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ADDRESS BY MR. H. T. GUSSOW,
DOMINION BOTANIST, ON WHEAT
RUST.

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PARLIAMENTARY SESSION 1924

SELECT STANDING COMMITTEE

ON

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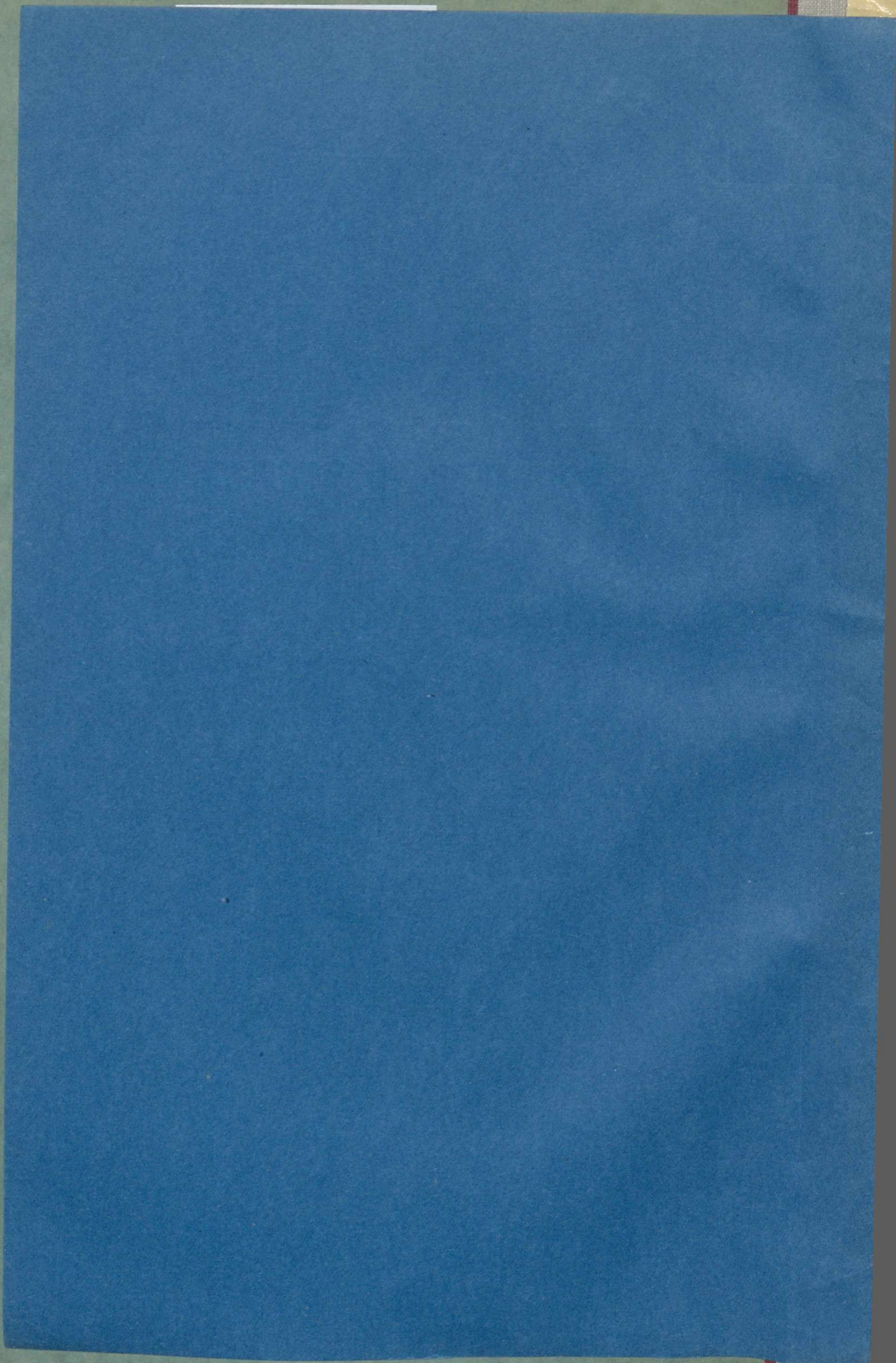
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Mr. H. T. GÜSSOW, Dominion Botanist

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HOUSE OF COMMONS,

COMMITTEE ROOM 424,

WEDNESDAY, June 18, 1924.

The Select Standing Committee on Agriculture and Colonization met at 11 o'clock a.m., Mr. W. F. Kay, the Chairman, presiding.

Mr. H. T. Güssow, Dominion Botanist, called and examined.

WITNESS: Mr. Chairman, Mr. Motherwell, and gentlemen, it affords me great pleasure in addressing you to-day on the wheat rust question. This is one of the most important questions to Canada, and in order to deal with the problem satisfactorily I have put on paper certain observations, which I might be allowed to read to you. (Reads):

"Wheat Rust, by which, as far as we are concerned, is meant Black Stem Rust, is and has been for the past century, the most important world problem in plant pathology, as well as in agriculture. Its economic importance within the Dominion of Canada is best illustrated by the following comparisons. In 1904, wheat rust reduced the wealth of Western Canada by not less than twenty million dollars. In 1916 the losses due to rust were in excess of \$150,000,000. In 1923, which gave us the highest wheat crop in the history of Canada, nevertheless an amount of \$50,000,000 was lost in the Red River Valley, Southern Manitoba, alone.

It may not be known that this is the eighth consecutive year for the farmers of that district to suffer such severe loss; when this is apparent it will be admitted that the solution of the grain rust problem is one of the most desperate needs of Western agriculture to-day.

The seriousness of the problem will be realized even better from the statement that in some years the losses from wheat rust amounted to treble the amount which Canada derives from its fisheries. In 1916, one of the worst years of rust epidemics, the losses were equal to the entire mineral production of Canada, viz. \$183,000,000 in 1922.

The rust problem is, without a doubt, one of the most difficult problems to solve. It has been known from biblical times and a large library may be filled with treatises on rust, but only during the past few years our knowledge has made considerable advance, promising results which command attention.

Grain Rust is of evergrowing importance in Canada, but it is by no means only of national, but decidedly of international importance. There is no doubt that the depreciation of the wheat crop of America in 1916 was one of the chief causes of the world shortage of food. With the elimination of this scourge from the grain crops of the world, the solution of a great many economic problems confronting the world to-day—and indeed the world's general unrest—will be largely effected. Shortage of food, the steady increase in the cost of the world's most essential and fundamental food supply will be greatly reduced by the solution of the problem. Canada is looked upon as the granary of the Empire. It is indeed the granary of the world, and while the effects of an abundant harvest may not be immediate, yet political economists assure us that they are decidedly cumulative.

In referring to these aspects of wheat rust, I do so intentionally to impress upon you that we are confronted by a problem to the solution of which the most liberal and generous support should be given.

Scientific research, a term which is nowadays frequently used and more frequently abused, is the only satisfactory and fundamental basis for progress in agriculture. It is immaterial to which phase of agriculture research is

applied; unless a systematic, painstaking effort is made to solve a problem from its initial stages upwards, we do not need to expect results. Research work in rust necessitates generous expenditure both in the provision of physical equipment as well as in able and well trained scientific man power. The problem is most urgent, and will not yield to half-hearted efforts. It might just as well be left alone, for if the efforts are half-hearted, results cannot be accomplished. Feeble efforts are worse than useless, for no results will be forthcoming, and that gives rise to criticisms that may be well founded but not deserved by the small band of earnest research workers who find themselves subjected to restrictions, rules and regulations, under which spontaneous research is successfully suppressed.

The solution of the rust problem is obviously of vital importance to Canada and the world as a whole. In addressing you to-day I am taking the liberty of speaking quite frankly, and I would sincerely solicit your support, assisting us from time to time in the provision of the absolutely necessary means, without which we cannot hope to accomplish much. I am well aware of the present days' financial stress and the loud clamour for decreased expenditure. Nevertheless, I am equally aware of the promise that can be truly held out of valuable results that are bound to follow really earnest and continued effort.

From experience I find that every year a new battle must be fought in justification of expenditures for scientific research. Once such important work is begun it should be pursued to the end. Objection is often raised to increased expenditures devoted to research, but the very fact that progress is being made every year and results are obtained which require to be followed up, explains the necessity of asking for further support.

