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Preface

The second meeting of the Western Section of the National Soil Survey Committee was held at the Department of Soils, University of Alberta, Edmonton on December 8 to 11, 1958. The Committee is deeply indebted to the University for providing good accommodation and to the staffs of the Department of Soils and the Alberta Soil Survey for the excellent arrangements and hospitality which greatly added to the enjoyment of the meeting.

The sessions were marked by keen and earnest discussion. The meeting was scheduled for three days but an additional half day was required to end it in a reasonably satisfactory manner. Even so several matters of concern to the National Soil Survey Committee did not receive attention. For example, no discussion was held on soil families. However, a paper on this topic from Manitoba was submitted by title to the meeting and it is included in these proceedings.

Several of the reports on soil classification are for study and trial purposes only. Hence, the suggestions they include do not have official status as yet. The report on Brunisolic soils is an exception as it has been accepted by both the eastern and western sections. The suggestions in the reports on soil classification should be carefully studied as it is hoped that the major problems on soil classification at the order, great group and sub-group levels can be resolved by the spring of 1960.

At the conclusion of the National Soil Survey Committee meeting the members participated in the meeting of the Western Section of the National Soil Fertility Committee.

NATIONAL SOIL SURVEY COMMITTEE

Second Conference of Western Section - Edmonton, Alberta

December 8-11, 1958

Chairman's Remarks - A. Leahey

We have been fortunate in having Dean McCalla open our meetings. His appropriate remarks concerning the value of cooperation and meetings such as ours in carrying out research programs has created just the right atmosphere for our deliberations. We are also indebted to the Department of Soils, University of Alberta, under the leadership of Dr. J. D. Newton, for the excellent arrangements made for our meetings.

The National Soil Survey Committee is composed of a rather deliberate body of men who have a strong tendency to take a second and even a third look at the first decisions we have made. Perhaps we err sometimes in this respect. However, while it may appear from a short time viewpoint that we are making slow progress in reaching many of our goals we have many solid accomplishments to our credit.

Since the Saskatoon meetings in 1955 our Committee has had two principal objectives. The first of these objectives has been to develop a taxonomic system of classification for the soils of Canada and the second has been to intergrate our work more closely with the research workers in soil fertility and soil management. The development of the classification scheme has received most of our attention and our progress in reaching this objective has been on the whole fairly satisfactory. However, to be quite frank, we have not devoted much time to our second major objective and hence progress on this matter has moved at a slow pace. This remark is not intended as a criticism as I believe most of us feel that we must first develop the classification system. For example at this meeting of the Western section practically all our time will be devoted to the classification system.

To those not fully conversant with the principles of the classification system we are working on, I would say that the classes in three higher categories are largely based on soil morphology but in some cases we are using certain chemical characteristics. However, in separating our soils into sub-groups, great groups and orders we do not give equal weight to all differences in morphology. Thus in placing our soils into classes within these categories relatively small differences may influence our decisions more than larger differences if we think that the small differences more clearly reflect the environmental conditions under which the particular soil has developed. We must recognize the fact that there is a strong genetic bias to the taxonomic system of soil classifications we are trying to create.

As an illustration of this point we may consider the Brown and Dark Brown great soil groups. Essentially the division between these two great groups is based on one colour chip difference in value of the A_1 horizons. This is a small difference but we know that from an environmental and genetic viewpoint it is a highly significant difference. The genetic bias in the proposed system should be kept in mind in our discussions and decisions on soil classification.

The two resolutions passed at the 1955 meeting which required the attention of the Chairman of the National Advisory Committee on Agricultural Services have been acted on in a manner satisfactory to this Committee. One of these resolutions was met two years ago by the establishment of the National Soil Fertility Committee. The resolution requesting that a research chemist be employed at Ottawa to study analytical methods, particularly those used by the soil survey laboratories, received no early action owing to staff limitations. However, this year the Chemistry Division at Ottawa found a position and a man for this purpose. I am sure you will be pleased that these resolutions have been implemented.

Review of 1958 Meeting of the Eastern Section of the N. S. S. C.

P. C. Stobbe

In briefly reviewing the meetings of the Eastern Section I would first of all say that they were marked by very good discussions which helped to clarify ideas and concepts. The main conclusions of the meetings have been published and placed in your hands. I would say that some of the reports were almost unanimously accepted while others represent only the majority opinion. In some instances there are still differing views on the classification of certain soils and these differences may not be resolved until more information has been obtained. In the meantime it was agreed to go along with something that appeared to be the most reasonable approach. It is understood, of course that these reports in the proceedings of the Eastern Section meetings were prepared for study purposes and hence are in no way final reports. Constructive criticism of the various proposals will be appreciated.

I do not intend to go over the reports of these meetings in detail as they are available for your study. However, I would like to mention a few items that are of direct concern to us at this Western Section meeting.

1 : Naming of categories: The Eastern members considered the proposals made of the Western Section at Vancouver in regard to the naming of the various categories in our classification system. They agreed to these

proposals except they would like to change the name for category 5 from "group" to "great group".

2 : Names for sub-group which represent central or zonal concept. This matter was debated at considerable length. Modal, orthic, ortho, typical, typo, zonal and normal were all considered. None of these names were acceptable to everyone. However, by majority vote "orthic" was accepted on a trial basis. It was hoped that suitable names might in time be found for all the orthic sub-groups, as for example chernozem for orthic black.

3 : The Eastern members generally preferred the term "gleyed" to "imperfectly drained" as applied to a sub-group name.

4 : Soil horizons. The subdivision of the O horizon into 3 sub-horizons as recommended by the Western Section was accepted. The Eastern Section also accepted the addition of Bcr for a colour B. Some general discussion took place regarding the case for a G horizon and changing ir to fe. However, no recommendations were made as it was felt that these and other matters regarding horizon nomenclature were required before definite action could be taken.

5 : Podzolic Order: You will have noticed by the Proceedings of the Eastern Section that most of the eastern members would like to divide the Podzolic order into two orders. Unfortunately we will not have time to discuss the pros and cons of this matter. However, since this will be a topic of discussion at our next national meeting you should be giving serious attention to this matter.

Terminology:

The following action was taken by the members of the Western Section on the first three matters of nomenclature mentioned by Dr. Stobbe.

(1) Approval was given to naming Category 5 "Great Group" in place of "Group".

(2) Approval was given for the adoption of the terms "orthic" and "gleyed". Since both eastern and western members have agreed on these terms they stand approved by the N. S. S. C.

In connection with this matter of terminology Dr. Ehrlich suggested the formation of a sub-committee on terminology. No action was taken on this suggestion.

The Classification of the Chernozemic and Solonetzic Soils of Western Canada

(Preliminary Report No. 5 to Western Section N.S.S.C.)

(Revised February, 1959)

H. C. Moss

Introduction

A record of the work done on the classification of the chernozemic and solonetzic (halomorphic) soils by the Western Section of the National Soil Survey Committee is given below.

1955 - Preliminary classification of Canadian soils adopted at Third Conference, National Soil Survey Committee, Saskatoon. The Classification Committee recommended that:

(a) "The classification scheme be given a thorough trial."

(b) "Sub-committees be established to define more accurately the three higher categories and to review, and where necessary re-define, the differentiating criteria."

1956, June - Field trip Saskatoon - Edmonton - Golden (B.C.) to study solonetzic and podzolic soils with a view to defining and naming categories VI and V of these soils.

1956, July - Preliminary report on this trip.

1956, October - A report dealing with Solonetzic soils, sent to Western members and to Ottawa.

1957, January - Second report on Solonetzic soils circulated, and used as Progress Report on the classification of the Solonetzic Soils of Western Canada, mimeographed and circulated to members of the N.S.S.C.

1957, June - Meeting of Western Section N.S.S.C. at Vancouver. Progress Report adopted, with added definition of solonetzic B horizon. Also first report on Chernozemic soils presented -- definition of Chernozemic A1 and preliminary definitions of Brown, Dark Brown, Black soils (Chernozemic soils, Category V) adopted. Above recorded in Report of the Meetings of the Western Section, National Soil Survey Committee, Vancouver, June 1957.

1958, March - Second report dealing with Chernozemic soils circulated to Western members.

1958, September - Report No. 3 dealing with replies to second report. The replies revealed a wide range of opinion concerning the definition of Chernozemic soils.

1958, September - Report No. 4 circulated. This report suggested two possible schemes (A and B) for classifying Chernozemic and Solonetzic soils.

1958, November - Replies to Report No. 4 indicated that four possible schemes (A,B,C,D) should be considered.

This was the situation in the last week of November, when it became necessary to prepare a report on the Chernozemic and Solonetzic soils for this meeting.

The Classification Problem

As already stated, two alternative schemes for classifying the soils of the prairie grasslands were submitted to the western provinces and to Ottawa. The first four replies represented four alternative schemes, which may be designated A, B, C, and D. The final count indicated that A was favoured by two groups, B by two groups, while C and D each received support from one group.

It will be evident then that no clear directive was received for presenting a classification scheme favoured by even a bare majority of the regional groups concerned. It is true that by taking account of second choices expressed by the groups, and by noting individual comments, some changes might be made in the order of preference given above. However, since all groups did not indicate a second choice nor were all individuals represented in the comments, it was still impossible to state what the majority desired.

Faced with this situation, the following alternative suggestions could be proposed:

1. That we accept the point of view that we are not ready to establish a final system of classification for the Chernozemic and Solonetzic soils of Canada.
2. That all four alternative schemes mentioned above be drawn up and presented in full to the meeting.
3. That the four schemes be presented in a brief outline and that one selected scheme be presented in reasonably full detail.

