The following Annual Reports for 1930 have not been published:—

Director of Experimental Farms
Division of Chemistry
Division of Animal Husbandry
Division of Forage Plants

Progress reports of the Division of Chemistry and the Division of Forage Plants covering the years 1930 to 1933, inclusive, have since been published but are not included in this present series.

DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF FORAGE PLANTS

REPORT
OF THE DOMINION AGROSTOLOGIST

L. E. Kirk, Ph. D.

FOR THE YEARS 1930 TO 1933 INCLUSIVE

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DIVISION OF FORAGE PLANTS

REPORT OF THE DOMINION AGROSTOLOGIST

L. E. KIRK, PH.D.

INTRODUCTION

This report deals with the work of the Division of Forage Plants for the years 1930 to 1933 inclusive, and it includes also the experimental work with forage crops on different Dominion Experimental Farms and Stations in Canada for the same period. The work of the Division is concerned not only with herbage plants, which include the various annual and perennial hay and pasture plants, but also with several crops which are grown primarily for feeding purposes such as corn, sunflowers and field roots. Experiments with turf grasses are also part of the work of this Division, as well as certain special crops, the most important of which are soybeans and sugar beets.

The breeding of forage plants adapted to Eastern Canada is conducted mainly at the Central Experimental Farm, Ottawa. Plant breeding work was greatly facilitated by the addition in 1932 of greenhouses well supplied with artificial lighting equipment. This made it possible to mature the seed of most plants in the greenhouse during the winter months, thus greatly speeding up the work by doubling the number of generations which can be grown in one season.

In the spring of 1932 a branch laboratory of this Division was established at Saskatoon, Sask., in co-operation with the University of Saskatchewan. Mr. T. M. Stevenson, M.S.A., was appointed to take charge. The work which was formerly conducted by the Field Husbandry Department of the College of Agriculture is being continued and expanded to meet the needs of the three prairie provinces. Plant breeding is the major activity with the main emphasis on the development of hardy and drought resistant grasses and legumes for Western Canada. Those crops being worked with most extensively are alfalfa, sweet clover, brome grass, slender wheat grass and crested wheat grass.

Range investigations are conducted at the Dominion Range Experiment Station which is located in the heart of the ranching area in southern Alberta about 100 miles south of Medicine Hat. Dr. S. E. Clarke is in charge of this work.

The various lines of investigation on the different Experimental Farms and Stations are closely co-ordinated. Variety tests, for instance, are standardized in such a way that the same varieties are studied on all of the Branch Farms located in a major agricultural zone. When the results from such tests are brought together it is possible to arrive at definite conclusions as to the suitability of individual varieties. These results also facilitate our study of varieties with respect to their adaptive response to variations in soil and climatic conditions.

All experimental plots are arranged in randomized blocks so that the results may be submitted to statistical analysis. Green weights are recorded at time of harvesting and shrinkage samples are taken for moisture determination. These are air-dried and forwarded in cartons to the nearest electric dehydrator.

In addition to the experimental and research work which relates to the improvement and culture of forage crops, the Division of Forage Plants at

Ottawa is responsible for the testing of plant introductions and seed importations. The Seeds Act requires that this testing be done before a licence for sale is granted. "Verification tests" of seeds submitted by the Dominion Seed Branch and the Canadian Seed Growers' Association are conducted also in order to determine trueness to variety as well as the purity of the varieties themselves.

Throughout this report Dominion Experimental Farms and Stations will be designated by the names of the places where they are located.

Office building, laboratory and greenhouses of the Division of Forage Plants.

PERENNIAL GRASSES

TIMOTHY

Timothy *Phleum pratense* is the most important cultivated grass in Canada. In Eastern Canada it is grown for hay almost to the exclusion of all others. Timothy is grown extensively also in the more humid parts of British Columbia. Its usefulness is greatly restricted and it does not thrive where the moisture supply is limited. In the Prairie Provinces, therefore, it is not grown to any appreciable extent except in certain parts of Manitoba and Alberta where the precipitation is sufficient.

The breeding of improved strains of timothy is one of the major projects at Ottawa. The main objective in this work is the development of leafy persistent pasture strains. This is regarded as of great importance from the standpoint of better pastures because timothy is used extensively as a pasture grass as well as a hay grass. Recent experiments have shown that timothy ranks first in palatability among pasture grasses, and its nutritive value, winter-hardiness and good seeding habits amply justify an extension of its use in pasture mixtures. However, the type of timothy grown in Canada, or imported, is a stemmy hay type which tends to seed freely but lacks the leafiness and free tillering habit of growth which is typical of the best plants for grazing. The breeding stocks used in this project consist chiefly of native material collected from almost every county in Ontario, Quebec, and from most of the other provinces. Some of this seed is from timothy that has been grown for succes-

sive generations on the same farm for from 25 to 40 years. Plants are selected on the basis of growth form, those being used as parents which conform to ideal types for pasture or for a combination hay and pasture type.

Another consideration in the breeding of timothy is the development of rust resistant strains. Twenty selections of the hay type have been isolated during the progress of this study over a period of years. These are almost completely rust resistant at Ottawa. A synthetic variety (Boon) produced by intercrossing a number of these selected strains has outyielded the best commercial seed. Approximately 1,000 pounds of Boon timothy seed has recently been placed with seed growers in the Ottawa valley.

Forty-two strains of timothy are being studied at Ottawa, 24 of which have been tested for some years and 18 other improved hay and pasture types which were introduced in 1932. Many of these do not show any superiority over commercial timothy but a few of them exhibit interesting characteristics and some are distinctly promising. In general it is noticeable that most of the European strains appear to be very susceptible to rust and tip burn. Of particular interest is a diploid strain from the Welsh Plant Breeding Station at Aberystwyth. This is a very leafy prostrate pasture type which can be propagated for seed without danger of crossing with ordinary timothy, owing to the fact the two types differ in number of chromosomes. The agricultural possibilities of this strain will be studied with great interest.

The standard test of timothy varieties includes the following: Boon, Huron, Swallow, Svalof M. C., Cornell M. C., and Commercial. This test is conducted on Branch Farms at Charlottetown, P.E.I., Nappan and Kentville, N.S., Lennoxville and Ste. Anne de la Pocatiere, Que., Kapuskasing, Ont., and Lacombe, Alta. Data are available for from 1 to 3 years only and as yet no significant differences in yield are indicated. All varieties belong strictly to the hay type. None of the improved strains have been grown in sufficient quantity to preserve their identity in the seed trade.

BLUE GRASSES

Kentucky blue grass *Poa pratensis* is highly adapted to the better classes of soils in Ontario and Quebec, especially those of limestone origin. It is the dominant species in the majority of old pastures and occurs spontaneously when cultivated land reverts to sod. It is also the most generally suitable lawn grass in Canada, being extensively used for this purpose and for the grassing of fairways and boulevards.

In areas adapted to Kentucky blue grass, it should be included as a constituent of grass seed mixtures which are intended for pasture. Even the comparatively small quantity of 3 to 5 pounds per acre is sufficient in the mixture to establish a sod composed largely of blue grass after two crops of hay have been taken. Blue grass establishes slowly but under favourable conditions it finally becomes the dominant species. It does not thrive on acid soils and for this reason has not attained a place of importance in the Maritime Provinces. Lack of sufficient moisture limits its range of adaptation in the Prairie Provinces to a portion of the Red River Valley in Manitoba. In British Columbia it can be grown successfully only east of the Rocky Mountains and on irrigated land.

Because of its natural adaptation, Kentucky blue grass ranks high as a pasture grass in Ontario and Quebec. For this reason, considerable attention is being given to the securing of better strains. The species contains a wealth of plant variations and it is especially amenable to improvement by selection because the plants are largely self-fertilized. In the nursery at Ottawa there are 10 strains, some of which are very distinctive and promising from the standpoint of securing a better pasture type. Improvement work with this species is only in the initial stage.

Canada blue grass *Poa compressa* is indigenous to Ontario. It occurs most frequently on the lighter types of soil where practically pure stands may be found, but in certain heavy clay soil areas it is sometimes the dominant species. It thrives best in sections of southwestern Ontario, where practically all the commercial seed is produced.

Canada blue grass is inferior to Kentucky blue grass for lawns. A detailed study of these two species is now being made at Ottawa as to their relative value for pasture purposes. Results indicate that Canada blue grass may have greater value relatively as a pasture grass than as a lawn grass.

BENT GRASSES

Species of bent grasses which are sold by the seed trade in Canada include red top *Agrostis alba,* brown top or colonial bent *Agrostis tenuis,* and creeping bent *Agrostis stolonifera.* Only red top is employed as a forage crop, the two latter named species being used chiefly on golf courses for putting greens and approaches to greens.

Red top has a very wide distribution throughout the Dominion. It is found naturally on a great variety of soils and in diverse moisture conditions. It is best adapted, however, to moist or relatively humid situations, and is frequently used as a component of grass mixtures for hay and pasture. It is also used as a constituent of seeds mixtures for making turf, in which case it acts as a temporary filler, most of it being eliminated by close cutting in the space of two years. There are no varieties or strains of this grass on the market and no attention has been given to its improvement. It does, however, occupy an important place in our pasture studies.

The bent grasses have the virtue of being tolerant of soil acidity so that they are important on soils which are deficient in lime. Brown top is the dominant species in the Maritime Provinces, being as characteristic of the flora of these provinces as blue grass is of the flora of Ontario. Variable quantities of seed have been harvested during the past few years, most of which have been sold for the purpose of making turf.

Creeping bent is characteristic also of the grass cover on low land and drainage areas in the Maritimes. It is usually present, therefore, in natural pastures in such locations. Creeping bent stolons are used extensively in the making of fine putting greens. The seed is very scarce and high priced but a small quantity is harvested from time to time in New Brunswick.

(See section of this report on "Turf Grasses").

BROME GRASS

Brome grass *Bromus inermis* is cultivated more extensively than any other grass in the Prairie Provinces. It is well adapted to this whole area except to the semi-arid sections of southwestern Saskatchewan and southern Alberta. In the prairie sections brome grass is valued for its persistence and ability to produce with a relatively low rainfall. In Manitoba, where moisture conditions are more favourable, it is very productive and greatly valued as a hay and pasture crop. Nevertheless in the black soil belt of all three provinces there are many farmers who hesitate to use brome grass because of its strongly stoloniferous habit of growth. For the same reason brome grass is not grown in Eastern Canada where it is commonly classed with twitch or couch grass because of the difficulty encountered in its eradication. Brome grass, nevertheless, would seem to have many advantages for Eastern Canada, providing strains can be bred which are non-creeping. It thrives under humid conditions and also possesses an unusual degree of drought resistance. To these may be added such qualities as palatability, high nutritive content, disease resistance and tolerance of frost and ice cover.

Breeding.—The improvement of brome gras is one of our major breeding projects, the chief objective being the development of desirable hay and pasture types. Special attention is being given to securing strains which are free from coarseness and the objectionable creeping underground stems. The method employed has been that of continuous inbreeding with selection within self-fertilized lines.

Forage crops nursery at the Dominion Forage Crops Laboratory, Saskatoon.

Improved strain of brome grass bred for leafiness and non-creeping habit of growth.

One hundred families have been grown in each of five generations. Self-sterility has increased and loss of vigour has been conspicuous as a result of inbreeding. In all other respects progress has been very satisfactory. Selection has always been toward dense, leafy and non-spreading types. A few such lines

have retained considerable vigour of growth. One in particular is very promising and a good seed producer. This has shown up well at Ottawa and steps have been taken to increase the seed for distribution. Plants out of the most desirable selfed lines are being crossed in pairs and an effort is being made to produce a vigorous synthesized variety by composite crossing.

WHEAT GRASSES

Wheat grasses are of major importance in Western Canada. Slender wheat grass *Agropyron tenerum*, locally called western rye grass, is indigenous to the Prairie Provinces, where it has been cultivated for many years as a hay crop. Slender wheat grass seldom remains productive for more than two years and it has not stood up as well as one would like to the dry weather of recent years. It has been shown also to be susceptible to the soil organisms which cause the foot rots of cereals, but the significance of this fact is not clear. For these reasons, slender wheat grass has lost somewhat in popularity. It has many excellent qualities, however, which are greatly appreciated, such as good seed production, ease of establishment, and tolerance of alkali salts, and doubtless it will be grown quite extensively for many years to come.

Slender wheat grass is well adapted to the black soils or park belt area and adjacent prairie sections of Western Canada. Good stands can be secured more easily with this than with any other species, and it is one of the best grasses to grow in a mixture with alfalfa.

BREEDING.—Improvement of slender wheat grass in Canada has proceeded by systematic selection within the progenies of individual plants collected in the wild. Of the original material, 130 were grown at Ottawa and 150 at Saskatoon, Sask. Dominion Experimental Farms in the West have assisted in the testing of selected strains. The breeding work is conducted at the Dominion Forage Crops Laboratory, University of Saskatchewan, and at the Dominion Experimental Station at Scott, Sask.

Three improved strains have been developed, namely, Grazier, Fyra, and Mecca. These, together with three other promising strains are being studied in comparative tests at Brandon, Saskatoon, Scott, Lethbridge, Lacombe and Beaverlodge.