We find ourselves to-day in possession of valuable data relating to rust-immunity of certain varieties of wheat. These must be tested one by one, almost grain by grain, not only by the plant pathologist, but also by the cerealist, for resistance to rust alone means little if not accompanied by heavy yields and other essential qualities. At the present time we are not doing justice to the investigation of the wheat rust problem. The first requisite is a personnel of proved ability, wide and successful experience—men of this type are in demand everywhere and they preferably associate themselves with institutions that comprehend and support scientific research fully and liberally. The salaries which the Civil Service of Canada has so far offered for such services are not attractive enough to men of experience, and in consequence our work suffers in quality. Were it not for the personal interest our men are taking, even though they are woefully underpaid, no advance would be possible.

Under the present organization of plant pathological research it may be mentioned that as far the Dominion service is concerned, cereal rust investigation work constitutes only a part of the general cereal disease work of the Division of Botany under the Experimental Farms. Cereal disease work is inclusive of all grain diseases, rust investigations receiving the largest share of attention, smut investigations coming secondly, and root diseases and other economically less important troubles making up the rest. No single phase of this work should be left unattended to, lest diseases of apparently minor importance at present, might gain a foothold and assume proportions beyond easy control. An example of this type of disease is afforded by the recent discovery of a disease known as "White heads" or "Take-all." The "Take-all", a root rot of wheat, attacks also barley, rye, and many of the common wild grasses. Oats are not susceptible. The disease has been troublesome in Australia, New Zealand, and Europe, for some years. In 1920 it was first reported in North America from New York State (though it was doubtless present for some time previously). Since then it has been found in Oregon, Arkansas, and Indiana, in all cases in winter wheat.

By Mr. Knox:

Q. Is it prevalent throughout the country here?—A. No, we have so far only found one authentic case in Saskatchewan.

Honourable Mr. MOTHERWELL: I think there is some suspicion of it around Humboldt.

The WITNESS: This specimen came from the neighbourhood of Indian Head, but I believe it to be also present near Scott.

By Mr. Lucas:

Q. Has it done much damage in Australia?—A. I understand that it has done serious damage in Australia. It is there, under certain conditions, a disease of similar importance to grain rust in Canada. It sometimes "takes" all the wheat in a locality. It is apparently a disease which depends upon certain unfavourable climatic and soil conditions. I do not believe it will become very serious in Canada. We cannot say so at the present time, but we must not allow any disease affecting wheat to remain unstudied, else it may go beyond our control. We may be able to do something towards its extermination at the present time, before there is much of it. I just wanted to point out, however, that grain rust alone is only a part of the general disease investigations carried on in the West.

By Mr. Knox:

Q. Have we any other disease that would resemble it in Canada?—A. Yes, we have the so-called "Fusarium root-rot" in Western Canada, which generally occurs on land on which wheat should not be grown. It is often the case that a certain piece of land is entirely unsuitable for the cultivation of wheat.

By Mr. Sales:

Q. What renders it unsuitable?—A. Cold, water-logged soils; low situations.

Q. That is the only thing?—A. That is the principal condition under which root rots will develop.

Specimens of diseased wheat were sent by a farmer to our Indian Head laboratory. The resident pathologist recognized that the wheat was attacked by something different from the usual root-rot. More specimens were secured, and a recent study of these in the laboratory showed evidence of the fungus which causes the Take-all disease of wheat. This disease is regarded in Australia as one of the most serious diseases occurring there. In Europe it is also regarded as a destructive disease. Its occurrence in the United States was viewed at first with alarm, but authors of a recent paper from Arkansas claimed that the disease is not really serious and that it is confined largely to plants weakened from other causes, such as lack of nutrients, water-logged soils, etc. It is impossible with our present knowledge to say how serious the disease is likely to become in Canada or the United States, but judging from the one field examined we do not think it should be lightly regarded. The diseased plants occurred in roughly circular patches, several feet in diameter. In these areas the wheat was stunted, and much shorter than the healthy wheat. The grain was very thin in these areas, as many plants had been killed in the early stage. The heads did not fill, or only shrivelled kernels were present. The ears of the diseased plants were bleached white, and were quite conspicuous as compared with the golden yellow of the sound ears at maturity.

To return to cereal rust investigations: These have to be considered (1) according to the relative importance of the host plant, viz., wheat, oats, barley, corn, rye, and fodder grasses, and (2) according to the relative importance of the various kinds of rust prevalent among the grain crops in Canada, viz., black stem rust—economically the most destructive, and affecting all our grains; crown rust of oats—also economically most important; leaf rust of barley and rye, as well as other more sporadic rusts.

Grain rust investigational work is construed to include, in the first place, all technical phases, and secondly, the vast amount of experimental work arising out of such technical investigations.

This technical work, as it concerns the entire Experimental Farms system, is carried on by a specific section, viz. plant pathology, of the Dominion Experimental Farms, while the experimental and field work is conducted in co-operation with a number of the Branch Experimental Farms, viz., in Saskatchewan at Rosthern, Scott, and Indian Head; in Alberta at Lacombe, and in Manitoba at Morden and Brandon.

In addition to these localities the work is further carried on in co-operation with the University of Saskatchewan, Saskatoon; the Manitoba Agricultural College, Winnipeg, and the School of Agriculture, Vermilion, Alberta.

It would be erroneous to conclude from the above review, that our work is quite as intensive as it may appear extensive. Our present facilities do not enable us to attend to one-half of the work in the manner in which it requires attention. The following table shows the value of the principal grain crops of Canada, together with a most conservative estimate of the annual losses due to the principal grain diseases, and will give an idea of the importance of the whole problem, as well as of the extreme inadequacy of facilities at our disposal to contribute materially to the solution of these important problems:—

COMPARISON OF VALUE OF PRINCIPAL GRAIN CROPS OF CANADA, WITH ESTIMATED ANNUAL LOSSES.

Value of grain crops	Losses	Value
Wheat.....\$340,000,000	15%	\$ 51,000,000
Oats.....198,000,000	10%	19,800,000
Barley.....34,000,000	8%	2,700,000
Rye.....21,000,000	6%	1,200,000
Total.....\$593,000,000	Annual Total	\$ 94,700,000

The grain disease research work, including the time and energy spent on rust research especially, is in charge of an officer of the rank of plant pathologist at a salary range of \$2,400 to \$2,760, who is located at Saskatoon, where he is provided by the University of Saskatchewan with laboratory and greenhouse space. The officer in charge is assisted by one permanent assistant plant pathologist, and one stenographer in charge of correspondence and records, and during the summer by one or two temporary field men, especially engaged in barberry survey.

COST DURING 1923 OF MAINTENANCE OF LABORATORY AT SASKATOON

Salaries, permanent and temporary staff.....	\$ 5,580 00
Travelling expenses.....	2,850 00
Maintenance.....	1,940 00
Total.....	\$ 10,670 00

The Saskatoon laboratory directs almost the entire activities of Western grain disease investigations. It carries on a survey for the extermination of the barberry. As you know, scientific research has established, beyond a doubt, that the barberry carries and spreads the most destructive of all our rusts, viz., black stem rust. It becomes infected with the rust in spring, and from every barberry bush near a grain field the disease spreads. It gives rise to the summer or red stage on grain, which once established, spreads from plant to plant, field to field, locality to locality; this is followed in the fall by the black

stage, in which condition the rust lives over winter. Without the barberry the rust is practically unimportant. In Denmark, barberry eradication was years ago made compulsory by law. Previous to the wholesale eradication practiced, black stem rust was a disease of great economic importance, but since the eradication of the barberry there has not occurred any outbreak of stem rust of any importance.

By Mr. Pritchard:

Q. Have they been trying to prevent the rust on the barberry bushes?—
A. It is impracticable to do it.

Q. In your experiments you were not able to defeat it?—A. No. Spraying nor any other treatment has the slightest effect on the control of rust on the barberry bushes or on wheat.

By Mr. Sales:

Q. When does it leave the wheat plant to get to the barberry?—A. In the fall the "black stage" of the stem rust develops. In this form the rust hibernates on the stubble, or on wheat stem generally. Early in the spring the spores adhering to the stem of the wheat germinate and return to the barberry. At the present time you will find the barberry everywhere covered with orange-red spots; these orange-red spots contain and discharge millions of spores which infect a number of grasses, including wheat. It has been claimed by one of the investigators in Minnesota that the infection on wheat was traced directly for more than ten miles to a single barberry hedge. How much farther the wind may carry the rust spores from this area no one can tell, but it has been determined that from a single infected barberry the rust has spread for some five miles and more.

