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This volume includes Progress Reports of the following Divisions at the Central Experimental Farm, Canada Department of Agriculture:

CANADA
DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS SERVICE

ANIMAL HUSBANDRY DIVISION

CENTRAL EXPERIMENTAL FARM, OTTAWA
Geo. W. MUIR, B.S.A., DOMINION ANIMAL HUSBANDMAN

PROGRESS REPORT
1937-1949

ADEQUATE GRAZING, WATER SUPPLY AND SHADE
ARE ESSENTIALS IN GOOD PASTURE MANAGEMENT

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ANIMAL HUSBANDRY DIVISION

Progress Report 1937-1949

INTRODUCTION

The previous report of this Division was published in 1939 and covered the period April 1, 1930 to December 31, 1936. The present report covers the years 1937 to 1949, inclusive.

During this period several changes were made in the personnel of the Division. In December, 1937, C. A. Gibson joined the staff as Dairy Specialist. C. G. Hickman was appointed Assistant in Swine in September, 1949, and F. K. Kristjansson was named Animal Geneticist in the same month.

Alan Deakin, Animal Geneticist in the Division from August, 1931, resigned in May, 1946. R. L. Cunningham, Assistant Animal Husbandman, retired on superannuation in July, 1946, after thirty-four years in the service of the Division. J. G. Stothart was transferred to the Experimental Station, Lacombe, Alta., in January, 1949, there to take charge of Animal Husbandry work.

During the war three members of the technical staff of the Division, namely, C. D. MacKenzie, J. G. Stothart, and S. B. Williams received leave of absence to join the Canadian Army, all serving overseas for several years, and returning with ranks of Captain, Major, and Captain, respectively. V. S. Logan resigned June 12, 1940, to enter commercial work, later joined the Canadian Army, returned with the rank of Captain, and was reappointed in January, 1946, to this Division as Assistant in Dairy Cattle.

During the wartime absence of the above staff members, their positions were not filled, the remainder of the staff carrying on the main lines of work of the Division along with increased wartime duties.

The activities of the Division include the immediate supervision at the Central Experimental Farm, Ottawa, of experimental work with beef cattle, dairy cattle and dairy products, horses, sheep, and swine, and the supervision of similar lines of work on all Branch Farms across Canada.

BEEF CATTLE

P. E. Sylvestre and S. B. Williams

A grade Shorthorn herd of some 45 breeding females has been maintained at the Central Experimental Farm since 1930. During this time purebred bulls have been used so that although unregistered, the herd might be considered as purebred. The herd has been tested regularly for tuberculosis and in 1945, a policy of calfhood vaccination against Brucellosis (Bang's disease) was initiated and 90 per cent of the females are now vaccinated.

Although the herd has been kept for experimental purposes, its management has approached closely that of a commercial farm herd thus providing information on management and maintenance of much practical value to the beef producer. However, the greatest part of the work was the conducting of various feeding and production experiments using the progeny not needed for replacement.

Breeding Studies

The breeding policy has been directed toward the formation of a good commercial farm herd. In the selection of females, emphasis has been placed on size, beef conformation, constitution, and the ability to raise a calf every year. In the selection of sires, more attention has been given to size, ruggedness, and beef conformation than to the fine points of the breed.

Comparison of Shorthorn and Aberdeen Angus × Shorthorn Steers and Heifers

Cross-breeding for beef production is not new. However, there still are differences of opinion regarding the rate of development of cross-bred steers and heifers as compared with purebreds. In order to study certain aspects of this problem, in 1936 two bulls, a Shorthorn and an Aberdeen Angus, each fairly representative of their breed, were used on the herd. Of the 1937 calf crop, 17

Fig. 1.—Grade Shorthorn cows on pasture. An abundance of summer pasture means economical summer and winter maintenance of the herd.

were sired by the Shorthorn bull and 22 by the Aberdeen Angus bull. The percentage of heifers was somewhat higher in the latter group. The management of all calves was identical. Weights were taken in the fall at weaning, the following spring, and in the fall of the second year.

Cross-bred steers more typey but a little lighter.—At a year and a half, the Shorthorns averaged 820 pounds and the cross-breds 802 pounds. The latter group was consistently lighter throughout the period under observation. Both groups made an average daily gain of 0·95 pounds. However, the rate of gain of the Shorhorn feeders was higher in the winter and lower in the summer than the cross-bred feeders.

The cross-bred steers and heifers were quite uniform and of very good type, being low-set and deep, while the Shorthorns were relatively larger-framed. The cross-breds were more nervous and consequently more difficult to handle. From the evidence, there seemed little to choose between the two groups.

Steers make more rapid gain than heifers.—The data from the two groups of animals were re-grouped to compare the heifers with the steers. The heifer lot was made up of seven Shorthorns and thirteen cross-breds, and the steer lot contained ten Shorthorns and nine cross-breds. The results indicated that the steers made greater gains during both the winter and the grazing season and averaged 58 pounds heavier than the heifers in the fall.

Nutritional Studies

In the field of nutrition the two main problems studied were: *(a)* the feeding value of cull potatoes for livestock, and *(b)* the evaluation of various cattle feeds through digestibility trials. This work was done in co-operation with the Chemistry Division of Science Service. Related work such as the feed requirements of beef cattle at different ages will be reported in the section on management and production.

Feeding Value of Raw and Dried Potatoes for Fattening Steers

In years of abundant supply or of limited markets, the disposal of low-grade, cull, and small potatoes is often a problem in the potato-growing districts. Being a perishable product the potatoes must be used in a relatively short time, or they must be converted to a more stable product. Drying appears to be a possibility, provided that the feeding value of the potatoes is not decreased. The following experiment was devised to answer this question.

Four different rations were fed.—Sixteen long-yearling, grade Shorthorn steers and heifers were used each year. They were allotted into four equal groups and fed the following rations:

Lot 1	Mixed hay Corn silage Grain mixture	Lot 2	Mixed hay Corn silage Grain mixture
Lot 3	Mixed hay Raw potatoes Grain mixture	Lot 4	Mixed hay Soaked dried potatoes Grain mixture

The grain mixture, made up of ground barley, 400 pounds; ground oats, 200 pounds; bran, 100 pounds; and oilmeal, 100 pounds, was fed to all lots except Lot 1 where barley was replaced by ground dried potatoes pound per pound. The dried potatoes were obtained from a potato drying experiment at Aylesford, N.S. The raw potatoes fed to Lot 3 were chopped, and for Lot 4, the dried potatoes were soaked for 24 hours before feeding.

In calculating the total digestible nutrients of the rations, Morrison's tables were used for oats and bran. For the remainder of the feeds, chemical analyses and coefficients of digestibility obtained at Ottawa were used.

Each animal was fed individually. The feed consumed, the live gain, the carcass weight, and the carcass grade were recorded.

Potato meal slightly superior to barley meal.—Table 1 shows the relative value of barley meal and potato meal when fed in a grain mixture to long-yearling steers and heifers.

TABLE 1—BARLEY MEAL VERSUS POTATO MEAL IN THE FATTENING OF CATTLE
2-YEAR AVERAGE 1936-37 INCL.

Lots		Barley Meal	Potato Meal
Average gain per head	lb.	153·8	164·5
Average daily gain per head	lb.	1·54	1·66
Gain per 100 lb. dry matter	lb.	8·77	9·49
Gain per 100 lb. T.D.N.	lb.	13·09	13·54
Dressing percentage, hot	%	59·85	60·56
Carcass grade: Red	No.	4	5
Blue	No.	1	0

The steers and heifers in the barley meal and potato meal lots averaged approximately 900 pounds at the start of the feeding period. Five animals only were slaughtered in each lot, three in the first year and two in the second year. A study of the table shows that the potato meal gave somewhat superior results as measured by the total gain, the average daily gain, the gain per 100 pounds of dry matter, the gain per 100 pounds of digestible nutrients, and the dressing percentage.

Raw potatoes and soaked dried potatoes just as good as corn silage.—Table 2 shows the averaged, two-year results obtained from the comparison of three succulent feeds namely, corn silage, raw potatoes, and soaked dried potatoes when fed to long-yearling steers and heifers in a fattening ration.

TABLE 2—COMPARATIVE VALUE OF RAW POTATOES, SOAKED DRIED POTATOES AND CORN SILAGE FOR FATTENING CATTLE
2-YEAR AVERAGE 1935-37 INCL.

Lots		Corn Silage	Raw Potatoes	Soaked Dried Potatoes
Average gain per head	lb.	177·0	166·4	193·0
Average daily gain per head	lb.	1·58	1·48	1·72
Gain per 100 lb. dry matter	lb.	9·07	8·31	9·28
Gain per 100 lb. T.D.N.	lb.	13·09	11·40	12·91
Dressing percentage, hot	%	59·8	61·7	61·7
Carcass grade: Red	No.	4	4	4
Blue	No.	1	0	0
Commercial	No.	0	1	1

It will be noted that the soaked-dried-potato lot was first in daily gain and gain per hundred pounds of dry matter, and second in gain per hundred pounds of total digestible nutrients. The raw-potato lot was inferior in all respects. Five steers were marketed from each lot, the remainder, being heifers, were kept for breeding. The steers from the soaked-dried-potato lot and the raw-potato lot had the same dressing percentage and gave carcasses of the same grade. The dressing percentage of the corn silage fed animals was lower by two per cent.

Considering the different methods of evaluating the three feeds, the differences were not large and it may be concluded that these feeds were of equal value when fed as indicated in this experiment.

The barley equivalents of potato products are estimated.—In order to arrive at an estimate of the monetary value of the various products used in the preceding experiment, the barley equivalents of these products when fed in a balanced ration were calculated. It was found that 100 pounds of raw potatoes had the same value as 14 pounds of barley, 100 pounds of ground, dried potatoes were equivalent to 129 pounds of barley, and 100 pounds of dried potatoes (soaked) were equal to 88 pounds of barley.

To find the approximate value of the various potato products in any locality when fed in a balanced ration, it is only necessary to multiply the barley equivalent by the price per pound of barley.

When valued on that basis, it was found that raw potatoes were not a very economical feed for steers unless potatoes which had no market value were used. Dried potatoes could be used to better advantage as a substitute for grain rather than as a succulent feed.

The information is summarized.—

1. Raw potatoes and dried potatoes (soaked) are equivalent to corn silage for fattening steers from 800 to 1,100 pounds.
2. For steers of this weight, 22 to 25 pounds per day of raw potatoes appears to be the limit. More than this may cause scouring.
3. Ground dried potatoes are equivalent to barley when fed in a grain mixture.
4. It appears to be more economical to feed dried ground potatoes in the grain mixture rather than as a succulent, since, in the former case, it replaces a more expensive feed and, in addition, there is some saving of labour.
5. Dried potatoes may have particular value where rapid fattening is desired. Large quantities can be consumed without digestive disturbance.
6. Soaked, dried potatoes proved very palatable.
7. There was no noticeable difference in the carcasses of the steers fed the different rations.

Evaluation of Canadian Feeds by Means of Digestibility Trials

An important problem in livestock feeding is the proper evaluation of feeds, either commercial or those grown on the farm. Of the many factors that contribute to the value of a feed, one of the most important is the digestibility of the feed itself and its available nutrient content.

The digestibility of any feed can be adequately determined only by actual trials. Consequently, work was instituted at the Central Experimental Farm to evaluate Canadian feeds in this manner. Before valid coefficients of digestibility could be obtained it was necessary to determine whether factors such as: *(a)* the level of feeding, *(b)* the feeding of two or more feeds together, *(c)* the age of the animal, and *(d)* the species, had any effect on the digestibility of the feeds.

A considerable amount of work has been done on this subject, and most of the results have been published in scientific journals; hence only an outline of the general procedure and conclusions will be given here.

General procedure is described.—The general procedure in these digestibility trials consisted of four steps:

1. Chemical analysis of the feed.
2. Feeding of a given amount of that feed to the animal on test.
3. Collection of the feces voided.
4. Chemical analysis of the feces.

The difference between the amount of the feed constituents fed and that recovered in the feces is what was apparently digested by the animal. Calculated on a percentage basis the value becomes what is called the "coefficient of digestibility" of that feed. Knowing the chemical composition of a feed and its coefficient of digestibility, the total digestible nutrients can be computed.

The digestibility of a feed which cannot be fed singly is determined by feeding it with a feed of known digestibility. Likewise, the effect of one feed on another is found by determining the digestibility of each feed singly and comparing their value with that obtained when the two feeds are fed together. In the work to be summarized beef steers were used as experimental animals.

Effect of level of feeding important.—In practice, it may be economical to feed cattle at other than optimum level. On the other hand, it may be that the digestibility of Canadian feeds is affected by levels of feeding. To answer this question, experiments were conducted in which dry roughages, succulents, grains, and roughage and grains combined were fed at different levels and the coefficients of digestibility determined.

Dried roughage.—A mixed clover and grass hay was fed at five different levels varying from 5·5 to 19·8 pounds per day. At levels of 8·8 to 19·8 pounds per day there was no difference in the coefficient of digestibility. At the 5·5 pound level, the digestibility was only slightly lower; however, this is a starvation ration, not a normal one.

Mangels.—Mangels were fed in two ways: alone, and with hay. In the latter case, the hay was fed at a constant level but the mangels were fed at levels of 12, 22, 43·5, 48·4, 60, and 110 pounds per day, plus another level where the animals were allowed to eat as much as they wanted. The results indicated that neither the quantity of mangels nor their association with hay has any effect on the coefficient of digestibility.

Corn silage.—Corn silage was fed in three different ways: alone, at five levels varying from 17·6 to 44 pounds; with hay where the hay-silage ratio was four to five but at four different levels; with hay fed at a constant level and corn silage at five levels from 11 to 48·8 pounds per day. The results were similar for all three kinds of feeding. As the quantity of silage increased, the digestibility of all constituents except the protein decreased. The decrease in value of the silage from the lowest to the highest level of feeding was approximately six per cent.

Hay-barley combination.—A simple ration of hay and barley, equal parts by weight, was fed at five levels from 2·2 to 11 pounds per day. It was found that the digestibility of the protein of the ration decreased as the level of feeding increased. No effect was noticeable with the other constituents of the feeds.

Hay-linseed oilmeal ration.—Two hay-linseed oilmeal rations were fed. In one case, equal parts by weight of hay and linseed oilmeal were fed at levels varying from 4·4 to 17·6 pounds per day and at will. In the other case, the hay remained constant at 6·6 pounds but the amount of oilmeal varied from 2·2 to approximately 11 pounds. In both cases, the digestibility of the carbohydrates of the ration was lowered as the quantities of feed consumed increased. As a

result, the total digestible nutrients in the dry matter decreased progressively from the lowest to the highest level. In the first ration the magnitude of the decrease was four per cent, in the second ration between two and three per cent.