Crested wheat grass *Agropyron cristatum* was introduced into Canada in 1915 but only in recent years has it become recognized as a very valuable species for hay and pasture in the drier areas of Western Canada. No other grass has been as satisfactory for reseeding abandoned land in the ranching areas. Its exceptional drought resistance, good seeding habits, absolute winter-hardiness, persistence under close grazing, and ability to form a sod quickly, seem to indicate an important future for this species.

BREEDING.—Selection, inbreeding and composite crossing are being employed in the improvement of this grass. This species contains a wealth of plant forms which provide ample opportunity for the plant breeder. Our experiments have shown that it is almost completely cross-fertilized, selfed seed being difficult to obtain. Inbred lines exhibit marked reduction in vigour and many of them produce an exceptionally large number of albino seedlings. There are indications that a very small percentage of the plants may be highly self-fertile.

A strain of crested wheat grass has been developed which possesses special merit as a forage and turf grass. This has been given the variety name "Fairway" and is eligible for registration by the Canadian Seed Growers' Association. Plants of this strain do not possess the tufted habit of growth which characterizes the majority of crested wheat grass plants. They are also finer stemmed, more leafy and propagate more freely by short underground stems.

Further information about crested wheat grass may be obtained from Pamphlet No. 157—New Series prepared by the Division of Forage Plants, Experimental Farms Branch, Ottawa.

RYE GRASSES

Perennial rye grass *Lolium perenne* and Italian rye grass *Lolium italicum* are of great importance in agriculture. The perennial species is essentially a pasture grass, being unexcelled for this purpose. Italian rye is comparatively short lived and is grown chiefly as a hay grass or as a quick growing temporary filler in mixtures with more permanent species.

The rye grasses do not possess, in general, sufficient frost resistance for Canadian climatic conditions except on Vancouver Island and in the Fraser River Valley of British Columbia. They are well adapted, however, to these latter areas where they are being compared with other species in special pasture and hay tests at Agassiz. Different strains of perennial rye grass also are being investigated both at Agassiz and at Saanichton on Vancouver Island.

Because of the excellence of perennial rye grass for grazing purposes, it would be a great advantage if sufficiently hardy strains, which could be grown with reasonable safety, were available for Eastern Canada. In tests at Ottawa, the "Victoria" strain from Sweden has proved to be distinctly more winter hardy than any other which is available commercially. Only one other strain has shown greater frost resistance, this being a selection of the Division of Forage Plants obtained out of an introduction from Russia. This strain has survived three winters in succession and it has come through at Nappan, N.S., and Lacombe, Alta., in seasons when others have winter-killed.

The possibilities of perennial rye grass for all the provinces of Eastern Canada are being investigated very thoroughly in order to determine its reliability for pasture, and special effort is being directed toward securing greater hardiness in this species. The result is still very problematical. Italian rye grass, on the other hand, does not appear to hold much promise, as it is less hardy than the perennial species.

ORCHARD GRASS

Orchard grass *Dactylis glomerata* commonly called cocksfoot in England, possesses somewhat greater frost resistance than does perennial rye grass. Like the latter it is well adapted to Vancouver Island and to the mainland of British Columbia west of the Rocky Mountains, but it winter-kills periodically in Eastern Canada. Nevertheless, it is sufficiently hardy in many areas in the eastern provinces to survive three winters out of four. In western Ontario, where conditions are less severe, it is a comparatively safe crop. At Lennoxville it has persisted in clipped pasture plots for four years in succession. Its range of adaptation is being studied very closely at Ottawa and on all Branch Farms in Quebec and the Maritime Provinces.

Orchard grass is valued in European countries both for hay and pasture. As with timothy, the seed of commerce produces stemmy plants of the strictly hay type but leafy persistent pasture types are being developed. Orchard grass withstands drought better than many other species and its ability to "come back" quickly after cutting or grazing is one of its chief merits. Experience with this species indicates that orchard grass will have a place in Eastern Canada as a constituent of pasture mixtures.

There are marked differences in winter hardiness between some 60 strains selected at Ottawa. Two or three of these have shown much promise and the seed is being multiplied.

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FESCUE GRASSES

Meadow fescue *Festuca elatior* is sufficiently winter-hardy in all parts of Canada. Tall fescue is a somewhat taller and coarser form of the same species. These fescues are adapted to rich, moist, or even wet soils. They do not succeed under dry conditions or on sandy land. The grass is grown in Europe for both hay and pasture but it is better suited for pasture than for meadows Meadow fescue is not produced in Canada to any appreciable extent although it can be grown in any of the more humid areas. Experiments indicate that it could be used with advantage in seeds mixture for pasture in Eastern Canada or in the Red River Valley of Manitoba.

It is questionable whether the smaller growing species, such as red fescue, sheep's fescue or hard fescue, should be regarded as of much importance from a forage standpoint in Canada. Genuine creeping red fescue is a possible exception as this species grows well and produces seed abundantly on the black soils of Alberta. At Lacombe, Alta.; Lennoxville, Que.; and at Ottawa, it is being tested as a pasture grass. Several strains, including Chewings' selection of red fescue, are under observation at Ottawa.

MEADOW FOXTAIL

Meadow foxtail *Alopecurus pratensis* is adapted primarily to moist cool regions. It is exceptionally frost resistant and begins growth very early in the spring. This grass is therefore well adapted to conditions in Eastern Canada. It has always looked promising at Ottawa and the progenies of some selected plants are being tested. In the pasture plot experiments it produced fairly high dry matter and protein yields, standing fifth in order among the cultivated pasture grasses. At Lennoxville, it has persisted well in pasture plots over a period of four years and has yielded almost as well as timothy. Unfortunately, the seed of meadow foxtail is light and difficult to handle in seeding and in harvesting. This fact, probably more than any other, and also its lack of drought resistance, tends to restrict its usefulness.

TALL OAT GRASS

Tall oat grass *Arrhenatherum elatius* has been tested for many years at Ottawa and on practically all of the Dominion Experimental Farms in Canada. It is a tall-growing drought-resistant species which, when it does not winter-kill, is quite productive and makes a very acceptable hay crop. Tall oat grass has about the same range of adaptation as orchard grass but it is somewhat less winter-hardy. It is therefore an unsafe and disappointing grass to grow except in British Columbia west of the mountains and perhaps in the southwestern section of Ontario. In some years at Ottawa it has produced excellent crops of hay but more often it has been killed or badly injured. On eastern Branch Farms it has been grown most successfully at Ste. Anne de la Pocatière, but there also it has winter-killed.

Tall oat grass is less useful for pasture than for hay as it does not stand grazing well. The seed is very difficult to handle, especially in seeding, because of the long twisted awn.

REED CANARY GRASS

Reed Canary grass *Phalaris arundinaceae* is a hardy native tall-growing perennial plant which is most at home in moist locations. It will thrive in water, and for this reason it is one of the most profitable grasses to grow on low land which is flooded periodically. Curiously enough, it is also very drought resistant, remaining green through hot summer weather on soil that is very dry. Under

such conditions, however, it is not productive, and it is very doubtful whether reed canary will ever replace to any extent the best available hay and pasture grasses on well-drained upland soil.

The Division of Forage Plants, Dominion Experimental Farm, has conducted experiments with reed canary grass for many years. These tests have shown that it is a valuable grass to grow on land which becomes flooded with water for a time each season. It does not thrive where stagnant water lies on the land throughout the summer but it grows well with free water close to the soil surface. Reed canary grass is most useful on land that is too wet for most other crops and especially on peaty and muck soils.

Once reed canary grass is established it will last for many years and may be cut for hay or pastured. It spreads by underground stems and forms a good sod, but unlike quack grass, it is fairly easy to eradicate if one desires to do so. There is no danger that it will give trouble by spreading to the cultivated upland fields.

To make the best quality hay, reed canary grass must be cut before it becomes too coarse. This is about the time that the heads appear. Hay cut at this stage will not give maximum yields but the feeding value, both protein content and palatability, will be greatest. Besides, early cutting of the first crop ensures a second cutting under favourable conditions. This second crop is always leafy and of good quality.

Those who wish to harvest seed must let the crop stand until the seed has matured. At this stage the stems are coarser but the leaves are still green and the crop will make fairly good feed. The aftermath, however, will be light and probably not worth cutting for hay.

Reed canary grass makes a very satisfactory pasture crop which starts early in the spring and continues to produce throughout the summer when soil and moisture conditions are favourable. Growth continues fairly late into the fall. The best pasture conditions are not secured until after the grass has become thick enough to form a good sod. It is advisable to cut the crop as hay for a year or two after seeding until a satisfactory sod for pasturing has been established.

Reed canary grass should be sown at about ten pounds of seed per acre on a well-prepared seed bed. Shallow seeding is necessary. The cost of seed is high, about 75 cents to $1 per pound. Because of this the seed is often sown at four or five pounds per acre and the plants allowed to thicken up more slowly and form a sod through the growth of underground stems. Seeding may be done either with or without a nurse crop. If weeds become troublesome they should be clipped back. Preparation of the land should be done in the fall of the year when the soil is dry and the seed should be sown early the next spring. If the land is likely to be wet in the spring, seeding should be done in the late fall, when the seed will not germinate until the following spring. If spring cultivation is necessary to prepare the land, it is better to delay seeding until late June or even July until the weeds are controlled and a good seed bed has been prepared.

Seed production of reed canary grass is a little difficult because the seed shatters readily, making it necessary to harvest at exactly the right time. This is when seeds in the upper half of the panicle are grey or brown in colour. Yields vary from 50 to 250 pounds per acre. The seed has a smooth oily appearance and weighs about 30 pounds per bushel. A beginning has been made at seed production in Canada, but Minnesota, Iowa, and Oregon are the chief sources of supply at the present time.

PERENNIAL AND BIENNIAL LEGUMES

The chief perennial and biennial legumes grown in Canada are red clover, alsike, white clover, alfalfa, and sweet clover.

RED CLOVER

Red clover *Trifolium pratense* has approximately the same range of adaptation as timothy. It is the most important legume produced in Canada, being grown extensively in all of the eastern provinces and in British Columbia. In the Prairie Provinces red clover can be grown successfully only in certain areas such as northern Manitoba, the district centering about Edmonton, Alta., and on irrigated land in southern Alberta.

The standard test of red clover varieties on Branch Experimental farms includes the following:—

1. Ontario early double-cut type (commercial).
2. Ontario early double-cut type (Ottawa selection).
3. Mammoth late single-cut type (Oxdrift).
4. Altaswede, late Swedish type (University of Alberta).

Best results have usually been secured from the genuine Ontario early double-cut type. Through natural selection this red clover has attained a degree of adaptation that is not possessed by most of the seed imported into this country. An important adaptation is the high percentage of plants which have hairy stems and foliage, a characteristic which affords protection from the attacks of leaf-hoppers. It is believed that these insect pests are responsible for eliminating the smooth or non-hairy types from red clover which has been grown from seed for several generations under Canadian conditions. Extensive tests of introduced red clovers from foreign sources have shown clearly the superiority of the Ontario and Quebec grown seed of the early double-cut type and the unsatisfactory character of much of the seed imported from overseas, especially from southern Europe. European red clovers, for the most part, are smooth types which together with their less hardy character, largely accounts for their lack of adaptation.

Mammoth late red clover is grown for seed in parts of northern Ontario, notably in the Oxdrift district. It blooms about three weeks later than early red clover and produces only one cut of hay per season. Most of the northern grown seed of late red clover is more or less mixed with the early type. Mammoth late red has a tendency toward perennialism and frequently survives the second winter. For this reason it is recommended in European countries in seeds mixtures for pasture. The pasture experiments at Ottawa and on eastern Branch Farms, provide for a close comparison of late and early red clover for grazing purposes.

Altaswede, a selection of the late Swedish type of red clover, is grown to some extent for forage and seed in the Edmonton district of Alberta. This variety also is being investigated for pasture. The plants are quite variable with respect to the degree of hairiness, this being one reason why the adaptation of Altaswede to eastern conditions is problematical.

Breeding.—Special attention is being directed to the improvement of red clover. An important feature of this work is the conservation of indigenous material. Tests are being made of seed samples representing locally grown Ontario and Quebec stocks in order to determine sources of seed which are typical of the early double-cut and late single-cut types. Provision is made in the Seeds Act for inspection of growing crops and seed certification by the Dominion Seed Branch.

Improvement is being effected also by systematic mass selection within the best home-grown seed. This has resulted in a very hardy and productive strain of early red clover which has outyielded other varieties in tests at Ottawa. Seed of this strain is being multiplied and a considerable quantity of the 1933 crop was certified and placed in the hands of good growers for further production. An ambitious breeding project has also been undertaken to determine the possibility of improving red clover by the composite crossing of superior plants.

A comparison is being made of varieties and strains for hay and pasture. The relative value of early and late red clover for grazing purposes is a matter of considerable interest in our pasture work. Seed production experiments are conducted at Ottawa and Kapuskasing, Ont., and at Lethbridge, Alta.