By Mr. Lovie:

Q. What other plant acts as a host?—A. Only the barberry. As a matter of fact, black stem rust has only one alternate host and that is the barberry; from the barberry however, it may go to a large number of wild and cultivated grasses. One of the typical offenders in that respect is wild barley, one of the commonest weeds throughout the West.

By Mr. Sales:

Q. If you destroy the barberry, does that destroy the link that is necessary for stem rust to reproduce itself?—A. Yes. I will come to that point right away. It has been so claimed by the pathologists of Denmark. Afterwards, Dr. Stakman of Minnesota was instructed by the United States Department of Agriculture to visit all European countries and to investigate the barberry situation in Europe. On his return he reports that Denmark is practically free from black stem rust of wheat. Other countries still have their share according to the amount of barberry that is left.

By Mr. Sales:

Q. They have adopted compulsory methods there?—A. They have, and have finally succeeded in eradicating the entire barberries throughout their country.

The United States are now eradicating their barberries, especially in the Western States. In Canada we do our share and look forward with great interest to the accomplishment of so vast an undertaking in the States, from which we all hope to reap great benefit. We hope to complete our barberry eradication in Saskatchewan this year. We hope the same for Manitoba, although it is most difficult to deal with cities like Winnipeg.

The barberry is of European origin and was brought to the Continent of America many years ago. The sooner we are able to rid the Continent of

America of this undesirable shrub, the sooner we will attain success in the control of grain rust. Unless conditions materially differ on the Continent of America from the Continent of Europe, it is safe to state that with the disappearance of the barberry, at any rate within the grain-producing States and Provinces, wheat rust will have lost its sting.

I am now quoting a few paragraphs from Dr. Stakman's report on the relation of barberry to black rust:—

"In 1865, De Bary, a German scientist, finally cleared up the matter of the relation between the barberry and grain rust. He made careful experiments and found that the life history of the rust parasite is as follows: The black stage of the rust lives through the winter. It cannot infect grains or grasses. The spores (seeds), however, do infect the common barberry, on which they produce the cluster-cup stage of the rust. These cluster-cup spores are then blown by the wind and infect grains and grasses, on which they produce the red or summer stage of the rust. This stage continues to propagate and spread until fall, when the black stage again is produced."

"Hundreds of scientists have shown that De Bary was right. No one any longer would dispute the fact."

"The barberry stands convicted. Farmers proved that the common barberry spreads rust. Scientists showed why and how. Both have shown that rust epidemics disappeared when the bushes were destroyed."

LESSONS FROM EUROPEAN EXPERIENCE

It is clear from the experience of Europe that the only way in which to eradicate barberries effectively from large areas is by a virgorous campaign. Even though farmers were almost universally convinced of the necessity for eradicating barberries as long as 200 years ago, it was impossible for them to get rid of all the bushes. There always were some persons too ignorant or too lazy to do the work.

Many local attempts were made to eradicate barberries. The evidence is that whenever the bushes were moved, the rust either disappeared entirely or the severity decreased. In many regions there were so many bushes that local eradication was not sufficient to protect the crops, because the rust blew in from some unprogressive neighbour's bushes. It is a striking fact also that when the bushes sprouted again, on account of having been imperfectly dug, the rust reappeared in those regions from which it had disappeared after the barberries had been dug.

Conditions in Europe are not essentially different from those in this country. There are tremendous numbers of bushes in the upper half of the United States. These bushes rust heavily in the spring. The rust spreads to grains and grasses, and terrific damage often results.

The question often is asked how far rust can spread from a barberry bush. There sometimes is an idea that it cannot spread far. But it can.

During the past year, spread of rust to grasses and grains in Minnesota was traced directly more than ten miles from a single barberry hedge.

A single barberry bush can cause extensive losses. During the past summer, Prof. H. S. Jackson, of Purdue University, made the following observation:—

"One thing that has generally interested us this summer, and on which Mr. Beeson, our State leader, made a special study, was on outbreak of stem rust which started from one barberry bush. It travelled in one direction, at least, for about five miles. The area was pretty carefully surveyed and I have a report here containing figures given by the farmers themselves on eighteen out of perhaps a total of twice that

many farms. The total wheat area was 963 acres. The average yield, due to stem rust, was 8.1 bushels. The average estimate of yield, had there been no black stem rust, was 21.4 bushels. The average crop this year was then 37 per cent of what it would have been without the black stem rust. The total loss in yield was 12,520 bushels, or an average loss of 696 bushels. At a dollar a bushel, each farmer lost \$696 worth of wheat."

The combined money loss was \$12,520. I might say in this connection a thing which I have been willing to say before. We feel that we have in the evidence in Indiana, proof that where we take out the barberry we have no more trouble with stem rust. That has been proved for the years that the campaign has been continued. *We have any number of cases where there was formerly serious stem rust traceable to the barberries which have now been removed, with the result that no signs of rust appeared this year.* (Italics are mine).

In addition, this laboratory devotes most of its time to technical investigations of black stem rust, principally from the standpoint of immunity and resistance of varieties of grain placed at their disposal by authorities of many countries, and including several quite promising new crosses or selections from American institutions.

TEST OF RUST RESISTANT VARIETIES

A number of new varieties of wheat produced at the Minnesota Agricultural College, were tested for rust resistance. These varieties were generously furnished by Professor Hayes. As will be seen from the table, they included seven Marquis x Kanred crosses, five crosses of Marquis and Iumillo, and a neutral cross and two selections of Kota. These were seeded in single rows 16 feet long, at the Dominion Experimental Farms at Brandon and Morden in Manitoba, and at Indian Head and Rosthern in Saskatchewan, through the co-operation of the Superintendents, also at Winnipeg and Saskatoon, through the co-operation of the Agricultural Colleges. The Dominion laboratory at Winnipeg co-operated in this experiment by seeding and harvesting the rows at Winnipeg. The seeding was done late so as to expose the rows to as severe rust conditions as possible. Two rows of Marquis were seeded for comparison. Rust was very severe at all the Stations in Manitoba, and moderately severe at Indian Head, Saskatoon and Rosthern. All the rows were examined when ready for harvesting, by the pathologists in charge at Saskatoon, Morden, Winnipeg, and Brandon.

An estimate of the percentage of rust present was made and the results are given in Table No. 1.

I may here point out that it is well known that if you sow your wheat late you run a severe risk from rust. If wheat is sown early it will, under normal conditions, mature early and in consequence may escape rust infection altogether. For our purpose we sow the wheat late, so as to enable us to determine accurately the relative resistance of various varieties to rust.

RESULTS OF THE EXPERIMENTS AT THE VARIOUS EXPERIMENTAL STATIONS AND UNIVERSITIES

Experimental Stations	Date sown, 1923	Date examined, 1923	Estimated percentage of rust on varieties of wheat																
			Marquis, M. A. 1239	Marquis x Kanred 11-18-8	Marquis x Kanred 11-18-10	Marquis x Kanred 11-19-7	Marquis x Kanred 11-15-57	Marquis x Kanred 11-15-58	Marquis x Kanred 12-5	Marquis x Kanred 13-11	Kota Natural Cross 11-19-4	Kota 255M	Kota 30f	Marquis x Iumillo 11-15-43	Marquis x Iumillo 11-15-44	Marquis x Iumillo 11-15-51	Marquis x Iumillo 11-15-55	Marquis x Iumillo 11-15-59	Marquis, Ottawa 15
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Morden.....	May 10..	Aug. 1..	55	55	55	50	45	70	60	75	30	20	15	10	15	20	20	15	60
Winnipeg.....	May 17..	Aug. 2..	60	60	65	55	70	70	70	70	40	25	15	5	5	20	20	10	75
Brandon.....	May 22..	Aug. 20..	75	75	75	45	70	80	75	75	75	45	45	8	10	10	45	20	75
Indian Head.....	May 15..	Aug. 24..	65	65	70	45	50	70	50	65	15	10	10	7	10	25	30	20	60
Saskatoon.....	May 20..	Sept. 5..	75	50	40	20	25	50	35	40	20	20	25	15	10	15	25	15	65
Rosthern.....	May 19..	Sept. 4..	30	10	25	10	15	30	15	20	10	5	5	5	5	5	15	20	45

I am not going to read Table No. 1, but I wish to point out the remarkable resistance which is inherent in some of these new crosses. For instance, ordinary Marquis wheat rusted at Morden 55-60 per cent, at Winnipeg 60-70 per cent. A cross between Marquis and Iumillo, which latter is a Durum wheat, rusted only 10 per cent at Morden and 5 per cent at Winnipeg. This very cross, Marquis x Iumillo (11-15-43) showed 10 per cent, 5 per cent, 8 per cent, 7 per cent, 15 per cent, and 5 per cent infection, whereas the Marquis showed 60 per cent, 75 per cent, 75 per cent, 60 per cent, 65 per cent, and 45 per cent infection, under identical conditions, side by side.