Suggestion No. 1 was not seriously considered, but it may well be the best. Soils can be identified and described and used in soil surveys without the aid of a final, detailed system of classification. The latter can be established when more is known about Canadian soils.

Suggestion No. 2 would seem to be the proper choice for this meeting, except for two serious objections. First, there would not be time to present four classification schemes in detail and secure full discussion of each. Second, we could end up in the same indecisive position as at present.

Suggestion No. 3 was therefore selected for presentation. This means that one of the classification schemes would be presented and disposed of - by acceptance or rejection. If it was rejected one of the remaining schemes introduced to the meeting might receive sufficient support to warrant its acceptance. Before discussing a selected classification scheme in detail, an outline of each of the four suggested schemes is given below.

Table 1 - Outline of Schemes A,B,C, and D for Classifying the Chernozemic and Solonetzic Soils

Scheme A

Chernozemic Soils

Similar to 1955 definition in that the Order comprises soils having chernozemic Ah but lacking distinct Ae horizons. However, under A, all soils with solonetzic morphology are excluded.

Category 6 would be re-defined to make the above conditions plain.

Category 5 would not require revision.

Category 4 would lose all profiles with solonetzic morphology and perhaps some profiles now classified as degrading types: That is, all profiles with Ae or Bt horizons would be excluded. (These horizons would have to be defined).

Solonetzic Soils

Under Scheme A the 1957 definition of these soils would require revision to permit inclusion of all soils with solonetzic morphology. The above change would affect Categories 6, 5, and 4. (See No. 4 Report, pp 2 and 3).

Scheme B

Chernozemic Soils

Similar to 1955 definition, but note the term "weakly-textured B horizons" may not cover all solonetzic, solodic, and degrading Chernozemic profiles. Hence Scheme B would require an agreement on the degree of Ae development to be permitted in these soils. Present definitions of Categories 6 and 5 would require additions to indicate that Ae and Bt horizons may occur (See No. 4 Report, pp 3 and 4).

Category 4 would not require revision.

Solonetzic Soils

Under Scheme B, no revision of the 1957 definition of these soils is required.

Scheme C

Chernozemic Soils

This scheme would combine all soils presently classified in Orders 1 and 2, or at least all those soils having chernozemic Ah horizons and either coloured, structured, textural, or solonetzic B horizons.

Category 6 would require revision.

Category 5 Group names would remain, but the definitions would be broadened.

Category 4 would require revision.

Solonetzic Soils

Under Scheme C these soils would disappear as a distinct Order, but would appear under their respective Great Groups of the Chernozemic Order. The grey wooded Solonetzic soils would presumably be placed in the Podzolic Order.

Scheme D

Chernozemic Soils

Similar to the concept required for Chernozemic soils under Scheme A. Hence Categories 6, 5, and 4 treated as in Scheme A.

Solonetzic Soils

Similar to present (1957) definition, and therefore similar to concept required for Scheme B. Hence no revision of present Solonetzic soils required.

Leached Chernozemic (Bleached, Claypan) Soils

A new order to take care of solonetzic soils with Ae and Bt (non-solonetzic) horizons. Place of Ah, Bt soils and Dark Wooded soils not clear. The above new Order will require new definitions to establish Categories 6, 5, and 4.

Discussion of Schemes A, B, C, and D

Table 1 gives in brief form the main features of each suggested scheme and also indicates what changes in the present classification are required to establish a given scheme. In this connection please note in the Table the statements indicating that certain categories do not require revision. This does not mean that the soils of such categories are not subject to future revision, but only that no changes in our present definitions are required to establish a given scheme.

The outline in Table 1 is intended to assist us in finding the most satisfactory scheme of classification. Any one of the suggested schemes could be adopted and used, and to this extent would be satisfactory. What is desired is the best scheme we can plan at this time.

Table 1 should be used therefore to compare the different schemes as to:

1. Their suitability for establishing the most satisfactory classification.
2. The kind and amount of work required to define the major categories.

(At this point Mr. Moss asked for the opinion of the members on two matters:

1 : "Halomorphic" or "Solonetzic" as the name for order 2.

2 : Which scheme at this time was supported by the members.

On a ballot vote the results were as follows:

	Committee Members	Others	Total
For Solonetzic	8	8	16
For Halomorphic	1	4	5
For scheme A	7	6	13
" " B	1	5	6
" " C	1	2	3
" " D	0	0	0

Professor Rowles and Mr. Kelley were not present when the vote was taken and Drs. Ripley and Leahey did not vote.

A. L.)

The Classification of the Chernozemic and Solonetzic Soils according to Scheme A

The reasons for presenting the details of only one of the suggested schemes have already been discussed. The particular selection of Scheme A requires further explanation. The main reasons for preferring Scheme A are listed below:

1. It is considered to be the most logical and also the simplest scheme from the standpoint of teaching soil classification. (The word teaching is used in the broadest sense to include giving information to individuals who are not familar with soil science, training student assistants, lecturing to V.L.A., assessment staffs and similar groups, and teaching formal University classes).

   Scheme A, from the above standpoint, presents a reasonable separation of soils that reflect the dominant influence of climate and vegetation from those in which other soil forming factors have super-imposed other important morphological, chemical, and physical characteristics on the soil profile.

2. Scheme A fits the general concepts of world soils as represented in much of the pedological literature. Thus books and papers by such names as Glinka, de Sigmond, Robinson, Joffe, Kellogg, and many others deal with the soils of the world in terms of chernozemic, solonetzic, podzolic, lateritic and hydromorphic groups. So far as we know these groups represent the major soil forming processes - humification (calcification if you prefer) solonization - solodization, podzolization, laterization and gleyzation. Despite differences

in terminology or in the precise definition and place of individual soil types, it seems reasonable to assume that the above concepts will remain in force. If so it is most desirable that the Canadian classification should not only satisfy our conditions but should also agree with the broad concepts mentioned above.

In short it is submitted that Scheme A is at least as suitable as the other schemes for the major purpose of classifying our soils, and superior in terms of ease of presentation, logic and agreement with prevailing concepts of world soils.

An outline of the classification, together with proposed definitions of the various categories, is given below. The original outline has been revised to include changes agreed upon at Edmonton. Some changes proposed by various groups since the meeting are also included, but other recent suggestions will require further study and discussion and therefore are not dealt with in this report.

Order 1 - Chernozemic Soils

Great Group	Sub-Groups
1.1 Brown Soils	1.11 orthic Brown 1.12 calcareous Brown 1.13 gleyed Brown
2.1 Dark Brown Soils	2.11 orthic Dark Brown 2.12 calcareous Dark Brown 2.13 degraded Dark Brown 2.14 gleyed Dark Brown
3.1 Black Soils	3.11 orthic Black 3.12 calcareous Black 3.13 wooded calcareous Black 3.14 degraded Black 3.15 gleyed Black

Note 1 - The wooded calcareous Black represents a dark coloured soil with thin O, well developed Ah, and a calcareous, structured and coloured B, occurring under forest vegetation. Objections have been raised to including this soil in the Sub-Group, it being suggested that it should be separated in a lower category or transferred to some other Order. The 3.13 soil is included here because it was presented at Edmonton where it was apparently accepted - the main criticism there being directed to the name used to identify it.

Note 2 - Salinization of the above soils will ordinarily occur in the gleyed profiles. It is suggested that salinized types be separated at the Family-Series level, on the presence of sufficient salts to affect crop growth and probably to influence native vegetation.

1. Chernozemic Order

Soils with chernozemic Ah horizons, coloured or structured (usually coloured and structured) B horizons, and C horizons of high base status, usually calcareous. A ca sub-horizon is usually present. May have O-Ah, Ahe, A-B, B-C, Bg, Bsa horizons. Imperfectly to well drained soils developed originally under grassland vegetation. Major processes, humification, and calcification (development of humus-mineral surface horizon and maintenance of high calcium status).

Major profile types Ah, B, C. Ah, Ahe, B, C. Ah, A-B, C.

Chernozemic Great Groups

1.1 Brown - A soil with brownish Ah, lighter than 4.5 (Munsell colour); a coloured and structured (usually prismatic or blocky) B horizon; a lighter coloured ca horizon is usually present; the C horizon is also usually calcareous and usually neutral to alkaline in reaction.

1.2 Dark Brown - A soil with a dark brownish Ah (values 4.5 to 3.5), higher in organic matter and with somewhat thicker solum than that of corresponding Brown soil. Otherwise B and C horizons are essentially similar to those of the Brown soil described above.

1.3 Black - A soil with a very dark brown to black Ah horizon (value darker than 3.5), higher to much higher in organic matter, and with thicker solum than that of corresponding Dark Brown soil. Otherwise B and C horizons are essentially similar to those of the Brown soils.

Chernozemic Sub-Groups

1.1 Brown

1.11 orthic Brown - a soil with brownish Ah horizon of granular to blocky structure; a brownish, prismatic B, breaking easily to blocky aggregates or colour B only; a light greyish ca, horizon is usually present.

1.12 calcareous Brown - a soil with brownish Ah horizon of granular to blocky structure; a relatively thin, brown to greyish brown, prismatic B, with greyish streaks and spots of lime carbonate; light coloured (grey to whitish), massive, ca horizon.

1.13 gleyed Brown - a brownish Ah (may be somewhat darker and thicker than in 1.11), and may show some lighter coloured streaks; a brownish grey, structured B horizon, with rusty, yellowish, light greyish streaks and spots; lower B and C horizons also mottled, and calcareous and frequently saline.