Summary.—In general, it may be said that with hay and mangels, the digestibility of the nutrients was not affected by the level of feeding. With corn silage at high levels of feeding, the total digestible nutrients, except the digestible crude protein, were reduced. With barley and hay at high levels, there was a reduction both in digestibility of all nutrients and of protein. With hay and linseed oilmeal the digestible protein was not affected but the total digestible nutrients were reduced.

Digestibility of one feed not usually affected by another.—It is known that some feeds affect the digestibility of others. This change in digestibility in a mixed ration is due to what is known as "associative digestibility". Since few of the rations commonly fed in Canada consist of one feed, it seemed important to know whether the digestibility of the mixed rations most commonly fed were so affected. To this end, studies were conducted to determine this point, with roughages, grains, and with roughages and grains combined.

Roughages.—Oat hulls were fed with hay, with corn silage, and with mangels. Straw was fed with hay, and with corn silage. Hay was fed with corn silage at two different levels, and with mangels in somewhat similar ratios.

It was found that the total digestibility of oat hulls was lower when fed in combination with hay, corn silage, or mangels than when fed alone. However, since oat hulls are not extensively fed in Canada, this is not of great practical importance. The total digestibility of oat straw was not affected when that roughage was fed with hay, with corn silage, or as the sole ration. Similar results weree obtained when hay was fed as the sole ration or with corn silage or with mangels.

The digestibility of the protein was somewhat lowered when hay was fed with silage or mangels. On the other hand, when oat hulls were fed in combination with hay or silage the digestibility of the protein tended to increase.

Grain and hay.—Barley, oats, and linseed oilmeal were fed each as the sole ration, and each with hay. When fed alone, or with hay, there was no difference in the digestibility of oilmeal. When barley was fed with hay the digestibility of the fat of the barley was higher than when the barley was fed alone. However, for all other constituents, no difference was found.

With the exception of the nitrogen and fat, the digestibility of the constituents of oats was decidedly lower when oats were fed with hay than when fed alone. The reduction in the total feeding value was in the order of five per cent. Comparing all these feeds there is a tendency for the digestibility to be lower when the grains are fed in combination with hay than when fed alone. However, the lower digestibility is important only in the case of oats when fed with hay.

In another series of experiments using hay as a basal ration, barley, oats, linseed oilmeal, bran, gluten feed, and soybean oilmeal were fed singly and in the following combinations: barley and oats; barley, oats and linseed oilmeal; bran, gluten feed and soybean oilmeal. It was found that the feeding of barley and oats together did not affect their digestibility. However, there was a small lowering of digestibility in the barley-oats-linseed oilmeal combination for the organic matter and carbohydrates, but none so far as the protein and fat were concerned. There was no difference in digestibility between the bran-gluten feed-soybean oilmeal combination, and the same feeds fed singly.

One grain and two different roughages.—The digestibility of timothy, alfalfa, and barley when fed singly, and when fed in combination was determined with sheep and steers. No difference in digestibility could be detected when these feeds were fed to sheep or steers.

Nutritive ratio.—Timothy hay, barley, and soybean oilmeal were fed to steers in different proportions to obtain rations varying in nutritive ratios from 1:2·8, to 1:10·1. Under the conditions of this experiment it was concluded that the nutritive ratio of a ration had no influence on the digestibility of the feeds.

Digestive powers of sheep and steers.—Timothy, alfalfa, mixed clover and alfalfa hay, and oat hulls were fed with barley or oats, and as the sole ration to representatives of the two species. In addition, a grain mixture of barley 3 parts, bran 2 parts, and linseed oilmeal 1 part was fed alone and with silage. Most of the mixed rations were also fed at different levels. Steers digested corn silage better, and hay slightly better than did sheep. Sheep, on the other hand, tended to digest grains better than did steers. The difference was not great except when oats were fed with hay. However, when the results of all rations were added together, there was little difference between the two species, in efficiency of digestion.

Summary.—The associative digestibility of grain, roughages, and roughages and grain, was studied with steers and the following results were obtained:

1. The total digestibility of hay, straw, silage, and mangels, was not affected when these roughages were fed with one another.
2. The total digestibility of oat hulls was lower when fed with hay, mangels, and corn silage than when fed alone.
3. There was no difference in total digestibility when grains or concentrates were fed singly or in combination.
4. The feeding of roughages and grains together did not influence their digestibility with the exception that when oats were fed with hay, the total digestible nutrients of the oats were reduced.
5. The nutritive ratio had no effect on the digestibility of the feeds making up the ration.
6. Sheep and steers digested the rations with almost equal efficiency.

Production and Management Studies

Beef cattle production in Eastern Canada has changed considerably in the last fifteen years. Previous to that it was generally believed that beef could be produced economically only on cheap marginal land under a rather extensive system of farming. Since then, under the influence of factors such as the scarcity of farm labour, a good market, and a tendency towards specialization on an increasing number of farms, beef cattle have found favour on the more fertile and more intensively cultivated land. There, they are regarded as economical converters of unsaleable and bulky crops, as restorers of organic matter and fertility to the soil, and as a means of utilizing more economically and efficiently throughout the year the labour available on the farm.

This renewed interest in beef cattle production has created a great demand for information. The management of the beef herd, the methods of finishing cattle in relation to the market demand and to the proper utilization of roughages, pasture, and grains are some of the factors on which information is needed.

In 1938, at the Central Experimental Farm, Ottawa, and at the Dominion Experimental Station, Lennoxville, Que., a project was initiated aimed at solving the above mentioned problems. During the period 1938 to 1949 the following phases have been studied.

1. Management and feed consumption of the herd.
2. Wintering of beef calves.
3. Production of baby beeves with and without the use of the creep.
4. Production of long-yearlings with and without grain on pasture.
5. Production of two-year-old steers on pasture.

This report deals with the work carried on at the Central Experimental Farm, Ottawa. The work carried out at Lennoxville will be found in the published progress report of that Station.

Management and Maintenance of the Beef Herd

In a properly managed commercial beef herd, the beef cow should be cared for and fed so as to produce and nurse a healthy calf every year of her adult life. In the maintenance of the herd, two factors loom large financially; one is housing, the other, feeding.

Loose housing superior.—Many beef barns are expensively built, unnecessarily warm, and are not planned to use labour efficiently. Therefore it was thought advisable to determine if a simple barn of the loose housing type would be satisfactory for wintering a beef herd.

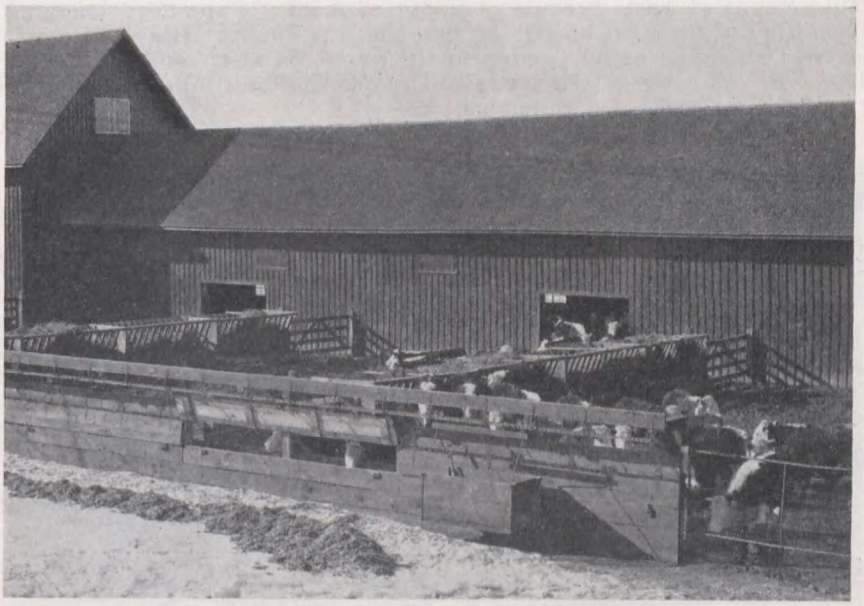

Fig. 2.—Beef cattle barn at the Central Experimental Farm, Ottawa. Loose housing and yard feeding reduces labour and permits the use of inexpensive buildings.

Since 1930, the beef herd at the Central Experimental Farm, Ottawa, has been kept every winter in a shed with openings on the south side. The shed is divided into pens which can accommodate 20 to 30 head. Each pen has a yard. The hay racks and the silage troughs are located outside. Water is provided in troughs equipped with electric immersion heaters. Storage barns are located at each end of the cattle shed. Animals of all ages are kept under similar conditions.

Observations over a period of 20 years reveal that beef cattle can be wintered very satisfactorily under these conditions without any detrimental effect on their health. Calves have been dropped in February and March in below-zero weather and no calf has been lost because of cold. As long as bedding is abundant, cleaning need be done only twice during the season.

From the above it may be concluded that beef cattle can be wintered in a cheaply constructed shelter provided that the following requirements are met:

(1) a southern exposure to catch the winter sun, (2) freedom from draughts, (3) facilities for outside exercise, (4) ample feed rack space, and (5) a good supply of water. In addition to these essential requirements the construction must be economical and planned so as to facilitate handy feeding and caring for the stock.

Roughage and pasture standard feed for the beef cow.—Adequate as well as economical feeding of the beef cow is essential since it can affect either the calf or the profit or both.

For six years at the Central Experimental Farm, records were kept of all feeds fed in order to determine the feed consumption of the herd. The ration consisted mostly of mixed grass and legume hay of from fair to poor quality, and good corn silage. No grain was fed even after calving. For a winter season averaging 168 days, the feed consumption per head was 3,310 pounds of hay and 3,991 pounds of corn silage, or approximately 20 pounds of hay and 24 pounds of silage per day. The hay consumption may appear a little high as there was a certain amount of waste because of the poor quality of the hay. Judging by the condition of the cows at calving time and the quality of the calf crop, the ration was adequate as no trouble was encountered that could be related to feeding. In the summer the cattle had ample, natural, unimproved pasture. Salt and minerals were fed throughout the year.

FIG. 3.—Baby beeves ready for market. They required 1,100 pounds of grain to reach the proper finish.

The cost of winter feeding can be reduced considerably if the cattle go into their winter quarters in good fleshy condition. As pasture is generally cheaper than dry roughage, an abundance of pasture will generally result in a lower cost of wintering. Such a procedure is called "Wintering the cattle in summer".

Winter feed consumption of beef calves.—On farms organized for the production of yearling and two-year-old steers the first winter is often a critical one for the beef calf. At weaning the young animal is in the most rapid period of its development. The growth impulse is so strong that a little extra feed at this time will result in surprising gain.

To obtain information on the feed requirements for normal growth during the winter, feed records on 122 calves were kept from weaning up to the time they were turned out to pasture the following spring. The results will be found in Table 3.

TABLE 3—WINTER FEED CONSUMPTION OF BEEF CALVES
6-YEAR AVERAGE 1939-45 INCL.

Feeding period	days	159·8
Average gain per head	lb.	165·9
Daily gain	lb.	1·04
Feed per head—		
Hay	lb.	1,389·0
Silage	lb.	1,548·0
Grain	lb.	204·0

A little grain is advisable.—Considering the small amount of grain consumed, 1·3 pounds per day, the calves made rather good gains. They averaged 473·9 pounds at weaning and 639·8 pounds in the spring. They were not fat but were well grown. These calves were born in March and April the previous year and had consequently made good growth during the summer as the weaning weight would indicate.

Production of Baby Beeves

In the large consuming centres there is a demand for young, well finished steers weighing from 700 to 900 pounds. Such steers called "baby beeves" or "fed calves" generally command a premium of one to two cents per pound over heavier and older beef of the same quality.

Creep feeding vs. no creep feeding.—To study the factors governing baby beef production, two lots of calves were fed for three successive years. Lot 1 was fed oats in a creep for 100 days before weaning while Lot 2 received no grain. From weaning time both lots were fed a ration of alfalfa hay, corn silage, and a grain mixture of oats, barley, wheat, and linseed oilmeal until they were ready for slaughter. At slaughter, the yield was determined and the carcasses graded. The results will be found in Table 4.

TABLE 4—PRODUCTION OF BABY BEEVES—CREEP FEEDING VS. NO CREEP FEEDING
3-YEAR AVERAGE 1939-41 INCL.

—		Lot 1	Lot 2
		Creep-fed on Pasture	Not Creep-fed on Pasture
Number of calves	No.	30	28
Creep-feeding period—			
Number days on feed	days	102·7	107·0
Gain per head	lb.	154·4	134·1
Daily gain	lb.	1·50	1·26
Grain per head	lb.	188	0
Dry-lot feeding—			
Number days on feed	days	122·0	150·7
Gain per head	lb.	198·0	241·8
Average daily gain	lb.	1·62	1·60
Feed per head—			
Hay	lb.	767	877
Silage	lb.	828	1,127
Grain	lb.	916	1,101
Carcass data—			
Dressing percentage, cold	%	58·5	58·5
Grade: red	%	73·3	67·5
blue	%	26·6	32·5

Creep feeding advantageous.—A study of Table 4 reveals that creep feeding nursing calves for a period of about 100 days resulted in a net gain of 20 pounds per head over those not creep fed. This was accomplished with 188 pounds of grain in addition to the dam's milk. In dry-lot, both lots made approximately the same daily gain, but Lot 1 was ready for market 28 days earlier than Lot 2. The total grain consumption including that of the creep feeding period of Lot 1 was about the same for both groups. However, the calves of Lot 2 consumed a little more hay and corn silage than did those of Lot 1.

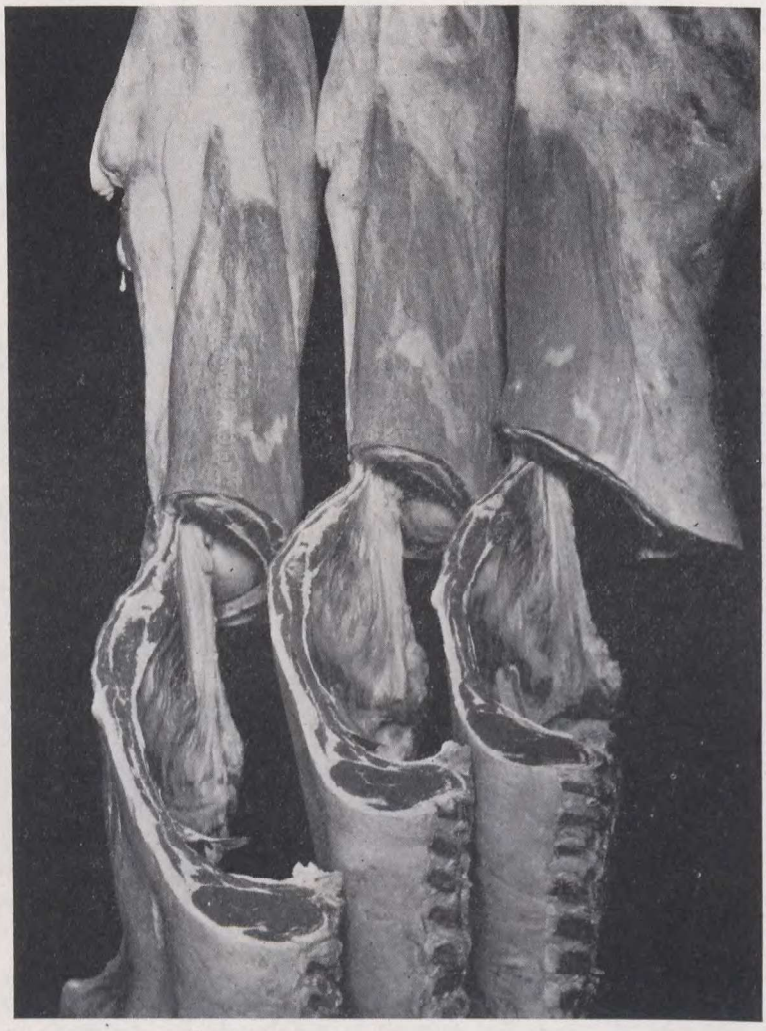

FIG. 4.—Carcasses of Red Brand baby beef. Creep-feeding helps produce such carcasses.