ALSIKE CLOVER

Alsike clover *Trifolium hydridum* is grown extensively for hay and seed in certain parts of Ontario. It thrives better than red clover on some soils especially those which incline to acidity. Alsike is partial to low lying land where moisture is abundant. In the red clover districts it is regarded as good practice to include about two pounds of alsike seed in the timothy and red clover mixture. It possesses somewhat greater winter-hardiness than red clover.

It has not been possible to detect any substantial difference in crops of alsike from seed grown in different parts of Ontario. Adequate tests of Canadian alsike with European strains have not been made nor has attention been given to the improvement of this crop.

WHITE CLOVER

Various varieties and strains of white clover *Trifolium repens* are being studied. The standard variety test on Branch Experimental Farms include the following: Common White Dutch, Danish Morso, English Wild White, and Ladino or Mammoth white clover. The method of testing is to seed the clover in replicated plots with grass and to clip the herbage periodically to simulate grazing. These and other strains are seeded also in rows in forage crop nurseries at Ottawa and the majority of Branch Farms.

Observations to date indicate that Common White Dutch clover lacks persistence and to some extent winter-hardiness. It is doubtful whether English Wild White will prove entirely suitable for Canadian conditions. It lacks winter-hardiness and productivity, especially under dry conditions. Danish Morso is a very promising strain of white clover, possessing greater frost resistance than either Common White Dutch or English Wild White. It produces more herbage than the latter and forms a better sward than the former. Mammoth White clover is especially promising. It is the most productive of these varieties and it has survived the winters remarkably well. It remains to be seen how persistent it will be under grazing.

Little has been attempted by way of improving the white clovers. Seed has been collected at Lennoxville, Que., Nappan, N.S., and Charlottetown, P.E.I., from native plants in the wild and these ecotypes will be studied with considerable interest.

ALFALFA

Tests of alfalfa *Medicago media* on Dominion Experimental Farms and other institutions have shown that this crop can be grown very successfully in all of the provinces of Canada. Alfalfa does not tolerate soil acidity and it is not productive where the available moisture is very limited. Once established, however, it will persist under very dry conditions because the strong tap root is able to penetrate the subsoil to great depths. A considerable area in the semi-

arid sections of the West receives scarcely enough rainfall to produce profitable crops except on low-lying land which receives the run-off from the surrounding slopes. The Experimental Station at Swift Current, Sask., has shown that hundreds of small fields could be established successfully in such locations if they were carefully selected.

Inbreeding a promising strain of alfalfa by bagging the flowers to prevent cross-pollination.

In Western Canada the Branch Experimental Farms at Brandon, Indian Head, Lacombe and Beaverlodge have had excellent results with alfalfa. Lethbridge has found that no other crop is so well adapted to irrigated land. The Station at Scott, however, has not been successful in growing alfalfa for reasons which are not well understood. This problem is being investigated at the present time, but the difficulty seems to be associated with the type of soil found in the district. These experiments have demonstrated that the black soils, or park belt areas of the Prairie Provinces are highly adapted to the growing of alfalfa, as also are some of the better moisture holding soils of the adjacent plains.

In Eastern Canada there are large sections where alfalfa produces exceptionally well. Especially is this true of Western Ontario and of the Ottawa valley. On acid soils such as are found quite generally in parts of Quebec and the Maritime Provinces, liming is absolutely necessary.

Yellow Flowered Alfalfa.—The hardiest species of alfalfa have yellow flowers and sickle-shaped pods. Numerous native forms grow wild across the northern plains of European Russia and Siberia. Many strains of Siberian alfalfa, as it is sometimes called, have been tested in Canada. There was high hope both in United States and Canada at one time that some of these Siberian strains could be established on the western range lands and that they would spread naturally from seed, thus improving the vegetation for grazing. This hope was never realized. Siberian alfalfa has not only proven disappointing for this purpose but, due to poor seeding habits, its use as a cultivated crop also has been a failure. Seed production has proved to be highly unprofitable and the seed has become more and more expensive until now it is very difficult to obtain, and costs two or three dollars a pound.

Because of its exceptional winter-hardiness, Siberian alfalfa is not without great possibilities, especially as a pasture plant. What is needed are strains that will set seed freely. Recently we have obtained a new supply of seed from the U.S.S.R. which was collected by hand from wild plants in Siberia. Numerous plants from this seed will be grown and studied in an effort to secure a desirable type with good seeding habits.

COMMON ALFALFA.—Common, or blue-flowered alfalfa is commonly grown in milder climates than ours and is not adapted to Canadian conditions. An exception should be made in the case of certain strains of Turkestan alfalfa which possess considerable frost resistance.

VARIEGATED ALFALFA.—In extensive tests of variegated varieties of alfalfa, including Grimm, Ontario Variegated, Cossack, Baltic, Macsel, Grimm Sask. 451 and Grimm Sask. 666, no significant differences in yield have been found. The varieties grown almost exclusively in Canada are "Grimm" and "Ontario Variegated."

With these at our disposal the successful growing of alfalfa becomes much more a question of management than one of varietal hardiness. Given a hardy variety and proper management, and inoculation of the seed with bacterial culture where necessary, there is no reason why the acreage of this very valuable crop should not be greatly extended beyond that which is grown at the present time.

Seed of the Grimm variety is produced chiefly on irrigated land in southern Alberta but considerable quantities are now being grown also on dry-land farms in Manitoba and Saskatchewan. Grimm alfalfa is eligible for registration by the Canadian Seed Growers' Association. Seed of Ontario Variegated is produced chiefly in western Ontario. It may be certified and sealed in the sack, providing the growing crop passes inspection by officers of the Dominion Seed Branch.

A comparatively new variety called "Ladak" has recently come into prominence in the United States, where it has been thoroughly tested and found to be productive, exceptionally winter-hardy, and what is still more important, fairly resistant to a disease known as "alfalfa wilt." This insidious disease has spread very rapidly in the alfalfa-growing sections of the United States, and while it has not been found in Canada there is no telling when or where it may put in an appearance. Ladak alfalfa comes originally from a province of Kashmir called Ladakh, high up in the Himalayan mountains just north of Tibet.

In productive capacity Ladak alfalfa is showing up very well in tests conducted on Dominion Experimental Farms. The writer introduced Ladak from the United States first in 1925 and seeded it at the University of Saskatchewan in a comparative test with several other varieties. In order to secure reliable results, the plots of each variety were replicated nine times and yields were taken for three successive years, in 1926, 1927, and 1928. In this test Ladak yielded significantly higher than Grimm in all three seasons.

In 1927 Ladak alfalfa was seeded in small plots in comparison with eight other varieties, including Grimm, at the Dominion Range Experiment Station at Manyberries, Alta. During the years 1928 to 1931, Ladak appeared to be the hardiest of all varieties in the test.

In the spring of 1932 Ladak alfalfa was included in the standard test of alfalfa varieties at Ottawa and on Branch Farms in Western Canada. Yields

for 1933 only are available. These show that at Ottawa, Indian Head, Lethbridge, and Beaverlodge, Ladak outyielded both Grimm and Ontario Variegated. At Brandon and Lacombe it was outyielded by both the other varieties.

At Manyberries, Ladak outyielded Grimm by 828 pounds per acre in the first cutting. Grimm, however, made a much quicker second growth than did Ladak and outyielded it by 789 pounds per acre in the second cutting. There was therefore very little difference in the total yield. The result at Manyberries emphasizes one characteristic of the Ladak variety which should be an advantage in those areas in the West where it is advisable to take only one cutting per season, namely, the ability to produce a strong growth for the first cut of hay.

Hybrid self-tripping alfalfa plants of families bred for seed production. Note the heavy crop of pods on three of the plants as compared with the check plant on the right which has practically no pods.

One of the most comprehensive tests of alfalfa varieties has been conducted at the Dominion Experimental Station at Beaverlodge, Alta., in the Peace River country. The results are particularly interesting because of the number of years during which the experiments have run and because of the extreme northern latitude in which the Station is located. These are tabulated below in summarized form as presented by the Superintendent.

TABLE 1.—RELATIVE AVERAGE YIELDS OF ALFALFA VARIETIES EXPRESSED IN PER CENT OF THE STRAIN OF GRIMM WHICH IS PRODUCED IN SOUTHERN ALBERTA AND SOLD BY THE ALFALFA SEED GROWERS' ASSOCIATION AT BROOKS, ALBERTA

Variety of strain	Number of annual seedings	Number of plots harvested per annum[1]	Percentage yields of cured hay
Grimm (Brooks)	8	92	100·0
Grimm (Beaverlodge)	2	32	95·9
Grimm (Lyman)	4	42	94·0
Grimm (Sask. 451)	5	40	92·8
Grimm (Sask. 666)	3	28	101·5
Ontario Variegated	7	74	96·8
Cossack	8	92	91·1
Baltic	5	62	97·4
Macsel	5	62	92·4
Scout	2	28	96·4
Siberian Yellow Flowered	6	80	90·8

[1] Plots cut once per season.

Breeding.—The improvement of alfalfa with respect to seed production is a major project of the Division of Forage Plants. The Dominion Forage Crops Laboratory at the University of Saskatchewan is co-operating with the Central Experimental Farm at Ottawa in this work. The problem is being attacked chiefly from the standpoint of genetics and some attention also is being given to the study of physiological factors. The following papers outline the basis and salient features of this study.

Kirk, L. E. and White, W. J. Autogamous Alfalfa. Sci. Agric. 13:591-593. 1933.

Kirk, L. E. Alfalfa breeding for seed production. Proceedings of the World's Grain Exhibition and Conference at Regina. Science Papers, Vol. 2, 1934.

Armstrong, J. M. and White, W. J. Factors which affect seed setting in alfalfa. In press.

A study of the "Inheritance of seed-coat colour in alfalfa" has been completed and will be published shortly.

SWEET CLOVER

White blossom and yellow blossom sweet clover *Melilotus alba* and *M. officinalis* are adapted to a very wide range of soil types and climatic conditions. For this reason sweet clover can often be grown on soils which are not suited to alfalfa but it is quite as exacting as alfalfa in its lime requirements. It is not at all tolerant of soil acidity. With respect to moisture requirements, sweet clover is much more productive under dry conditions, chiefly because it is a biennial plant and can thus take advantage of reserve subsoil moisture. Experiments in the West have shown that sweet clover will produce more feed than any other crop in a very dry season. It possesses also a greater tolerance of alkali salts than almost any other cultivated crop. It can be grown successfully on soils that are too strongly alkali for wheat, barley or oats.

An annual test of sweet clover varieties is being conducted on 14 of the Dominion Experimental Farms. The standard test includes the following varieties: White blossom—Common, Arctic, Arctic A. Grundy County, Alpha, and Brandon Dwarf; Yellow blossom—Albotrea, I. H. C. Selection.

White blossom sweet clover is generally preferred to the yellow blossom because of its erect habit of growth, slightly better yield, and a preference in flower colour. Yellow blossom grows more prostrate and seed frequently ripens

on the lower uncut or ungrazed branches, thus enabling it to persist from volunteer plants. This is considered by many to be an objection. On the other hand, on rough pasture land the tendency to persist has obvious advantages.

Seed of commerce consists almost altogether of common white blossom, Arctic, and common yellow blossom. The Arctic variety is preferred to common white blossom in Saskatchewan and Alberta because of its earlier maturity, somewhat shorter and finer stems, and greater winter-hardiness. Alpha is a fine stemmed semi-dwarf leafy strain that branches freely at or near the crown. It also contains much less coumarin than common sweet clover. This variety is finding favour, especially in those areas where common sweet clover or Arctic grows too coarse. Seed stocks are still quite inadequate. Brandon Dwarf is similar to Alpha in many respects but more dwarf in habit of growth. Arctic A is a pure strain developed from a selected single plant. Grundy County is a western American variety which is similar in many respects to Arctic and adapted to the same area.

Albotrea is a strain of typical common yellow blossom sweet clover. I. H. C. Selection was developed by a process of selection at the Brandon Experimental Farm from the I. H. C. variety. It differs markedly in certain respects from common yellow.

Experiments have shown that the western varieties, Arctic and Alpha, are not well adapted to eastern conditions. Here the seed of commerce consists entirely of common white blossom or yellow blossom sweet clover. The variety Albotrea, which originated in Ontario has disappeared from the trade.

BREEDING.—Sweet clover breeding is conducted mainly at the Dominion Forage Crops Laboratory located at the University of Saskatchewan. The methods employed include inbreeding, hybridization, and selection. Effort is being directed toward the development of pure strains which are fine stemmed and leafy, winter-hardy, disease resistant and free from the bitter taste due to coumarin.

Inheritance studies include the following:—

1. Intergeneric crosses between Melilotus, Medicago, and Trigonella.
2. Interspecies crosses in Melilotus.
3. Inheritance of seed pigmentation in Melilotus.
4. Inheritance of pod colour in Melilotus.
5. Inheritance of seed-coat permeability in Melilotus.
6. Selection of coumarin-free strains of Melilotus.

Important advances have been made in all of the above studies and results will be published in due course.

A contribution from the Division of Forage Plants at Ottawa has recently been submitted for publication entitled " A Single Factor Mutation in *Melilotus alba* Desc. Having Multiple Effects in Homologous Structures."