2.1 Dark Brown

Except for dark brownish Ah, similar to corresponding soils of Brown Group.

3.1 Black

3.11 orthic Black - a soil with dark to very dark (very dark brown to black) Ah of granular to soft blocky structure; a brownish B of prismatic to blocky structure or colour B only; a light coloured ca horizon is usually present.

3.12 calcareous Black - a soil with dark Ah, chiefly of granular structure; a relatively thin, brownish, prismatic B with greyish streaks and spots of lime carbonate; a light coloured, prismatic to massive ca horizon.

3.13 wooded calcareous Black - a soil with very dark greyish Ao-Ah surface horizon (unless destroyed by fire); a thick, dark greyish, blocky-platy to granular structured Ah, usually containing free lime carbonate; a greyish to yellowish brown, prismatic to very coarse blocky B, with lime carbonate; light coloured ca horizon.

3.14 degraded Black - a soil with a thin O horizon; a very dark grey to dark grey Ah horizon, with lighter greyish, leached, spots or bands (Ahe); a brownish, prismatic to very coarse blocky B, somewhat finer textured than A; a ca horizon is usually present.

3.15 gleyed Black - a soil with very dark Ah, which may contain some lighter spots and streaks; a dark greyish, or greyish brown (sometimes black) B horizon, with rusty, yellowish, and greyish streaks and mottles; lower horizons mottled, calcareous, and may be saline.

Order 2 - Solonetzic Soils

Great Group	Sub-Group
2.1 Solonetz-like (Pseudo-Solonetz)	2.11 brown Solonetz-like
	2.12 dark brown Solonetz-like
	2.13 black Solonetz-like
	2.14 dark grey wooded Solonetz-like
	2.15 grey wooded Solonetz-like
2.2 Solonetz	2.21 brown Solonetz
	2.22 dark brown Solonetz
	2.23 black solonetz
	2.24 dark grey wooded Solonetz?
	2.25 grey wooded Solonetz?
2.3 Solodized-Solonetz	2.31 brown Solodized-Solonetz
	2.32 dark brown Solodized-Solonetz
	2.33 black Solodized-Solonetz
	2.34 dark grey wooded Solodized-Solonetz
	2.35 grey wooded Solodized-Solonetz
2.4 Solod	2.41 brown Solod
	2.42 dark brown Solod
	2.43 black Solod
	2.44 dark grey wooded Solod
	2.45 grey wooded Solod ?
2.5 Solodic	2.51 brown Solodic
	2.52 dark brown Solodic
	2.53 black Solodic
	2.54 dark grey wooded Solodic ?

Note 1 - It is considered doubtful if soils 2.24, 2.25, 2.45, and 2.54 can be identified, or even be said to exist. They are listed here as potential profiles until the wooded Solonetzic soils are reviewed from the standpoint of the proposed classification.

2 - Solonetzic Order

Soils with Ah or Ae horizons, hard to very hard, usually columnar or prismatic Bt horizons and developed on saline parent materials or under the influence of saline waters. The B horizons usually show organic staining and surface coatings, and may contain more exchangeable sodium plus magnesium than exchangeable calcium (solonetzic B as defined in 1957). In Solodic profiles the B is usually blocky structured.

Solonetzic soils may have O, Ahe, A-B, Bg horizons, and usually ca and sa horizons are present.

Imperfectly to well drained soils of grassland or forest regions under arid to sub-humid climates. Major processes desalinization, de-alkalinization and degradation (break-down of original B horizon).

Major profile types: Ah, B, C. Ah, Ae, B, C. O, Ahe, B, C. O, Ae, B, C. Ae, B, C.

Solonetzic Great Groups

2.1 Solonetz-like (pseudo-solonetz). - A soil with Ah or Ahe and absent to very thin Ae, or with O and Ae horizons, and a hard, columnar or prismatic Bt horizon, moderately acid to neutral in reaction. The C horizon is usually calcareous and slightly saline.

2.2 Solonetz - A soil with Ah horizon that is thin in comparison with the B, a dark, very hard, columnar Bt horizon with surface coatings and organic staining, and usually alkaline to highly alkaline in reaction. The C horizon is usually saline and also usually calcareous. (If wooded Solonetz is recognized, O horizon may be present).

2.3 Solodized Solonetz - A soil with a light coloured Ae horizon, (O or Ah may be present) and a very hard, white-capped columnar Bt horizon, with surface coatings and organic staining, and ranging from acid to alkaline in reaction. The C horizon is usually saline and calcareous.

2.4 Solod - A soil with Ah or Ahe horizon, a light coloured Ae horizon, thick in comparison with the B, and of faint columnar structure with sharp horizontal cleavage, and acid reaction; a hard, textural B horizon with weak columnar or prismatic macro-structure (a remnant of the former solonetzic B), and acid to neutral in reaction. The C horizon is usually saline and calcareous.

2.5 Solodic - A soil with Ah horizon, a somewhat lighter coloured Ahe or Ae horizon, (sometimes an Ae-B horizon), a textural B horizon with blocky structure or with faint columnar or prismatic outline, falling easily into hard blocky aggregates. Lower horizons usually calcareous and may be saline.

Note 1 - In the 1957 definition all Solonetzic soils had to possess solonetzic B horizons which were characterized by the hard, structural, and textural qualities listed above and the requirement that exchangeable Na + Mg should exceed exchangeable Ca. The latter characteristic is no longer required since the objection was raised that chemical properties cannot be determined in the field.

Note 2 - With reference to the solonetzic B - one having both morphological and chemical characteristics as defined in 1957, - a solonetzic B will occur in the Solonetz (2.2), in most of the Solodized Solonetz (2.3), and in many of the Solod (2.4) soils.

Note 3 - We need agreement on a name for 2.1. "Solonetzic" is alright except for the fact that it is the term used for the Order. Solonetz-like has been objected to, and pseudo-solonetz was proposed. No decision was taken on this at Edmonton. Solonetz-like has been used here until it or another term is finally approved.

Solonetzic Sub-Groups

The Sub-Groups of the Solonetzic soils are based on the recognition of zonal features in each of the Great Group profiles. To attempt a description of each Sub-Group soil would involve a great deal of repetition. For each Great Group soil the various Sub-Groups possess similar profiles except for the differences in zonal features. For example, under Solodized Solonetz soils the Sub-Groups consist of brown, dark brown, black, dark grey wooded, and grey wooded Solodized Solonetz profiles, - all conforming to the description given under 2.3, but differing in colour of Ah or in its absence or the presence of a O horizon.

It should be noted that in general, and with particular reference to the Brown and Dark Brown zones, the Ah horizons of Solonetzic soils are somewhat lighter coloured than those of the Chernozemic soils. There is also a tendency in Solonetz-like and Solonetz soils for columnar structures to extend into the A horizons.

Note 1 - No reference is made to gleyed (imperfectly drained) Solonetzic soils. This is because it is necessary to specify the kind of Solonetzic profile as well as the presence of poorly drained features; this can only be done by listing a gleyed profile for each Sub-Group soil. It is simpler therefore to treat conditions of soil drainage as a Series and Family separation.

Conclusions

At the conclusion of the Edmonton meeting it was agreed that the proposed classification of Chernozemic and Solonetzic soils should be circulated to the Western Section of the National Soil Survey Committee. The western groups would study the classification and forward their comments to H. C. Moss, who would prepare a report for publication in the Proceedings of the Edmonton meeting.

This plan was followed except that the present report does not deal with all of the criticisms and suggestions sent in by the various groups concerned. It was found that some of the criticisms, if accepted, would make it necessary to adopt some other scheme of classification. In addition there were a number of different suggestions for dealing with the same problem. Thus it became apparent that further joint work would be required before a classification system acceptable to the Committees could be established.

The present report therefore cannot be regarded as a final report, but rather as a revised edition of the Preliminary Report (No. 5) presented at Edmonton.

It is planned to prepare another report, dealing with the more recent criticisms and suggestions, and to send it to the various groups in Western Canada and Ottawa. This should lead to a decision as to whether or not a satisfactory classification of the Chernozemic and Solonetzic soils is possible at the present time.

Grey Wooded Soils

Wm. Odynsky

Two proposals were submitted to the Committee for consideration with respect to the classification of Grey Wooded soils. One scheme followed closely the separations in the 1955 submission while the other suggested separations at the Category V level of the Dark Grey Wooded and Bisequa Profiles. The ensuing discussion indicated a reluctance to accept either of the proposals and some of the definitions - especially those of "distinct", "prominent", "orthic", and "bisequa". The stalemate was broken by the Chairman's vote in favor of the 1955 sequence to permit a review of the sub-group separations and definitions. The revised submission was again forwarded to the Committee members for further suggestions and criticisms. While there is a lack of enthusiasm regarding some of the proposed names, the following are the descriptions of the kinds of profiles that may merit separation in this group of soils and appear to be acceptable to the Western Committee:

Category V (Great Groups)

3.2 Grey Wooded

Under undisturbed conditions the soils of this group have an organic surface layer (O), a light colored eluviated horizon (A_2 or A_e), and an illuviated horizon in which clay is the main accumulation product (B_2 or B_t).

These soils are formed under a forest vegetation in the cooler portions of the North Temperate Zone, usually on calcareous parent material and often have a drab grey to greyish brown colored solum. They may have an Ah or A_{he} and a transitional AB horizon. The solum has a medium to high base saturation.

