motion was Carried.

DISCUSSION

Mr. Aalund - What is the objection to Storie's method of deductive rating?

Dr. Kellogg - The significance of any soil characteristic, or group of selected characteristics, which can be observed depends on the other characteristics.

There is no straight line relationship between a soil characteristic and the final value or rating of the soil and it can, therefore, not be expressed in simple numerical values. In evaluating the soil, the combined effects of all soil characteristics must be considered and this is too complicated to express in simple figures. The results obtained are uncertain, they may be too high or too low and a few failures nullify all the apparently good results. The assumption used and the calculations made are not mathematically sound.

Prof. Ellis - The rating does not take care of the interaction of the different factors.

Mr. Aalund - I realize this rating is not perfect, but it gives at least a lead and some close approximation. To my mind it is better than just the judgment of the individual.

Dr. Kellogg - I should suggest that we use our judgment. Storie's final ratings are usually quite good. The difficulty, however, is that the reader is led to believe that the final reading can be mathematically calculated. He may even attempt to assign the values given for a characteristic in one soil rating to the same characteristic in another soil.

The Chairman next called on Dr. Wyatt to present a summarized statement for the sub-committee on LAND SETTLEMENT.

Dr. Wyatt stated that it had been impossible for the Committee to get all the information to complete the report in regard to the land available for settlement. There are many points in which the work of the sub-committee, as now constituted, would overlap with the work of other sub-committees. He would suggest that the Committee continue with the rehabilitation aspect of land settlement. In Alberta various experts, including the soil surveyors sit on an Advisory Committee studying the steps to be taken in following-up the initial surveys as far as settlement is concerned. This Committee is only local and deals with their own problems and it must have access to all information available. Similar committees would perhaps be of assistance elsewhere.

DISCUSSION

Dr. Leahey - The sub-committee was given the task to investigate two things (1) To collect information on what land is available for settlement and (2) to determine what methods should be employed in studying these areas.

Dr. Wyatt - The sub-committee should have more information before it can submit even a tentative report on how much land is available. The methods which are to be used are largely governed by the location and the type of land that one is dealing with. In many cases it is necessary to make an exploratory survey first, while in other cases a detailed survey is required for the location of each individual lot or farmstead. Before the sub-committee can deal with the second point it must know where the available land is and what its settlement possibilities roughly are.

Dr. Smith - In N.S. they have an economic Council which consists of men in various fields of work including foresters. The latter are also very interested in land settlement. In order to avoid overlapping the activities of the various interested organizations are planned. Aerial photographs have been obtained for the main library in N.S. which can be used by the different organizations and these are of great help in locating suitable land.

Dr. Wyatt - moved that the membership of the sub-committee be dissolved but that the Committee as such be continued. This was seconded by Dr. Laird - Carried.

Mr. F.F. Morwick, Chairman of the Sub-Committee on REPORTS AND MAPS was next called upon to present a brief statement.

Mr. Morwick stated that during the absence of some of the regular members of the sub-committee Mr. Bowser and Mr. Shaefer had been added to the sub-committee for the present. As a result of the discussion the sub-committee felt that a number of points should be included into the original report. The revised report will be handed to the Secretary for inclusion in the proceedings.

It was moved by Mr. Morwick and seconded by Mr. Whiteside that the report be accepted as a progress report and that a sub-committee on Maps and Reports be continued - Carried.

OTHER BUSINESS

The Chairman raised the question of what should be done with the proceedings of the convention?

He suggested that in view that it may take a considerable time to complete a full report on the proceedings it may be advisable to prepare a brief statement for the administrative authorities first.

A more complete report should be prepared later on and all the chairmen of the sub-committees should submit to the Secretary copies of the revised reports for inclusion in the proceedings as soon as possible.

Mr. Whiteside - The Committee should have had a stenographic record of the proceedings.

Dr. Kellogg - The discussions at this Conference have been very informal. A stenographic record of every word said could, in some cases be very misleading. It is generally more satisfactory to present a summarized statement of the discussions. Dr. Kellogg stated that he would prefer to see a preliminary draft of the discussions before they are published in order to be able to edit statements attributed to him. This would avoid misleading statements from appearing in the final records.

Dr. Leahey - The next question is how widely should the proceedings be distributed? As most of the discussions have been technical and in some cases controversial in nature, the proceedings will be of direct value only to men engaged in survey work. It would, therefore, be advisable to prepare only a limited number of confidential reports. They would be distributed to soil surveyors and those people closely associated with the work.

SOIL TERMINOLOGY

The Chairman suggested that there is a need for a sub-committee on Soil Terminology. Each sub-committee should probably define its own terms but the suggested new sub-committee on soil terminology should compile terms already defined and secure definitions of other terms in order to establish greater uniformity in the use of such terms.