PLANT INTRODUCTIONS

In addition to the species of perennial and biennial grasses and legumes which have been dealt with in the preceding paragraphs, the forage crops nurseries contain many introduced species from foreign sources as well as native species collected in Canada. When these have been grown at Ottawa and have been found to show some promise as forage plants they are sent to the Branch Farms for further study as to their regional adaptation. The plant introduction nursery at Ottawa contains the following:—

—	Genera	Species	Strains
Perennial grasses	38	69	134
Perennial and biennial legumes	17	21	41
Annual grasses	10	11	49
Annual legumes	12	29	92
Other than grasses and legumes	7	10	12

Special interest attaches to certain species of legumes which are highly tolerant of soil acidity. These include the following:—

Perennial Lespedeza—*Lespedeza sericea.*
Annual Lespedeza—*Lespedeza spp.*
Lupines—*Lupinus spp.*
Seradella—*Ornithopus sativus.*
Zigzag clover—*Trifolium medium.*
Crown Vetch—*Coronilla varia.*

Perennial lespedeza has winter-killed at Ottawa in each of the last two seasons. An extra-early annual form of lespedeza matured an abundant crop of seed both in 1932 and 1933. Good seed crops were obtained also on Branch Farms in the Maritime Provinces and at Brandon, Man. Tests of this legume as a pasture crop, however, were disappointing, due chiefly to the small amount of herbage produced. It is not expected that annual lespedeza will compete successfully with white clover in permanent pastures, but its possibilities will be more fully investigated.

Lupines (annuals) do not thrive at Ottawa, the weather being too hot and dry in midsummer. Experiments on Branch Farms in the Maritime Provinces indicate that they are much better adapted to that area. Their value for ploughing down on light land is being investigated. Lupines prefer acid soils.

Seradella (annual) has produced excellent growth on Branch Farms in the eastern provinces and its value as a cover crop in orchards is being investigated. It has not produced seed.

Zigzag clover (perennial) resembles red clover, but unlike the latter it is highly tolerant of soil acidity. Its usefulness is greatly restricted because of the very small quantity of seed which it produces.

Crown vetch (perennial) appears to be quite hardy in Eastern Canada. It may be very useful on acid soils.

HAY AND PASTURE INVESTIGATIONS

With respect to the problems of perennial and biennial grasses and legumes sown alone and in mixtures for hay and pasture, it is apparent that discussion will be facilitated by considering these questions as they affect the major agricultural zones within Canada, since these are determined by soil and climatic factors which control the adaptation of all forage plants. Having in mind the fact that space is available only for a very limited discussion of this subject, it seems advisable to consider only the general conclusions based on experimental work, first in Ontario, Quebec, and the Maritime Provinces as a whole, then in the Prairie Provinces, and lastly in the Pacific Coast area of British Columbia west of the Rocky mountains.

EASTERN CANADA

HAY.—The main species grown for hay in Eastern Canada are timothy, red clover, alsike, and alfalfa. The first three of these crops are so well and so widely adapted to climatic conditions in all of the eastern provinces that they

are grown almost to the exclusion of all others. Sometimes they are grown separately, and especially is this the case with alfalfa, but more often timothy and red clover are grown together. Red clover may be replaced by alsike in areas where the latter is better adapted. Frequently two or three pounds of alsike seed is included with timothy and red clover, a practice which is generally recommended. On soils that are adapted to alfalfa, as at Ottawa, we have found the addition of four to five pounds of alfalfa highly desirable. Mixtures of timothy, clover, and alfalfa have outyielded all other mixtures for hay by a very substantial amount. The following results obtained during the last three years from perennial grass plots seeded in 1929 show the wide spread in yields of hay which may result from different mixtures:—

RESULTS FROM PERENNIAL GRASS PLOTS SEEDED IN 1929

Crop	Yield per acre (moisture-free)			
	1931	1932	1933	Average
	lb.	lb.	lb.	lb.
Timothy	1,843	1,625	1,884	1,784
Mixture A	5,444	2,254	1,700	3,133
Mixture B	7,305	7,576	3,295	6,059
Mixture C	7,740	8,287	3,315	6,447

Mixture A consisted of timothy, red clover, and alsike. Mixture B contained alfalfa in addition. Mixture C was made up of timothy (8), red clover (8), alsike (2), alfalfa (6), orchard grass (2), meadow fescue (2), Kentucky blue grass (2), red top (2), and common white Dutch clover.

The greater yields from mixtures B and C were due almost entirely to the presence of alfalfa in the mixture. It should be said that alfalfa is particularly well adapted to soils on the Central Experimental Farm at Ottawa, and also that the three years in question were relatively dry seasons which enabled the alfalfa to show up to advantage. The addition of orchard grass, meadow fescue, and the bottom grasses (Kentucky blue, red top, white Dutch clover) apparently slightly improved mixture C over that of mixture B. The advantage of adding the bottom grasses would be more apparent if the field were utilized as pasture following two years of hay.

At Ste. Anne de la Pocatière, a test was made of twenty-eight mixtures of grasses and legumes which were seeded for ten consecutive years in duplicate $\frac{1}{50}$th-acre plots. This experiment was concluded in 1933. The trials were conducted on clay soil, well drained and of good fertility. Hay crops were harvested only for two seasons and a single cut taken. The average yields of the best mixtures were about two tons per acre. At the first cut the yield was better when the seeding comprised more legumes than grasses; at the second cut the best results were obtained in plots heavily sown to grasses. The seedings of timothy and clovers alone provided a good cut of hay, but a poor aftermath. Red top and Kentucky blue grass did not prove to be predominant species in the various mixtures.

In view of the fact that each annual seeding at Ste. Anne de la Pocatière was harvested only for two successive seasons, it follows that bottom grasses and the white clover could not provide their full efficiency of production. For this reason, the mixtures of timothy and clovers alone produced almost as much as any of the other mixtures, and their seeding cost was much lower.

Hay tests conducted at Lennoxville, Que.; Fredericton, N.B.; Kentville, N.S.; Nappan, N.S.; Charlottetown, P.E.I.; and Kapuskasing, Ont., have given similar results to those obtained at Ottawa and Ste. Anne de la Pocatière. These serve to confirm the conclusions derived from experiments at the latter places.

PASTURE.—At Ottawa a series of test plots were seeded in 1929 for the purpose of testing pure species and mixtures for pasture. All plots were replicated six times. These were clipped with a lawn mower four times per season to simulate grazing. The average yields of herbage per acre (moisture-free basis) for 1931 and 1932 were as follows:—

TABLE 2.—AVERAGE YIELDS OF PASTURE HERBAGE

Grasses and mixtures	Dry-matter per acre
	lb.
Timothy	948
Orchard grass	715
Meadow fescue	754
Kentucky blue grass	797
Canada blue grass	1,242
Red top	1,348
Western rye grass	1,007
Reed Canary grass	1,257
Mixture A	1,312
Mixture B	1,687
Mixture C	2,010
Mixture D	3,977
Mixture E	3,293

Composition of mixtures (pounds per acre in brackets).

A: Timothy (8), red clover (6).
B: Timothy (10), red clover (10), alsike (2).
C: Timothy (3), red clover (5), alsike (2), alfalfa (10).
D: Timothy (8), red clover (8), Alsike (2), Alfalfa (6), orchard grass (2), meadow fescue (2), Kentucky blue (2), red top (2), White Dutch clover (1).
E: Timothy (2), alsike (2), alfalfa (5), orchard grass (4), meadow fescue (3) meadow foxtail (2), tall oat grass (3), yellow trefoil (1), white Dutch clover (1). *Ontario Agricultural College mixture.*

It is apparent from the results of this experiment that it was highly profitable to include alfalfa in Mixture C and that the further addition of small amounts of orchard grass, meadow fescue and the bottom grasses in Mixture D further greatly improved the yield of herbage.

At Lennoxville, Que., a series of 25 pasture plots, in duplicate, of pure species and mixtures were laid down in 1930. These were clipped eight to ten times per season for the last three years. Of the various pure species tested, timothy and orchard grass gave, on the whole, the most satisfactory results. Both grasses have maintained their stand in pure culture and still form a fair proportion of the herbage where they were included in the mixtures.

Botanical analyses of the plots made in 1933 gave an excellent indication of the relative persistence of the different species. Good stands of the following species were maintained throughout the four year period: timothy, orchard grass, red top, meadow foxtail, red fescue, reed canary grass and red clover. Kentucky blue grass and Canada blue grass maintained themselves when seeded alone but failed rather badly in competition with other species. Alfalfa was practically eliminated by the close clipping, this being more severe than the clipping treatment used at Ottawa. The amount of white clover in the plots was not uniform but it averaged about 15 per cent. The timothy—red clover—alsike mixture gave the highest yield.

At Fredericton, N.B., in 1932, an acre of land was seeded with 5 pure species and 5 mixtures for pasture. These were grazed in 1933 and yields secured from caged areas. Timothy gave the highest yield of the grasses seeded separately. Red top was next, followed in order by Kentucky blue, orchard grass and crested wheat grass. The highest yielding pasture mixture consisted of timothy (8), red clover (8), alsike (2), Kentucky blue grass (5), red top

(3), White Dutch clover (1). In this experiment the addition of orchard grass, meadow fescue and alfalfa did not compensate for the omission of bottom grasses.

Sheep grazing experiment at Ottawa to test the pasture value of different grasses and legumes.

In 1932 and 1933, pasture investigations were greatly extended at Ottawa to include a comprehensive test of pure species and mixtures with different fertilizer treatments under a system of controlled grazing as well as more extensive tests on clipped plots. Special experiments were also laid down on five of the eastern Branch Farms to determine the adaptation and yield of pure species and mixtures grown at different levels of soil fertility. As all of these experiments are in the initial stages, it will be more satisfactory if the data already obtained are reserved for a later report.

PRAIRIE PROVINCES

Hay.—In the three Prairie Provinces, hay crops are confined almost exclusively to slender wheat grass, brome grass, alfalfa and sweet clover. Timothy is also used to a limited extent in certain of the more humid sections. To these may now be added crested wheat grass, a comparatively new crop of exceptional promise for the drier areas. These grasses and legumes are most frequently grown separately in pure cultures but they are also seeded in various combinations such as slender wheat and brome grass; slender wheat grass and alfalfa, or brome grass and alfalfa. There is much to be said for this practice where it is not desired to take a seed crop. Especially is this true in the case of alfalfa mixed with one or two of the grasses.

In an experiment conducted at Saskatoon, Sask., over a period of eight years, involving 18 crops of hay, a comparative test was made between slender wheat grass, brome grass, and alfalfa seeded separately, and when mixed in various combinations. The results of this test, as reported by the Dominion Forage Crops Laboratory at the University of Saskatchewan, was that there were no significant differences in yield between any of the pure species, nor between any one of them and a mixture of the two grasses. This was explained on the basis that at Saskatoon moisture was always the limiting factor in

growth. In other words, each of the three crops and also the grass mixtures used up annually all of the available moisture, after which growth was strictly limited by the amount of seasonal precipitation.

Mixtures of slender wheat grass with alfalfa or brome grass with alfalfa, however, did yield significantly more than any of the three when seeded alone. The reason for this seemed to be that the alfalfa helped to supply nitrogen for the grass by reason of the fact that it was able to secure it from the air through nodule-bacteria on its roots. This assumption was borne out by the more vigorous appearance and deeper green colour of the grasses growing with alfalfa as compared with the grasses growing by themselves. By taking samples in each for two years and analyzing them, it was found that the brome grass growing with alfalfa contained 16 per cent more protein than that growing alone. The increase in protein shown by western rye grass was still greater, being almost 40 per cent. Not only, therefore, did the grass and alfalfa mixture give a significantly greater quantity of feed, but the quality of the grass was greatly improved by growing the alfalfa with it.

Tests of crested wheat grass in comparison with brome and western rye grass for hay are being conducted on all of the Dominion Experimental Farms in the Prairie Provinces but these have not yet run long enough to provide satisfactory data. Results are available, however, from the Dominion Forage Crops Laboratory at Saskatoon covering a period of five years. These are given in Table 3.

TABLE 3.—YIELD COMPARISONS OF CRESTED WHEAT GRASS, SLENDER WHEAT GRASS AND BROME GRASS FOR 1927 TO 1931 INCLUSIVE. SEEDED IN 1926, 1-20 ACRE PLOTS IN DUPLICATE

Crop	Cured hay per acre					
	1927	1928	1929	1930	1931	Average
	lb.	lb.	lb.	lb.	lb.	lb.
Crested wheat grass	3,576	2,627	1,580	734	1,106	1,925
Slender wheat grass	3,060	3,186	1,458	482	811	1,799
Brome grass	2,108	3,044	1,470	784	1,040	1,689

The differences in average yield for the three grass crops shown in Table 4 are not great, but they are sufficient to indicate that crested wheat grass yielded as well or better than either of the other two grasses. Table 4 gives the chemical composition of crested wheat grass, western rye grass and brome grass based on crops harvested at Saskatoon. Determinations were made by the Division of Chemistry, University of Saskatchewan.