By Mr. Lovie:

Q. Was it an early wheat, the cross?—A. It is of about the same maturity as Marquis, but it was purposely sown late. Had this wheat been sown early there might have been no infection at all. This variety promises to be absolutely resistant under certain conditions.

It will further be seen from this table that all the Marquis x Iumillo hybrids were markedly resistant in all trial plots. Had they been seeded early they would probably have been practically free from rust. The straw was strong and the heads in appearance resembled Marquis. The Marquis x Kanred crosses proved susceptible.

The yield in grams per row of each of these varieties at each Station, is given in Table No. 2:

YIELD IN GRAMS PER ROW OF 16 FT

	Wov No	Morden	Winnipeg	Brandon	Saskatoon	Rosthern	Indian Head	Average
Marquis, M. A. 13239.....	1	239.8	312.3	125.0	549.4	276.5	190.4	282.23
Marquis x Kanred, 11-18-8.....	2	291.0	240.2	139.0	798.3	518.8	191.0	363.05
Marquis x Kanred, 11-18-10.....	3	260.2	195.3	198.2	651.3	391.8	273.4	328.36
Marquis x Kanred, 11-19-7.....	4	316.4	214.0	153.7	598.2	396.8	202.2	313.55
Marquis x Kanred, 11-15-57.....	5	302.3	141.5	178.2	601.0	313.8	174.7	285.25
Marquis x Kanred, 11-15-58.....	6	213.9	101.8	228.5	612.2	348.8	281.7	297.81
Marquis x Kanred, B2-5.....	7	280.5	175.0	184.0	665.8	435.8	145.5	314.43
Marquis x Kanred, B8-11.....	8	279.0	179.3	142.0	678.7	453.6	450.8	363.90
Kota Natural Cross, 11-19-4.....	9	278.2	153.3	221.3	465.2	359.8	238.3	286.01
Kota, 255-M.....	10	345.2	207.0	233.2	694.2	308.8	197.5	330.98
Kota, 30f.....	11	332.0	216.8	265.5	717.3	353.3	190.9	345.96
Marquis x Iumillo, 11-15-43.....	12	350.7	242.0	203.5	711.2	339.3	165.5	335.36
Matquis x Iumillo, 11-15-44.....	13	324.0	225.5	207.0	740.2	370.8	375.9	373.90
Marquis x Iumillo, 11-15-51.....	14	299.7	262.0	266.7	729.2	439.8	203.2	366.77
Marquis x Iumillo, 11-15-55.....	15	298.3	232.0	294.0	636.2	414.2	264.5	339.86
Marquis x Iumillo, 11-15-59.....	16	284.7	207.0	266.0	625.2	370.5	192.9	324.38
Marquis, Ottawa 15.....	17	198.0	88.5	617.0	360.5	301.8	311.57

The yields there represent, as far as single rows are significant, the yields under dry soil conditions and very severe rust prevalence.

It will be seen from the tables that practically all the rows out-yielded our ordinary Marquis, and though yields from single rows are not of much value, there are at least indications that the varieties tested are satisfactory from the standpoint of yield. Should the Marquis x Iumillo hybrids prove to have the bread-making qualities of Marquis, they should be very valuable wheats in districts where rust is prevalent. It seems very desirable that further tests be made with these varieties.

The average yield of the Marquis samples was 296 grams, about 30 grams to the ounce. The crosses, Marquis and Iumillo, gave an average of 348 grams. The highest average yield was obtained by these crosses, and not in a single case has there been obtained a lower yield than from the ordinary Marquis wheat. As far as yield is concerned we have a decided promise, in addition to remarkable resistance to rust.

By Mr. Gould:

Q. That causes me to wonder how you arrive at your computation of the loss that has been sustained in Canada, of \$94,000,000 annually. Is this the method of your computation, a comparison between Marquis wheat and Marquis and Iumillo?—A. The computation of losses is generally given by the returns of the yield per acre in districts affected by rust, as compared with the yield per acre in districts where rust is absent. At first we found it difficult to get reliable figures, but in the Red River Valley almost every year we are able to make most reliable determinations of losses due to rust. The same applies to smut. In this case it is far more simple to actually determine the loss.

By Mr. Lucas:

Q. Do climatic conditions play an important part in the development of rust?—A. Undoubtedly. Generally speaking, any condition that retards maturity in grain is responsible for severe injury due to rust if such is prevalent, that is to say, weather or any other conditions that will enable the plant to continue strong luxuriant growth until late in the season, are bound to expose such wheat to very serious loss from rust infection.

By Honourable Mr. Motherwell:

Q. In 1916 in many parts of Saskatchewan the outbreak of rust was preceded by dry weather, and the crops appeared to be in a dangerous condition from lack of moisture. Will that affect the resistance of the plant?—A. The condition which you describe should have favoured escape from rust.

Q. By hastening maturity?—A. Yes.

Q. But it had not reached that stage?—A. Was not the dry period followed by rain? Had the drought persisted, the grain would have matured without serious loss from rust, though the yield might have been light. The wet period, however, gave the wheat another lease of life, it started again to make vigorous growth, which delayed maturity and exposed it thus to the severe attack from rust.

Q. In Mr. McConica's district it was a race between rust and the wheat, but around Qu'Appelle and in the southern part too, the rust got far advanced, but I have noticed two or three times that when you have a very severe drought, say, the wheat is about shooting out, it seems to weaken it down and increase the disposition to be affected by rust.

Mr. SALES: That has not been my experience. The close weather, the humid weather, when you can scarcely breathe, that is the time it is on.

Hon. Mr. MOTHERWELL: Murky, no sunshine, and clouding.

Mr. SALES: Your theory is that it weakens.

Hon. Mr. MOTHERWELL: It lowers the resistance.

WITNESS: As a matter of fact, any period of drought checks the development of the grain for as long as it lasts. Growth is simply at a standstill. It does not make any further progress for a time. If the weather changes, becomes moist and murky, the wheat will rapidly resume its growth, and so does the rust fungus, with the result that infection becomes severe. Once the grain has passed the milky stage, losses from rust attacks are rarely serious. If we could have a good wheat maturing several weeks earlier than at the present time, we would not need to bother about rust at all, under our usual conditions.

By Mr. Forrester:

Q. Is not the condition of the plant itself one of the causes that will catch rust?—A. The immunity investigations to which I referred just now, would indicate that there is pronounced resistance in individual wheat varieties. It is, if I may say so, the constitution of certain varieties that enables them to escape from rust. It is an inherent physiological resistance.

By Mr. Pritchard:

Q. How is it that the wheat was dead with rust around Winnipeg, when out at Indian Head it was not touched?

Hon. Mr. MOTHERWELL: I have the idea that the epidemic comes to us from the south, coming from the Gulf, right down to Oklahoma, Kansas, the Dakotas, and Minnesota, striking Manitoba first. I believe I never knew Minnesota and Dakota to get the epidemic but what Manitoba got more or less of it. Going west you get less and less, but last year it went even into eastern Alberta and as the season advanced I expected it to reach the Rocky Mountains.

By Mr. Knox:

Q. I would like to ask the witness as to the theory that Mr. Motherwell has just been propounding. I have heard it stated, something along the same line, that the rust outbreak starts down at the Gulf of Mexico and travels north, and that the spores of the rust can be found as high as two miles in the air. If that is so, would the eradication of the barberry effect anything in the northern portion of the continent?—A. That is an extremely difficult question to reply to. It has been believed for a number of years that the rust epidemics come to us from the south. In some years indications are in favour of such theory; in others there cannot be any doubt but that rust started in Canada. It is certainly a logical argument. It is a good working hypothesis, but so far I am not able to state that it is practically correct. If we were to abide by and accept such an hypothesis without careful enquiry, we might be doing very serious harm to the solution of the problem. At present we are endeavouring to finally settle this interesting point, co-operatively with the United States authorities. We have observed original outbreaks of stem rust in Manitoba as early as the 20th of June, and from that date the summer stage spreads rapidly from plant to plant and from locality to locality, according to prevailing favourable conditions. The appearance of rust in the Dakotas and Minnesota is not very much earlier than in Canada. As far as the Gulf States are concerned, spring wheat is not grown as far south as that. I do not think spring wheat is grown to any extent further south than latitude 43, i.e., Wyoming, Nebraska, Iowa, and winter wheat which is grown further south is not materially affected by stem rust, judging from our experiences in Ontario.