The calves were marketed after having reached the live weight of 760 and 769 pounds for Lot 1 and Lot 2 respectively. The dressing percentage was the same for both lots. However, Lot 1 had a little higher percentage of carcasses that graded red than Lot 2.

Summarizing, it appears that creep feeding during nursing is advantageous in the production of baby beeves. The feed requirements are smaller, the feeding period shorter, and the quality of the carcass a little better. Baby beeves can be marketed over a fairly wide range in weight. On the other hand, because field work requires most of the farm labour from May on, it is advisable to sell not later than April. Early finish on his calves gives the operator the added advantage of being able to sell immediately or wait for a more favourable market without impairing the quality of his calves.

Baby beef means heavy grain feeding.—Whatever method of feeding is adopted, baby beef production requires a great deal of grain. For calves averaging 770 pounds, it was found that for every pound of hay or its equivalent, approximately one pound of grain was required. This appears necessary if proper finish is to be obtained within the desired weight. Consequently, any feeder before undertaking to produce this type of beef will need ample reserves of grain. According to practical producers, the secret of this type of production is, in addition to good breeding and conformation, to retain the baby fat of the calves. In this manner, tenderness is ensured while beef flavour is imparted to the meat.

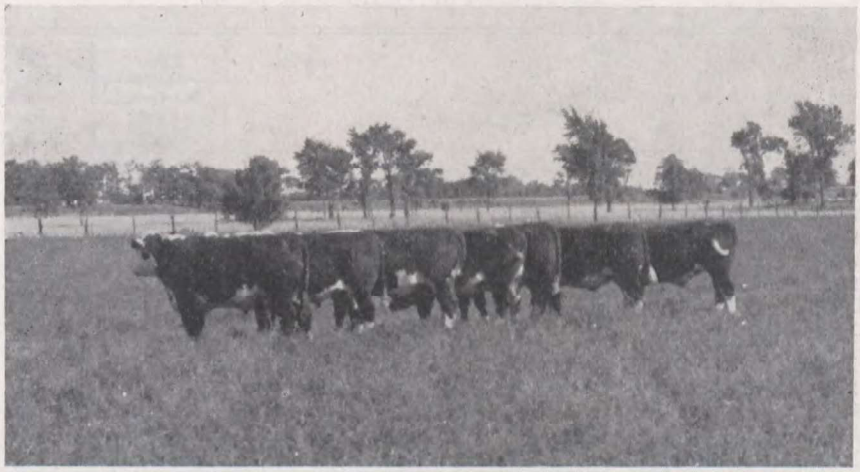

FIG. 5.—Two-year-old steers being finished on pasture. Alfalfa aftermath is a good substitute for grain.

PRODUCTION OF YEARLINGS

Among the different classes of animals marketed for beef, the 1000-pound steer or "butcher steer" is always in demand. Its popularity with the average butcher is due to the medium weight of its carcass. This class of beef does not have the pronounced beef flavour of the more mature animal but it has tenderness and, in addition, it provides cuts of more suitable size for the average consumer.

This beef is best produced by fattening well developed yearlings in dry-lot. This method of beef production is quite flexible. The length of the finishing period or the intensity of feeding may be governed by the development of the animals in the fall, the time of marketing, and the different kinds of feeds available.

From 1938 to 1945, three experiments were conducted to study,

1. The feeding of grain to calves after weaning.
2. The time of marketing.
3. The feeding of grain on pasture.

Feeding of grain to calves after weaning advisable.—From 1943 to 1945, an experiment was conducted to determine if grain is necessary for the proper development of weaned calves destined to be finished as butcher beef.

For this purpose, in the fall of 1943, two groups of Shorthorn calves were chosen. Lot 1 was fed a basic ration of alfalfa hay and corn silage. Lot 2 received the same basic ration and in addition two pounds of a mixture of oats, four parts, and bran, one part. The following spring the animals were turned out to pasture together and then finished in dry-lot the following winter.

The finishing ration consisted of good mixed hay, corn silage, and a mixture of barley, wheat, oats, and linseed oilmeal. With the exception of the first winter, all animals were treated and fed alike. They were sent to slaughter as they acquired the proper finish, and all carcasses were graded.

Table 5 gives the gain and the feed consumed by the two groups from weaning to slaughter.

TABLE 5—EFFECT OF GRAIN VERSUS NO GRAIN DURING FIRST WINTER IN THE FATTENING OF YEARLINGS, 1943-45

—		Lot 1	Lot 2
		No Grain First Winter	Grain Fed First Winter
Gain and carcass yield—			
Total number of days	days	423	418
Average final weight	lb.	1,069	1,085
Average gain per head	lb.	539	554
Average daily gain	lb.	1·27	1·32
Dressing percentage	%	53·5	53·2
Carcass grade: red	%	62·5	71·4
blue	%	37·5	28·6
Total feed per head—			
Hay	lb.	2,755	2,865
Silage	lb.	2,724	2,404
Grain	lb.	826	872
Pasture days	days	172	172

From Table 5 it will be seen that the steers in the grain-fed lot finished earlier, at a heavier weight and produced slightly better carcasses than those fed no grain the first winter. By converting silage into hay equivalents on the basis of three pounds of silage for one pound of hay, it will be found that both lots consumed the same amount of roughage but Lot 2 consumed 46 pounds more grain per head. Although not indicated in the Table, the grain-fed calves made a quarter of a pound more gain per day than those fed the basic ration during the first winter. This advantage was maintained throughout the pasture season during which time both lots made the same gain. For the finishing period both groups made a daily gain of over two pounds but, for some unknown reason, Lot 1 made slightly better gain than Lot 2.

From the above results it appears that the feeding of a small amount of grain daily to weaned calves during the first winter is advisable. Alfalfa hay and corn silage produced good gains but, in proportion to the grain eaten, the extra gain in Lot 2 was cheap.

Early finishing of yearlings advisable under certain conditions.—This experiment was initiated to determine whether it is more advantageous to feed yearling steers heavily as soon as they come off pasture, or to carry them on roughage for a while before fattening. For this purpose, two lots were put on feed November 12, 1938. Both lots received the basic ration of hay and silage. However, Lot 1 was given in addition a mixture of barley, oats, and linseed oilmeal while Lot 2 did not receive the grain mixture until December 30, 1938. Once on grain, both lots were brought to full feed as rapidly as possible. The steers of Lot 1 were marketed at the end of February, 1939 and those of Lot 2 at the end of April, 1939. The hot dressed weights were recorded and the carcasses graded. Table 6 gives the gain and the feed per 100 pounds of gain.

TABLE 6—EARLY VERSUS LATE FINISHING OF YEARLINGS, 1938-39

		Lot 1	Lot 2
		Early Finishing	Late Finishing
Gain and carcass yield—			
Number of animals	No.	11	11
Number days on trial	days	108	169
Gain per head	lb.	142·7	185·4
Average daily gain	lb.	1·32	1·10
Dressing percentage	%	59·5	60·1
Carcass grade- red	%	18·2	45·4
blue	%	54·5	45·4
commercial	%	27·3	9·1
Feed per 100 pound gain—			
Hay	lb.	687	962
Silage	lb.	1,655	1,800
Grain	lb.	656	565

Table 6 shows that Lot 1, which was put on feed early in the season and brought along as rapidly as possible, required more grain but less roughage and was marketed two months earlier than Lot 2. The latter lot on the other hand, consumed more of the home-grown roughages, graded higher, and also produced more manure. Consequently, the choice of method will depend on the type of enterprise the farmer is engaged in, the amount of roughages and grain available, the value of his labour, and his ability to predict the price which will prevail at the time of marketing.

Grain to yearlings on pasture shortens finishing period.—Invariably in the fall, a large number of yearling cattle are sold as feeders or stockers. Were these animals better fed in the latter months of the grazing season, a greater number might be sold as finished animals either off grass or after a short feeding period. In order to determine if the feeding period could be shortened, or a saving of feed effected by grain feeding on pasture, the following experiment was conducted in 1940 and 1941.

Well grown yearling steers were placed on pasture in the spring. In September, after 120 days of grazing, the animals were divided into two groups: Lot 1 received a mixture of oats and barley at the average rate of five pounds per head per day; Lot 2 received none. At the end of the pasture season both lots were finished in dry-lot and marketed when carrying sufficient finish to grade Red or Blue.

Table 7 gives the average gain and feed consumption.

TABLE 7—GRAIN VERSUS NO GRAIN FOR YEARLINGS ON PASTURE
2-YEAR AVERAGE, 1940-42

—		Lot 1 Grain Fed on Pasture	Lot 2 No Grain on Pasture
Gain and carcass yield—			
Number of animals	No.	20	19
Number of days	days	233·2	270·4
Gain per head	lb.	308	343
Average daily gain	lb.	1·32	1·26
Dressing percentage	%	57·1	59·5
Carcass grade: red	%	80·0	41·6
blue	%	15·0	58·4
commercial	%	5·0	0
Feed per head—			
Hay	lb.	489	807
Silage	lb.	874	1,571
Grain	lb.	751	752
Pasture period	days	177	177

The lot grain-fed on pasture was ready for market 37 days earlier on the average than the lot fed no grain. Lot 1 was fed grain on pasture for 57 days during which time the steers consumed 48 per cent of their total grain allowance. At the end of the pasture season, five steers were sufficiently finished to sell off grass and the remainder were fed in dry-lot for 56 days, while Lot 2 required 93 days feeding before they could be sold.

During the entire trial both lots consumed the same amount of grain, but there was a saving of 318 pounds of hay and 697 pounds of silage per head in favour of the lot fed grain on pasture. The advantages of feeding grain on pasture are therefore, a shorter feeding period, a saving of hay and silage, and an economy of labour. As a rule, yearling cattle on pasture are inclined to grow rather than to fatten. Thus to follow an early finishing program the steers used must be well grown and of good quality.

Production of Two-Year-Old Steers

Where roughages and pasture are abundant and cheap, long-yearling steers are generally over-wintered and finished as long-two-year-olds the following summer. These animals are wintered as cheaply as possible and then put on pasture with or without grain depending on the time they are to be marketed.

As grains are generally expensive it was thought advisable to determine whether a limited amount of grain fed during the winter would prove advantageous and whether good pasture in late summer and early fall would reduce the grain necessary to properly finish cattle of this age. Furthermore, it was desired to determine the quantity of feed required for that class of cattle from birth to marketing.

Grain supplement for wintering yearlings subsequently finished on grass.—To determine whether a limited amount of grain fed during the winter might prove advantageous in the finishing of steers on pasture, two groups of eighteen long-yearling steers were fed the following ration: Lot 1 received hay alone; Lot 2, hay plus two pounds of grain per head daily. The hay was grass hay and the

grain was a mixture of equal parts of oats and barley. In the spring, all animals were put on a permanent pasture. From the end of July they were fed a grain mixture of equal parts of oats and barley on pasture and were marketed in early fall when sufficiently finished to grade either Red or Blue brand.

Table 8 gives a summary of the results obtained from the time the animals were put on winter feed until they were marketed off pasture. This experiment was conducted for three years.

TABLE 8—GRASS FINISHED STEERS WINTERED WITH AND WITHOUT GRAIN
3-YEAR AVERAGE, 1947-49

—		Lot 1	Lot 2
		Wintered on Hay	Wintered on Hay and Grain
Gain and carcass yield—			
Average number of days	days	316·6	290·9
Average final weight	lb.	1,137·6	1,155
Average gain per head	lb.	321·8	336·6
Average daily gain	lb.	1·01	1·15
Dressing percentage	%	53·7	53·9
Carcass grade: red	%	81·2	87·0
blue	%	18·8	13·0
Feed per head—			
Hay	lb.	3,433	3,056
Grain	lb.	387	643
Pasture period	days	167	140

Feeding of grain in winter unnecessary.—The winter feeding period lasted 150 days. During that time the grain-fed lot gained 99 pounds per head while the lot fed hay alone, gained only 51 pounds. There was a little saving of hay in the grain-fed lot but they consumed 288 pounds of grain per head on the average.

On pasture, Lot 1, hay alone, made slightly better gains than Lot 2, the grain-fed lot, but this gain was not sufficient to overcome the extra gain made by the other lot during the winter. The grain-fed steers always showed a more finished appearance throughout the summer season and probably could have been marketed earlier. Such a feature may be of value if it is desired to sell early in order to take advantage of a strong market. Finally the steers wintered on hay and grain were heavier at marketing, finished 25 days earlier and gave a higher percentage of top grade carcasses than those receiving hay only during the previous winter. However, they consumed 257 pounds more grain than did the steers of the other lot.

Under the conditions of this experiment it does not seem advisable to feed grain during the winter to yearling steers to be finished on grass the following summer. It should be mentioned, however, that the hay fed, although mostly grass hay, could be considered as good hay for that class of cattle and that they were given all they would clean up. Where hay is poor or where straw is fed as the sole roughage, a little grain might be advisable in order to prevent losses in weight.

Permanent pasture versus aftermath for finishing two-year-old steers.—From 1947 to 1949, an experiment was conducted to determine whether a saving of grain could be effected by the use of aftermath in the finishing of two-year-old steers. For this purpose, at the end of July a group of 24 steers, which had been grazing together on a permanent pasture since spring, was divided into two

equal groups. One lot remained on the permanent pasture and was fed a grain mixture of equal parts of oats and barley. The other lot was placed on an alfalfa aftermath and grain feeding was started four to five weeks later depending on the season. All animals were marketed when considered to be sufficiently finished to grade Red or Blue brand.

A summary of the results on a per head basis will be found in Table 9.