TABLE 4.—CHEMICAL COMPOSITION OF CRESTED WHEAT GRASS, SLENDER WHEAT GRASS, AND BROME GRASS HAY. FOUR YEAR AVERAGE 1927-1930 INCLUSIVE

Name of grass	Percentage composition of dry matter					
	Crude protain	Carbo-hydrates	Crude fat	Crude fibre	Total ash	Ash on fibre
	%	%	%	%	%	%
Crested wheat grass	9·73	51·48	2·02	30·04	6·73	0·61
Slender wheat grass	9·18	48·11	2·11	34·14	6·46	0·37
Brome grass	10·27	51·43	1·66	28·60	8·04	0·43

The relative value of these grasses and legumes for hay and pasture was not by any means the same in the districts served by different experimental farms and stations in Manitoba, Saskatchewan, and Alberta. The Brandon Farm has found sweet clover and brome grass to be outstanding crops in

Manitoba. A mixture compounded of slender wheat grass and alfalfa has always done especially well at the Indian Head Farm. Brome grass and sweet clover thrive best at Rosthern. At the Scott station, western rye grass seems to be particularly well adapted, while alfalfa has never been grown successfully. Crested wheat grass is highly adapted to the areas served by the Stations at Swift Current, Scott and Manyberries.

Lacombe is located in the black soil belt of central Alberta and is favourably situated with respect to moisture so that a wider variety of grasses and legumes can be grown than in the drier areas. Timothy and alfalfa are the most desirable hay plants, especially so when grown together. Western rye grass, brome grass and sweet clover also hold prominent places as hay crops. At Beaverlodge, located in the Peace River country, a 4-4-4-4 mixture has given very good results, consisting of 4 pounds of seed each of western rye grass, brome grass, sweet clover and alfalfa. At Lethbridge, on irrigated land in southern Alberta, alfalfa is the main hay crop, being by far the best adapted for this purpose. Timothy is regarded as the best hay grass on irrigated land and experiments have shown that red clover is usually winter-hardy and very productive at Lethbridge.

PASTURE.—With regard to the question of pasture grasses and legumes in the Prairie Provinces, definite experimental data are available only for the last two years from two Experimental Farms located at Lacombe, Alta. and Brandon, Man. Experimental work in this connection has now been extended to include the laying down of special grazing tests on several of the Dominion Experimental Farms in the West. These provide comparisons of pure species and mixtures of slender wheat grass, crested wheat grass, brome grass, alfalfa, and sweet clover, and mixtures of these under actual grazing conditions. Experience for many years on all of the Branch Farms in the West, however, has given definite leads as to the best grasses and legumes for pasture, the consensus of opinion being that brome grass and sweet clover have been the most generally useful crops for this purpose.

An experiment to test the value of various species and mixtures for pasture was seeded at the Lacombe Station in 1931. The late fall cutting of the first year's growth resulted in most of the legumes being winter-killed. Another series of pasture plots in quadruplicate was seeded in 1932, consisting of 9 species of grasses and legumes and 7 mixtures. The herbage was cut with a hand sickle when the growth reached a height of about 8 to 10 inches. Samples were taken for dry matter and protein analysis, and in the case of the mixtures, the percentage by weight of dry matter which each species contributed to the herbage was determined. The following observations with reference to certain of the species and mixtures have been summarized from the annual report of the Superintendent:—

Brome grass produced the highest total yield per acre of both green and dry weight. It continued to produce a new leafy growth throughout the summer. The chief objection to brome grass as pasture was that it produced a rather soft herbage which was frozen early, so that it had little value for late fall, winter or early spring pasture. On the other hand, it formed a dense sod that stood continuous tramping well and was considered one of the best grasses for permanent pasture.

Slender wheat grass, though an excellent grass for hay, had little value for pasture except perhaps in grass mixtures for climatic conditions which are drier than those at Lacombe. It did not renew itself quickly after grazing and it tended to become more or less dormant during the summer regardless of whether or not conditions for growth were favourable. The fall growth was easily killed by frost and therefore of little value for late fall or early spring grazing.

Crested wheat grass at Lacombe responded in the same manner as slender wheat grass to continuous cutting. The growth was too sparse during the summer months, allowing the weeds to propagate. As a pasture grass it was considered that crested wheat should find its greatest usefulness in mixtures with other species in the drier areas.

Timothy proved to be an excellent pasture grass. It continued to produce succulent leafy herbage throughout the growing season. In districts where a moderate or heavy rainfall is assured, it was thought that timothy would probably be one of the best pasture grasses. The chief criticism of timothy was that the leaves were easily frozen in the fall. Late fall clipping had the effect of seriously reducing the yield.

Kentucky blue grass gave a relatively low yield of green herbage, but since its dry matter content was relatively high, the yield of dry matter per acre was greater than was indicated by the green weight. Although an excellent pasture grass, it was believed that Kentucky blue grass would be better adapted to more humid conditions than usually prevail in central Alberta. Kentucky blue grass was not injured by fall frosts as was brome grass and timothy.

Reed canary grass was the lowest yielding species in the pasture test. It would probably be better adapted to lower and wetter land. This grass developed rather slowly, indicating that older stands may give relatively larger yields. The herbage appeared to be coarse and rather unattractive for feed.

Yellow blossom sweet clover proved superior to white blossom sweet clover from the standpoint of both yield and winter-hardiness. The growth was retarded less by close cutting because of its more spreading habit of branching. Clover that was cut at freeze-up was injured much less for the next season than that which was cut earlier in the fall.

White blossom sweet clover was less satisfactory for pasture than the yellow blossom species for the reasons given above and also because fewer buds remained after cutting from which new growth could be produced.

Alfalfa was considered a better pasture plant than either white or yellow blossom sweet clover. After grazing it quickly produced new shoots throughout the season but it was not certain whether or not continuous cutting or grazing might result in winter-killing. Thus far it proved hardier than sweet clover, but it was observed that early fall cutting seriously reduced the vigour of growth in the next year and this effect was reflected in lower yields.

A mixture consisting of brome grass and sweet clover produced good yields of high quality herbage which on analysis was found to contain from 60 to 70 per cent of sweet clover. It was thought that sweet clover with brome grass may retard the development of the root-bound condition which develops with brome grass, thus prolonging its period of productivity. Another mixture which was considered very promising, consisted of slender wheat grass, timothy, and alfalfa. Alfalfa was regarded as a better legume constituent of pasture mixtures than sweet clover.

In 1931 an experiment was laid down at the Brandon Experimental Farm in which grasses and legumes were sown singly and in combination for the purpose of studying the pasture value of the different species and mixtures. Unfortunately, very poor stands were obtained with all seedings except those of brome and alfalfa. New seedings were made in 1932 with much better success. The plots were sown in May without a nurse crop and grasses were left undisturbed during the seedling year. Alfalfa and sweet clover made rank growth and were clipped in August. During 1933 the plots were clipped at intervals throughout the season and the green weight of the clippings taken. In addition, the proportion of the various species within a mixture was determined for each clipping. The plots were clipped at intervals when the crop was six to ten inches in height. Clipping was done with a Planet Junior garden tractor and field mower attach-

ment. The attachment was set ahead of the tractor and cut a swath forty inches wide. With this outfit it was possible to leave the stubble as short as one and a half inches. The following observations have been taken from the annual report of the Superintendent:—

Alfalfa was the outstanding species in the test. Not only did it provide pasturage quite early in the spring, but it yielded well throughout the season. While the last clipping was made on August 14 and further pasture was available in September, it seemed best to leave this growth for winter protection.

Sweet clover, both yellow blossomed and Brandon dwarf, gave good yields from the end of May to the end of August, after which no further growth was made. In both varieties seed was produced on the short lower branches, sufficient probably to reseed the land for next season.

Of the grasses, brome gave the best yields. It began growth early in the spring but, like nearly all the grasses in the test, it made very little growth during July and August.

Crested wheat was the first grass to start growth in the spring, showing green aproximately one week earlier than brome. However, its growth was not as rapid as that of brome and by May 22, when the first clipping was made, the latter outstripped it both in height and yield. During the summer months it remained practically dormant. It turned green again in the fall and probably would afford some pasture. The growth was too short for clipping when snow fell in October.

Western rye grass started its spring growth somewhat later than brome and while it gave some pasturage during the late spring and early summer, no growth of consequence occurred during July and August. In early September the western rye plots showed green again but not sufficient growth for clipping was made before snow fell.

Meadow fescue did fairly well. It was late starting in the spring but remained green all summer, unlike crested wheat and western rye. In total yield it was second only to brome among the grasses.

The addition of alfalfa or sweet clover to a grass mixture increased the yield of the mixture throughout the season. All the highest yielding mixtures contained alfalfa. Those mixtures which stood up well during July and August contained alfalfa or sweet clover. In fact the bulk of the crop consisted of these. The highest yielding mixtures were brome and alfalfa; brome, meadow fescue, and alfalfa; and brome and yellow sweet clover. Of the mixtures containing grasses only those having brome as a constituent were superior.

The proportion of the different constituents in the clippings from a mixture changed with each clipping. In mixtures containing grasses and alfalfa these constituents were in approximately equal proportions during the early part of the season. As the season advanced the proportion of alfalfa increased with a corresponding decrease in that of the grass.

In mixtures containing yellow sweet clover, the clover formed the greater part of the clippings in June and July, while during the other months the grass was equally as prominent.

When brome was mixed with crested wheat or western rye it formed the greater part of the clippings throughout the season. When mixed with meadow fescue, brome was considerably in excess during the early and late months. In June and July, the proportion of meadow fescue in the mixture practically equalled that of brome.

BRITISH COLUMBIA

Conditions at the Agassiz Farm are fairly representative of the Fraser River valley. Rainfall is usually adequate for maximum production of all classes of forage crops and the winter season is relatively mild. Timothy, orchard grass, perennial rye, Italian rye grass, red clover, alsike, and White Dutch clover

are all highly adapted to this area, so that conditions are much more favourable than anywhere else in Canada for the development of the best permanent pastures.

Test plots of alfalfa varieties at Ottawa

HAY.—At Agassiz during the five years, 1928-1932 inclusive, a test of six pure species and six mixtures was seeded annually in replicated plots to determine the most satisfactory crops for hay. Each seeding was harvested for two successive years so that the last crop will be taken in 1934. This will conclude the experiment and the results of the completed test will then be published. Based on the results of this work a new experiment was outlined and seeded in 1933 consisting of the following mixtures for hay:—

1. Early red clover, alsike, Italian rye, orchard grass.
2. Late red clover, alsike, Italian rye, orchard grass.
3. Late red clover, alsike, Italian rye, timothy.
4. Early red clover, timothy, orchard grass.
5. Late red clover, timothy, orchard grass.
6. Alfalfa, timothy, orchard grass.

The first mixture in this new series of test plots outlined above was the one which gave best results in the previous five-year test. It was distinctly superior to the mixture which is commonly used for hay in the district, namely timothy, early red clover, and alsike. The previous work showed also that grasses invariably did better when seeded in combination with clover than when seeded alone. The growing of clover alone was not found desirable because it lodged badly but when seeded in mixtures with grasses, the grasses supplied the necessary support to prevent lodging.

PASTURE.—A test of grasses and legumes for pasture was begun at Agassiz for the first time in 1933. This was seeded in replicated plots which will be cut frequently to simulate grazing. The test consists of six mixtures as follows:—

1. Timothy, early red clover, alsike, wild white clover.
2. Timothy, late red clover, alsike, wild white clover.
3. Timothy, orchard grass, alsike, wild white clover.
4. Perennial rye, orchard grass, alsike, wild white clover.
5. Perennial rye, wild white clover.
6. Orchard grass, wild white clover.

RANGE INVESTIGATIONS

The extensive ranching areas of Alberta, Saskatchewan and British Columbia are among the most valuable agricultural assets of this country. The conservation and improvement of these natural grasslands constitute a problem of the first importance. This is the chief objective of various lines of investigations which have been conducted during the past six or seven years at the Manyberries Station, located about one hundred miles south of Medicine Hat in the heart of the ranching country.

Problems on the range may be divided under two main categories, depending on whether the viewpoint is that of livestock management or conservation of the native vegetation. It is these latter phases with which the Division of Forage Plants is chiefly concerned. First and foremost is the effect of different systems of grazing (continuous, deferred and rotational) on the grass cover. Then there is the problem of range improvement, including a study of the best methods for regrassing of abandoned fields. Grazing capacity studies have also been undertaken. Finally a detailed botanical survey has been made of the native species of the short grass plains areas, and special attention has been given to a study of their nutritive value at different stages of growth. For purposes of discussion these may be considered under separate headings.

EFFECT OF RANGE MANAGEMENT ON THE NATIVE VEGETATION

An extensive study has been made during the last five years on the effect of different systems of range management on the native vegetation. These methods include continuous, deferred and rotational grazing. On the dry range lands of the short grass plains changes in the vegetation take place very slowly, so that determinations will have to be made several more years before sufficient accurate data are available to enable arrival at definite conclusions. However, the indications are that over-grazing has been responsible more than any other factor for the depleted condition of certain range areas. It seems clear also that the most economical way of restoring depleted pastures on the range is to protect them during the spring and summer months and then graze them in the fall and winter after the seed has been shed. If the pasture is badly depleted this method of deferred grazing should be adopted for several years in succession.