Category IV (Sub-group)

3.21 Orthic Grey Wooded

Soils with an O horizon, a well developed, light colored, A_e horizon and a textural B horizon (B_t).

They may have an A_h or A_{he} horizon less than 2 inches thick and some yellowish or rusty staining or mottles in the lower portion of the A_e horizon. A transitional AB horizon is often present and the C horizon is usually calcareous. The solum is often drab in color and has a medium to high base saturation.

3.22 Dark Grey Wooded

Soils which differ from the orthic sub-group in having a thicker (more than 2 inches) A_h or A_{he} horizon. The plowed A horizon will have a darker color than that of the Orthic Grey Wooded. The A_h horizon usually has a Munsell color value of 2 to 3 while the A_{he} horizon usually has a Munsell color value of 4 to 5.

The other characteristics are similar to those of the Orthic Grey Wooded.

3.23 Gleyed Grey Wooded

Soils with the same general profile characteristics as the orthic sub-group but with yellowish to rusty streaks or mottles in the major portion of the A_e horizon and in much of the B horizon due to periodic wetness. The C horizon is usually calcareous but may be saline.

3.24 Gleyed Dark Grey Wooded

Soils with the same general profile characteristics as outlined for Dark Grey Wooded (3.22) but with yellowish to rusty streaks or mottles in the major portion of the A_e horizon and in much of the B horizon due to periodic wetness. The C horizon is usually calcareous but may be saline.

3.25 Suggested names: "Alto" Grey Wooded, Podzolized Grey Wooded, Sequa Grey Wooded, Bleached Grey Wooded. (Titles not acceptable and some doubt regarding the need of this sub-group.)

Soils with the same general profile characteristics as those of the orthic sub-group except that the A_e horizon can be subdivided into an upper horizon that is much lighter in color, usually light grey to pinkish white, and a lower horizon that is somewhat darker, usually pale brown to light yellowish brown in color.

3.26 Suggested names: Brunisolic Grey Wooded, Chromo Grey Wooded, Brown Podzolic Grey Wooded. (Titles not acceptable and some doubt regarding the need of this sub-group.)

Soils with the same general profile characteristics as those of the orthic sub-group except that the A_e horizon can be subdivided into an upper horizon that is much darker in color, usually brown to reddish brown, and a lower horizon that is somewhat lighter in color, usually pale brown to light yellowish brown.

3.27 Bisequa Grey Wooded or Podzol Grey Wooded

Soils in which a Podzol sequence of horizons occur within the A_e horizon overlying a textural B horizon. The remaining portion of the solum has characteristics similar to those of the orthic sub-group.

The Podzol sequence consists of a light colored horizon (light grey to pinkish white) and a dark colored horizon (brown to reddish brown). This upper sequum is usually underlain by and separated from the textural B horizon by a pale brown to yellowish brown horizon. The reaction and base saturation of this sequum is usually somewhat lower than that of the Orthic Grey Wooded A_e horizon.

Sub-Committee:

Wm. Odynsky (Chairman)

J. D. Lindsay

T. W. Peters

Report on the Classification of Brunisolic Soils

A. Leahey

Since there will be no committee report dealing with the classification of Brunisolic soils presented at this meeting your comments and criticisms of the reports on this matter which appeared in the Report of the Eastern Section, N.S.S.C. 1958 would be appreciated. If you have no serious objections I would ask for your formal approval of the reports dealing with the Brunisolic order and the Brown Podzolic, Brown Wooded, and Brown Forest great groups. The proposals regarding the Acid Dark Brown Forest and the Concretionery Brown great groups have not been studied by committees of the N.S.S.C. and hence I will not ask for formal approval of these proposals at this meeting.

No serious objections were taken to the proposed classification of the Brunisolic soils or to the definitions proposed for the order, great groups and sub-groups. However, as a result of the discussion the meeting recommended the following changes in wording:

(1) Change modal to orthic and imperfectly drained to gleyed.

(2) In the definition of Brown Podzolic soils delete "podzol" from the term "podzol Ae".

The following resolution was moved by H. C. Moss and seconded by W. L. Hutcheon:

"That the report on the Brunisolic soils be adopted at this meeting with reference to the order, the Brown Forest, the Brown Wooded and the Brown Podzolic great groups and the sub-groups of these great groups and that the British Columbia pedologists together with any other interested parties submit any suggestions for redefining the Acid Dark Brown Forest and the Concretionary Brown great groups if considered necessary by them."

This motion was carried unanimously.

Classification of Regosolic Soils

L. Farstad

This is the first report of the sub-committee on the classification of regosolic soils occurring in Western Canada. The classes proposed and their definitions need careful study to determine whether or not they are appropriate throughout Canada as the suggestions in this report are based very largely on regosolic soils found in British Columbia.

The proposals made in this report differ markedly from those made at the Eastern Section meetings at Ottawa in February 1958. There are several reasons for this departure from the eastern viewpoint.

(1) The present proposals give some weight to the zonal influences which often can be detected in these soils.

(2) The present proposals provide a more logical classification at the great group and sub-group levels for the large number of regosolic soils which occur in British Columbia than did the proposals made in former reports.

(3) The present proposals adhere more closely to the principles of our classification system than previous proposals. That is we have used, as far as possible, morphological features to classify these soils at Categories 4 and 5 and we have relegated geological origin and nature, as far as possible, to the three lower categories.

5. Regosolic Order

Soils with little or no genetic horizon development due to the nature of the parent material, age, climate or position.

Profile development is restricted mainly to the accumulation of organic matter to form an Ah, Ahe or O horizon, to the translocation of lime or soluble salts.

Mainly well, imperfectly drained and poorly drained soils (which are not gleyed) developed under various climatic and vegetative conditions.

Profile types - Ah, C; Ahe, C; O, Ahe, C; O, A, C; O, C; and C.

5. Regosolic Order

Great Group		Sub-Group
5.1 Pralithic* Regosol	-	5.11 Grey Brown 5.12 Brown 5.13 Dark Brown 5.14 Black 5.15 Dark Grey 5.16 Saline 5.17 Imperfectly drained
5.2 Arbolithic* Regosol		5.21 Calcic 5.22 Non-Calcic 5.23 Imperfectly drained
5.3 Regolithic Regosol		5.31 Regolithic 5.32 Lithosolic 5.33 Saline
5.4 Tundra		5.41 Mor-Tundra 5.42 Raw mark or Polygon

5.1 -- Pralithic Regosol

Soils with an Ah horizon generally over 2 inches thick which grades into the parent material (C).

These soils are developed mainly under grass or grass-shrub vegetation.

5.11 - Grey Brown Sub-Group

Soils with an indistinct, grey brown, Ah horizon which grades into the underlying parent material.

Indications are the organic matter content of the surface few inches will be less than 2 per cent and the C/N ratio less than 10. This sub-group has been established to include the Desertic and Brown-Desert intergrade soils in B. C.

* Pradera is a Spanish term meaning grassland and Arbol means tree.

5.12 - Brown

A soil with a brownish chernozemic Ah horizon which grades into the the underlying parent material. Essentially similar to the Brown Ah horizon (1.1).

5.13 - Dark Brown

A soil with a dark brownish chernozemic Ah horizon which grades into the underlying parent material. Essentially similar to the Dark Brown Ah horizon (2.1).

5.14 - Black

A soil with a very dark brownish to black chernozemic Ah horizon which grades into the underlying parent material. Essentially similar to the Black Ah horizon (3.1).

5.15 - Dark Grey

A soil with a very dark grey, dark grey or very dark greyish brown Ah or Ahe which grades into the underlying parent material. This sub-group is included to cover those regosolic soils with a C/N ratio greater than 13.5. The A horizon is usually quite irregular.

5.16 - Saline

A soil containing soluble salts in the Ah or Ahe horizon. No limits of salinity are suggested at the present time. Some Solonchak soils may belong here. The saline surface horizon may be a distinguishing feature in Category III.

5.17 - Imperfectly drained

A soil with a prominent dark colored Ah horizon which may show brownish or yellowish streaks and spots which grades to a mottled parent material which is usually calcareous.

The Imperfectly drained and Saline Sub-groups were established to cover the Regosolic soils sufficiently saline or imperfectly drained to noticeably affect soil color and organic matter content of the Ah horizons. They usually occur on low-lying areas on wet alluvial and regosol soils with poor natural drainage.

5.2 -- Arbolithic Regosol

Soils with an O and an Ahe horizon which grades into the parent material. These soils are formed or are forming under forest vegetation.

5.21 - Calcic

A soil with a thin (< 6" thick) dark colored usually non-calcareous Ahe surface mineral horizon that grades into the calcareous parent material.

5.22 - Non-Calcic

A soil with a thin (2 to 4" thick) surface organo-mineral horizon (A or C1?) that grades into a parent material that is non-calcareous.

With reference to the A or C1 horizon - a surface organo-mineral horizon having stronger color (usually one to two Munsel units when moist) and lower bulk density than the oxidized portion of the parent material.

Sub-groups 5.21 and 5.22 represent an intermediate stage of development between a soil that is almost entirely C and the Brown Wooded or Brown Podzolic. The terms are not entirely satisfactory.

5.23 - Imperfectly drained

A soil with a thin Ahe or mixed O-Ahe less than 6 inches thick. Mottling at or near the surface or in the sub-soil may occur.

This sub-group consists mainly of wet alluvial and regosolic soils having poor to very poor drainage and occurring under forest vegetation.