TABLE 9—PERMANENT PASTURE VERSUS AFTERMATH FOR FINISHING TWO-YEAR-OLD STEERS—2-YEAR AVERAGE, 1947–49

—		Lot 1	Lot 2
		Permanent Pasture and Grain	Aftermath Pasture and Grain
Gain and carcass yield—			
Average final weight	lb.	1,136·3	1,170·3
Average gain per head	lb.	83·7	122·1
Average daily gain	lb.	1·22	1·53
Dressing percentage	%	54·5	54·2
Carcass grade: red	%	78·3	97·2
blue	%	18·9	2·8
commercial	%	2·8	0
Feed consumed—			
Average grain per head	lb.	502	182
Average number pasture days	days	69	80

Alfalfa aftermath is a good substitute for grain.—From Table 9 it will be seen that the steers on aftermath made greater gains, gave a higher percentage of top grade carcasses, and consumed considerably less grain than those on permanent pasture. This saving of grain amounted to 320 pounds per head. Lot 2, on aftermath, was fed grain for the last 32 days of the grazing period only.

Two-year-old steers, because they have completed most of their growth, are much more easily fattened on pasture than are yearlings. However, during late summer and early autumn, permanent pastures are generally at a low ebb and farmers are inclined to supplement them with grain. Therefore, it would appear to be a good policy to have in reserve some kind of aftermath for this period of low grass production. Alfalfa aftermath appears to be a valuable substitute.

Relationship of Feeds to Methods of Beef Production

Since different classes of beef cattle have different feed requirements, the selection of the method of beef production best suited to a given farm is dependent on the respective amounts of pasture, roughages, and grain which that farm can produce. To ignore this principle may mean either a surplus of some feeds or the purchase of supplementary feeds.

In order to help the beef producer to organize his farm a table was prepared showing the relative feed requirements of baby beeves, yearlings or "butcher beef", and two-year-old steers fattened on grass. For this purpose, the data from all the experiments previously discussed have been summarized into their respective classes. For yearlings and two-year-olds, the live weight and gain of the animals, the feed requirements and the amount of grain per 100 pounds live gain were calculated from weaning to marketing. For baby beeves, the same items were calculated from the beginning of creep feeding about 100 days earlier. Finally a grain-roughage ratio was worked out after converting the silage to hay equivalent on the basis of three pounds of silage to one pound of hay.

This will be found in Table 10. The data should not be looked upon as giving the exact requirements but rather as a guide in planning a beef enterprise.

TABLE 10—COMPARATIVE FEED REQUIREMENTS FOR FINISHING BABY BEEVES, YEARLINGS, AND TWO-YEAR-OLDS WITH MAXIMUM USE OF PASTURE

—		Baby Beeves	Yearlings	Two-year-olds
Age at marketing	days	352	645	876
Marketing weight	lb.	765	1,025	1,146
Gain	lb.	364	513	672
Carcass weight	lb.	431	553	618
Feed requirements—				
Hay	lb.	822	2,332	4,684
Silage	lb.	978	2,511	1,548
Grain	lb.	1,086	901	719
Pasture period	days	—	176	348
Grain per 100 lb. live gain	lb.	298	176	107
Grain/roughage ratio		10:11	10:35	10:72

More grain for baby beeves, more roughage and pasture for older cattle —An analysis of Table 10 shows that as the animal gets older and heavier, the amount of grain necessary for finishing decreases while the roughages and pasture show an increase. There is a similar tendency when the feeds are expressed in relation to live gain.

The grain-roughage ratio shows perhaps more clearly the suitability of any class for a given farm or area. Thus, it will be seen that in the production of baby beeves, about as much grain is required as roughage, while in the other two groups, it takes three to seven times more roughage than grain. A similar relationship exists in the number of pasture days which goes from nothing for baby beeves to 176 and 348 for the other two classes respectively.

From the above, it may be concluded that the production of baby beeves is a grain proposition and as such should best be undertaken where pasture is limited but grain abundant. The turnover is rapid. The production of long-yearlings on the other hand is less intensive. It requires more shelter and the maintenance of the animal for an extra year, but it utilizes to a greater extent two of the cheapest feeds, pasture and roughage. This production is also more flexible. In years of abundant pasture, steers may be marketed early or late depending on the market and the feeds available. In poor pasture years, the steers may be sold as feeders or stockers or they can be finished during the winter.

The fattening of two-year-olds on pasture is the most extensive of all as far as pasture and roughage utilization is concerned. If the cattle are to be raised on the farm, the land requirements for pasture and roughage production will be large. It is doubtful if such a method would be practical on the present-size farms in Eastern Canada. More often, long-yearlings are bought in the fall and pastured the following summer. Although there is an element of risk in the purchase of cattle, this procedure results in a more rapid turnover than would be the case were these cattle to be raised on the farm.

HYBRIDIZATION OF DOMESTIC BEEF CATTLE AND BUFFALO

V. S. Logan and P. E. Sylvestre

The object of this experiment is to develop a range beef animal for Western Canada which combines the hardy characteristics of the buffalo (bison) and the superior meat qualities of the domestic breeds. There are vast areas in the northern portion of the Prairie Provinces which are capable of growing good fodder crops. Low temperatures and severe blizzards which occur in winter, and heavy fly infestations during summer, produce conditions which are detrimental to the improved domestic breeds. The buffalo, with its heavy hide and thick, curly hair, and its instinct to face storms rather than drift with them, can withstand this severe climate. Even in the more southerly regions, on the prairie range country, late spring blizzards often take a heavy toll of range cattle through the animals drifting with the storm until they become bogged down in snow.

A statement of the early progress of this experiment was published in bulletin form in 1935. Further results were reported in a brochure published in 1941. These publications are now out of print.

This report deals with the period 1937 to 1949, inclusive, and presents recent comparative trials with domestic-buffalo crosses and pure domestic breeds. In order to clearly focus this period the early steps in the development of the hybridization experiment are reviewed.

Establishment of the Cattalo herd

The experiment was started in 1915 with sixteen female and four male hybrids purchased from the Mossom Boyd Company of Bobcaygeon, Ont. This group consisted of: four hybrid cows (50 per cent domestic) which were proven breeders; four second-cross cows (25 per cent domestic and also proven breeders); one second-cross cow (75 per cent domestic); seven cows and heifers (50 to 75 per cent domestic); and four hybrid bulls (25 to 70 per cent domestic) one of which was reputed to be a proven breeder.

The initial experiment was set up at the Dominion Experimental Station, Scott, Sask., and later moved to an enclosure in Buffalo Park, Wainwright, Alta. In 1949 the herd was moved to the Dominion Range Experiment Station, Manyberries, Alta.

Unfortunately, owing perhaps to the change of environment and to their age, none of the hybrid animals reproduced after being purchased by the Department of Agriculture, and hence, the experiment had to be started again with original crosses between buffalo and domestic cattle. Consequently, a few buffalo calves were raised on domestic cows and later used for crossing with domestic females of the Shorthorn, Hereford, and Holstein breeds. The mating of buffalo males with domestic females resulted in a very high mortality of both cows and calves at the time of birth and was discontinued. The reverse mating was then used, namely, domestic males with buffalo females. The chief difficulty with these latter matings was the difficulty of getting the domestic bulls to associate with the buffalo females.

A number of yak, an Asiatic species of cattle, were included in the early hybridization work. Yak are considered to occupy an intermediate position between buffalo and domestic cattle zoologically, so it was thought that through their use fertile hybrid males might be obtained. Crosses obtained from yak on

domestic, the reciprocal cross of domestic on yak, and yak on buffalo appeared to confirm this opinion. However, it was felt that the introduction of yak blood complicated the experiment too much, and hence all yak crosses were later eliminated.

Hybridization of domestic cattle and buffalo poses many breeding problems

The results of the early work established that while the female hybrids appeared to have a normal conception rate, all male hybrids (first-cross) were definitely sterile. Female hybrids, therefore, could be mated successfully either to buffalo males or domestic males. Since domestic meat is superior to that of the buffalo, it was decided to back-cross to the domestic to increase the percentage of domestic "blood". The first 75 per cent domestic males produced also proved to be sterile. Thus, the period under review has been devoted to back-crossing to domestic bulls, under the assumption that the greater the proportion of domestic "blood" the greater the possibility would be of obtaining fertile males while retaining a sufficient portion of buffalo blood. Eventually a few males of the second, third, and fourth, etc., back-crosses of the hybrids and their female progeny to domestic bulls, were found to be fertile, and were mated with small groups of domestic-buffalo females. The progeny from such matings are true "Cattalo", which is the name given to offspring, both parents of which are of domestic-buffalo breeding.

FIG. 6.—Domestic × buffalo hybrids. The result of crossing domestic beef bulls on buffalo cows.

In Table 11 is a list of the total number of matings, offspring produced, and the composition of the parents and offspring in terms of the percentage of domestic blood. It may be noted in Table 11 that sires used range from pure domestic (100 per cent) to 75 per cent domestic, while the females range from 50 to 92 per cent domestic, and the offspring from 50 to 96 per cent domestic.

The first line of figures running horizontally in Table 11 represents the matings of domestic bulls and buffalo females. A few domestic bulls were group-mated with 71 head of young buffalo females for a period of three years. One of these bulls, which was raised in association with the original hybrid herd, sired most of the calves.

TABLE 11—BREEDING RESULTS FROM DOMESTIC SIRES AND BUFFALO DAMS AND THEIR PROGENY AS EXPRESSED IN TERMS OF PER CENT DOMESTIC BLOOD 13 YEARS, 1937-49, INCL.

Matings Per Cent Domestic Blood		Number of Matings	Number Live Offspring Born		Offspring—Per Cent Domestic Blood
Sires	Dams		Males	Females	
100	0	213	34	16	50
100	50	250	53	98	75
100	75	79	23	38	87
100	86	37	18	14	93
100	87	22	4	5	94
100	92	7	1	2	96
97	50	271	75	124	73
97	75	107	34	45	86
97	87	5	1	3	92
87	86	5	—	3	87
86	75	73	15	41	80
86	86	74	28	30	86
86	93	3	1	1	89
75	75	32	2	4	75
75	80	4	—	1	78
75	86	20	6	6	80

The offspring listed in Table 11 indicate a definite trend toward a larger proportion of females than males. Some conjecture has been made as to the possibility of foetal deaths of males occurring to a greater extent than of females. No definite proof of this trend has been established. As the animals have an extensive summer and winter range, abortions and stillbirths may occur unobserved.

Sterile Males a Problem

The lack of fertility in the males is the chief stumbling block to the successful conclusion of the preliminary experimental phase of this project. The cause of sterility may be due to a modified form of cryptorchidism. It is considered that the highly insulated scrotal sac inherited from the buffalo maintains the testes in the domestic-buffalo progeny at a temperature too high for spermatogenesis.

The fertility of the bulls is tested by microscopic examination of the semen and by mating with selected groups of females. Due to the shyness of these bulls, which are maintained in a semi-wild condition, collection of semen is difficult and this test cannot always be made.

The breeding of the first bull found to be partially fertile was 93·8 per cent domestic. This bull, mated to a domestic cow, sired a male offspring that proved to be of normal fertility. During the period under review, up to 20 bulls, ranging in breeding from 75 per cent domestic to 96 per cent domestic, have been examined each year. Approximately 25 per cent of these showed partial fertility. From the results to date there does not appear to be an increase in the fertility of the males that directly corresponds with the increase in the proportion of domestic breeding. In a few instances, bulls with quite viable semen have not shown evidence of fertility when allotted to mating groups.

To date, fifteen bulls ranging in breeding from 75 per cent to 96 per cent domestic breeding have been mated and have sired offspring. Eight of these bulls were considered to be of normal fertility.

The domestic-buffalo offspring are healthy

Tuberculosis and Bang's tests made on the domestic-buffalo crosses in 1939 showed them to be relatively free of these diseases. Out of 94 animals tested, two reacted to the tuberculosis test, and one reacted positive, with four questionable, to the Bang's test.

In 1949 the entire herd was found to be free from tuberculosis infection. Two animals which gave suspicious reactions to the Bang's disease blood test, were discarded.

The conformation of the Cattalo does not compare favourably at present with the Hereford

The conformation of the Cattalo does not yet compare favourably with that of improved domestic beef breeds. In general, the adult Cattalo is heavy in the shoulders and light in the hindquarters. These characteristics become more accentuated as the percentage of buffalo blood increases. The 75 per cent domestic are about halfway between the hybrids and the domestic. The 86 per cent domestic seems to conform more closely to domestic type. However, there appears to be more variation in type in the 86 per cent domestic than in the other two groups. This is as might be expected, since most of the animals of this breeding are the progeny of parents both having a percentage of buffalo "blood". There are individual animals which compare well with the average of domestic beef breeds. The variability observed is desirable at present, as it permits effective selection of desirable types.

The weight of the Cattalo compares favourably with the Hereford

As a means of estimating the relative size of Cattalo to that of domestic cattle, all animals were weighed at the close of the grazing season. These weights are shown in Table 12.

TABLE 12—COMPARATIVE AVERAGE LIVE WEIGHTS OF CATTALO AND HEREFORD CATTLE

Blood Groups	Mature (Females)		Yearlings (Females)		Calves (Both sexes)	
	Number Head	Average Weight	Number Head	Average Weight	Number Head	Average Weight
		lb.		lb.		lb.
50% domestic	38	1,031	—	—	—	—
75% domestic	37	1,013	14	711	67	388
86% domestic	27	1,021	5	670		
Hereford	65	1,081	35	711	60	335

There was not a great deal of difference in the average weights of Cattalo of different "blood" percentages and Herefords. It should be noted that the Cattalo calves averaged 53 pounds heavier than the pure domestic, but apparently this advantage in weight is lost as the animals get older.

In general, there is indication that the animals in the 86 per cent domestic group possess more of the characteristics desired in a beef producing animal than those in the 75 per cent domestic group, and that they have more cold tolerance than the domestic. If the cold tolerance and hardiness factors are found to be adequate in the 86 per cent domestic animals, this group may prove to be the most satisfactory.

Transfer of Cattalo Herd

As the work continued it became increasingly evident that further progress could be made only if more stock, greater facilities and more technical staff were provided. Further expansion of the work was impossible at Wainwright, so it was decided to transfer the herd to the Range Experiment Station at Manyberries,

Alta., where greater facilities and a trained technical staff would be available. All calves and a number of bulls were transferred early in the fall of 1949, and the remainder of the herd was moved later.

Table 13 gives the composition and number of the Cattalo herd.

TABLE 13—NUMBER OF ANIMALS AND BREEDING OF THE CATTALO HERD, 1949

Per Cent Domestic Blood	Number of Males			Number of Females			Total
	Calves	Yearlings	2 Years and Over	Calves	Yearlings	2 Years and Over	
50·0	—	—	—	—	—	41	41
75·0	17	5	5	15	12	32	86
80·5	8	—	2	8	2	6	26
84·4	—	—	—	—	—	2	2
86·0	7	1	4	10	2	24	48
87·5	—	2	1	—	3	1	7
93·0	—	—	1	—	—	—	1
93·8	—	—	1	—	—	—	1
	32	8	14	33	19	106	212

In order to ensure an adequate supply of fertile bulls a large number must be raised to maturity and tested.