Deferred and rotational grazing is recommended, but the range should not be divided into fields of too small units, or the grass cover will be destroyed by excessive tramping. Uniform grazing can be obtained by a good distribution of watering places and salt boxes. Areas that have been closely grazed in the fall should not be eaten off in the spring. On spring pastures there should be a carry-over of at least thirty per cent of the previous year's grass.

RANGE IMPROVEMENT

Many tests have been made in the reseeding of depleted range lands, both at the Range Station and on other prairie areas, also in the Cypress Hills and in the foothills and mountains. On the dry prairies reseeding has proven successful only in cases where the native grasses have been almost completely killed out. Where there still remains even a thin stand of native grass it is probably better to protect the area from grazing or to graze during the late fall months only and thus allow the grass to go to seed and spread naturally. Reseeding has been partly successful on the burned-over mountain areas in the Crow's Nest Pass. Here the precipitation is greater and temperatures lower than on the prairies and such varieties as timothy, alsike, blue grass, fescue grass and wheat grass have become established. In the Kamloops area of British Columbia, crested wheat grass is giving promising results.

Seed of many varieties of grasses and legumes has been sown on abandoned fields. Crested wheat grass has given by far the best results. Good stands of this grass have been obtained by scattering the seed by hand, among the weeds, either late in the fall or early in the spring and giving a single discing after seeding. Some of the plots produced a good growth in 1933 after being closely grazed every summer and all summer for five years in succession.

GRAZING CAPACITY

Charted quadrates and permanent enclosures have been established on each of the nine fields used in the grazing capacity study project, and also on four large fields assigned especially for this study. In addition the vegetation cover of each field was carefully examined three times each season; before grazing began, about mid-season, and at the time that the cattle were removed from the field.

In general it was found that fields grazed at the rate of 20 acres per head were much over-grazed. Those grazed at 30 acres per head were slightly over-grazed, while pastures grazed at 40 acres per head were under-grazed.

PLANT STUDIES

The identification of native forage plants of the short grass plains has been completed and a key has been prepared for the grasses of the Prairie Provinces. Considerable attention has been given to the effect of climatic conditions on plant growth and other ecological problems.

About one hundred samples of native vegetation have been collected each season and forwarded to the Chemistry Division, at Ottawa, for analysis, in order to determine to what extent seasonal climatic conditions influence the chemical composition of various species. Samples of hay used at the Station were forwarded for analysis also. The percentages of the various nutrients contained by five principal grasses were averaged for four years. These data are presented in the following table:—

FOUR YEAR AVERAGE FOR FIVE PRINCIPAL GRASSES

Growth stage	Protein	Carbo-hydrates	Crude fibre	P_2O_5	Ca O
	%	%	%	%	%
Leaf	18·00	48·50	24·30	0·51	0·57
Flower	9·50	51·70	31·80	0·37	0·43
Seed	9·00	53·00	32·00	0·30	0·39
Cured	5·00	55·00	32·00	0·18	0·56
After winter exposure	3·00	52·00	36·00	0·17	0·49

It will be observed that these native species are high in protein content while in the leaf stage and that at this time they contain also sufficient phosphorus and calcium to meet the animals' requirements. As the plants approach maturity and become cured, there is a marked drop in both protein and phosphoric acid. As cured grass, for late fall and winter feed, there is a marked deficiency in the phosphorus content of these species. The calcium content does not drop to any considerable extent. To overcome this lack of phosphorus in the native herbage, stockmen are now beginning to feed mineral supplements such as bone-meal and monocalcium phosphate.

ANNUAL CROPS FOR HAY AND PASTURE

The most commonly used annual hay crops are the cereal grains, namely, oats, barley, wheat, and rye. In annual hay tests at all of the Dominion Experimental Farms oats have been shown to be more productive for hay than any other annual crop. They also make the best feed. Oats are grown much more extensively in Canada than all other annual hay crops combined. Peas are frequently grown in a mixture with oats in order to increase the nutritive value. The desirability of the oats and peas mixture has been emphasized at Ottawa and at a number of the Branch Farms, notably Ste. Anne de la Pocatière, Kapuskasing, Brandon, Indian Head, Rosthern, Lacombe, and Agassiz. The rate of seeding is two bushels of oats and one of peas per acre.

An alternative to peas and oats is a mixture of peas, oats and common vetch. This addition of one-quarter bushel of vetch seed is another recommendation at Ste. Anne de la Pocatière and at Agassiz. At Ottawa and most of the other stations it is questionable whether the addition of vetch is worth while, since this adds considerably to the cost of seed and the vetches have not been found to increase either the yield or feeding value of the hay.

Millets have been found advantageous at Ottawa as late seeded catch crops for hay. By June the weather is usually warm enough so that millets will make a rapid growth and, if hot weather follows, they are sometimes better than late seeded oats. The foxtail and Japanese types of millet are superior to the broom corn or panicled millets for hay purposes. In the West, foxtail millets are superior to Japanese millet, but in Eastern Canada the latter is frequently more productive.

About fifteen new strains of millet have recently been developed at Ottawa by selection from material introduced several years ago from Russia. Some of these are exceptionally promising.

Sudan grass is often recommended as an annual hay crop. It does well in Ontario in certain seasons but on the average oats are more productive and satisfactory. The same is true to a greater extent in the Prairie Provinces. Sudan grass is superior for hay to early amber cane sorghum, frequently called sugar cane or early amber sugar cane.

The soybean is one of the few annual legumes suitable for the production of hay. The Ontario Agricultural College and the Dominion Experimental Station at Harrow, Ont., have shown the value of the crop for this purpose. In feeding value it compares favourably with alfalfa hay. The following yields have been obtained:—

YIELDS OF SOYBEAN HAY

Station	Variety	Crop years	Yield per acre
			tons
Harrow, Ont.	A.K.	1929–1932 incl.	3·41
Ottawa, Ont.	Mandarin	1929–1932 incl.	3·21
Brandon, Man.	Wisconsin Black	1929–1932 incl.	2·42
Lennoxville, Que.	Mandarin	1933	3·57
Nappan, N.S.	Mandarin	1933	2·76

At Morden the soybean crop has been a failure for the last two years due to grasshoppers and blisterbeetles. At all stations in Saskatchewan and Alberta, soybeans as a hay crop are not considered to be a success, due chiefly to the lower mean temperatures at the higher altitudes. The following observations apply to the Station at Agassiz in the Fraser River valley of B.C.: "The results with soybeans for hay as a whole were far from encouraging and the

possibility of success in growing soybeans for hay in the Fraser River valley is very questionable owing to the unfavourable weather conditions which frequently prevail at time of harvest, making the hay difficult to cure."

As an annual pasture crop oats are again better than any of the grain crops. This fact has been clearly demonstrated by a study of cereals as annual pasture crops conducted at the Dominion Experimental Farm, Indian Head, Sask., during the last two years. A paper presenting the results of this study is in press and will shortly be published in "Scientific Agriculture." The results of this study have been summarized as follows:—

"Oats, barley, wheat and spring rye were compared with reference to yield, feeding value and utilization as annual pasture crops.

"With respect to yield of dry matter per acre and percentage of protein, oats were always superior to barley, followed in order by wheat and spring rye.

"In total average yield of protein per acre from the early seeding, oats exceeded barley by 54 per cent, wheat by 96 per cent and spring rye by 112 per cent. At the later date of seeding oats exceeded barley by 23 per cent, wheat by 53 per cent and rye by 85 per cent.

"The total pasture yield of all crops increased and the percentage protein decreased as the first date of cutting was delayed.

"Oats had a lower dry matter content than the other cereal crops.

"Oats produced 5 cuttings in 1932 and 7 cuttings in 1933 as compared with 4 cuttings in both seasons by the other three crops.

"Largest yields of protein per acre were obtained from oats when pasture cuttings were begun at the 5-leaf stage.[1]

"Oats from the early seeding produced 3,000 pounds of dry matter per acre with an average protein content of 25 per cent. This is equivalent to a greater carrying capacity than was obtained at Ottawa on good quality native blue-grass sod.

"Young oats herbage may be regarded as a highly concentrated protein feed."

Experiments at the Morden Station have shown that Sudan grass makes a valuable annual pasture crop because of its ability to produce new growth when eaten off. Being a warm climate crop, it should be seeded late, about June 1. Thus it is not as suitable as oats for early pasture, though it may prove better than oats for late seeding in certain seasons.

In Western Canada a favourite mixture for hay and pasture consists of two bushels of oats and one bushel of fall rye per acre. Being a winter-annual, the fall rye produces a leafy bottom growth in the oats. Although the rye may not add much to the yield of hay, it makes fall pasture after the oats have been cut and frequently it will produce early spring pasture the next season. The rye, being frost resistant is very useful for this purpose.

All of the annual crops mentioned above, in addition to several others, are being tested this year at Ottawa under grazing by dairy cows.

Ensilage and Fodder Crops

The chief crops grown in Canada for ensilage are corn, sunflowers and green oats. All three crops make good ensilage when they attain a reasonably advanced stage of development. Corn usually makes the most palatable silage but the relative feeding value of corn and sunflowers is largely a matter of comparative maturity. The one which most nearly approaches the best stage of development to make good silage usually results in the most satisfactory feed; but wherever the yield of corn approaches the yield of sunflowers, it should always be grown in preference to the latter as an ensilage crop. There

[1] The 5-leaf stage of growth corresponds to a height of 7 to 8 inches.

are many places, however, where the corn crop has proven to be thoroughly unreliable as at Kapuskasing, Ont., Scott, Sask., Lacombe and Beaverlodge, Alta. Under such conditions sunflowers or green oats have produced from 50 to 100 per cent greater yield than corn and in addition there has not been the same risk of crop failure.

Oats frequently yield as much or more than sunflowers. This is the case at Beaverlodge, Alta., where the average yields of oats, sunflowers and corn for the past eight years have been in the ratio of 100, 76, and 22 respectively. There is much to be said for oats as an ensilage crop under these circumstances. They can be harvested more easily with the ordinary farm machinery and are less difficult to handle.

Even where corn is generally recognized as the best ensilage crop, as at Ottawa, sunflowers should not be overlooked as an additional insurance against feed shortage. A few acres seeded after the corn crop has been planted will usually produce an equally good yield since the sunflowers will continue to grow after the corn has been harvested, being less easily injured by early fall frosts. A good plan is to first fill the silo with corn and, after the corn silage has settled, refill it with sunflowers two or three weeks later. This makes it possible to fully utilize silo space and, if the corn crop happens to be light, provides against a possible shortage of feed.

CORN (EASTERN CANADA)

CORN FOR SILAGE.—Corn varieties have been tested extensively for many years at Ottawa and on Dominion Experimental Farms in Ontario, Quebec, and the Maritime Provinces. At all of these except Kapuskasing, Ont., it has been demonstrated that both dent and flint varieties can be grown successfully. Very satisfactory yields of corn for ensilage have consistently been obtained. The standard test at the present time consists of the following varieties: Wisconsin No. 7, Golden Glow, Northwestern Dent, Compton's Early, Longfellow, Iroquois, and Burr-Leaming.

According to the results of tests conducted by the various Experimental Stations in Ontario, Quebec, and the Maritime Provinces, the following varieties of corn have been found to be among the best for ensilage purposes that are readily available:—

Yellow dents—Golden Glow.
White dents—Wisconsin No. 7.
Yellow flint—Compton's early.
(12 row)
Yellow flint—Longfellow.
(8 row).
White flint—Salzer's North Dakota.
(8 row).

Compared with the dents, the flint varieties are about seven to ten days earlier, but on the average they are slightly lower in yield. The dent varieties are often preferred because they do not tiller as much as the flints and are therefore somewhat easier to harvest. One bushel of seed of any of the recommended varieties is sufficient to plant 2½ to 3 acres in rows 3½ feet apart. Best results have been secured at Ottawa when the plants were spaced 8 to 10 inches apart in the row.

A statistical analysis of yields of corn varieties grown at Ottawa, Ont., and Fredericton, N.B., for seven and nine years respectively, and comprising late, medium, and early sorts, have shown that while the large late-maturing varieties such as Eureka, Red Cob, and Burr-Leaming have yielded the highest tonnage

of green fodder, when reduced to the more comparable basis of dry weight, they have not proven superior in yield to the somewhat smaller but earlier recommended varieties.

CORN FOR GRAIN.—Except in western Ontario, the summer season is too short in Eastern Canada to consistently mature seed of the dent varieties. At the Harrow Station, however, all of the dent varieties which are commonly grown in this country mature regularly. The varieties which have given best results for grain at Harrow are Golden Glow, Wisconsin No. 7, Bailey, and Burr-Leaming. Corn for grain is an important crop in the district of western Ontario served by the Harrow Station, but corn-borer infestation during the last few years has greatly curtailed the acreage and reduced the yields.