Groups 5.1 and 5.2 require further study so that differences due to the forces of climate and vegetation will not be overlooked or over-emphasized. Further study may show that the number of sub-groups can be reduced. For example, the sub-group across the Brown and Dark Brown, or across Dark Brown and Black zones may be combined. In the case of contrasting soil zones such as Brown and Black this would not be advisable.

5.3 -- Regolithic Regosol

Soils without definite horizon development other than an indistinct O, Ah or Ahe.

The O, Ah or Ahe horizons ordinarily would not be used as differentiating criteria of the soil profile. They are often discontinued and would not or could not be sampled.

5.31 - Regolithic

A soil developing from unconsolidated deposits.

5.32 - Lithosolic

A soil developing on rock, disintegrating rock, or materials consisting largely of coarse rock fragments that lack genetic horizons.

5.33 - Saline

A soil developing on recent or recently exposed saline parent materials. They may or may not have prominent surface salt encrustations.

This class was added to cover some of the recent soils, such as lake beds, marine clays, etc., which occur in British Columbia.

5.4 -- Tundra

5.41 - Mor-Tundra

5.42 - Raw mark or Polygon Tundra.

Report on Classification of Gleysolic Soils

W. A. Ehrlich

6.0 Gleysolic Order

Soils with an O horizon (< 12 inches thick) or with an Ah horizon or with both, or without the two surface horizons but with some organic material dispersed throughout the mineral soil. The subsoils are gleyed and are dull colored but may have brighter colored prominent mottles.

Soils associated with wetness. They have developed under various climatic and vegetative conditions and in the presence of a higher or highly fluctuating water table. The major soil forming process is gleyzation.

6.1 Meadow Great Group

Soils with a dark colored Ah horizon more than 2 inches thick which grades into a dull colored horizon or horizons which may or may not show gleying. May have an O horizon not exceeding 12 inches in thickness.

In cultivated fields the O horizon may become mixed with the mineral soil and may become indistinguishable from the Ah horizon.

These soils have developed under grasses, hedges and swamp-forests.

6.11 Orthic Meadow Sub-Group

Soils with a non-calcareous, dark colored Ah horizon which grades into a dull colored horizon or horizons. Underlying materials are usually calcareous. May have an O horizon up to 3 inches thick.

6.12 Calcareous Meadow Sub-Group

Soils with a calcareous, dark colored Ah horizon which grades into a calcareous (not significantly saline), dull colored horizon or horizons. May have an O horizon up to 3 inches thick.

6.13 Saline Meadow Sub-Group

Soils with a dark colored Ah horizon underlain by a saline, frequently calcareous horizon or horizons. May have an O horizon up to 3 inches thick. Water soluble salts usually occur in the Ah horizon. Salinity of this soil is sufficiently high to affect plants with a low salt tolerance.

6.14 Degraded Meadow Sub-Group

Soils with a dark colored Ah horizon underlain by a mottled Btg horizon. An Ae sub-horizon may be present in the lower part of the A horizon. May have an O horizon up to 3 inches thick.

6.15 Solonetzic Meadow Sub-Group

Soils with a dark colored Ah horizon underlain with a mottled, columnar or prismatic Bg horizon. May have an O horizon up to 3 inches thick.

6.16 Peaty Meadow Sub-Group*

Soils similar to the Orthic Meadow but containing 3 to 12 inches of peat.

6.2 Dark Grey Gleysolic

This group of soils was not defined by the Western Section.

*Meadow soils other than the Orthic Meadow sub-group with 3 to 12 inches of peat should be referred to as Peaty Calcareous Meadow, Peaty Saline Meadow, Peaty Degraded Meadow or Peaty Solonetzic Meadow.

6.3 Gleysol Great Group

Soils with an O horizon less than 12 inches thick or without an O horizon grading into a strongly gleyed mineral horizon or horizons. May contain an Ah horizon up to 2 inches thick. No noticeable eluvial or illuvial horizons.

Developed under swamp-forest, heath or swamp vegetation.

6.31 Orthic Gleysol Sub-Group

Soils with an O horizon less than 6 inches thick, a thin (< 2 in.) or absent Ah horizon underlain by a strongly gleyed horizon or horizons.

6.32 Saline Gleysol Sub-Group

Soils with an O horizon less than 6 inches thick, a thin (< 2 inches) or absent Ah horizon underlain with a strongly gleyed horizon or horizons containing water soluble salts in sufficient quantities to affect plants with a low salt tolerance.

6.33 Peaty Gleysol Sub-Group*

Soils similar to Orthic Gleysol but containing 6 to 12 inches of peat.

6.34 Rego-Gleysol Sub-Group

Soils with less than one inch of peat or muck and without an Ah horizon. Some organic material in the form of peat, muck, or organic mud, may be dispersed through the mineral section. Strongly gleyed mineral soil occurs at or near the surface.

*Saline Gleysol soils with 6 to 12 inches of peat should be referred to as Peaty Saline Gleysol.

6.4 Eluviated Gley Great Group

Soils with an O horizon up to 12 inches thick, a thin (< 2 inches) or absent Ah with a mottled gleyed Aeg horizon and a mottled gleyed Bg horizon.

Developed mainly under swamp-forest.

6.41 (Podzol)[**] Gley Sub-Group

Soils with an O horizon less than 6 inches thick, a thin or absent Ah horizon underlain with a bleached, strongly gleyed Aeg horizon and a strongly gleyed Birg horizon.

Development of Aeg and Birg is weak. It has not been established whether the development of the Aeg is entirely due to eluviation or in part due to bleaching. Mottling is more intense in the Birg than in the Aeg.

6.42 Peaty (Podzol)[**] Gley Sub-Group

Similar to 6.41 but containing 6 to 12 inches of peat.

6.43 (Grey Wooded)[**] Gley

Soils with an O horizon less than 6 inches thick, a thin or absent Ah horizon underlain with a strongly gleyed Aeg and a strongly gleyed Btg horizon.

6.44 Peaty (Grey Wooded)[**] Gley

Soils similar to 6.43 but containing 6 to 12 inches of peat.

[**] Terms that are bracketed have not been accepted by the Western Section but are used to indicate the soils being defined.

Discussion on Gleysolic Soils

1. Mr. Moss favoured Hydromorphic or Hydrosolic to Gleysolic but the majority of the group preferred retention of the term Gleysolic for wet soils.
2. Criticism was directed at the inconsistency of the definitions on the respective thickness of the Ah horizons permitted in the Meadow and Gleysol soils. Originally the definitions stated that the minimum thickness of the Ah horizon in the Meadow soils be 3 inches and the maximum thickness in some Gleysol soils be 2 inches. For the sake of consistency the group voted 10 to 2 in favour of lowering the minimum thickness of the Ah horizon in the Meadow soils to 2 inches.
3. It was suggested that the degree of salinity in Saline Meadow soils be expressed on the basis of "salts in sufficient quantity to affect plants with a low salt tolerance".
4. The need for Solonetzic Meadow soils was questioned. However after some discussion the group decided to retain this soil in the classification scheme for the present time.
5. The use of peaty in the classification of Gleysolic soils was discussed at considerable length. It was finally decided that Peaty Meadow would refer only to a soil similar to Orthic Meadow with 3 to 12 inches of peat. Other Meadow soils with 3 to 12 inches of peat should be referred to as Peaty Calcareous Meadow, Peaty Saline Meadow, Peaty Degraded Meadow and Peaty Solonetzic Meadow.
6. No revisions of definitions on the Dark Grey Gleysolic soils were made, however the members questioned the need for this group of soils because of the apparent similarity to the Meadow soils. This matter was not discussed in detail; most of the members felt that they were not sufficiently familiar with this group of soils.

7. Definition of the Gleysol Great Group was considered as cumbersome due to the inclusion of Rego-Gleysol soils which do not have the main morphological features of the other Gleysol soils. Establishment of Rego-Gleysol soils as a Great Group was proposed but this proposal was not generally accepted. After considerable discussion it was decided to retain the Rego-Gleysol soils under the Gleysol Great Group but some refinement of the definition should be attempted.

8. In the definition of Orthic Gleysol some discussion developed on the use of layer and on the thickness of the O horizon. It was generally agreed that "horizon" should be used in place of "layer" and that the O horizon should have a range of 1 to 6 inches in thickness. Some members felt the maximum thickness of the O horizon in this group of soils should be the same as that which was specified for Meadow soils.

9. The need for Saline Gleysols soils in this scheme was questioned.However after some members indicated that these soils exist, it was decided to retain this type as a separate entity at the Sub-Group level.

10. In the discussion on Peaty Gleysol, the members generally agreed that this soil should be similar to the Orthic Gleysol containing 6 to 12 inches of peat. The Saline Gleysol soil containing 6 to 12 inches of peat should be referred to as Peaty Saline Gleysol.

11. The concept of Rego-Gleysol as defined by the Eastern Section was viewed somewhat differently by the members of the Western Section. Some members of the Western Section felt that this definition could include some wet alluvial soils. Several members stated that many of the old lake-beds and sloughs have more than one inch of organic mud or other

organic material on the surface. Dr. Stobbe stated that recent alluvial soils should be classed as Regosols and those that are flooded periodically and contain a few inches of organic mud, muck, or peat should be classed as Orthic Gleysols.

12. Eluviated Gley was suggested and accepted as an alternative term for Podzolic Gley as a Great Group name. The terms Podzol Gley and Grey Wooded Gley were not accepted by the group and no alternative names found favour with the group as a whole. It was decided that a committee be chosen to study and select appropriate names for a number of questionably named soils in our present classification scheme.