By Hon. Mr. Motherwell:

Q. Texas?—A. Anyway, apart from that we are following along definite lines with regard to increasing the resistance of our own wheats. The only solution, apart from the question of barberry eradication, is early maturity and rust resistance. The other phases are of interest epidemiologically. In regard to the question whether the eradication of the barberry in the south would affect our conditions, I would refer you to the experiences at Indiana just mentioned, i.e., where they had taken out the barberry no more trouble developed from stem rust. I am decidedly of the opinion that we would materially benefit from the work now done in the States on barberry eradication.

By Mr. Gould:

Q. Would you expect serious difficulty if this should become an international question, the destruction of the barberry bush?—A. No, not at all. The United States have made the destruction of the barberry subject to a law, and we have done the same in Western Canada, so the effort is truly co-operative. The United States spent last year \$250,000—one-quarter of a million—towards eradication of the barberry.

By Hon. Mr. Motherwell:

Q. France has taken some steps in that direction?—A. Two hundred and fifty thousand dollars were spent in the United States for the eradication of the barberry. We are spending \$25,000 on the entire grain disease investigations, including rust.

By the Chairman:

Q. Do they compensate the owners of barberry?—A. No. It is quite impracticable to compensate them. We tried compensation some years ago in regard to current and gooseberry bushes, which harbour the white pine blister rust. We spent \$6,000 in compensation in one year. It is quite out of the question to compensate, and beyond all reason. A few years ago the owner of 12 black

currant bushes claimed \$200 for compensation for something of about \$4.00 value. People who are truly interested in the welfare of their country will eradicate their barberries voluntarily, others will do so under pressure.

To continue, in addition, many other varieties that have been tested for resistance for several years, were seeded in rows at the same stations as the new varieties. The results were the same as in previous years. The Durums, Iumillo, Acme, Monad, and Pentad showed marked resistance to grain rust. Kota was the only one of the bread wheats that showed promising resistance. While a considerable amount of rust develops on it, especially if it is allowed to remain uncut after maturity, yet the attack is always so late that practically no injury is done to the grain.

Iumillo has proved practically immune to stem rust under greenhouse and field tests for a number of years. This lends support to the view that the crosses of Marquis and Iumillo—already referred to—will continue to prove resistant.

A considerable time is spent on the determination of the races of black stem rust (biological strains) present in Canada. The discovery of such strains is the most important addition to our knowledge made during the past ten years; briefly stated, it has been found that some varieties of wheat are susceptible to almost every strain of rust so far known, while others are decidedly resistant, and others again positively immune towards certain strains. Obviously, a wheat only susceptible to a few strains will prove a valuable asset in many districts. Moreover, if such a variety of wheat were grown in a locality where the strains to which it is susceptible do not exist, we would have a wheat worth while growing, with comparative safety and assurance of crop. Along with the actual determination of strains, there are carried on investigations relating to the geographical distribution of the same. The differences in the reaction of wheat varieties to these biologic forms appear to be entirely physiological. The strains themselves are indistinguishable, even under microscopic examination.

This is one of the most promising lines of research, based exclusively upon fundamental scientific principles and, if carefully carried on, precludes many costly errors and much waste of time and effort. It is also *the* phase of work demanding the very closest co-operation of experienced plant breeders with our service. To be successful—unless such breeder already possesses the requisite knowledge—it will be essential for him to be working under the closest guidance and direction of men who are thoroughly conversant with the points upon which rust resistance rests; otherwise, unless such co-operation is reciprocative in effect, new varieties that may exhibit most desirable improvements over varieties now known, may succumb at once when subjected to the immunity tests already outlined.

PHYSIOLOGICAL VARIETIES OR STRAINS OF RUST ON WHEAT

Work on the physiological varieties or strains of stem rust on wheat was continued in the greenhouse in 1923. In determining the strains, use was made of the keys and the differential wheat hosts that are listed by Stakman and Levine in Technical Bulletin No. 8, Minnesota Agricultural College. Determinations of the collections of wheat rust made in 1922, were completed.

Strain No. XVII is usually the most prevalent and the most widely distributed in Western Canada. XXI was most common in 1922. Strain IX was prevalent in 1919, causing Emmer to rust heavily. Since then it has only been collected occasionally and correspondingly Emmer, in the field has been practically free from rust. Strain III was quite prevalent in 1922 and 1923. The prevalence of this strain is noteworthy as it readily attacks Kanred, and probably was responsible for the severe attacks on the Marquis x Kanred crosses in 1923. As far as tested, the strain present on these crosses was Strain III. (vide Table 1.)

Another important phase of our investigations deals with the

WINTERING OVER OF THE RED STAGE OF STEM RUST

The germination was tested of the red spores of stem rust on wheat, that had overwintered. The first test of spores from wheat wintered under natural conditions at Saskatoon, gave a very low percentage of germination, less than 1 per cent. Tests on April 4th, with spores from wheat wintered at Rosthern gave negative results, though spores from beneath the sheath of barley gave a germination of about $\frac{1}{2}$ per cent.

Extensive tests about the first of May, of spores from unthreshed wheat sheaves left out during the winter at Sintaluta, gave negative results. Wheat seedlings were also inoculated with similar spore material, with negative results.

In the spring and early summer, susceptible grasses were carefully observed by the field men for the first appearance of stem rust. If the rust lives over in the grasses by mycelium or spores, it was thought that rust would appear on them first. Observations have been continued for a number of years, and every season rust was collected first and in a more advanced stage on wheat than on grasses. This year, however, the first collection of stem rust in Saskatchewan, except that which could be directly traced to the barberry, was made at Rouleau in Southern Saskatchewan. This infection was on the common wild barley grass (*Hordeum jubatum* L.). It was rather severe, and indicated that rust had been present for some time. The infection was very local. No barberries could be located in the vicinity, nor could rust be found in the neighbouring wheat fields. The early appearance of rust on wild barley and its severity at the time of collecting, suggested the possibility of wintering-over on that grass, but infection may have come from wind-blown spores, as the rust was in a more advanced stage on wheat further south, though not prevalent. Two days later a few pustules were collected at Estevan which showed winter spores.

These remarks may suffice to indicate to you the highly intricate and diverse nature of these investigations, only the principal ones of which, among many others, have been mentioned. Other phases of grain disease investigations are carried on, but are not pertaining to grain rust especially. It is hoped, however, that I have conveyed an idea of the vast amount of data that must be taken every year, to be confirmed year after year, until we have really accomplished something of value. There cannot be any doubt that an increase in staff and provision of better facilities will materially aid in securing more immediate results.

The Experimental Farms system further maintains a number of small laboratories devoted to grain disease research:

(1) At the Experimental Farm, Indian Head, a small and—for winter work—quite inadequate laboratory is provided, but one of the absolutely necessary essentials, viz., greenhouse accommodation, is lacking. Hence the plant pathologist stationed there must be moved during the winter months to Saskatoon, with the result of crowding of space in that laboratory. Besides supervision of field experiments on grain rust and smut of grain, the officer in charge specializes in the study of foot rots of grain. He for instance determined the presence of "Take-all". Exclusive of initial equipment and cost of building, this laboratory is maintained on \$4,625 per annum, including the salary of one plant pathologist, comprising the whole staff.

(2) At the Experimental Farm, Brandon, Man. What has been said of the Indian Head accommodation is even more true of Brandon. The accommodation is merely suited for summer work. The officer-in-charge specializes in the bionomics of smut diseases, which includes field experiments on their control by the most up-to-date methods, including the new dust treatments. A systematic study of the factors determining resistance to smut diseases is also carried on.

The cost of maintaining this laboratory is \$5,375 per annum, including the salary of one pathologist.

In the winter the pathologist has to be provided with working space, either at Saskatoon or Winnipeg.

(3) At Winnipeg, Man., the laboratory is situated at the Manitoba Agricultural College, and is in charge of an able young man who received his training under Stakman of Minnesota. He principally carries on studies of stem and crown rusts of oats, but also deals with many other grain troubles, as well as with considerable survey, field, and experimental work.

In passing, it may be said that owing to the severe annual losses from Wheat Rust in the Red River Valley, farmers begin taking more interest in oats, which grow to perfection, but which unfortunately, in some seasons, are subject to severe losses from crown rust—an entirely different rust from stem rust, which has the buckthorn as alternate host. What has been said about the eradication of the barberry, equally applies to the European buckthorn as the carrier of the crown rust of oats.