An experiment was begun at Harrow in 1930 to determine the effect of date of planting on corn-borer infestation. The following abstract relating to this study was taken from the Superintendent's report for 1933:—

"Dates of planting were on May 20 to 23, May 29 to 31, and June 5 to 9, the date varying somewhat with the season. In 1930 to 1932, the second date of planting gave the highest yields but in 1933 the latest planting gave best results. This was probably accounted for by the very dry summer followed by rains in September, which permitted the ears to fill. The numbers of corn borers have increased considerably during the past three years. This may be seen from the figures giving the average number of borers per stalk, which was 0·64 in 1930, 0·85 in 1931, 1·33 in 1932, and 2·88 in 1933."

At Ottawa and on Branch Farms in Quebec and the Maritime Provinces the flint varieties give most satisfactory results for the production of grain. Two of the best of these are Quebec No. 28 and Twitchell's Pride. Both are yellow flints, the former being a 12-rowed and the latter an 8-rowed variety.

CORN BREEDING.—Corn breeding is conducted at the Central Experimental Farm, Ottawa, and at the Harrow Station in western Ontario. The objective at the latter Station is the development of moderately early-maturing high-yielding strains. Selfed-line breeding with subsequent crossing is the method of improvement which has been adopted. A number of single and double hybrid strains have given promising results.

At Ottawa, 273 selfed lines, representing the principal early-maturing varieties, have been inbred for from three to ten years. The great majority of these are sufficiently pure genetically for purposes of recombination. Various single and multiple crosses have been made and also a number of synthetic crosses. One of the most promising of the synthetic crosses has resulted from a recombination of selfed lines of Howe's Alberta flint. This strain produces exceptionally fine ears, which are carried well up on the stalk. The seed is being multiplied.

CORN (PRAIRIE PROVINCES)

CORN FOR FODDER.—The acreage of corn in the Prairie Provinces is relatively very small but there are indications that it is due for a considerable increase in 1934. Even in corn-growing districts the silo is not used to any appreciable extent, the corn being largely utilized as dried fodder or as a soiling crop.

The corn crop has been grown most extensively in the southern part of the Red River valley in Manitoba and to some extent also in the neighbourhood of Maple Creek, Sask. and on irrigated land in southern Alberta. Experiments conducted for many years at Morden, Brandon, Swift Current, Manyberries and Lethbridge have shown that the corn crop deserves a larger place on farms in the southern sections of all three provinces. Experimental work at Scott, Lacombe and Beaverlodge has demonstrated the pronounced limitations of this crop for the northern sections.

The standard tests of corn varieties on Branch Experimental Stations in the Prairie Provinces are as follows:—

Corn for Silage

Minnesota No. 13	Worthy strain.
Golden Glow	Commercial.
Longfellow	Commercial.
Northwestern dent	Lethbridge strain.
Falconer	Northrup King.
Quebec No. 28	Macdonald College.

Corn for Grain

Minnesota No. 13	Worthy strain.
Northwestern dent	Lethbridge strain.
Minnesota No. 23	Colquhoun strain.
Falconer	Northrup King.
Gehu	Maple Creek strain.
Dakota White flint	Maple Creek strain.
Manalta	Manitoba Agricultural College strain.

The suitability of the varieties listed above, except in the case of Golden Glow and Longfellow, have been demonstrated by tests over a period of years and the desirability, because of early maturity, of the particular strains indicated, has been clearly shown as a result of five years' work conducted at the Manyberries Station and on Mr. P. C. Colquhoun's farm at Maple Creek, Sask. The eastern varieties, Golden Glow and Longfellow, were recently included in the test for silage.

CORN (BRITISH COLUMBIA)

The recommendations as to varieties of corn which have been given above for Eastern Canada apply also to British Columbia. These are based on experiments conducted at Agassiz, Summerland, and Saanichton.

SUNFLOWERS

The standard test of sunflowers consists of the following varieties: Mammoth Russian, Manchuria, Ottawa Selection No. 76, and Mennonite. This test has been conducted on ten of the Branch Farms. The varieties are listed above in order of earliness of maturity. Table 5 gives the percentage yields of dry matter in terms of Mammoth Russian for three years at six Stations.

TABLE 5.—AVERAGE PERCENTAGE YIELDS OF SUNFLOWER VARIETIES FOR THREE YEARS ON DOMINION EXPERIMENTAL FARMS

Station	Mammoth Russian	Manchurian	Ottawa 76	Mennonite
Indian Head, Sask.	100·0	78·8	86·5	57·0
Scott, Sask.	100·0	60·6	71·6	44·5
Lacombe, Alta.	100·0	97·2	63·2	47·2
Beaverlodge, Alta.	100·0	95·0	95·8	85·4
Nappan, N.S.	100·0	77·9	69·3	38·4
Kapuskasing, Ont.	100·0	78·6	76·7	56·7
Average	100·0	81·3	77·2	54·9

Since quantity is the chief consideration in the growing of sunflowers, Mammoth Russian has been recommended at practically all Stations as the best variety.

BREEDING.—Beginning in 1920 with an extensive collection of sunflowers from different sources, inbreeding has been practised for several generations. In general the effects of inbreeding have been similar to those obtained with corn. The first three years of selfing resulted in a very marked increase in uniformity and at the same time a marked reduction in size of the plants. Unlike corn, a number of sunflower selfed lines did not become reduced in vigour. Some of the tallest, leafiest, and highest yielding rows had been inbred for five generations. Inbreeding resulted, also, in the isolation of many very distinct types. These are being tested to determine their economic value. The chief objectives in this work are earlier maturing and more productive strains, and also the development of early maturing types for the production of seed.

Field Roots

Mangels and swedes are crops of considerable importance in Canada but fall turnips and field carrots are produced only to a very limited extent. Mangels and swedes are grown chiefly in Eastern Canada and British Columbia, the average annual production for the past 15 years being 213,464 acres.

A limited number of field root varieties are tested annually on 13 of the Branch Farms. Those which are included in the tests represent a selection of leading types rather than of named varieties. Variety names mean very little since they vary considerably from year to year. Very often the same variety occurs under different names. Turnips and carrots have recently been eliminated from the regular tests of field roots. The standard test of mangels and swedes includes the following types and varieties:—

Mangels	*Swedes*
Yellow Globe.	Hall's Westbury.
Yellow Tankard.	Purple Top.
Yellow Intermediate.	Ditmar's.
Half Sugar White.	Corning's Green Top.
Long Red.	Bangholm 8312-M.C.
Danish Sludstrup.	*Bangholm (club-root resistant).

MANGELS

Intermediate and half-long mangels have been found to be the most desirable types for general use. They are reasonably easy to harvest, produce excellent yields, keep well in storage, and generally speaking they are usually more uniform than other types. True tankards, as a rule, give excellent results and are easy to harvest. They are the most suitable for shallow soils where they generally outyield globes.

Mangels of the long type are usually very difficult to harvest requiring extra labour and there is danger from loss in storage through breakage in digging. and hollow roots which are of frequent occurrence in this type. For these reasons it is considered inadvisable to recommend the long types for general use. Half-long to Intermediate types of rose-coloured mangels, including the half-sugar rose, rose feeding sugar, etc. have proven extremely variable in our tests both between and within lots. Frequently they are rooty and lie deeply in the ground like sugar beets which necessitates digging them out.

*Club-root resistant strains of Bangholm included in the test were from three sources, namely, Charlottetown, Nappan, and Kentville.

These " rose " types do not compare favourably with the half-long to intermediate " white " and " yellow " types which are generally much more uniform. Globes as a class are high yielders in so far as the green weights are concerned but they are comparatively low in dry matter. They are suitable for shallow soils but always have the disadvantage of growing so high out of the ground that many of them are dislodged by cultivation.

SWEDES

In variety tests with swedes, the " globe " and " oval " types have been most generally satisfactory. Since swedes for table use are grown in many areas as a cash crop and since a purple-top swede is preferred for this purpose, the purple-top " ovals " and " globes " are generally recommended. An exception should be made in the case of Ditmar's green-top as grown in the Maritime Provinces. This is an excellent variety which has found general favour in eastern markets. It belongs to the globe type and has a bronze to greenish top. It is a good yielder, a good keeper, and it possesses exceptionally good quality for table use.

VERIFICATION TESTS

Previous to 1931 an attempt was made to test at the Central and Branch Experimental Farms the various named varieties of field roots being sold in Canada. These became so numerous, however, that it was found impossible to find the space and labour necessary for this work. It was decided therefore to confine the tests on Branch Farms to some of the main types of roots only and to centralize the complete test of named varieties at Ottawa for mangels and carrots, and at Lennoxville for fall turnips and swedes. This policy was followed in 1931 and 1932, during which time the test included all Canadian grown material, all seeds entering Canada through customs, and all available varieties being retailed by the seed houses. In 1932 the tests at Ottawa included 280 samples of mangels, 72 samples of field carrots, and 37 lots of sugar beets. At Lennoxville there were tested 475 lots of fall turnips and 450 lots of swedes.

In 1933 the centralized tests were further modified to include only Canadian grown lots of seed and those which are imported through customs. These cover everything that may be sold in Canada and information is made available as to type and uniformity of the field roots which are purchasable by the Canadian farmer.

Results of these tests benefit both the farmer and the seed merchant. The merchant may obtain a report on the character of any particular importation of seed and the farmer receives protection against improperly classified material. The centralized tests make it possible to locate all wrongly named and inferior stocks as they enter the trade and to trace their origin to the original source.

DISEASE RESISTANCE, BROWN-HEART AND CLUB-ROOT OF SWEDES

The growing prevalence of brown-heart and club-root in swedes during the last few years, especially in the Maritime Provinces, constitutes a serious problem in the production of this crop. The nature of the brown-heart disease is not well understood but it appears to be associated with some form of soil deficiency. Club-root, on the other hand, is caused by a soil fungus. If the roots are severely affected with brown-heart they are rendered entirely unfit for table use. In the case of club-root the crop may be partially or wholly destroyed.

Problems relating to the control of these diseases are being investigated by a special committee consisting of Experimental Farm workers in the Maritime Provinces. Those phases of the project which relate to the work of the Division of Forage Plants have to do with varietal resistance and the develop-

ment by breeding of resistant strains. In the case of brown-heart, out of 227 lots of swedes tested in 1933 at Lennoxville and 180 lots at Fredericton, not one showed the slighest indication of resistance. Tests for brown-heart have now been made for two successive years with similar results. These have included every variety, strain and selection available in Canada. It seems fairly safe to conclude therefore that this disease will not be amenable to control by breeding methods.

In the case of club-root disease, the systematic selection of resistant roots has proven to be a promising line of attack. For a number of years special attention has been given to the matter of disease resistance in all of the tests that have been conducted and considerable progress has been made in locating and testing varieties and strains of swedes that possess more or less resistance to club-root. Fourteen such varieties and strains were tested in 1933 at Charlottetown, Nappan, and Kentville, and on 14 Illustration Stations in Quebec, New Brunswick, Nova Scotia and Prince Edward Island. The results of these experiments are available in a report compiled by the research committee. The most resistant material was found to be the Wilhelmsburger variety and certain strains of Bangholm. It was clearly demonstrated also that the same varieties did not always exhibit the same degree of resistance in different localities.

Seed of a resistant strain of Bangholm, known as the " Christenson Selection " and originally introduced in 1923 by the Division of Forage Plants. has been produced and distributed annually for a number of years by the Dominion Experimental Farms at Nappan, N.S., and Charlottetown, P.E.I.

BREEDING

Breeding work is in progress with mangels, swedes and field carrots. The chief objectives are yield, desirability of type, uniformity, good keeping qualities, high dry matter content, and disease resistance (club-root and brown-heart in swedes). Systematic selection within selfed lines is the method which has been followed for several years with promising results. Selected strains of mangels (yellow intermediate), swedes (purple top globe), and field carrots (intermediate yellow) are now being maintained at Ottawa.

SOYBEANS

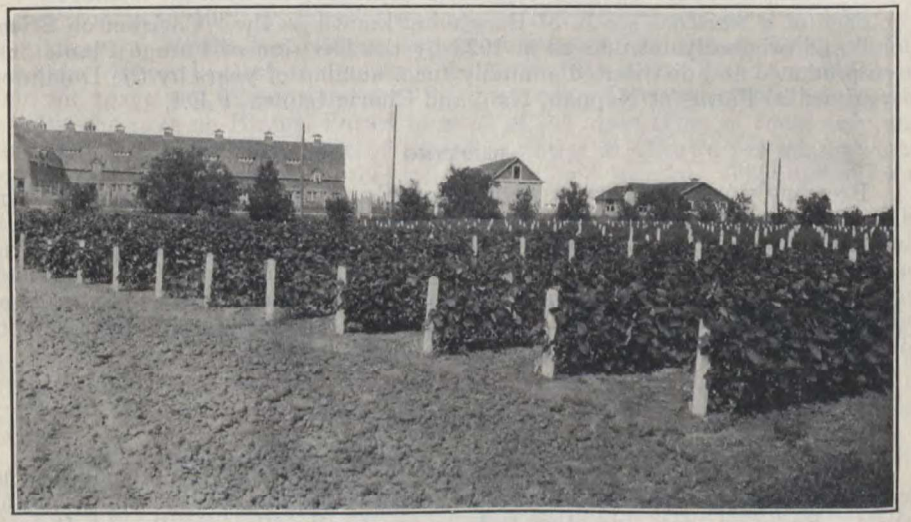
During the past ten years the Division of Forage Plants has introduced and tested hundreds of varieties and strains of soybeans from various parts of the world. Based on these and other tests on practically all of the Branch Experimental Farms the following varieties are considered the best of those available at present for production in Canada.