It was moved by Mr. Moss and seconded by Mr. Cann that a sub-committee on Soil Terminology be set up and that it act as a clearing house for the Terminology suggested by the other sub-committees and collect definitions of other soil terms. - Carried.

It was next moved by Mr. Baril and seconded by Mr. Lajoie that the sub-committee on translations be continued and that the sub-committee on terminology supply it from time to time with soil terms and definitions. Carried.

The Chairman next introduced Dr. E.S. Archibald, Director of the Experimental Farms Service, to the meeting and asked him to say a few words to the Conference.

Dr. Archibald pointed out that the need of soil survey work has been known to him for a long time. Many years ago while engaged in Animal Husbandry work he realized the need of soil survey work as a result of encountering various nutrition problems in animals.

Crop production and experimentation in connection with crop production must be based on soil survey information. Enough money has been wasted in fertilizers and other experimental work, not counting the loss sustained by the farmers, due to the lack of adequate soil information, to survey a considerable portion of the country. If this Committee had been established 25 years ago much money would have been saved.

Questions pertaining to soils come up every day. To mention only a few of the current problems at hand, there is the study of alkali irrigation water in B.C. and the planting of trees in the prairies, where the influence of soil and trees is mutual.

We must never overlook the usefulness of the soil survey work and in many of our soil problems the surveyors can be considered as the doctors. The soil surveys have been especially useful in the P.F.R.A. development in the west. Among other things they have been responsible for avoiding many costly developments in irrigation on land unsuitable for the purpose.

The surveyors have performed a very valuable piece of work in making the detailed surveys of the Experimental Farms. These surveys have been responsible in making some badly needed adjustments. This service need be extended to our 200 Illustration Stations and Substations. We probably will find that some work and money has been wasted. The survey eventually should be the basis of all experimental work in Canada and every man engaged in soil fertility work should know something of this Conference and of this Committee.

There is still much work to be done by the soil surveys. Practically every brief which has been presented to the Rehabilitation Committee, which has been set up under the Federal Department, has contained requests to change the P.F.R.A. to C.F.R.A. What the final outcome of this will be or how it will be set up we do not know. However, we do know that soil surveys are fundamental to any reconstruction program that may be undertaken.

The soil survey work to date has in most cases functioned on a skeleton staff and it will become necessary to increase this staff by 2 or 3 times in order to be able to handle the soils work for the readjustment of agriculture. It is necessary therefore, to train more men and the brighter young men in the colleges should be stimulated in order that they may take up soils work as their profession. If it is necessary the Experimental Farms may create temporary positions for the training of such men.

In conclusion, he stated that the Soil Survey Committee has the complete support of the Director of the Experimental Farms Service and of his staff.

The Chairman thanked Dr. Archibald for his enthusiastic talk and for the financial and moral support which has made this Conference possible and which has helped to develop soil survey work in Canada since its inception.

The meeting adjourned for lunch at 12 a.m.

FRIDAY, MAY 11th, 1945

AFTERNOON SESSION 1 p.m. - 2.30 p.m.

The Chairman called the meeting to order and asked Dr. Laird, Chairman of the Resolutions Committee for his report.

Dr. Laird stated that the Resolutions Committee wished to present a number of resolutions the first three of which would require some action.

(1) Soil Map of Canada

Whereas the need of a revised Soil Map of Canada is clearly apparent - Be it resolved, that a Soil Map of Canada Project be set up and that a sub-committee be appointed with instructions t revise the existing map and add thereto as data becomes available.

It was moved by Dr. Laird and seconded by Mr. Baril that the above resolution be adopted - Carried.

(2) Official Secretary

Whereas our official secretary is very busy and should be free to take part in all discussions without diversion and whereas many important points are brought out in discussion - Be it resolved, that in the future an official be engaged to report on all Conference sessions in order to have available for each member a comprehensive report for future reference.

It was moved by Dr. Laird and seconded by Mr. Whiteside, that the above resolution be adopted - Carried.

(3) Training of Students

Whereas there is at present a definite scarcity of trained soils men, and whereas it would seem desirable to have a closer tie-up between soil science, plant and animal production and research - Be it resolved, that the National Soil Survey Committee through its parent body, the National Advisory Committee on Agricultural Services, confer with the various Agricultural Colleges and Universities in Canada with a view to revising curricula or outline of courses whereby more adequate training may be provided for students electing to major in soils; and with a view of making certain soils courses pre-requisites for majoring in agronomy, horticulture, agricultural economics and other related subjects.

It was moved by Dr. Laird and seconded by Dr. Delong, that the above resolution be adopted - Carried.