Objectives in the establishment of the Cattalo herd

With the better facilities at the Dominion Range Experiment Station, Manyberries, Alta., the project is being gradually reorganized. Efforts will be made to increase the herd, more complete data will be obtained and more detailed observations recorded on the characteristics of the animals comprising the herd. The project poses a number of physiological and genetical problems, among which the following are examples:—

(*a*) Thriftiness and hardiness of the domestic-buffalo crosses.

(*b*) Comparative development, rate of maturity and beef-producing qualities of domestic-buffalo and Hereford animals.

(*c*) Male sterility problems.

(*d*) Improvement of the Cattalo herd consistent specifically with the ability of the animals to withstand low temperatures and winter storms.

At the present time it would seem that the Cattalo, having a maximum of the hardy characteristics of the buffalo and superior meat qualities of the domestic, should be fixed somewhere between the 75 per cent and 86 per cent domestic blood level.

DAIRY CATTLE

C. D. MacKenzie and V. S. Logan

Two herds of purebred dairy cattle of the Ayrshire and Holstein breeds are maintained for research purposes. During the thirteen-year period under review the average size of herds, including young stock, has been 65 head of Ayrshires and 85 head of Holsteins. Both herds have been housed and managed as a single dairy herd unit. The experimental work conducted with dairy cattle involved problems relating to breeding, feeding, management and disease control. The projects have emphasized the practical and economic aspects of these problems.

Breeding Studies

The object of the breeding plan followed for the Ayrshire and Holstein herds has been to achieve high, economical production from animals of reasonably good body conformation. The selection of sires of the Holstein breed has been made with a view to increasing the butterfat test of the herd to four per cent along with increased production. The objective in the breeding of the Ayrshire herd has been to increase the level of production, at the same time retaining the average butterfat test at above four per cent.

Improvement in production has been measured by means of the Record of Performance test and the evaluation of conformation has been based on the Selective and Advanced Registry ratings of the different breeds. A project to develop a polled strain of Ayrshires was begun during the latter part of the period under review.

Outcrossing and Line Breeding

Ayrshire breeding.—The plan followed in developing the Ayrshire herd has been to use bulls bearing only slight relationship to the herd. The difficulty of procuring suitable bulls at the required time has occasionally necessitated some slight deviation from this plan. The herd sires used prior to the war were imported from Scotland and were selected from exceptionally high producing herds. With the limitation of importations during the war period, bulls of high rating from other sources were used.

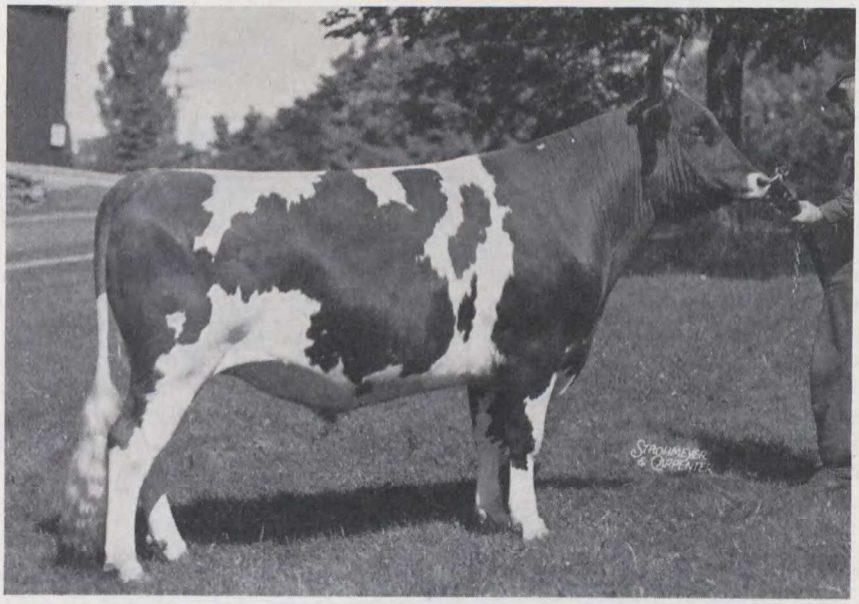

Fig. 7.—"Cowgrove Klondyke (imp)" 205807. Typical Ayrshire bull used in the outcross breeding program.

Ayrshire sires used from 1937 to 1949.—

Lessnessock Electra (imp)—177014—R.O.P. No. 1002, A.R. No. 377, Class "AA".

Cowgrove Klondyke (imp)—205807—R.O.P. No. 1295, A.R. No. 726, Class "AA".

Kapuskasing Old Times 13th—202401—R.O.P. No. 1342, A.R. No. 583, Class "AA."

Warfield Patty's Pickens—167704—R.O.P. No. 1048, A.R. No. 403, Class "AA".

Ste. Anne Douglas 51st—281897—A.R. No. 1006, Class "AA".

Strathglass Laird's Renown—275324—R.O.P. No. 2260, A.R. No. 116, Class "AA".

It will be noted that all bulls used were Classed AA in the Advanced Registry, showing a high standard for type and rated as R.O.P. sires based on the production of their daughters.

Yield and test increased.—The production results of the milking herd shown in Table 14 indicate that the milk yield has been increased and the butterfat test improved to over four per cent between the years 1937 and 1949. While the breeding program has resulted in the development of a large number of good type individuals, the herd as a whole lacks uniformity.

TABLE 14—AVERAGE MONTHLY PRODUCTION PER HEAD FOR AYRSHIRES IN 1937 AND 1949

Year	Milk	Butterfat	Test
	lb.	lb.	%
1937	738	29	3·9
1949	755	31	4·2

Holstein breeding.—Line breeding and inbreeding have been practised to a considerable extent in the development of the Holstein herd. Sires of potentially high production and of exceptional type rating have been used in the breeding program. When the transmitting ability of bulls used indicated improvement, their period of service was extended in the C.E.F. herd. Such bulls were also transferred to Branch Experimental Farms that had similar breeding. Two bulls which have appeared most prominently in the development of the present herd were Montvic Abbekerk Posch Pabst and Montvic Rag Apple Joe. These bulls were half brothers and were descendants of the noted bull, Johanna Rag Apple Pabst, which has contributed considerably to the improvement of the Holstein breed in Canada. Succeeding bulls in the order of breeding were also related to Johanna Rag Apple Pabst.

Holstein sires used from 1937 to 1949.—

Silver Acres King Pabst Segis 110108, S.R. No. 581, Class "XX".

Montvic Abbekerk Posch Pabst 113931, R.O.P. No. 2210, S.R. No. 630, Class "XX" and "Extra".

Montvic Rag Apple Joe 123825, R.O.P. No. 2681, S.R. No. 818, Class "XX" and "Extra".

Montview Rag Apple Ajax 182787, R.O.P. No. 5260, S.R. No. 44, Class "XXX".

Ottawa Rag Apple Ajax 196732, S.R. No. 2379, Class "XX".

Glenafton Rag Apple Alert 180656, S.R. No. 42, Class "XXX".

Glenafton Consort 204063.

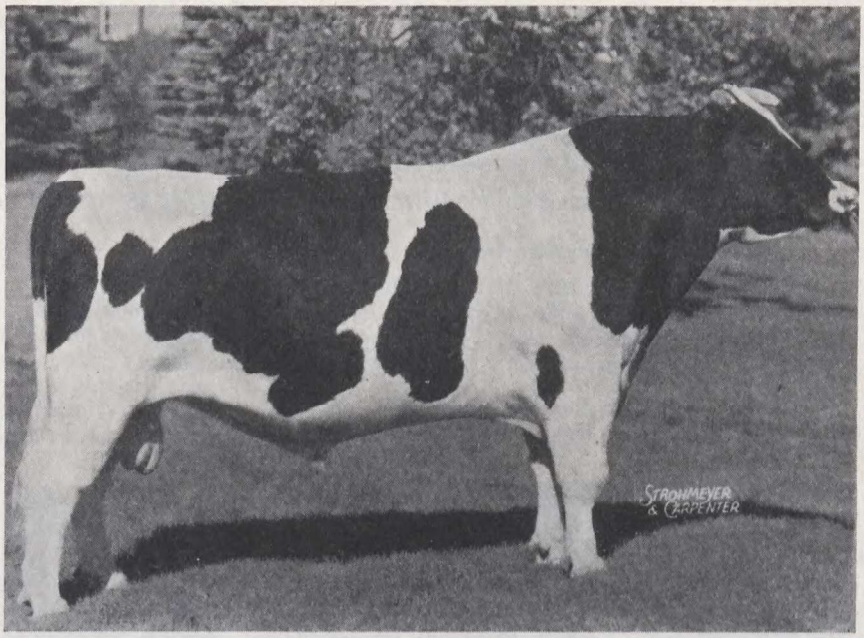

FIG. 8.—Holstein sire "Montvic Abbekerk Posch Pabst" 113931, at 6 years of age. An R.O.P. Class XX and Extra sire used for many years in the line breeding program and also for artificial insemination.

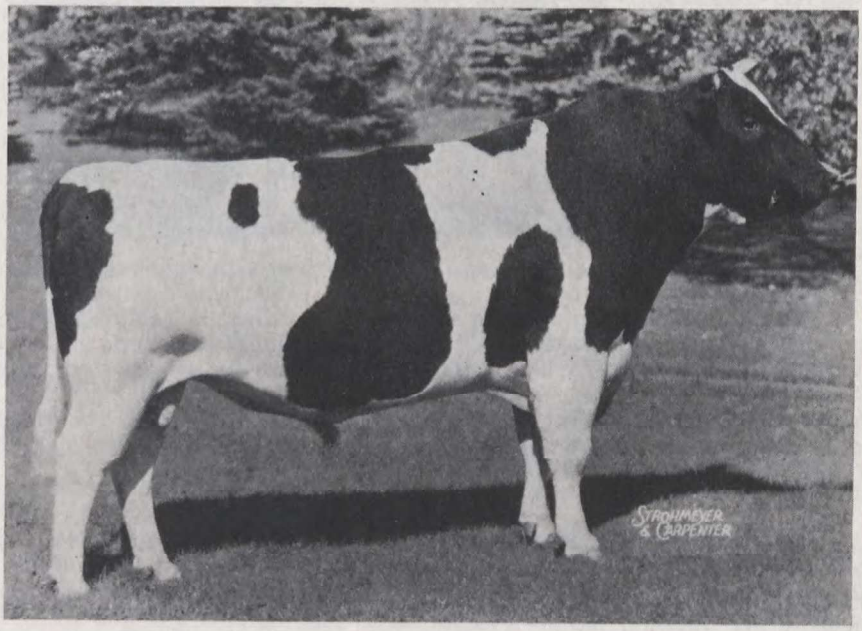

FIG. 9.—Holstein sire "Montvic Rag Apple Joe" 123825. An R.O.P., Class XX, and Extra sire. In the line breeding program this bull was mated to the daughters of his half-brother "Montvic Abbekerk Posch Pabst".

Production and conformation improved.—This method of breeding has had a beneficial effect on milk production as well as increasing the butterfat test as is shown in Table 15.

TABLE 15—AVERAGE MONTHLY PRODUCTION PER HEAD FOR HOLSTEINS IN 1937 AND 1949

Year	Milk	Butterfat	Test
	lb.	lb.	%
1937	917	31	3·4
1949	960	36	3·8

Type in the Holstein herd has been decidedly improved and, in particular, the individuals making up the herd are more uniform as to size and conformation.

FIG. 10.—Holstein cows, daughters of the herd sire "Montvic Abbekerk Posch Pabst" 113931.

Summary.—Comparing the two systems of breeding, in each case the rate of production was maintained or slighly increased and the butterfat improved, particularly in the Holstein herd. This increase was to be expected since in each case the sires were selected and the herds culled with production as the primary consideration. With the line-breeding plan followed in the Holstein herd, greater uniformity was obtained and no ill effects were noted as a result of the close breeding.

POLLED AYRSHIRES

Many Canadian breeders have adopted the practice of dehorning their herds because of losses resulting from horn injury. In recent years there has been considerable interest expressed in the development of the polled characteristic, particularly in the Ayrshire breed.

A project was initiated in 1947 to develop a strain of polled Ayrshires linked with the breeding lines of the Ayrshire herds at the C.E. Farm and at the Dominion Experimental Station, Ste. Anne de la Pocatiere, Que.

An Ayrshire bull carrying polled characteristics was procured for a season and mated to 15 horned females. Fourteen living offspring were born to these matings, four of which were horned, three bore scurs, and seven were polled. A second bull carrying polled characteristics has been procured to continue this project at Ottawa, while the original bull used in the experiment was transferred to the Experimental Station at Ste. Anne de la Pocatière.

The demand for polled bulls from the initial mating indicates that polled Ayrshires will prove to be popular with commercial milk producers.

Artificial Insemination

The value of artificial insemination in extending the influence of high quality bulls, particularly tested or proven sires, was early recognized. In 1934, the improved types of equipment used in England and Russia were procured. Experiments were conducted to study methods of collecting semen, time of insemination of cows relative to heat periods, sterilization of equipment, and semen dilution and storage. The results of these various studies are summarized in a mimeographed pamphlet entitled "Artificial Insemination of Dairy Cattle" issued in 1942 (revised 1943).

Record of Performance

All cows freshening normally in the dairy herds are entered on Record of Performance except those on experiments which are likely to seriously influence their production. The chief reason for this is to have the records of production of the Central Experimental Farm herds on a comparable basis with those of Branch Farm herds and other herds similarly managed. Bull indices calculated from these records, are used for comparative breeding evaluation.

During the period under review, 316 Ayrshires, an average of 24·3 per year, have completed records. Of these 147 met or exceeded the qualification standards for R.O.P. while 169 failed to qualify. In the Holstein herd 229 were qualified with 144 falling below the established production standards. However, the breeding program followed has resulted in a gradual increase in the proportion of the Holstein cows qualifying. In the Ayrshire herd there has been little change in the proportion of cows qualifying in R.O.P.

Nutritional Studies

The experimental feeding projects were concerned with types of roughage and meal mixtures fed to different classes of dairy stock, level of feeding, and the influence of specific products such as thyroprotein on production. Economy of feeding was studied, the feed cost of milk production being calculated for the milking herd.

Feed Cost of Milk Production

Records have been kept of the amount of feed consumed by the dairy herds. In order to have a reasonably accurate estimate of the feed required to produce 100 pounds of milk in a commercial dairy herd the records included were those from the potential milking herd. This herd consisted of all cows in milk and dry cows between lactation periods. Freshening heifers were included from four to eight weeks before calving.

Table 16 gives the amounts of the different feed ingredients required to produce 100 pounds of milk for both the Holstein and Ayrshire herds. Since a number of factors influence the milk production such as the proportion of the herd in milk, the average age of the herd, etc., these items are included in Table 16. The figures given in Table 16 are obtained by dividing the total weight of milk produced for a specific period by the weight of the separate feed ingredients consumed in that period and the number of days on pasture.