J. A. McKeague

J. A. Barr

Progress Report of the Mineralogy of some Canadian Soils

by J. E. Brydon

Profiles of several of the representative soils of the Great Soil Groups have been obtained as follows:

British Columbia	Concretionary Brown	Albeni Watkin
Alberta	Brown	Maleb
	Black	Antler
	Podzol-Gray Wooded	Lobley
Manitoba	Black	Oxbow
	Gray Wooded	Granville
Quebec	Podzol	Arago
New Brunswick	Podzol	Holmesville
Nova Scotia	Podzol	Barney

The number of horizons sampled varied somewhat depending upon the nature of the profile. Only one C horizon sample was taken where the material was calcareous. In the podzol profiles where fragipan formation was suspected, several samples were taken below the normal B horizon to ensure as far as possible that the complete zone of soil development was included. Analysis of the three podzol profiles is now in progress.

Physical Analyses for Soil Surveys

C. A. Rowles,
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When the Subcommittee on Chemical and Physical Analyses of the National Soil Survey Committee was separated in 1955 into Chemical and Physical subcommittees, the first action taken by the Physical group was to prepare a questionnaire and distribute it to the Canadian laboratories doing physical analysis work. The questionnaire asked for answers to 14 questions relative to the following three topics:

1. What physical analyses were being made and recommended?
2. What physical methods of analyses were being used and recommended?
3. What physical analyses and methods should be used for soil survey purposes?

The response to the questionnaire was very good and formed the basis for the Subcommittee's report at the Third Conference of the National Soil Survey Committee, Saskatoon, 1955. The first section of this report consisting of 13 pages dealing mainly with recommendations was published in the Conference report. The remaining section of 30 pages dealing with methods of analysis was not included and received limited distribution to the laboratories that had cooperated.

The published section of the report contained recommendations relative to such things as methods of mechanical analysis, expression of mechanical analysis results, soil separates, soil classes and the textural triangle. The report also drew attention to the need for more physical analyses and mentioned, in addition to mechanical analysis, the following determinations as being particularly appropriate from which to make selections for survey work.

1) Bulk density

2) Soil moisture constants such as .1 atmosphere percentage, 1/3 atmosphere percentage, moisture equivalent, field capacity and permanent wilting percentage.

3) Total, macro and micro porosity.

4) Hydraulic conductivity.

5) Atterberg limits.

Since 1955 there has not been a national meeting of the subcommittees. However, at the Western and Eastern Section Meetings, discussions relative to physical analyses were held. In Vancouver, Mr. Earl Bowser, Edmonton, and Dr. Lyle T. Alexander, Beltsville, discussed permeability and hydraulic conductivity and problems of sampling and measurement. At the Eastern Section meetings Dr. Matthews of Guelph was the principal contributor and drew attention to the fact that despite the recommendations made in 1955, little had apparently been accomplished with respect to additional physical analyses on soil survey samples or the testing of the Subcommittee's recommendations with respect to mechanical analysis.

Dr. Matthews stated that the Committee should make a concerted effort to promote:

1) the development of methods for measuring available moisture, field capacity and permeability of soils.

2) the use of these methods to characterize each soil family and eventually each soil type.

Dr. Matthews also suggested that the Committee recommend that bulk density measurements be made on all profiles that are to be analyzed for total chemical or mineralogical content.

In the discussion the meeting seemed to agree that the measurement of soil moisture and aeration directly would be very desirable and that the development of improved methods for measuring available moisture, field capacity, and permeability of soils should be encouraged.

The meeting agreed that "an outline of the methods of physical analysis should be prepared and that an evaluation of the different methods, (where more than one method is available) should be included in the outline". At a joint meeting with the National Soil Fertility Committee it was suggested that a subcommittee from the two national committees should be assigned the job of preparing the outline of methods.

Since it was not possible to convene a meeting of the Subcommittee for the present Western Section Conference, it was decided to prepare a short report on physical analyses and during the Conference call an informal meeting of all those attending who were particularly interested to discuss it.

The report was prepared and has been informally discussed under two headings:

1) the 1955 report and recommendations

2) physical analysis for soil survey purposes

The criticisms, comments and suggestions of all those members who attended the informal meeting are gratefully acknowledged.

The 1955 Report and Recommendations

As has been pointed out previously, very little has been accomplished with regard to Recommendation 1 of the 1955 report which recommended that more emphasis be placed on physical analyses; or Recommendation 4 (part 3) that the reference samples distributed by the National Soil Survey Committee be tested again to check the proposals with respect to methods of mechanical analysis.

These two matters are related, as both require laboratory facilities, staff, and time, all of which are at a premium. No further suggestions are offered with respect to them at this time.

A further matter arising from the 1955 report is that of methods of analyses. Since the Subcommittee's compilation of methods and its comments on them could not be distributed as part of the 1955 report because of their length, this information was not available to all members of the National Soil Survey Committee. However, if as has been suggested, a joint subcommittee on physical analyses is formed with the National Soil Fertility Committee, this unpublished section of the 1955 report, together with the report compiled by Sylvio J. Bourget entitled "Soil Physical Properties, their Definition, Importance and Methods of Determination," should form a good starting point for the joint committee.

Selection of Physical Analyses for Soil Surveys

A definition and understanding of the purpose or purposes for which physical analyses are included as part of the soil survey operation is basic to any discussion of the selection of physical analyses for soil surveys. These objectives may be summarized as follows:

1) To help characterize soils so that they may be placed in a nationwide system of soil classification at the type, series, family, or higher categoric level. In this regard it should be noted that in agronomic and engineering classifications, physical properties and analyses are particularly useful. Therefore, with a growing use of the soil family concept, the importance of physical analyses may be expected to increase.
2) To improve our understanding of soil genesis and the processes that go on in soils.

3) To characterize soils with respect to their behaviour so that the most useful interpretations may be made of soil maps. For example, as the use of supplementary irrigation increases there will be an increasing need to provide information on soil moisture relationships, permeability and infiltration rates for the mapped soils. Similarly, with the growing use of soil survey maps and reports by highway and public works engineers, there is a growing need for more physical analyses relative to mechanical behaviour, consistency, and hydraulic conductivity.

It is obvious that the physical analyses selected by the soil survey should satisfy these objectives. It also follows, that the most desirable physical analysis to select in a particular survey will depend upon whether it is desired to have the analyses meet equally well the three objectives or whether one or perhaps two need to receive special emphasis.

There are, of course, many other factors besides the survey objectives that must be taken into consideration in selecting physical analyses and the following are some of the more important of these.

The experienced soil surveyor has great skill in evaluating and classifying physical properties in the field by means of careful observation and hand tests. In fact, the whole soil survey operation is based upon this fact. At the same time the survey recognizes the necessity of having these field observations correlated and checked by more quantitative laboratory analyses. Selection of the laboratory analyses, therefore, should be made to supplement and strengthen field observations. In many instances the surveyor's field evaluation itself may be sufficient without further laboratory work.

It is also well known that certain physical properties are related and correlated with one or more other physical properties. For example, from mechanical analysis data it is possible to predict with some reliability a good deal about moisture, mechanical and consistency relationships of the soil. Therefore, selection of such an analysis will usually be desirable on the basis of the amount of information it provides. In a similar manner, selection of certain combinations of analyses may be particularly desirable in providing a basis for prediction or calculation of other physical properties. A good example of this would be the collection of samples for the determination of bulk density following the adjustment of the field moisture to the field capacity. In this case the additional estimation of the permanent wilting percentage and real density permit the porosity, air capacity, and available moisture storage capacity to be calculated also.

Another factor that has an important bearing on the selection of analyses is the fact that the results of certain physical analyses are markedly affected by such variables as season, date of sampling, soil moisture content and previous treatment. Aggregation, porosity and hydraulic conductivity are examples of analyses in which this is true. Therefore, although these analyses are very important, special sampling arrangements and precautions must be taken if they are to be used and this will influence their selection.

Closely related to this sampling problem is the fact that for certain physical analyses a great many replicates are required in order to obtain a reliable estimate of the physical property. Hydraulic conductivity estimated using undisturbed soil cores is an example. Selection of such an analysis though necessary for certain soil survey objectives, would not be justified for all.

Finally, in selecting physical analyses, there is always the question of laboratory space, equipment, staff and time to carry out the tests. This is a more important factor in some surveys than others but there is always the tendency to select and complete only the analyses for which these items are easily available.

In view of all these factors it is evident that what the soil survey has usually done is complete and publish as many reliable analyses of the more useful and permanent physical properties as facilities and time permit and hope that they meet, in part at least, the major objectives of the survey.

At the same time it is clear from its published recommendations that the soil survey has recognized the need to complete more physical analyses than it is now doing. With this in mind it is suggested that the survey set as a minimum objective the completion of analyses for at least the physical characteristics included in Table 1 as follows - mechanical composition, bulk density, porosity, and the upper and lower limits of the available moisture range and the interpretation and calculation of other properties from these. Attention is also directed to the analyses included in Table 2 which should be utilized whenever justified and possible.

Tables 1 and 2 were prepared with the objectives and factors listed above in mind and they are recommended on the basis that they will be used in the same manner. Mechanical analysis is listed first because it measures an important, relatively permanent property which may be used to predict several other properties and most laboratories are equipped to perform it. However, mechanical composition may be determined by the field surveyor with considerable precision and full advantage should always be taken of this fact to keep laboratory estimation to a minimum.