The facilities at the college are so far by no means exceptionally good, and the work is handicapped to quite an extent; more liberal accommodation is greatly desired and might be provided.

The cost of maintaining this establishment per annum is \$4,900.00.

To summarize, the total cost of maintaining these four laboratories, devoted to all phases of grain disease research throughout the Dominion, but exclusively confined to the West, amounts to the sum of \$25,570.00, including all salaries.

From several years' experience we are in a position to state that the provision made for this very important work in Canada is barely enabling us to perform the minimum of the work necessary. We find ourselves fundamentally handicapped in practically every direction, viz., lack of the essential assistance, lack of suitable accommodation, and unfortunately by a provision of salary ranges insufficiently attractive to men of mature experience, knowledge, and reputation. I wish to emphasize that I think most important of all is the personnel of the laboratories. There has been continual change in the assistants and plant pathologists in Western Canada, a condition more recently rectified. The prospects as regards salary range should be made more attractive to retain the services of men who have shown ability along this line of work, and some means or other should be provided of having appointments made of men of tried experience and judgment, rather than of such having high academic qualifications only. Just in what way positions could be made more attractive is difficult to say, but one way would be to increase at least the maximum of salaries paid at present, as well as to increase the staff by a number of junior members who could be trained.

The Dominion loses easily from \$90,000,000 to \$100,000,000 per annum from grain diseases. Our plain duty is to save the country these enormous sums lost every year, and for the Government to do everything possible within reason to provide a liberal appropriation which will enable us to accomplish the task. To the outsider it may appear as if we had an organization of considerable importance. At any rate it would appear so, were we to enumerate our activities in detail. We have the nucleus of an organization, our men show enthusiasm and knowledge, but we sadly lack encouraging support. Among scientists and others outside the Government service there are a number who are quite capable of correctly estimating the importance of our work, although often without a knowledge of facts, and criticism is frequent enough. Realizing that our service is inadequate, others are engaging independently in such investigations, with the result that work is being carried on in several centres, which may or may not duplicate our own efforts, with accompanying waste of energy.

It is my privilege to acknowledge, as well as to remove any impression of casting undeserved reflections, that our work in relation to the study of grain disease is receiving every and untiring support from the Director of the Experimental Farms, who has given every aid to see this work succeed. I am sure that many times he has placed at our disposal, facilities even at a sacrifice of other phases of work in order to promote the progress of this work. But even the Director of the Experimental Farms is not always certain of the support that is required for the much-needed advancement and progress of agriculture in Canada as founded upon scientific research and experimentation. We cannot permanently draw upon our stores of knowledge without being given every aid in adding to the same, to the benefit of the agricultural industry of the whole Dominion.

I now come to the point of suggesting some constructive criticism. I have pointed out that our work is carried on at four places—Saskatoon, Indian Head, Brandon and Winnipeg. The requirements of each of these laboratories as at present constituted are exactly similar. This means that we have to quadruplicate equipment and that we are not in a financial position to provide each of these laboratories with more than the minimum in labour, technical and otherwise, the physical equipment in laboratory apparatus, the necessary greenhouse accommodation, and the free use of land according to our requirements.

We are spending annually about \$25,000, a sum entirely out of proportion to the interests involved. Under the circumstances, centralization of effort suggests itself primarily, instead of the provision of more elaborate facilities at each Station. The present laboratories should serve as field or summer quarters. In addition, however, there should be provided an up-to-date laboratory where all our efforts may be centralized. This would save considerable sums of money now necessary to maintain the individual laboratories; it would economize at once in administration, as well as in the provision of technical assistance to each single field laboratory.

Such laboratory building should be erected in the most suitable locality, where preferably gas, water, and electricity are available, and not too far removed from any important centre, within a recognized rust zone, preferably. Attached, or in connection with such central an adequate greenhouse provision, as well as some ten or twenty acres of land.

The work would be in charge, under supervision from Ottawa—mainly because of effecting the necessary relief from executive work—of an experienced man, with at least the present number of assistants at his disposal, to which number should be added, as the work grows, a number of other specialists. It is essential that there should be, instead of one assistant as at present, at least four assistants and several junior pathologists, to perform the many duties for which higher paid officials should not be used, and to intelligently look after the field work in different localities. Furthermore, this central laboratory should be large enough to accommodate at least one experienced geneticist, or plant breeder, with—eventually—several assistants, in order to co-ordinate all breeding work carried on in an endeavour to bring a solution of the subject considerably more within reach.

It is felt that the establishment of such an institution, and liberal financial support for a period of some ten years or more, will very materially aid our work, as well as constitute one of the most important steps towards the solution of the great wheat rust problem. Moreover, it will eventually provide a very necessary headquarters where fellowship problems now endowed at various centres by the National Research Council, may be worked out. We have in view that such institution with full equipment and every facility for research might be generously enough supported so as to attract all those men who are now more or less independently work at this problem. Endowed in such a manner we would have an institution of which the Dominion could be the proud leader in that phase of agricultural research, instead of a poor follower as at present.

The rust problem, it seems to me, should be approached from three well-defined points of attack—Plant Pathological, in its ordinarily accepted sense, Plant Breeding and Biochemical. There seems little doubt that the best interests of the work, where some of these lines investigation parallel each other or even overlap, would be most effectively served by the close contact of workers which centralization of effort would necessarily involve. On the other hand, if such centralization demanded the divorcing of all our research problems from university contact and influence, some of the most fundamental, most essential and most significant phases of our research would suffer materially. Such is not the intention. Everyone should wholeheartedly aid.

The question where such co-operative scheme in which all interests should be represented, Federal, Provincial, College and University, should be inaugurated, may be left to the discussion of the subject on the occasion of a conference recently proposed by our Department to be held shortly in Winnipeg, where all parties interested in this exceedingly important question will be afforded an opportunity to express their views. Tentatively, I would submit that an initial appropriation of some \$100,000 would take care of the necessary buildings and land as well as nearly every other expenditure for the first year. Thereafter an increase of our present expenditure and its support for a number of years will fairly adequately accomplish our aims. In consideration of the \$90—100,000,000 annual losses from grain diseases in Canada, this expenditure would not seem out of proportion, and as far as I have been able to ascertain, such proposal will meet with the unanimous support of many experienced and able technical men consulted; an organization capable of rendering the widest possible national service.

In closing I wish to draw attention as an alternative to Federal control, to a method of solution which has been accomplished in Great Britain through the establishment of the National Institute of Agricultural Botany at Cambridge. The institution owes its foundation to the abnormal conditions which prevailed during the war. The Minister of Agriculture and the Director General of Food Production strongly supported proposals for the creation of an institute of applied Botany. The provision of universal generous support gave hope of a satisfactory financial basis for the scheme, and in the winter 1917-18 memoranda explaining the scope and aim of the Institute were prepared and circulated to those who were likely to be interested. The generous response made to this appeal by members of the leading organizations of the Seed trade, grain merchants and millers, assured the movement of success and enabled the promoters to proceed with this plan. Eminent officials scientific and educational authorities, gave their aid and advice freely in the long and sometimes delicate negotiations with various Departments, official bodies and individuals, until finally the Trust Deed was formally adopted.

The aim of the Institute is the general improvement of yield and quality of all farm crops. It has been pointed out that the problem of wheat rust is a national problem, as well as an international one, that success of the work depends largely upon generous financial support, so that equipment, including buildings, as well as personnel of the highest type available, may be secured. What has been possible in Great Britain surely ought to be possible in Canada, and no doubt great interest would be taken in the success of this kind of work were direct interests in Canada in a position to contribute to the maintenance of such research project. It is to their interest that progress be made; they have a right to demand every assistance, but they may also be afforded an opportunity of supporting such important work by contributions devoted to the solution of this and every other problem of vital interest to the nation.

By Mr. Sales:

Q. Do these men work all the year round?—A. Yes.

Q. What do you call them?—A. Plant Pathologists: men who study the diseases of plants.

Q. How long an education do they have to have before they are fitted for this work?—A. Four to five years' university training; two to three years' post-graduate work or equivalent experience as research assistants.

Q. What are they paid?—A. The initial salary of the plant pathologist is \$2,400 with a maximum of \$2,760 per annum.

Q. Do you find that that is sufficient to attract capable men to the service?—A. No, not the type of men required to remain in our service when they have become really useful. That is a desirable salary for an assistant, but when you compare the salaries given to men performing similar work in the United States, I mean such men to whom Canada is at present indebted for the placing at her disposal of promising varieties of wheat—the result of their knowledge and training—instead of originating our own varieties, you will agree it is simply a farce to lay claim to much original achievement by our men. It seems as hopeless as digging a grave with a tooth-pick.