TABLE 16—FEED REQUIREMENTS PER 100 POUNDS OF MILK—13-YEAR AVERAGE 1937-49 INCL.

—		Holsteins	Ayrshires
Cows—			
In milk	No.	30	24
Dry	No.	3	3
Average age of cows	years	4·75	5·33
Average monthly production	lb.	876	643
Average butterfat test	%	3·7	4·1
Feed consumed per 100 lb. of milk—			
Meal	lb.	23	24
Succulents	lb.	107	129
Hay	lb.	25	25
Time on pasture	days	1·4	1·9

Because of the variation in feed prices at different periods and in different localities, costs have not been included. By applying local prices to the respective feed quantities in the above table an estimate of the feed cost of milk production can be made. It should be borne in mind that while the feed requirement to produce 100 pounds of milk was greater for the Ayrshires, this milk, having a higher test, would have had a higher market value than that of the Holsteins.

Summer Versus Winter Milk Production

The question arises from time to time as to the relative cost of producing milk during the winter months as compared with the summer season. Table 17 has been prepared from records kept over a thirteen-year period with the feed requirements to produce 100 pounds of milk separated for the two seasons.

TABLE 17—WINTER AND SUMMER FEED REQUIREMENTS TO PRODUCE 100 POUNDS OF MILK—13-YEAR AVERAGE 1937-49 INCL.

—		Winter	Summer
Cows—			
In milk	No.	22	24
Dry	No.	4	2
Monthly rate of production	lb.	573	748
Average butterfat test	%	4·3	4·1
Feed consumed per 100 lb. of milk—			
Meal	lb.	31	17
Succulents	lb.	258	—
Hay	lb.	43	—
Pasture	days	—	3·9

Local feed prices may be applied to these feed requirements and an estimate made of the cost of milk production in summer as compared with that produced in winter.

Legume Silages

Although corn has been successfully grown and ensiled for many years, and at the present time is the standard ensilage crop, it is only in recent years that the practice of ensiling other crops, notably legumes, has been given widespread attention. Attention is also being given to determining the most suitable method of ensiling legumes.

Experimental feeding of legume silages.—In order to obtain information on the effect of different methods of ensiling on the comparative feeding value of the ensilage, four crops were compared during the winter season, 1938-39, (1) corn mixed with soybeans (13 per cent soybeans, 87 per cent corn), (2) red clover, (3) red clover plus three per cent molasses, and (4) corn.

To evaluate these silages, feeding experiments with milking cows and digestibility trials with steers, were carried out. Twenty-two cows were used in a single reversal type of feeding experiment. Hay and grain were fed on the same basis with each type of silage used.

Based on milk production and gain or loss in body weight there were no differences between the four silages when fed to milking cows. The outstanding feature of the digestion trials was the high digestibility of the corn-soybean silage as compared with the other silages, which meant that a comparatively high yield of digestible dry matter and digestible protein was obtained per acre from this silage. Further study is necessary to determine the relative economy of feeding legume and corn silages.

A variety of silages for dairy cows.—For the 1939-40 winter feeding season the project was further developed along the following lines: (1) The addition of other legume ensilage crops. (2) The replacement of the entire hay portion of the ration with legume silage.

The ensilage crops included in the study were: (1) Corn—Improved Leaming and Wisconsin No. 7, mixed in equal proportions, harvested in the early glaze stage of maturity; (2) Soybeans—A.K. sown at rate of ½ bushel per acre in rows 35 inches apart. (3) Corn and Soybeans—Sown at rate of 20 and 15 pounds per acre, respectively, in rows 35 inches apart. When harvested the crop was about 80 per cent corn and 20 per cent soybeans. (4) Red Clover—First cut and harvested in full bloom stage; (5) Red Clover plus three per cent molasses First cut and harvested in full bloom stage; (6) Alfalfa—Third cut and harvested in 1/10 bloom stage; (7) Alfalfa plus three per cent molasses—Third cut and harvested in 1/10 bloom stage.

In six single reversal feeding trials which consisted of three periods of 21 days each, the legume silages replaced the corn silage portion of the ration (alfalfa hay, meal and corn silage) in the second period of each trial. Although the differences were not great, the results indicated that corn silage was superior to the legume silages and that it was the most economical silage for milk production. In order of palatability the silages appeared to rank: corn, corn-soybean, clover-molasses, clover, alfalfa-molasses, alfalfa, and soybean.

In six similar trials with dairy cows the respective legume silages replaced the hay portion of the ration (alfalfa hay, meal and corn silage) in the second period of each trial. These trials indicated that the feeding of good legume hay was more economical and that it was a better practice than that of feeding a legume silage in its place. In these trials it was noticed that the cows, when receiving a legume silage in place of hay, looked gaunt, drawn up and hungry.

Concurrent digestibility trials, using Shorthorn steers were undertaken. The outstanding features in these studies were the relatively low dry-matter content (20·13 per cent) of corn-soybean silage, and the low apparent digestibility of dry matter (47·0 per cent) and high digestibility of protein (70·7 per cent) for alfalfa.

Corn silage most satisfactory.—The tonnage yields per acre of the various crops studied were offset to a certain extent by shrinkage of the crops in the silos. It would appear that there is a relatively greater loss in the silo with the legume crops than with corn. Considering shrinkage and comparing the various silages studied, corn appeared to rank first in that it had the highest yield of digestible

dry matter per acre and the lowest cost of digestible dry matter per ton. Because of the variability of the results, and since studies now in progress indicate higher feeding values for legume silage, it is evident that considerable further work is necessary to determine the economy of feeding legume silages.

Corn silage versus legume silage in two systems of feeding.—Since unsuitable weather conditions are frequently encountered during the hay harvest period, the alternative of curing the crop as ensilage might provide a better means of preserving the nutrient content of the crop. In an experiment in 1948, silage harvested during dull weather, from a crop composed of approximately 70 per cent legumes and 30 per cent grasses was compared with corn silage for milking cows. Comparisons were made where each of the two types of silages were fed with hay and grain according to standard feeding practice and also in rations where each silage was the only roughage fed.

Milking Ayrshire and Holstein cows were used for this trial. The cows were allotted to four groups of four cows each on the basis of stage of lactation, body weight, and milk production. The reversal pattern was used over four five-week periods and the trial was run for two winter seasons. A record was kept of the feed intake, the milk produced, the butterfat test of the milk, and changes in body weight.

Silage can replace hay for limited periods.—The results from this experiment showed that legume-grass silage harvested under weather conditions adverse to hay making was equal to corn silage for the maintenance and milk production of dairy cows, also that silage can replace hay with equivalent results at least for limited periods.

Feeding legume silage to young heifers.—In good silage, especially legume silage, the vitamin A content is better preserved than in hay. However, it is possible that, owing to the lack of vitamin D, legume silage as a sole roughage may not permit of good growth in young stock. An experiment was conducted over a 5-month period during the winter 1941-42, to test this possibility. Two groups, five heifers in each, were used. Group 1 consisted of 3 Ayrshires and 2 Holsteins and was fed legume silage made from first cut mixed clover and alfalfa as the sole roughage. Group II consisted of 2 Ayrshires and 3 Holsteins which received legume silage and hay. The silages fed to both groups and the hay fed to Group II were of the same composition.

Each group received grain and roughage on a body weight basis fed twice daily. The average amount of silage fed daily to Group I without hay, was 36·7 pounds, the equivalent of 12 pounds of dry matter, while Group II was fed 21·3 pounds silage and 6·1 pounds hay, equal to 12·5 pounds of dry matter daily. Since Group II gained more rapidly in body weight it received 1·6 pounds of grain per head compared with 1·4 pounds of grain per head daily, fed to Group I.

Group II made an average gain of 1·66 pounds per day while Group I gained 1·30 pounds per day. The difference in the average daily gain was accounted for largely by the fact that the heifers in Group I, receiving only silage roughage, gained very little during the first two months of the experiment. One heifer in this group actually lost weight. It seemed that they did not relish the all-silage ration. The silage-fed heifers, however, kept in fairly good flesh condition and grew at about the same rate as the others during the last three months of the experiment.

Legume silage as sole diet not satisfactory for heifers.—The results from this trial, while based on a limited number of heifers, suggest that growing heifers should not be fed entirely on legume silage and that at least a portion of the roughage should be supplied in the form of good quality hay to add palatability to the ration and as a possible source of vitamin D.

The Comparative Feeding Value of Hay Harvested and Stored by Different Methods

In recent years improvements have been made in the methods of harvesting and curing hay. These methods include chopping hay, baling hay in the field as it is harvested, and artificially drying hay by different methods.

To determine the resulting feeding value of hay harvested and stored by some of these methods, an experiment was carried out in 1948 using dairy heifers. For this trial, Holstein and Ayrshire heifers, approximately one year of age, were used. Field chopped hay, field baled hay, barn dried hay (artificially dried in the barn) and hay harvested by the standard procedure were fed to each of four groups. The hay mixtures were similar in composition being 45 per cent legume and 55 per cent timothy except in the case of the standard field harvested hay which was 20 per cent legume and 80 per cent timothy. The reversal system of experimentation was used with a latin square design. The roughage was fed according to body weight.

Artificially dried hay produced greatest gains.—The mean gains made over the four periods on the respective hays were as follows: field chopped hay 130 pounds, field baled hay 145 pounds, barn dried hay 177 pounds, and standard field harvested hay 108 pounds. The gains made by heifers fed barn dried hay were significantly greater than with standard field harvested hay or field chopped hay.

The estimated cost of the artificially barn dried hay and the field baled hay was higher per ton than when harvested by either of the other two methods. Therefore, the difference in harvesting costs would have to be balanced against the increased gains to determine the economic advantage of these methods of harvesting hay.

Field chopping or baling does not alter hay value.—A similar type of experiment was conducted with dairy heifers in 1949. The trial differed from that of the previous year, however, in that no barn dried hay was available. Second c alfalfa (90 per cent alfalfa, 10 per cent timothy) was substituted for the ficially dried hay.

Thus, the experiment compared hay harvested by the following methods. field chopped hay, field baled hay, standard field harvested hay, and second c alfalfa. The hay used in the first three of these methods of harvesting were similar composition.

In this trial there were no significant differences in the gains of the heife The indications based on the results of these two experiments, are that fie chopping or baling of hay does not alter the resulting quality of the hay from t of the standard field curing process.

Soybean Meal Versus Linseed Oilmeal for Calf Feeding

Ground flax and linseed oilmeal are a common source of protein in meal mixtures for calves. More recently increased amounts of soybeans and soybean products have become available and in most cases at a lower protein cost than the linseed oilmeal source.

In order to determine if soybeans could satisfactorily replace flaxseed and linseed oilmeal in the feeding of dairy calves a trial was conducted based on the feed formula used at this Farm.

Two groups of eight Ayrshire and Holstein heifers were used for this comparison. The calves were allotted to the groups at birth and records of growth and health were kept up to six months of age. Each group of calves received whole milk, skim-milk, calf porridge, concentrate mixture, and alfalfa hay on a

comparable basis. Group 1 received scalded flaxseed and linseed oilmeal while Group 2 received scalded ground soybeans and soybean oilmeal porridge fed with skim-milk. The ration ingredients are listed below.

Group 1 (check)		Group 2 (experimental)	
Scalded Flaxseed Porridge		*Scalded Soybean Porridge*	
Ground oats	150 lb.	Ground oats	150 lb.
Ground peas	100 lb.	Ground peas	100 lb.
Ground flaxseed	100 lb.	Ground soybeans	100 lb.
Concentrate Mixture		*Concentrate Mixture*	
Wheat bran	300 lb.	Wheat bran	300 lb.
Ground oats	400 lb.	Ground oats	400 lb.
Corn gluten feed	100 lb.	Corn gluten feed	100 lb.
Linseed oilmeal	300 lb.	Soybean oilmeal	200 lb.
Salt	11 lb.	Salt	10 lb.
Solmin	11 lb.	Solmin	10 lb.

The average initial weight and average gain of the calves in Group 1 was 87 pounds and 290 pounds respectively as compared with 85 pounds and 262 pounds for the calves in Group 2. The incidence of scours was more prevalent in Group 2, six cases being noted while only two slight cases occurred in Group 1. It was necessary to exercise greater care in preparing soybean porridge because of souring. Judging by the manner in which the calves cleaned up the respective grain mixtures, it would appear that the meal mixture containing linseed oilmeal was more palatable than the mixture containing soybean oilmeal. The calves maintained on linseed oilmeal exhibited sleeker coats and showed a more thrifty appearance than the calves on soybeans.

Soybeans were not equal to flaxseed and linseed oilmeal.—From the results obtained in this experiment the differences between the two sources of protein for calves tends to favour flaxseed porridge and linseed oilmeal. The differences in gain and health of the two groups of calves and the palatability of the ration suggest that the use of soybeans as a protein source for dairy calves would be dependent on balancing the gain and outcome of the calves against the cost of the feed.

Feeding Synthetic Thyroprotein to Dairy Cattle

The effect on dairy cows of feeding synthetic thyroprotein, a product possessing thyroxine-like activity, has received considerable study in recent years. This material has a marked effect on the body in that it increases metabolic rate.

In a trial conducted during 1946, "Protamone" containing 3·07 per cent thyroxine was fed to Holstein and Ayrshire cows at the rate of 15 grams daily for six weeks. Both milk and butterfat yields were increased. On a 4 per cent fat corrected milk basis this increase amounted to approximately 18 per cent. The increase in production was accompanied by an increase in pulse rate and a pronounced loss in body weight in spite of an increase in the feed allowance. Although no ill-effects on general health were noted during the trial, further investigation is necessary over longer periods of time before this material can be safely recommended. The complete report of this study is given in Scientific Agriculture, Volume 28, Number 8.

Pasture Studies

The pasturing of dairy cattle has been studied from the standpoint of management, types of pastures, and carrying capacity with different schemes of grazing.

Permanent Pasture Versus a Rotation of Crops for Pasture

One of the problems in the summer management of dairy cows is that of providing a uniform supply of high quality herbage throughout the season. To investigate this problem an experiment was carried out for a three-year period from 1939 to 1941 inclusive, in which two rotations of crops for pasture were

FIG. 11.—Dairy cows on experimental pasture fields. The electric fence facilitates better utilization of the pasture.

compared with a seeded down permanent pasture. The two rotations were similar to the extent that the first year both consisted of a mixture of oats and sudan grass. However, the areas in the rotation grazed by Lot 1 were seeded down to an alfalfa-alsike-timothy mixture while in the rotated pasture of Lot 2 red clover was substituted for alfalfa. The control, Lot 3, was grazed on a permanent pasture previously seeded to timothy, blue grass and white clover. All lots had supplementary grazing on the oats and sudan grass pastures. In all cases the pastures received comparable fertilizer treatments.

The summarized results for this study over the three-year period, on an acreage basis are given in Table 18.

TABLE 18—PERMANENT PASTURE VERSUS A ROTATION OF CROPS USED AS PASTURE FOR DAIRY CATTLE. 3-YEAR AVERAGE 1939–41 INCL.