(4) Expressions of Appreciation and Thanks

Be it resolved, that the National Soil Survey Committee express its very keen appreciation and extend its very sincere thanks to Dr. E.S. Archibald, Director, Experimental Farms Service, Dominion Department of Agriculture, Ottawa, for making this, The First Soil Survey Committee, Conference, possible, for his clear statement on policy re Soils and Soil Surveys, and for placing at the disposal of the Committee the facilities of the Central Experimental Farm.

It was moved by Dr. Laird and seconded by Prof. Ellis, that the above motion be adopted - Carried.

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Be it resolved, that the National Soil Survey Committee express its keen appreciation and extend its very sincere thanks to Dr. G.S.H. Barton, Deputy Minister of Agriculture and Chairman of the National Advisory Committee on Agriculture for authorizing this conference, for taking the time to appear before the Committee and for setting forth clearly the broad functions of the Soil Survey Committee and its relation to the parent body, the National Advisory Committee on Agricultural Services.

It was moved by Dr. Laird and seconded by Mr. Bowser, that the above resolution be adopted - Carried.

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Be it resolved that we extend to Mr. M.B. Davis, Dominion Horticulturist, our appreciation and sincere thanks for the use of this very comfortable room for our deliberations.

It was moved by Dr. Laird and seconded by Mr. Baril that the above resolution be adopted - Carried.

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Dr. Kellogg has been with us for the week and has contributed immeasurably to the success of this Conference. We appreciate the fact that he is an extremely busy man, yet he has given freely of his time and has stimulated us to no end with his enthusiasm.

Be it therefore resolved, that the grateful thanks of the National Soil Survey Committee of Canada be extended to Dr. Charles E. Kellogg, Chief of the Division of Soil Survey, U.S.D.A. for his daily attendance at the Conference, for freely giving his time, knowledge and experience, for his geniality and pleasantries and for his generosity in directing members of this Committee to sources of information.

And further resolved that a copy of this resolution with an appropriate covering letter be forwarded to Mr. P.V. Cardon, Administrator, Agricultural Research Administration, U.S. Dept. of Agriculture, Washington, D.C.

It was moved by Dr. Laird and seconded by Mr. Moss, that the above resolution be adopted - Carried.

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We the members at large are mindful of the immense amount of work done by the Executive Committee, Dr. Leahey and Mr. Stobbe and by the Chairmen and members of the various sub-committees without whose efforts this successful Conference would not have been possible. Your Resolutions Committee would indeed be remiss in its duty did it not take cognizance of these facts.

Be it resolved, that we, the lay members, of the National Soil Survey Committee express our indebtedness and thanks to Dr. Leahey and Mr. Stobbe to Dr. Wyatt and Prof. Ruhnke and the Chairmen and the Members of the various sub-committees for their untiring efforts for the good of the Committee.

It was moved by Dr. Laird and seconded by Dr. Smith that the above resolution be adopted - Carried.

The Chairman next called on Mr. Bowser to submit a report of the COMMITTEE ON CONSTITUTION.

Mr. Bowser stated that the Committee on Constitution would like to suggest that some consideration be given to the renaming of the NATIONAL SOIL SURVEY COMMITTEE and that the functions of the Committee should possibly be more clearly defined.

Further, the Committee, having reviewed the organization, terms of reference and the way the National Soil Survey Committee has functioned to date, recommends that:

(1) The National Soil Survey Committee, as now constituted, continue to function for the present without change in organization or terms of reference.

(a) That subscription 2 Part A dealing with duties of the sub-committee be deleted.

(b) That additional sub-committees may be formed as needed.

It was moved by Mr. Bowser and seconded by Prof. Ruhnke that this report be accepted - Carried.

Executive Officers of the National Soil Survey Committee for 1945-1946

Dr. A. Leahey, Chairman
Mr. P.C. Stobbe, Secretary
Dr. F.A. Wyatt, Western Representative
Prof. G.N. Ruhnke, Eastern Representative

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In closing the Chairman thanked every one present for the contributions they had made toward the success of the meetings. He was especially grateful to Dr. Kellogg for spending the entire week with us in constant sessions. He greatly appreciated the work done by the Chairmen of the different sub-committees and he hoped that the reports which will be forwarded to the secretary for reproduction will provide some guidance in the future.

As this is but our first meeting we must build for and hope for more development in the future. It is the desire of the Executive to hold annual conferences like this one but if this is not possible for financial or other reasons a strong attempt will be made to hold at least a meeting between the Western and Eastern members.

The Conference at Ottawa adjourned at 2.30 p.m.

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Two field trips were organized for the members of the National Soil Survey Committee on Saturday and Sunday, May 12th and 13th.

One field trip was made to the Province of Quebec extending into the Eastern Townships of the Appalachian Region and the other field trip was made into South-Western Ontario.

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