Q. The United States are paying them more money than we are?—A. Double the amount.

Q. How much more?—A. From four to six thousand dollars are paid annually to men of initiative and experience such as are required to carry on responsible research work.

Q. Have you any idea how many of those men are employed?—A. In the entire Federal Department of Agriculture?

Q. Rather in the United States?—A. Salaried between four and six thousand? I should say about two hundred.

Q. In this particular work?—A. In plant pathology.

Q. Yes?—A. I believe I can only venture a guess. There might be one hundred men engaged in this kind of biological work.

By Mr. Gould:

Q. That will be half a million dollars?—A. In salaries alone.

Q. That is in the United States?—A. Yes, in the United States.

By Mr. Knox:

Q. Do some of the States deal with that matter individually?—A. It is generally done co-operatively. Federal research men are attached to universities and experimental stations working co-operatively with the State Departments under State and Federal grants.

By Mr. Lapierre:

Q. Are our provincial governments doing anything along that line at all?—A. The provincial governments are co-operating with us wherever possible. At the University of Manitoba work is carried on, in Edmonton and in Saskatoon, by very able and experienced men; very satisfactory work in this particular line has been accomplished.

Q. Is there any co-operation between the Federal Government and the provinces with regard to this work?—A. Yes. Much interest is taken, especially by the authorities of the grain provinces. We are receiving every support and are granted many privileges for the carrying on of our work, but I believe no direct financial contribution is made. I am sure the provinces would all eagerly support a more extensive project in this regard.

By Mr. Gould:

Q. Would you recommend the government putting up a large prize for the accomplishment of some of these desirable objects or ends in different fields of

research work?—A. I have not given any thought to such prospect. Speaking without due consideration, I do not think I would be in favour of offering prizes. I am sure every person in Canada would offer, as in our experience we have already been offered, a large number of absolutely infallible cures of rust. We would be overwhelmed with so many offers of solutions that we would not have one hour's time to devote to our work. It would be disastrous.

Q. I had in mind the fact that Dr. Saunders found the Marquis wheat, for instance, that he might have been given a remuneration?—A. I feel, personally, that such offer may be prejudicial to painstaking research, as it seems to me entirely opposed to the true spirit of scientific research. I do not know. I have never taken that into consideration. In England The Royal Agricultural Society once offered a prize for the control of late blight of potatoes; a prize of £2,000 was offered some years ago, but it has never been claimed, although late blight is now quite easy to control.

By Mr. Sales:

Q. Where do you think would be a desirable point to have this laboratory?—A. That, without further consideration, is difficult to say. It should be closely associated with an educational centre, preferably say Winnipeg or Saskatoon.

Q. Would you not have to have them where the rust is most prevalent?—A. That is not essential, because we must carry on this work throughout Western Canada. I pointed out that we must carry on field experiments in many localities, regardless to where such central laboratory may be located, in order to test the geographical distribution of the physiological strains as well as the relative resistance of varieties which according to prevailing strains varies considerably. At present the laboratory accommodation at Winnipeg and at Saskatoon is very limited. I believe our laboratory accommodation at Saskatoon is about the size of this room, including greenhouse space and everything.

Q. I was thinking that the further west you go the less moisture you get and the less rust.—A. Yes, but you cannot put a laboratory of that type into an area or locality where you have no facilities as far as electricity, water and gas are concerned, besides the other advantages existing at some more established centre. If you did so, there would at once arise difficulties as regards domestic accommodation for staff, etc., etc. If we maintain an institution of this kind in the West we must bear another aspect in mind. If the officer in charge is also responsible for all the executive work, it would simply take all his time to sign accounts, write requisitions, and to do administrative work generally. A scientific worker should be relieved of such work if possible. Such laboratory should be in charge of an experienced man with an administrating clerk and a number of assistants under him, to which there should be additions as the work grows, of a number of other specialists. It is most desirable that there should be, instead of one assistant at the present time, at least four assistants. It is inconsistent for a man of research to have to perform the many duties for which higher paid officials should not be used. At the present time the pathologist in charge has, on occasions, to pot a large number of wheat seedlings: in order to test biological strains and susceptibility we have got to do this. We could hire day labour, but if you do hire day labour only a limited number of seedlings will grow. Supposing that we find among these as decided a resistance as in the crosses between Marquis and Lumillo already referred to. They should be selected carefully and be handed over to the cerealist, who should try his skill by improving the yield or other desirable characters of any such strain, without sacrificing the rust resistance. He may originate new crosses and varieties, which should be given to us to test for immunity. This work should be given as close co-operation as possible.

By Mr. Knox:

Q. Do the cerealists work along that line at the present time?—A. Both types of investigators have one point in view at the present time, viz. the production of a prolific rust resistant type of wheat of superior milling qualities. At present that is not being done. Nearly all the new crosses of promise came from the United States. We hope to discuss some day the question of fellow-ship problems, awards made by the National Research Council. Young students are given funds to carry on research work in certain phases of rust, which is exceedingly desirable; but we might have in Canada an institution of our own where their researches would contribute to the solution of our problems. If we had an institution of the kind suggested, where this work might be carried on in co-operation, under supervision, with one end in view, I believe we would have much to gain from such united effort. I hope I have been able to interest you to-day that there is decided and immediate promise from the systematic carrying on of this work.

By the Chairman:

Would any members of the Committee like to ask Mr. Güssow any further questions?

By Mr. Lovie:

Q. Do you find that the rusting varieties of wheat always have bearded heads?—A. Some are bearded; some not. Severe rust attacks depend much more upon the time of maturity. The cross between Marquis and Lumillo of which I spoke resembles Marquis, but further selections may be necessary.

Q. How soon would they revert back to the bearded head?—A. If they are properly fixed they should not revert back. That depends largely upon the care which has been exercised in destroying all those types differing from or inferior to the desired type. If one would persistently for a number of generations destroy all bearded heads, the beardless type would become permanently fixed.

By Mr. Sales:

Q. What about the milling qualities of these?—A. An investigation of the milling qualities has been carried on in Minnesota, and so far they have given very excellent promise. I understand the only reason why they are not being introduced more widely is that they are not grown in large enough quantities to pay the miller to use this wheat.

By Mr. Lovie:

Q. How about the stiffness of straw in these crosses?—A. Some of these crosses are apt to lodge easily, but that is a factor which can be overcome. It is one of the factors that can be eliminated by careful breeding or selection.

Q. Do you know whether there was tested in Canada wheat selected by a farmer of Miami, Man.?—A. I am not able to answer this question. The variety, if of promise, very likely has been given to the Experimental Farms. There is no reason why any observant farmer should not succeed in selecting a strain that is absolutely rust resistant or superior to any wheat known. Think of the successful work of Dr. Seager Wheeler.

Q. What is your experience with Kubanka wheat? What is the reason that the milling people discriminate against it?—A. That is a question which I am not able to answer. If I remember correctly, this wheat does not easily mill into a good baking flour, but is used more largely for a granular kind of flour. It is a macaroni wheat. There is a good market for it in the States as a macaroni wheat, and the reports received about Kubanka are very favourable indeed; but as far as the relative baking quality of wheats are concerned I am not able to give you much information because I can only speak from reports.

Q. I know something about Kubanka wheat. I would like to say from my experience the wheat is very bad as regards the way the milling companies for the Grain Exchange or else those who grade the wheat in Winnipeg discriminate against it.—A. Perhaps if you have many carloads of it you will have no great difficulty.

Mr. LOVIE: It is generally conceded that there is weight enough in the Grain Exchange to sort of domineer over the men who are grading the wheat. That should not be, because they are under the Department of Trade and Commerce, and it put all the farmers in our district out of business, for it would have been a great thing if they could have had Kubanka wheat. This year it has been higher in price than any Marquis and nobody has had any of it.

WITNESS: Kubanka is one of the leading varieties of the commercial Durums grown. It is very resistant to rust and drouth.

Mr. GOULD: Did you appear before the Grain Commission? It would be very useful to bring it before the Royal Grain Inquiry.

Mr. LOVIE: There was wheat that never got any rain, absolutely true to type, and yet it was discriminated against.

Mr. SALES: With regard to this valuable information which we got from Mr. GÜSSOW this morning, I was wondering if we could not get this multigraphed.

The CHAIRMAN: I might say had you been in at the beginning of the proceedings I mentioned that a motion would be in order to have this printed.