Lots		1	2	3
Treatment		Alfalfa, Oats and Sudan Grass	Clover, Oats and Sudan Grass	Permanent, Oats and Sudan Grass
Area of fields (acres)		9·16	9·16	6·36
Yield of dry matter	lb.	3,820	3,995	3,187
Pasture days	No.	120	120	115
Average number animals per lot	No.	0·75	0·76	0·65
Total gain	lb.	43·4	55·5	50·8
Total fat corrected milk produced	lb.	2,787·6	3,025·0	2,438·5
Average daily fat corrected milk per head	lb.	30·9	33·1	32·5
Total digestible nutrients produced	lb.	1,819·5	1,915·4	1,586·6
Carrying capacity in animal units per day	No.	0·96	0·99	0·84
Carrying capacity in animal units per day for season of 150 days	No.	0·77	0·79	0·64

Rotation of crops gave best results.—It will be noted that in both cases a rotation of crops for pasture gave a considerably higher production of dry matter and actual carrying capacity in animal units than did the permanent blue grass pasture supplemented with annual pasture.

Supplementary Feeding of Milking Cows on Pasture

Experiments have been carried out which have indicated that even on good pasture a cow cannot graze sufficiently to maintain body weight and a high level of milk production.

With this consideration in mind it was decided in 1938 to carry out an experiment to determine the relative economy of milk production on pasture under two rates of grain feeding and of a check group where no grain supplement was supplied.

A herd of 54 Ayrshire and Holstein milking cows was divided into three balanced groups. Meal composed of equal parts of oats and barley was fed throughout the experimental period. The rates of feeding of the three groups were as follows:

Lot 1: Holsteins—0·4 pounds of grain for each pound of milk over 30 pounds produced. Ayrshires—0·5 pounds of grain for each pound of milk over 25 pounds produced.

Lot 2: Holsteins—0·4 pounds of grain for each pound of milk over 40 pounds produced. Ayrshires—0·5 pounds of grain for each pound of milk over 35 pounds produced.

Lot 3: Received no grain supplement.

The results from these comparisons are shown in Table 19.

TABLE 19—RATES OF FEEDING GRAIN SUPPLEMENT ON PASTURE 1938

—		Lot 1 High Supplement Rate	Lot 2 Low Supplement Rate	Lot 3 Check No Grain
Average number animals in lot	No.	14·8	16·9	15·9
Number animal days	No.	2,068	2,363	2,220
Average daily gain per head	lb.	0·80	0·60	0·66
Fat corrected milk per head per day	lb.	32·3	30·4	26·1
Grain fed per day	lb.	3·9	1·3	—
Milk increase daily per pound of grain supplement	lb.	1·6	3·3	—

Table 19 presents the results of this feeding trial. It will be noted that each lot gained in body weight. Although these gains do not differ greatly the larger proportionate gain occurred in the lot receiving the higher grain supplement.

Economics of grain feeding depends on prices.—From an economic standpoint, based on daily increase of milk per pound grain supplement, the results indicate the low rate of grain feeding of Lot 2 gave the most economical increase. An estimate of the cost of the milk increases in Lots 1 and 2 can be determined using the market prices of these grains. Based on such an estimate it might be stated that the feeding of grain supplements will depend on the price of the milk produced and the value of the grains fed.

Management Studies

Work conducted in this field has been concerned with the testing of new products for the control of flies and lice, investigating the advantages of electric fences for pasturing and experimenting with different tattoo inks for the identification of animals.

The Suitability of Electric Fences for Dairy Animals

The use of electric fences in the management of dairy animals has received widespread attention. The possible economic advantages from their use appear obvious. In order to determine their suitability and practicability two units were tried in 1938. Using "Prime" and "Gem" types of electric units with single wire fences made from (1) barbed wire, (2) plain wire, and (3) baling wire, observations were made on the reaction of animals and the suitability of these fences for animals on pasture. The result of these trials showed that: (1) The electric fences were practically 100 per cent efficient and effective. (2) The ease of moving the fences made the management and use of pasture more simple. (3) The reaction of cows was that after receiving a shock once or twice they stayed away from the electric fence. (4) Plain wire and even baling wire appeared as effective as barbed wire.

Comparison of Methods and Inks for Tattooing Dairy Animals

In recent years special attention has been given to the identification of livestock by various methods. This is particularly so in the case of purebred dairy animals. The Division of Chemistry initiated work in this regard and in co-operation with this Division, studies have been carried out to determine the most suitable methods of applying tattoo ink to dairy animals and to test different types and colours of inks for distinctiveness and permanence. Records were kept of methods and inks used and observations made using animals of the Ayrshire and Holstein breeds. The pigments tested included red and yellow iron oxides, titanium dioxide, aluminum paste and commercial black tattooing ink. Further tests were made comparing three different modifications of green tattoo ink and standard black tattoo ink. Various treatments of the ear surface were investigated, namely, comparisons between washing with carbon tetrachloride or alcohol and no washing, the application of collodion to the tattoo, and the use of adrenalin to reduce bleeding. Comparisons were also made of two types of tattoo pliers differing in the length of the jaws and length and taper of the needles.

Green tattoo ink gave excellent results.—It was found that one of the modifications of the green tattoo ink was superior to all others for identification purposes. This green ink was particularly superior to black for identification on the generally dark pigmented ear of the Holstein. There was no difference in the legibility of the tattoo in washed and unwashed ears. The data obtained on Ayrshires show that for this breed, better and longer lasting tattoos may be expected from concentrated black pigments than from more fluid black mixtures. The most suitable type of pliers was that made with long jaws to reach the centre of the ear, clear of the hair growth which blurs the tattoo. This type of pliers also avoided pinching the outer edge of the ear. Long chisel-shaped needles resulted in the most legible tattoo.

DDT for the Control of Lice on Dairy Animals

In view of the spectacular effect that DDT has had not only in the control of flies as they affect livestock but in the control of lice on humans, it was considered advisable to carry out trials on dairy heifers. These studies were made in co-operation with the Division of Entomology using three groups of 12 each, made up of Ayrshire and Holstein heifers. DDT in powdered form at three different strengths, namely 3, 5, and 10 per cent was applied to individual animals.

DDT controlled lice.—All three strengths of DDT were found satisfactory, although it was found that the DDT had to be applied to all parts of the animal to be fully effective. No harmful results to the heifers were noted.

Disease Control

There are three diseases of dairy cattle with which farmers in Canada are primarily concerned. These diseases are tuberculosis, brucellosis or Bang's disease, and mastitis. The losses resulting through a herd becoming seriously infected with any one of them, can be disastrous to a dairyman.

During the period under review, attention has been given to control measures for each of these diseases. This work was done in co-operation with the Health of Animals Division and units of Science Service.

Tuberculosis

All animals were tested annually for tuberculosis, by officials of the Health of Animals Division, under the Accredited Herd Plan. No reactors have appeared during the period under review.

Bang's Disease

The practice followed in the control of Bang's disease has been to place the herd under the Brucellosis-Free Listed Herd Regulations of the Health of Animals Division. These regulations call for an annual blood test of all individuals in the herd. If the blood test reveals that certain animals are questionable or positive to the test, these animals are immediately removed from the main herd. Questionable animals are placed in isolation while positive reactors are disposed of.

Mastitis

The wastage in dairy herds because of chronic mastitis has placed the control of this disease among the serious problems of the dairy industry. Chronic mastitis in the majority of cases is caused by the organism, *Streptococcus agalactiae*. Despite the early precautions that had been taken in the milking and general care of the cows, the disease had caused considerable loss in the herd at this Farm.

In 1937, a project was initiated in co-operation with the Division of Bacteriology and Dairy Research in an attempt to control and eliminate this disease on as practical a basis as possible. The procedure adopted for this project called for a periodic routine examination of the milk from each of the four quarters of individual cows in the herd. This was done by the use of a strip cup at the beginning of the milking operation and by the chemical and bacteriological tests of the milk. On the basis of these tests the cows were segregated into three groups depending on the degree of infection. Strict sanitary and hygenic methods were followed for the milking procedure, taking care to have infected animals milked last. Badly infected animals were isolated or disposed of depending on the extent of infection and the possibility of recovery. As a result of this work, although there had been occasional newly infected animals, the extent of mastitis infection in the herd had been reduced from approximately 20 per cent to approaching zero. Since the war the use of the antibiotic, penicillin, has been a highly beneficial supplement in the control of mastitis. The use of this drug was most effective as a treatment for mastitis detected in early stages. The infusion of 50,000 units of penicillin into a newly infected quarter after the cow had been milked out or during the dry period resulted in the termination of a large percentage of the infections. The use of aureomycin was a further advance in the control of this disease. At the present time there are commercial mixtures of antibiotics supplied in glass tube containers convenient for infusing the contents directly into the teat of the infected quarter.

DAIRY RESEARCH

C. A. Gibson and C. D. MacKenzie

The Central Experimental Farm dairy handles the milk and milk processing for the two herds of dairy cattle maintained at the Central Farm. Approximately 450,000 pounds of milk are produced annually. The major portion is used for experimental purposes either as milk, butter or cheese, and the surplus is sold. Routine twice-a-month butterfat testing of the milk of individual cows in the dairy herd, along with special tests for experimental animals, is carried out. In addition, milk is tested for butterfat for local farmers and they are advised on dairy problems.

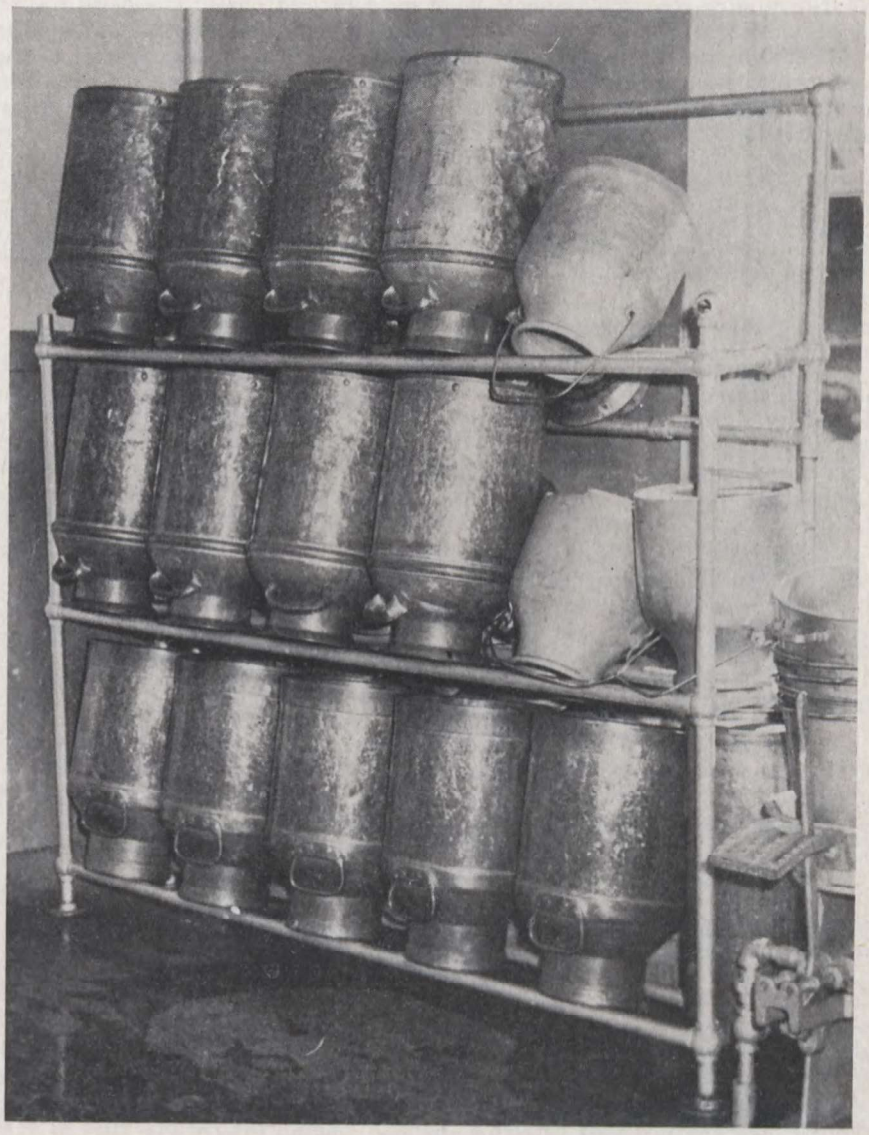

FIG. 12.—Dairy washroom, showing a homemade milk can rack. Lower quality cheese results when milk utensils are not kept clean.

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Since the last report, the manufacturing floor of the dairy has been remodelled and the second floor made into laboratories and offices. At the present time, the dairy has facilities for the washing and sterilizing of the milking utensils and cans used in handling the milk produced by the Farm herd. These utensils are sterilized in an electric sterilizing unit, equipped with a thermostatic control. The dairy is also equipped for pasteurizing and bottling milk and cream and complies with the Ontario Board of Health regulations. Facilities and equipment are available to undertake experimental studies on the manufacture of butter and certain varieties of cheese. The cold storage plant has five rooms with individual thermostatic controls which permit a temperature range from minus 30°F. to plus 60°F.

Various dairy research projects have been carried out in co-operation with the Division of Bacteriology and Dairy Research, and the Division of Chemistry, Science Service; and the Division of Dairy Products, Marketing Service. Since the results of these projects have been published, only summaries of the published papers are presented herein. Reprints of these papers are available on request to this Division.

Cheese

The work with cheese has been concentrated on flavour and texture defects. In addition, data have been obtained on milk quality tests for cheese making and on the value of abnormal milk for cheese production.

Rancid Flavour in Cheddar Cheese, 1940-49

The development of rancid flavours in cheddar cheese has been one of the most troublesome problems of the Canadian cheese industry. This rancidity is caused by a breakdown of the butterfat into fatty acids and other end-products. The theory is advanced that the enzyme lipase is the causative agent. Many factors require study in connection with the lipase theory. They may be mentioned briefly as follows. (1) The bacteriology of lipase-producing organisms is related to cheese flavour. (2) The amount of milk lipase may depend primarily on the physiology of the cow. Such factors as late lactation, individuality of the cow, and change in feed are thought to increase the lipase activity of milk. (3) Activation of milk lipase may be brought about by raising and lowering the temperature of milk. (4) Agitation of milk in delivery and handling may result in a tendency toward a breaking up and a dispersion of the fat globules. Size of butterfat particles when secreted and the lowering of surface tension have been shown to activate the lipase enzyme.