Variety	Maturity	Colour of seed
Manitoba Brown	Very early	Brown
Wisconsin Black	Early	Black
Mandarin (Ottawa)	Medium early	Yellow
Manchu (Hudson)	Medium late	Yellow (black hilum)
O.A.C. No. 211	Medium late	Yellow
Manchu	Late	Yellow (black hilum)
A. K. (Harrow)	Very late	Yellow (brown hilum)

Manitoba Brown is a semi-dwarf variety. Harvesting of the seed is difficult due to its short length. It is essentially seed type. Wisconsin Black grows considerably taller than Manitoba Brown and may be used for hay or seed. Mandarin is a seed rather than hay type, although it can be used for

hay. Manchu (Hudson) is a tall growing variety suitable for either hay or seed. O. A. C. No. 211 produces a medium tall growth. It is a good dual purpose variety, adapted for both hay and seed production. Manchu and A. K. are both tall-growing varieties suitable for either hay or seed production.

In Quebec and the Maritime Provinces, Mandarin can be depended upon to mature only in those sections most favoured with regard to both soil and season. Manitoba Brown and Wisconsin Black might prove suitable in districts with less favoured conditions. In Ontario, Mandarin, O. A. C. No. 211, Manchu and A. K. are being grown at present. Mandarin matures regularly at Ottawa and is therefore adapted for production over a fairly wide portion of Eastern Ontario. O.A.C. No. 211 is suitable for seed production in Central and Western Ontario generally, while A. K. is limited in adaptation to the extreme southwest portion of the province. Manchu can be used where a variety intermediate in maturity between O. A. C. No. 211 and A. K. is desired. While Manchu (Hudson) appears to be somewhat earlier than O. A. C. No. 211 it nevertheless has much the same adaptation for seed purposes.



Test of soybean varieties.

The Prairie Provinces are limited almost entirely to the early maturing varieties, Manitoba Brown and Wisconsin Black. Manitoba Brown, being considerably earlier, has much the wider adaptation of the two, but where conditions warrant the use of a somewhat later variety, Wisconsin Black can be used. Mandarin has been grown to maturity in southern Manitoba but only under very favourable conditions can it be depended upon to produce seed. Both Mandarin and O. A. C. No. 211 have been matured in British Columbia, and it is probable that these varieties may be adapted for seed purposes to certain favoured sections of the province.

In general, the yield of soybean varieties varies according to maturity, the later the variety the higher the yield. Table 6 gives the average yield of soybean varieties at Ottawa and Harrow for five and eight year periods respectively.

TABLE 6.—SOYBEAN SEED PRODUCTION

Variety	Ottawa, Ont.[1]			Harrow, Ont.[2]		
	Date of harvest	Height	Bushels per acre	Date of harvest	Height	Bushels per acre
		in.	12% moisture		in.	12% moisture
Manitoba Brown	Sept. 2	25	20·97			
Wisconsin Black	Sept. 14	31	25·35			
Mandarin (Ottawa)	Sept. 22	30	30·36	Sept. 5	27	30·10
O.A.C. No. 211				Sept. 18	31	33·16
Manchu				Sept. 25	37	35·99
A. K. (Harrow)				Sept. 28	41	37·41

[1]1932. Row seeding. Date of seeding, May 19.
[2]Averages, 4 years 1929 to 1932. Drill seeding. Average date of seeding May 20.

Since the soybean is comparatively new as a farm crop in Canada, a pamphlet has recently been published by the Division of Forage Plants giving information as to the characteristics of the soybean plant and seed; its adaptation to soil and climatic conditions; the various purposes for which soybeans are used; the most suitable varieties that are available; and general instructions on how the crop should be grown and handled. This publication may be obtained from the Publications Branch, Department of Agriculture, Ottawa.

SOYBEAN BREEDING

Improvement work with soybeans has received much attention at Ottawa and at the Harrow Station for several years past. At Ottawa, 460 individual plants were selected in 1931 out of material which came originally from several lots of mixed seed collected in the vicinity of Harbin, Manchuria. The progenies of these selections were tested in 1932 and 1933. It was interesting to observe that a large number of the lines were practically indistinguishable from the Ottawa selection of Mandarin, whether in plant type, date of maturity, or seed characteristics. Other lines were quite different from Mandarin but equally early. A number of these are promising and will be given further study. The artificial cross Mandarin x Manitoba Brown has produced hybrid strains which give indications of having great agricultural value. One hundred and ninety such families have been studied recently. Selection in the segregating generations has been toward a yellow seeded type similar to Mandarin and with the early maturity of Manitoba Brown. Several such strains have been isolated which possess the desired characteristics and which appear also to yield well.

Selection and breeding work of a similar nature to that at Ottawa is being done at the Harrow Station, but with varieties which mature somewhat later than Mandarin. Some exceptionally promising strains have been produced and are now being tested.

SUGAR BEETS

Tests of varieties and strains of sugar beets were conducted by the Experiment Station at Harrow, Ont., during the five years 1927 to 1931, inclusive. Seed for these tests was supplied by the Michigan State Agricultural College, the United States Department of Agriculture, and the Canada and Dominion Sugar Company at Chatham, Ont. Practically all of the varieties which were used in the sugar beet growing district of western Ontario were included as well as a considerable number of selected inbred lines and a few varieties of Russian origin. Determinations for sugar content were made by the Canada and Dominion Sugar Company at Chatham. The tests were conducted at three locations,

namely, Harrow, Kingsville, and Chatham. The number of varieties and strains tested at each place for each of the five years was as follows:—

Location	Number of varieties and strains				
	1927	1928	1929	1930	1931
Harrow, Ont.	23	29	32	34	42
Kingsville, Ont.	.....	30	32	34	42
Chatham, Ont.	20	30	32	34	42

Data on the relative yields of roots and the sugar content of each variety are available and tables have been compiled showing the relative yields of sugar per acre produced by the beets from different sources.

In 1934, experimental work with sugar beets will be expanded to include a more intensive study of some of the more important improved strains with reference to yield, sugar content, disease resistance, and seed production. A beginning will be made also in the improvement of this crop for Canadian conditions by breeding.

LAWN GRASSES

Based on results of experiments on Dominion Experimental Farms, Kentucky blue grass has proved to be the most generally suitable grass for lawns in Canada. Sown alone it produces a lawn of good quality, good colour, and one which normally can be expected to remain in good condition with the minimum amount of attention. Colonial bent, sometimes sold as New Zealand bent, Brown top or Rhode Island bent, is one of the non-creeping bents. It is perfectly hardy in Canada, of fine texture and capable of producing exceptionally fine lawns. A mixture consisting of one part of Colonial bent and four parts of Kentucky blue grass, sown at a rate of three pounds per 1,000 square feet, is generally recommended for ordinary lawn purposes. White Dutch clover at about one-quarter ounce per 1,000 square feet can be added with advantage to the Kentucky blue and Colonial bent mixture.

Grass seed sold under the trade name of creeping bent, mixed bent or German mixed bent is not a creeping bent at all, but a mixture principally of colonial bent with red top and containing small percentages of true creeping bent types and sometimes velvet bent. This so-called creeping bent varies greatly in turf producing qualities depending on the proportion of the different kinds that make up the mixture.

Where a particularly fine lawn is desired, Colonial bent or New Brunswick creeping bent can be used alone or in equal parts, seeding from 2 to 3 pounds per 1,000 square feet. New Brunswick creeping bent produces the dense, even, fine turf desired on putting greens. For those who will give a lawn the attention which putting greens require, this type of bent can be recommended. Creeping bent, grown from stolons, is not recommended at all for ordinary lawns. Velvet bent, of which a limited quantity is grown in the Maritime Provinces, produces an exceptionally beautiful lawn but should only be used where extra care can be taken in maintaining it.

Where drought conditions are particularly severe, as in many parts of the Prairie Provinces, crested wheat grass is the only grass for lawns which will survive. Although it dries out and becomes brown in periods of drought, unlike other grasses suitable for lawns, it recovers quickly when moisture is available and will persist where other grasses are complete failures. Red fescue, of which there are two types on the market, ordinary and creeping, gives fair results under dry conditions, but does best when moisture is present. Both must be maintained

as a very thick sod, otherwise their bunching habit produces undesirable turf. Red top will produce a good quality lawn but the surface is only a temporary one which at best can be expected to persist for only one or two years after seeding. For shady places rough-stalked meadow grass, Wood meadow grass or sheep's fescue can be sown alone or in a mixture with Kentucky blue and bent grass.

MISCELLANEOUS EXPERIMENTS

VERNALIZATION OF CORN AND SOYBEANS (OTTAWA)

Seed of corn and soybeans was vernalized or pre-treated according to the method outlined by Lyssenko. This consisted of soaking the seed in a given quantity of water for a specified time, after which it was maintained in darkness at a constant temperature of 25° C for a period of 15 days. An ordinary egg incubator proved to be a convenient means of providing the necessary conditions of temperature and humidity.

The effect of this treatment on soybeans was to reduce the germination from 95 to 35 per cent. Those seeds which did germinate were reduced in vigour of growth. Development of the plants was retarded throughout the season and at no time did they appear as far advanced as the check plants.

Vernalization did not affect the germination of the corn seed. The plants from both treated and untreated seed developed equally well, but pre-treatment had no effect in increasing the yield or hastening maturity.

TEMPERATURE, LIGHT INTENSITY, AND OTHER FACTORS IN THE GROWING OF GRASSES AND LEGUMES FOR SEED UNDER GREENHOUSE CONDITIONS (OTTAWA)

During the winter season of 1932-33 some experiments were conducted to ascertain the best methods of growing herbage plants under greenhouse conditions in order to secure normal growth, early maturity and seed production. The effect of several factors was studied, including the use of artificial light, temperature control, size of pots, and the relative advantages of planting in ground beds vs. in pots. The species used in these experiments were as follows:—

Grasses:—Timothy, orchard grass, brome grass, crested wheat grass, Kentucky blue grass.

Legumes:—Alfalfa, red clover, sweet clover, soybeans.

A report presenting the details of technique and the results obtained has been prepared, but it is only possible here to state briefly some of the main conclusions. These are as follows:—

1. Both grasses and legumes were much better plants when germinated and grown during early stages of plant development in a cool greenhouse at 55° to 60° F.
2. At the later stages of development from the beginning of bud formation to maturity, legumes require increasingly higher temperatures up to 80° F. They set seed better and matured about three weeks earlier than when grown in a cool greenhouse.
3. Grasses give best results when they are grown to maturity in a cool greenhouse. In the warm greenhouse they grew a little faster and headed earlier but the heads were very small and seed setting was low. The heads of all perennial grasses when grown in the cool section, were large and plump, seed setting was very satisfactory, and many more heads were produced than in the warm section.

4. A light intensity supplied by 1,000 watt bulbs produce better results with legumes in both warm and cool temperatures. In the warm greenhouse the grasses give better results under the 500 watt lights, but in the cool section 1,000 watt lights are more beneficial.
5. Continuous light is beneficial for the legumes but has a detrimental effect on the grasses.
6. For the purpose of growing plants to maturity, 2 inch pots are not satisfactory, while 3 inch pots are fairly satisfactory for some purposes, particularly where space is limited. Ordinary 5 inch pots and 6 inch pots are necessary for clons and transplanted plants as well as seedlings where these are to be kept for long periods.
7. Planting in beds as compared with pots induces stronger vegetative growth, delayed flowering and results in less satisfactory seed production. Pots are also better in plant breeding work which necessitates large populations and easy accessibility of plants.

As with other legumes, soybeans produced much better plants when they were germinated and grown for about 6 weeks from planting at a temperature of 55° to 60° F. They should then be subjected to higher temperatures of 70 to 75 degrees. Artificial light was beneficial up until the time of full bloom.

Soybeans have a tendency to grow spindly and abnormally tall. Especially was this the case with those plants which were grown continuously in a warm greenhouse. As a result of a series of experiments it was found that when the growing tip was removed at an appropriate stage of growth, a much shorter and more branching habit of growth was produced resulting in a very desirable type of plant. Very little retardation of growth was observed, the plants coming into bloom at the same time as those which had not been subjected to this treatment. The best time to remove the growing tip was found to be after the third set of true leaves had been produced.

RESPONSE OF ORCHARD GRASS, RED CLOVER AND ALFALFA TO DIFFERENT SOIL TYPES AND FERTILIZER TREATMENTS (OTTAWA)

The soil samples used in this experiment were representative of the soil types at the Central Experimental Farm, Ottawa, and the Branch Experimental Farms at Kapuskasing, Ont., and Fredericton, N.B. The tests were conducted in replicated pots under greenhouse conditions. The results of this experiment are available in a separate report.

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