Bulk density is placed second in the table because of its importance as a soil characteristic and because it is necessary in order to make many other calculations including the expression of chemical and physical analyses on a volume, depth or pound per acre basis. Bulk density is the only test included among those listed in Table 1 that is normally significantly affected by the variables discussed above such as soil moisture and treatment. However, several of the analyses included in Table 2, i. e., moisture retained at very low tensions, hydraulic conductivity, dispersion ratio, and aggregate analyses are affected by these things and in all these, special precautions must be taken to keep their effects to a minimum.

The effect of previous treatment may be kept to a minimum by sampling from virgin, undisturbed sites. Where such sites are not available, special precautions must be taken when using these tests to characterize or compare soils. The effect of different treatments on mapped soils might be predicted to some degree but if more detailed information is needed it should normally be left for subsequent soil research.

Seasonal effects may be minimized by collecting samples for analysis at the same time each year, i.e., at the beginning, middle, or end of the field season.

Control of the effects of soil moisture presents special problems. In the case of bulk density it is recommended that samples on which it is determined be at field capacity. This will mean that the sampling must be done after a heavy rain or artificial irrigation following which the soil has been covered and the downward flow into unsaturated soil has become small. However, the extra effort involved will be more than compensated for by the fact that the bulk density determination will be made at a standard reproducible moisture content and several important additional properties may be determined at the same time. Thus, the same samples may be used to determine field moisture capacity and if total porosity is calculated also, the air capacity of the soil. Sampling at field capacity for the other analyses included in Table 2 would have similar advantages.

Two methods for estimating bulk density are recommended in Table 1. Of the two, the first mentioned using soil cores is much more convenient and satisfactory. In this method a core is forced into the soil to enclose sample of known volume. The sample so enclosed is either transferred to the laboratory in the core or emptied into another container for shipment in bulk. The second method is recommended because there are soils which are too hard and stony to be sampled with cores. In these soils it is recommended that bulk density be estimated by removing the soil from a hole; the volume of the hole is subsequently measured and the soil removed transferred to the laboratory in bulk. The estimation of bulk density and field capacity by either method requires that provision be made for the determination of the moisture content of the field soil at time of sampling.

Total pore space is included along with bulk density in Table 1 and it is recommended that this be calculated using the real density determined or estimated for the same soil. And further, although it is not mentioned in the table, the air capacity of the soil may then be calculated from the total porosity and moisture at field capacity.

The third group of tests included in Table 1 are recommended to characterize the upper limit of the available soil moisture range. The three tests are all well known as well as are their limitations and it is recommended that the results be expressed on a volume and where desirable, a depth basis.

The final two analyses in Table 1 are recommended because they define the lower limit of the available soil moisture range. Any of the three methods mentioned should be satisfactory and selection may be on the basis of convenience and preference.

Although not mentioned in Table 1, it is evident that with the lower and upper limits of the available soil moisture range defined, the total available moisture storage capacity of the soil should be calculated.

The analyses listed in Table 2 have been separated from those in Table 1, not because they are less important or less useful. However, the information they give is more related to specific or special purposes and therefore they have not been included with the minimum analyses required for general survey work.

The additional soil moisture tension determinations recommended in Table 2 are particularly valuable where a more complete evaluation of soil moisture availability is desired, for example, in controlling irrigation to obtain maximum crop yields. In some cases, measurements at even lower moisture tensions using undisturbed soil samples are also desirable, particularly where porosity and permeability are important.

Hydraulic conductivity measurements are very important in soils where drainage is a factor or problem and they greatly help in the utilization of soil maps under these conditions. The analyses may be made with undisturbed soil cores, disturbed samples, or _in situ_ in the field. The choice of method will depend upon the circumstances and problem, although it should be noted that with undisturbed soil cores the individual core variability is high and many determinations are needed to give a reliable estimate. Also, special precautions are needed in collecting soil cores and preparing disturbed samples.

The dispersion ratio and aggregate analyses tests are recommended for use in special circumstances when a more quantitative measure of structure or aggregation is needed. In both analyses, special precautions must be taken in collecting and preparing natural undisturbed soil samples as season, moisture content, and treatment have a marked effect upon the results. The dispersion ratio is recommended for routine soil survey purposes because it is more convenient and rapid and the results are adequate for most purposes.

The final special analysis recommended in Table 2 is the Atterberg limit test. This test is very important to the soil mechanics engineer and is used in the engineering classification of soils. The main purpose of the test, therefore, would be to increase the value of soil survey maps to the highway and public works engineers.

There are, of course, many other physical analyses that have not been included in these discussions and under some circumstances some of these may take precedence over those included. Preparation and use of thin sections would be an example.

In conclusion, it should be noted that although certain suggestions and recommendations for the selection and use of analyses have been offered, the final choice must rest with the surveyor. This is because the major objectives as well as the circumstances of surveys differ and, therefore, so may the choice of analyses. However, it is hoped that the recommended minimum number of physical analyses will always be reached or surpassed in future surveys.

TABLE 1 RECOMMENDED MINIMUM PHYSICAL ANALYSES FOR SOIL SURVEYS

Analysis	Purpose for which the analysis is most useful	Method	Type
A. Mechanical	Soil classification Soil genesis and processes Utilization of soil maps	See N.S.S.C. Recommendations 1955	Bulk
B. Bulk Density (gm/cc) Total Pore Space(%)	Soil genesis and processes Soil classification Utilization of soil maps	Soil cores or Excavations	Natural soils at or close to field capacity
C. Field Capacity		Amount of water remaining in a well drained soil when the velocity of downward flow into unsaturated soil has become small.	Natural soil
1/3 atmosphere percentage	Classification, utilization of soil maps	Pressure pot	Bulk
Moisture equivalent		Moisture equivalent centrifuge	Bulk
D. 15 atmosphere percentage	Classification, utilization of soil maps	Pressure membrane	Bulk
Permanent wilting percentage		Sunflower or Dessicator	Bulk

TABLE 2 ADDITIONAL ANALYSES RECOMMENDED FOR MORE SPECIFIC PURPOSES

Analysis	Special Purpose
1. Additional soil moisture tension values, i.e., .1, 1 and 3 atmospheres percentages	Classification, use of soil maps, irrigation
2. Hydraulic conductivity ins./hr.	Drainage, irrigation.
3. Dispersion ratio or Aggregate analysis (wet sieving)	Classification, utilization of soil maps.
4. Atterberg limits, (upper particularly)	For engineering classification

Soil Horizon Nomenclature

A. Leahey

Owing to the absence from the country of the Chairman of the Sub-committee on Soil Horizons no formal report will be presented on this topic. However, I did hold an informal evening meeting with Messrs. Pratt, Clayton, Ellis, Peters, Sprout and Hortie to discuss certain aspects of the problem of soil horizon nomenclature and, as the result of our discussions, we wish to present the following resolutions for your consideration:

1. That in technical communications between ourselves, such as the Proceedings of this meeting, the connotative system should be used providing the symbolic letters are used as defined in the 1955 and 1957 reports of the National Soil Survey Committee.

2. That in printed reports the symbolic letter system may be used providing the letters are placed in brackets after the present letter and number designations and also providing the symbolic letters are used as defined in the 1955 and 1957 reports of the National Soil Survey Committee.

3. That the Committee on Soil Horizons be reactivated with enlarged personnel with the object of:-

(a) Completing a review of opinions in each province regarding the merits of the symbolic letter system before the start of the 1959 field season.

(b) To study the desirability of arriving at a symbolic letter system to designate the horizons of each Great Soil Group in a connotative manner.

After a brief discussion these resolutions were carried.

Iuring the discussion the following points were brought out:-

(a) The symbolic letter designations were being used in most of the reports on soil classification and the intent of Resolution 1 was to bring this practice formally to the attention of the Western Section for approval or disapproval.

(b) Some pedologists had requested authorization to use the symbolic letter designations in published soil survey reports. The purpose of Resolution 2 was to obtain the views of the Western Section on this matter. The Western Section by passing this resolution gave only qualified approval to the symbolic letter designations at the present time. The Western Section of the National Soil Survey Committee does not advocate this change in horizon designation but if a pedologist wishes to use the new system he may do so without incurring the disapproval of the Committee providing he follows the restrictions noted in the resolution.

(c) It was pointed out that the entire scheme of symbolic letter designations needed thorough study by the National Committee on Soil Horizons particularly from the viewpoint of preparing careful and accurate definitions. While this duty was not specifically mentioned in Resolution 3, it is one of the urgent matters awaiting the Committee's attention. The intent of Resolution 3 (b) was that this specific point should be kept in mind when definitions were being prepared.

Business Matters

A. Leahey

In order to implement resolution 3a mention in the report on soil horizon nomenclature I appointed myself as acting chairman of the sub-committee on soil horizons and appointed Mr. H. C. Moss and Dr. P. C. Stobbe to be additional members. Hence the personnel of the enlarged sub-committee are: Bowser (Chairman) Baril, Millette, Moss and Stobbe. The survey mentioned in resolution 3a was completed during the winter months and a memorandum on the results of the review was sent to all members under date of May 6, 1959. (The field season probably started a little late this year.)

The Western Sections of the National Soil Survey Committee and the National Soil Fertility Committee gave full support to the suggestion made by the Eastern Sections of the two committees that a joint committee be set up to prepare an outline of the methods of physical analyses and an evaluation of these methods wherever possible. Such a joint committee was established with the following members:

Nominees of the National Soil Survey Committee:

Professor C. A. Rowles, University of British Columbia, Vancouver, B.C.

Professor B. C. Mathews, Ontario Agricultural College, Guelph, Ont.

Nominees of the National Soil Fertility Committee:

Professor W. L. Hutcheon, University of Saskatchewan, Saskatoon, Sask.