Mr. SALES: I might say had I received any notice I would have been here. I got it in my mail this morning.

The CHAIRMAN: I will say that the notices were delivered last night.

Mr. SALES: I was dining with the Governor General last night.

The CHAIRMAN: Have you any questions to ask the witness?

By Mr. McConica:

Q. Do you find that wheat that originated from a cross tends to revert to other old types in time?—A. Yes. There is a tendency for a selection not properly fixed, to use a term that is used in breeding plants, to revert, but one can always guard against reversion by the careful discarding of undesirables.

Q. How about Kota wheat?—A. Kota is a good milling wheat, and is resistant to rust and drouth.

Q. Is it bearded?—A. I could not say just now. I am under the impression that it is bearded wheat. It is a bearded wheat.

By Mr. Forrester:

Q. Wheat that is hybridized may form a new type?—A. That is to say, if you cross two varieties of wheat of prominent parental characters you may have the characters of both parents in the offspring, or you may have a predominance of one character over another, or even occasionally of an ancestor in the offspring. You may expect a number of variations, due to the crossing. It has been found that rust resistance is a factor that can be perpetuated by breeding.

By Mr. Lucas:

Q. Have you had any experience with glume rot?—A. Yes. It does not amount to much in Canada. It looks more serious than it is. People are getting very alarmed about it at times, since it often causes lower grading.

Q. It was prevalent in Alberta last season.—A. It did not do much damage to your crop.

Q. It had the effect of reducing our grade.—A. I have never seen evidence that glume rot would affect the quality of the grain unless there is an exceptionally severe outbreak.

Q. They took advantage of it very seriously last year. It was just a little black spot on the end of the kernel, and in grading our wheat the elevator men would simply point out the black spot and reduce our grade.—A. Very frequently that condition which you describe is not due to glume rot, but is due to bad weather conditions. Wheat wet in the stook often shows a black tip, and that naturally would result in degrading the wheat.

Mr. SALES: Have you considered, Dr. Grisdale, recommending to the Minister anything for this rust research work?

Dr. GRISDALE (Deputy Minister of Agriculture): The question of expenditure for this research work has been up before the Minister many times, and there is money in the estimates now that can be diverted to that purpose.

Mr. SALES: How much?

Dr. GRISDALE: Not the amount that Mr. Güssow mentioned, but enough to do all the work that can be done this year.

Mr. SALES: Do you know how much?

Dr. GRISDALE: About 25 or 30 thousand dollars.

Mr. GOULD: I make a motion that this Committee recommends that a sum be given by Council for the work that Mr. Güssow has outlined this morning, that is the research work.

Mr. LOVIE: I would second that motion.

Mr. GOULD: I would say I would make a recommendation for \$50,000 for the work Mr. Güssow has outlined as a recommendation of this Committee.

Dr. GRISDALE: I suggested that amount because I think it is the amount we require this year, because the Minister is in favour of it.

The CHAIRMAN: Do you wish that to be reported to the House?

Mr. GOULD: Yes, I would make that as a report to the House from this Committee.

The CHAIRMAN: I am not sure as to the rules. We will pass the motion. I will find out if we have the right to present it to the House. We will suggest it anyway.

It was moved by Mr. Gould, seconded by Mr. Lovie, that this Committee recommend to the House an appropriation of \$50,000 for the purpose of special aid in research work in connection with grain rust.

Motion agreed to.

Mr. SALES: I would move that these reports be printed.

Mr. GOULD: I second that.

Motion agreed to.

By the Chairmna:

Q. I was going to ask you about the elimination of the barberry. Are not the nurseries allowed to propagate barberries and distribute them?—A. No sir, not in the West. That is against the law.

By Mr. Sales:

Q. Is there a fine for men peddling out barberry bushes now?—A. Yes, as far as Western Canada is concerned, if barberry is planted against definite instruction. We advise people to plant any other shrub—in fact, there is another barberry which is known as “Thunbergs barberry”, which is more beautiful and which does not curry the rust; this shrub might be planted any time at any place where the rust barberry would ordinarily be planted.

Q. Is there anywhere a description of the barberry bush?—A. Yes, the Department has published a coloured illustration of the barberry—a spiny shrub with yellow flowers and red berries—showing the rust spots, together with the black stem rust on wheat, giving the life history of the rust as well as the relation of the barberry to the rust in popular form. The barberry is not very widely distributed in the prairie provinces. We hope, as far as Saskatchewan is concerned, that we will complete our eradication this year, and I believe the same for Manitoba; only in the city of Winnipeg we have great difficulty in getting rid of the barberries.

By Mr. Sales:

Q. There is a thorn bush in the Qu'Appelle Valley, pretty prevalent, which bears a red berry, but it does not bear that yellow flower you speak of.—A. I think you mean the buffalo berry, which has no relation to grain rust at all.

Q. Do you consider the barberry bushes growing in the city of Winnipeg a menace to the wheat?—A. I certainly think so. It has been said that the rust may spread from a barberry for a distance of ten miles. It is possible that fungus spores may spread for 150 miles. At any rate, in our investigations of the spreading of white pine blister rust in British Columbia, we found that the rust spores from pines reached cultivated black currants, some 150 miles away from the nearest pine. There is no telling how far the barberries in the city of Winnipeg may aid in the dissemination of the grain rust. When the winter spores of stem rust germinate in spring, they produce exceedingly minute secondary spores, which are distributed by air currents.

Q. What colour are they?—A. These secondary spores? Colourless, like water. Many of these spores could be placed side by side on the head of a pin; they are very small.

By Mr. Gould:

Q. Have you any information concerning the statement that was in the press some time ago of a definite area in South Dakota where barberry was entirely eliminated, and of another area where barberry was allowed to grow, and the yields from the two were given?—A. Work of this type has been carried on in the United States. I quoted an experiment from Indiana. The results are rather promising. Where they failed there were undoubtedly some barberries located later, responsible for the failure.

By Dr. Grisdale:

Q. Is it not true that the spores of the red stage would spread very far afield?—A. The red stage of rust spread from plant to plant, field to field, locality to locality. The origin of the red stage may be traced frequently to a neighbouring barberry bush. Some twelve days after the sowing of spores from the barberry the red stage matures on wheat, and these spores are then carried by the wind far afield, infecting new areas within a surprisingly short time. Had there been no barberries present it is doubtful whether rust would have appeared.

Q. Do I understand the red stage is mature?—A. The red stage is the so-called summer stage, and occurs exclusively on wheat and grasses. It is the most dangerous for wholesale spreading from wheat to wheat without the intervention of the barberry. Let me recapitulate briefly: The first signs of our annual grain rust outbreaks occur on the barberry. On the leaves of this spiny bush there develop in May and June bright orange pustules—the so-called cluster cups. In these pustules are produced a large number of minute spores which are dispersed by air currents. They eventually fall upon the surface of the leaves of wild and cultivated grasses and grain. There they germinate and push their rootlike organs into the substance of the leaf and eventually produce the well-known numerous red rust spots—the summer or red stage of

stem rust. When maturity is reached, which is within some ten to fourteen days after germination, these spores are able to infect all grains and grasses for miles around. The red stage spreads with extraordinary rapidity. A crop of wheat promising twenty to thirty bushels at the beginning of the week may by the end of the week become so heavily rusted that no grain may develop. Towards the close of the natural life of the wheat plant, the rust parasite once more changes its cycle by producing a new type of spore that turns the red spots black. These black spots contain thick-walled, dark brown spores, permanently fixed to the wheat stem. By that time the wheat is cut and the spores pass through the winter. Early in spring the winter spores begin to germinate and produce a secondary, exceedingly minute, colourless spore that must fall upon the leaves of a barberry. It cannot germinate on wheat or on grasses, but must have a barberry leaf to continue its life cycle. There it germinates and gives rise to the cluster cup described above. Without the intervention of the barberry, black stem rust cannot exist, as shown by the experiences in many countries.

Q. You might have one barberry plant in Manitoba to cover the whole province?—A. That is the case. Inasmuch as this single barberry gives rise to rust on grain in its immediate surroundings, from which the red summer spores will spread, according to favourable conditions, over the entire province. And yet people are not enthusiastic in eradicating their barberry bushes. We have met often with very drastic repudiations of our endeavours. Some absolutely refuse to take out their barberries.

By Mr. Sales:

Q. Have you got the names and addresses of the people who refused to take them out?—A. Yes, they are known to us, principally city people, who are not interested.

The witness retired.

The Committee adjourned.