Dr. J. J. Doyle, Research Station, Fredericton, N. B.

Chairman (Selected by the chairman of the National Soil Survey Committee and National Soil Fertility Committee)

Dr. H. J. Atkinson, Research Branch, Canada Department of Agriculture, Ottawa.

Soil Families in Manitoba

L. E. Pratt

The first attempt at grouping Manitoba soils into Families was started during the winter of 1956-57. These efforts revealed the need for some field inspection of certain soil units in the older map areas before this first approximation could be completed. This work was done during the summer of 1957 and a preliminary report on Soil Families in Southern Manitoba was prepared for the First Manitoba Soil Science Meeting, held in December of 1957. Copies of this report are available upon request.

The first problem to be faced when considering the establishment of soil families, in an area such as Manitoba where nearly all of the survey work has been done at the association level of classification, is the definition and naming of soil series. After considerable thought and discussion, it was decided that only the dominant series of each association was sufficiently well known to be adequately handled in this first attempt at family grouping. In most associations, the dominant series is the well-drained member. However, some associations are dominantly imperfectly drained and, in others, large areas of poorly drained soils had been separated during reconnaissance mapping. In these cases, the imperfectly and poorly drained series were also grouped into tentative families. Since this first attempt at family grouping has been completed, we have considered expanding the classification to include all the soil associates (or series) that have been recognized in the province. Such a classification would be very tentative, due to the nature of the units we would be handling, but would be valuable in the future when soil series were being established and correlated.

While attempting to group the dominant series of each association into families, we encountered many association units in which the soils of one drainage member had to be divided into two or more families. This was not unexpected. It usually resulted from either too wide a textural range having been allowed in the association or from having soils of more than one sub-group in the same drainage category of an association. Where these variants occurred they were considered as separate units and placed into different families. This experience illustrates one of the important uses of soil family grouping. That is its value as a check on previous field work.

In the preliminary report on soil families presented to the Manitoba Soils Group, the soil units classified into families were named according to the naming system used in the various published Soil Survey Reports. While this presented difficulties, due to some conflicting and overlapping terminology used in different reports, it was considered necessary if the classification was to receive trial use by other agricultural workers. In the future, as these soil units are established as defined series their series names will be entered in the family classification. The tentative soil families that were established were named according to the dominant soil or soils they contained. If all the soils in the family were developed on one type of parent material (for example, lacustrine deposits) then the family was called by the name of the dominant series. If the family contained soils developed on boulder till and soils developed on lacustrine sediments, two series names were used to indicate this range. While this system of naming may not be the best, it was thought that using the two names for families including soils developed on two types of parent material would help to convey the family concept to local users of this information.

The soil families established in this first grouping were used as a basis for compiling a Generalized Soil Map of the surveyed portion of southern Manitoba. This map was drafted at the scale of 1 inch equals 4 miles. The map units comprise association areas in which the dominant associates belong to the same soil family. While this map can not strictly be called a soil family map it has been very useful in instructing interested persons in the concept of soil families. It also has provided the best generalized soil map of the agricultural portion of the province that we have obtained to date.

The criteria used for family separations in Manitoba have not been rigidly defined. We are dealing with associates of associations on which the information is incomplete and varied. The degree of variability of many soil characteristics within associations has varied in different landscape areas of the province and with the stage of mapping experience. Precise measurements of soil permeability or infiltration rate have not been made and, therefore cannot be used as family criteria. The criteria that were used were adopted from the United States system as outlined in the Soil Survey Manual and other publications. In a general way, these are the same as the criteria used for series separations but with broader limits of variability. Specifically these criteria are: texture, drainage, permeability, consistence and, in some cases, chemical composition of the parent material. The mode of deposition of the parent material is not critical and topography and stoniness are used to separate phases within the soil families. These criteria, when applied to soils within the same sub-group, seem to yield useful soil family groups.

The soil textural classes outlined in the United States Soil Survey Manual were used in this work. These are: coarse, moderately coarse, medium, moderately fine, and fine textured soils. Generally, a range of two complete classes or one complete class and one-half of each adjoining class was allowed in a soil family. The drainage classes were the same as those adopted by the National Soil Survey Committee. The drainage variation allowed within a family is usually controlled by the drainage requirements of the sub-group classes. Soil permeability was expressed in relative terms of percolation rates as defined in the United States Survey Manual. These are: none, very slow, slow, medium, rapid and very rapid. A range of two classes was allowed within a soil family, but this criterion was not found to be very useful after texture and overall drainage had been considered. Soil consistence was expressed in the moist and dry states by means of the terms outlined by the National Soil Survey Committee. Consistence did not play an important role in family separations. It might be of importance when considering soils developed on different types of clay. The chemical composition of the parent material was used mainly in respect to lime content.

In our first attempt at this work we used a card system of compiling data on each soil unit. When completed the cards were arranged according to sub-groups and then compared for tentative groupings into soil families. The soil families arrived at in this manner were then reviewed from a soil management viewpoint. Using this system we established about 60 soil families which include 180 soil series. The ratio of soil series to families would increase if all the associates of each association were included in the classification.

While it seems desirable that we develop more specific criteria for soil families, the use of such criteria must await the accumulation of more detailed information on our soil series. In the meantime, we feel that family groupings based on the best information available serve many useful purposes and should be expanded and revised as more information becomes available.

As a footnote to this presentation I would like to mention a matter that has caused me much concern. This has to do with the use of the family category in our classification system for separating so-called "intergrades between intergrades". Reference is frequently made to this when discussing such soils as, for example, imperfectly drained Degrading Blacks. It seems to me that relegation of this type of separation to the family level is purely hypothetical. With the criteria presently used for family grouping of soil series, it would be merely coincidental if this grouping resulted in the desired separation of intergrades. To illustrate this, let us assume we have two soil series developed on the same parent material; one is an imperfectly drained Black and the other an imperfectly drained degrading Black. Firstly it would be necessary to classify the later at the sub-group level. If, on the basis of a consideration of the dominant characteristics, it was placed with the degrading Black sub-group then at the family level it would have to be separated from the imperfectly drained Black series. If it was placed in the imperfectly drained Black sub-group then on the basis of the present family criteria it would most likely fall in the same family as the other series (that is the modal imperfectly drained Black).

It seems to me that unless we change the criteria for family separations and consider families as a sub-division of sub-groups rather than a grouping of series, we cannot honestly relegate the so-called intergrades between intergrades to the family level of our classification system.

Members of the National Soil Survey Committee

attending the meeting.

Dr. R. A. Hedlin - Department of Soils, University of Manitoba, Winnipeg, Man.

Dr. W. A. Ehrlich - Manitoba Soil Survey, University of Manitoba, Winnipeg, Man.

Dr. W. L. Hutcheon - Department of Soils, University of Saskatchewan, Saskatoon, Sask.

Mr. H. C. Moss - Saskatchewan Soil Survey, University of Saskatchewan, Saskatoon, Sask.

Dr. J. D. Newton - Department of Soils, University of Alberta, Edmonton, Alta.

Mr. W. Odynsky - Alberta Soil Survey, University of Alberta, Edmonton, Alta.

Mr. T. W. Peters* - Alberta Soil Survey, University of Alberta, Edmonton, Alta.

Dr. C. Rowles - Department of Soils, University of British Columbia, Vancouver, B.C.

Mr. L. Farstad - British Columbia Soil Survey, University of British Columbia, Vancouver, B. C.

Mr. C. C. Kelley - British Columbia Soil Survey, Kelowna, B. C.

Dr. P. O. Ripley - Experimental Farms Service, Ottawa, Ont.

Dr. P. C. Stobbe - Experimental Farms Service, Ottawa, Ont.

Dr. A. Leahey - Experimental Farms Service, Ottawa, Ont.

* vice W. E. Bowser.

Others attending all or part of the meeting

Mr. J. A. Barr : Department of Lands and Forests - Winnipeg, Man.

Mr. L. E. Pratt : Manitoba Soil Survey, University of Manitoba, Winnipeg, Man.

Dr. L. A. Zwarich : Department of Soils, University of Manitoba, Winnipeg, Man.

Mr. J. S. Clayton : Saskatchewan Soil Survey, University of Saskatchewan, Saskatoon, Sask.

Mr. J. G. Ellis : Saskatchewan Soil Survey, University of Saskatchewan, Saskatoon, Sask.

Mr. W. E. Johnson : Department of Agriculture, Regina, Sask.

Mr. H. J. Hortie : British Columbia Soil Survey, University of British Columbia, Vancouver, B. C.

Mr. N. Sprout : British Columbia Soil Survey, Kelowna, B. C.

Mr. R. A. Milne : Canada Department of Agriculture, Vauxhall, Alta.

Mr. J. van Schaik : " " " " " "

Dr. R. Cairns : " " " " , Vegreville, "

Dr. C. F. Bentley : Department of Soils, University of Alberta, Edmonton, Alta.

Mr. J. A. Robertson : " " " " " " " "

Mr. J. A. Carson : Alberta Soil Survey, University of Alberta, Edmonton, Alta.

Mr. P. K. Heringa : " " " " " " " "

Mr. A. A. Kjearsgaard : " " " " " " " "

Mr. J. D. Lindsay : " " " " " " " "

Mr. J. A. McKeague : " " " " " " " "

Dr. S. Pawluk. " " " " " " " "

Mr. S. W. Reeder : " " " " " " " "

Mr. M. Scheeler : " " " " " " " "

Dr. K. F. Nielsen : Experimental Farms Service, Ottawa, Ont.