Commercial lipase lowered grades.—In the initial study on the problem typical rancid cheese were reproduced experimentally with the addition of commercial lipase to the cheese milk. The condition was also reproduced experimentally with the addition of homogenized milk as a means of lipase activation. The addition of commercial lipase or homogenized milk to the regular cheese milk was found to be partially inactivated by the use of varying amounts and proportions of rennet and pepsin. A higher flavour score was obtained in cheese to which lipase was added when higher amounts of pepsin or rennet or both were used in its manufacture than in the control cheese where smaller amounts of the enzymes were added. However, the cheese with the higher amounts of rennet or pepsin did not maintain its original flavour score, falling in grade after a period of six weeks. Experimental methods for the study of the probable role of lipase in the development of rancidity were also worked out. The complete studies are published in The Canadian Dairy and Ice Cream Journal, Vol. XX, No. 3, March, 1941, and in The Journal of Dairy Science, Vol. XXIV, No. 7, July 1941.

Copper does not inhibit lipase.—In the course of studies on the behaviour of milk lipase in cheese, the effect of copper on lipase activity was investigated. The conclusion drawn was that although copper inhibits lipase activity in milk under ordinary conditions, it is ineffective as a lipase inhibitor in cheese. This work was reported in the Journal of Dairy Science, Vol. XXV, No. 11, November, 1942.

Agitation of milk detrimental to cheese quality.—In further experiments on the problem of rancid flavours in cheese, the effect of agitation at different temperatures of milk used for cheesemaking as factors in relation to lipase activity was studied. In this work cheese milk was submitted to vigorous agitation by churning at temperatures of from 45° to 86°F. for periods of from five to fifteen minutes. The effect of this treatment, particularly at the higher temperatures, was to activate the milk lipase and produce a rancid flavour in the resulting cheese. When the activation of lipase was less, flavours termed "unclean" were produced, which indicated that certain types of unclean flavours are related in origin to rancidity. The longer the milk was agitated and the higher the temperature during agitation the lower the flavour score of the resulting cheese. Recommendations for improving the quality of cheddar cheese flavour were made and include the minimum of agitation and proper cooling of cheese milk. The results of this work were published in the Journal of Dairy Science, Vol. XXVI, No. 12, December, 1943; and The Canadian Dairy and Ice Cream Journal, Vol. XXIII, No. 2, February, 1944, and Vol. XXIII, No. 3, March, 1944.

Lipase less active in cooled milk.—As a further part of the studies relating to rancid flavour in cheesemaking and in connection with the agitation and temperature of cheese milk, trials were carried out to show the effect of cooling on the extent of fat dispersion in agitated milk. In one set of experiments, morning milk was cooled at 85°, 75°, 65°, 55°, and 45°F., two 8-gallon cans of milk were taken at each temperature, agitated by churning for five minutes, warmed to 85°F., separated and samples of skim-milk were taken for butterfat determinations. In a second set of experiments, evening milk which had been cooled to below 45°F. was warmed up to each of the above temperatures and the same procedure repeated. Data were taken on the percentage of butterfat in the skim-milk in each of the experiments. As the temperature at which milk was agitated became progressively lower, the butterfat content of the skim-milk was also lower. On the basis of previous work, the results were interpreted to mean that vigorous agitation of milk causes larger fat globules to break up but that this effect is minimized by cooling the milk to below 55° F. The results of this work were reported in The Journal of Dairy Science, Vol. XXVIII, No. 1, January, 1945, and in The Canadian Dairy and Ice Cream Journal, Vol. XXIV, No. 4, April, 1945.

Acid inhibits lipase action.—This series of experiments was undertaken to determine the influence of acidity on the development of lipolytic flavour defects in cheddar cheese. When the cheese milk was prepared, acid was allowed to exert its effect on milk lipase. This milk when made into cheese scored slightly higher than cheese where the inactivation of milk lipase did not occur. The results are explained on the basis of lipase inhibition by contact with acid over a period of time. The complete details of this work are published in Scientific Agriculture, Vol. XXVII, No. 1, January, 1947.

Lipolytic bacteria lower cheese quality.—In order to determine the effect of lipolytic bacteria on the flavour score of cheddar cheese, twenty-six vats of cheese were made with the addition of varying percentages of pure cultures of lipolytic bacteria to the milk in the vat. Cheese made from these milks, gave lower flavour scores and higher fat-acidity values than those from the control

vats made without adding lipolytic cultures. However, until a practical test can be devised for detecting these bacteria in milk, the only recommendation that can be made to assist the cheese-maker in overcoming rancid flavours caused by lipolytic bacteria in cheese milk, is to reject all doubtful milk supplies and encourage the production of milk of low bacteria count. The complete details of this work are reported in The Canadian Dairy and Ice Cream Journal, Vol. XXVIII, Nos. 2 and 6, February and June, 1949.

Sterren Rennet Tablets, 1941

This study was made to compare the quality of cheddar cheese resulting from the use of Sterren Rennet Tablets (a British product with a possible market in Canada) in place of Hansen's rennet.

Sterren tablets made satisfactory cheese.—This work was reported in mimeograph form and showed that experimental cheddar cheese made with Sterren tablets was equal in quality to control cheddar cheese made with Hansen's rennet at the usual period of grading and after 3 to 3½ months' storage.

Starter in Relation to Cheese Yield, 1942

This project was initiated in order to find the answer to the question, "Is the starter added to the cheese milk incorporated in the cheese or lost in large part in the whey?"

Starter becomes part of cheese.—When experimental cheeses were made with three per cent starter milk in contrast to naturally ripened milk it was found that the starter was incorporated in the cheese. It is evident from the results obtained that the protein losses in whey were no greater in vats made with three per cent of starter than with vats made from naturally ripened milk. No significant differences were found in the quality of the cheese made with three per cent starter and naturally ripened milk. The work was reported in The Canadian Dairy and Ice Cream Journal, Vol. XXI, No. 3, March, 1942.

The Methylene Blue Test, 1943

The methylene blue test is used to evaluate cheese milk quality in many cheese factories throughout Canada. It was the opinion that this test was not a reliable guide for assessing milk quality for cheese-making purposes.

Methylene blue test unreliable for cheese milk.—An analysis was made of the results on 16 pairs of comparative vats of cheese, each pair made from milk of the same composition and the same initial bacterial flora. The milks were incubated at high and low temperatures. These treatments gave short and long reduction periods when the milk was subjected to the methylene blue test. When the cheeses were graded there was no significant difference in their flavour scores.

The methylene blue test does not differentiate between relatively harmless or beneficial bacteria and those which adversely affect the flavour or texture of the cheese. It was found of uncertain value as a practical test in this investigation for assessing the bacteriological quality of cheese milk. It appeared from the investigation that the methylene blue test should not be used either for grading or rejecting cheese factory milk supplies, since it is based on bacterial numbers and does not indicate types. More complete details are given in The Canadian Dairy and Ice Cream Journal, Vol. XXII, No. 2, February 1943.

Mastitis Milk for Cheddar Cheese, 1940-44.

It is generally accepted that milk which is visibly abnormal is unsuitable for cheddar cheesemaking. It has also been reported that latent infection with *Streptococcus agalactiae* renders the milk undesirable for this purpose, both yield and quality of cheese being adversely affected. On the other hand, it has been claimed that cheese equal in yield and quality to that from normal milk may be obtained by the use of larger amounts of starter or by the addition of mineral acid to the milk.

Mastitis milk lowers cheese yield.—To throw further light on this problem, a study was carried out and it was found that milk of normal appearance from cows having a latent infection with *Streptococcus agalactiae* yielded definitely less cheese than that from normal cows. Milk, from cows free from "agalactiae" infection, yet classed as "abnormal" behaved similarly. The lowered yield appeared to result from the lower casein and solids-not-fat contents of these "mastitis" milks. With a single exception, the cheese made from these "mastitis" milks were not inferior in quality to those made from normal milks. In another series of experiments, it was concluded that abnormal milk may adversely affect either yield or quality of cheese or both. This work is reported in The Journal of Dairy Research, Vol. XI, No. 3, September 1940, The Dairy and Ice Cream Journal, Vol. XIX, No. 5, May 1940, and the Journal of Dairy Research, Vol. XIII, No. 3, March 1944.

The Pink Test, 1947.

This is a new method for determining setting-time in cheddar cheesemaking. It depends upon the reduction of resazurin to its pink end-point and is called the "pink-test". The test is based on a sound principle for it measures the rate of lactic acid development in the vat by measuring its rate over a short interval in cheese milk. The complete details for making this test may be found in The Canadian Dairy and Ice Cream Journal, Vol. XXVI, No. V, May 1947.

Openness in Cheddar Cheese, 1948.

One of the problems confronting the cheesemaker is that of openness in cheddar cheese. This is caused by the failure of the curd to knit together.

Texture improved by lengthened milling to salting time.—In a study on the causative factors and remedial measures to overcome openness in cheddar cheese, it was demonstrated experimentally that when one hour or longer was allowed between milling and salting 100 per cent of the cheeses were graded as "close". When less time was allowed between milling and salting, namely, from 10 to 60 minutes, 89·5 per cent of the cheeses were faulted to some degree for openness. The work was reported in the Canadian Dairy and Ice Cream Journal, Vol. XXVII, No. 3, March 1948.

BUTTER

Relatively little work has been done on butter but one study was made on "Winter or Bitter Flavour", of Butter.

Studies on the "Winter" Flavour of Butter, 1946.

During the winter months a certain percentage of the cream reaching the creameries is "off" flavoured. One of the most important of these flavour defects is that which produces "winter" flavoured or "bitter" butter, a condition that may lower butter grades.

Stage of lactation not a factor in "winter" flavour.— Studies were made of the effect of the stage of lactation and methods of handling milk and cream on the lipase action in cream in relation to the development of "bitter" or "winter" flavours in the cream and butter. When cows were fed a well balanced ration containing succulent feeds and the milk and cream were handled according to the recommended methods, stage of lactation was not an important factor in lipase activity and the development of "off" flavours. Lipase activity in winter cream, as indicated by titratable acidities of the cream, acid degree of the fresh butter, and the flavour quality of both cream and butter, were accentuated by cooling and rewarming the milk before separation and by the addition of warm cream to cold cream. Considerable bacterial growth takes place in cream held at temperatures of 35°F. or lower, especially when warm cream is added to previously collected cold cream and the mixture is air-cooled at a temperature of approximately 30° F. In some cases the types of organisms growing in the cream may produce unclean flavours, and if many lipolytic bacteria are present they may be a factor in producing rancid flavours in cream. To obtain and maintain the highest flavour quality in winter cream and butter, milk should be separated as soon after milking as possible, and each lot of fresh cream should be cooled before being added to cream previously collected and cooled. The results of this work were reported in full in The Canadian Dairy and Ice Cream Journal, Vol. XXV, Nos. 2 and 3, February and March 1946.

HORSES

V. S. Logan

In the report for the period 1930 to 1936 inclusive, mention was made of the renewed interest in horse breeding. This interest was manifested from 1933 to 1936 and was considered to be due to the economy of the draught horse as compared with the tractor in the depression years. Interest in draught horses declined during the period under review, 1937 to 1949, firstly because of renewed prosperity on the farms with a consequent trend toward mechanization and secondly because of the shortage of labour accompanied by an unprecedented demand for farm products during the war years.

Considering these trends it was felt that an even greater effort should be made by federal and provincial institutions to preserve a nucleus of breeding stock around which to build up the horse breeding industry should circumstances force a return to more reliance on horses as a source of farm power. An average of approximately 46 breeding and work horses were kept in the Farm stud during the period under review.

The Clydesdale Stud

The breeding of Clydesdale horses at the Central Experimental Farm has been maintained with a slightly reduced number of breeding mares, mated to the best stallions available. Most of the stallions used were imported from Scotland in co-operation with Production Service.

All stallions were graded as premium stallions under the provincial stallion enrolment policy. Farmers' mares are bred free of charge and farmers are encouraged to take advantage of this service. Table 20 is a record of the stallions used each year, the number of Experimental Farm mares bred and foaled, and the total mares served during the season. This latter figure includes the Experimental Farm mares and is a measure of the activity in Clydesdale breeding each year in this locality.

TABLE 20—PREMIUM CLYDESDALE STALLION BREEDING RESULTS—12 YEARS 1937-49 INCL.

Year	Name of Stallion	C.E.F. Mares		Total Mares Bred During Season
		Bred	Foaled	
1937	Windlaw Gayman (imp) [26992]	14	9	53
1938	Windlaw Gayman (imp) [26992]	11	8	48
1939	Black Douglas (imp) [28876]	11	6	26
	Windlaw Dominion (imp) [26995]			11
1940	Drumlanrig Inspiration (imp) [29297]	11	7	12
	Windlaw Dominion (imp) [26995]			12
1941	Drumlanrig Inspiration (imp) [29297]	12	4	32
	Gay Boy [29149]	1	1	2
1942	Drumlanrig Inspiration (imp) [29297]	11	2	31
1943	Strathore James (imp) [26996]	11	5	30
	Gay Boy [29149]	1		3
1944	Strathore James (imp) [26996]	8	6	26
	Landmark Renown (imp) [28901]	1		3
1945	Strathore James (imp) [26996]	6	4	21
	Landmark Renown (imp) [28901]	5	4	16
1946	Landmark Renown (imp) [28901]	9	6	48
1947	Royal Monarch (imp) [29990]	5	3	28
	Muirton Sensation (imp) [28739]	4	4	18
1948	Royal Monarch (imp) [29990]	7	2	29
	Cumberland Churchill (imp) [29993]	1	1	11
1949	Cumberland Churchill (imp) [29993]	8	2	24

Breeding Results

In general, the results from the stallions used during this period were highly satisfactory. The resulting progeny at the end of this period indicate that the choice of breeding stallions was judicious and successful. Excellent examples are the outstanding progeny sired by Drumlanrig Inspiration and out of dams from the mating of Strathore James on granddaughters of Windlaw Gayman. Similarly, daughters of Strathore James mated to Cumberland Churchill have produced high quality offspring.

All sound fillies born at the Central Experimental Farm stud are raised and their acceptance as breeding mares depends on their type and possible reproductive ability. Mares not suitable for breeding are retained as work horses or are sold. After rigid selection, a few stallions have been raised for breeding. Examples of these are Gay Boy [29149] sired by the noted imported stallion Windlaw Gayman (imp) [26992] and out of Lady Mary [55601]. This horse stood for service at the Central Experimental Farm. Ottawa Strathore Footprint [29906] by Strathore James (imp) [26996] out of Tarraby Moss Rose (imp) [60442] was transferred to and stood for service at the Experimental Farm, Nappan, N.S. Ottawa Strathore Gartley sired by Strathore James and out of Lady Gay was purchased by Neil Campbell, Melburne, Ont. In competition with seven stallions, this stallion won the Grand Championship at Stratford, Ont.

Cross-Breeding for Hunter and Saddle Type Horses

The crossing of Thoroughbred stallions with Clydesdale mares to produce heavy hunters has been the practice in Ireland for some years. The increasing demand for hunter and saddle type horses in Canada indicated that information on this cross-breeding plan would be useful.

A project was set up, therefore, in which two good bodied, clean legged mares were bred to a Thoroughbred stallion.

Two foals have been born to date from one of the mares. The other mare proved to be a non-breeder.

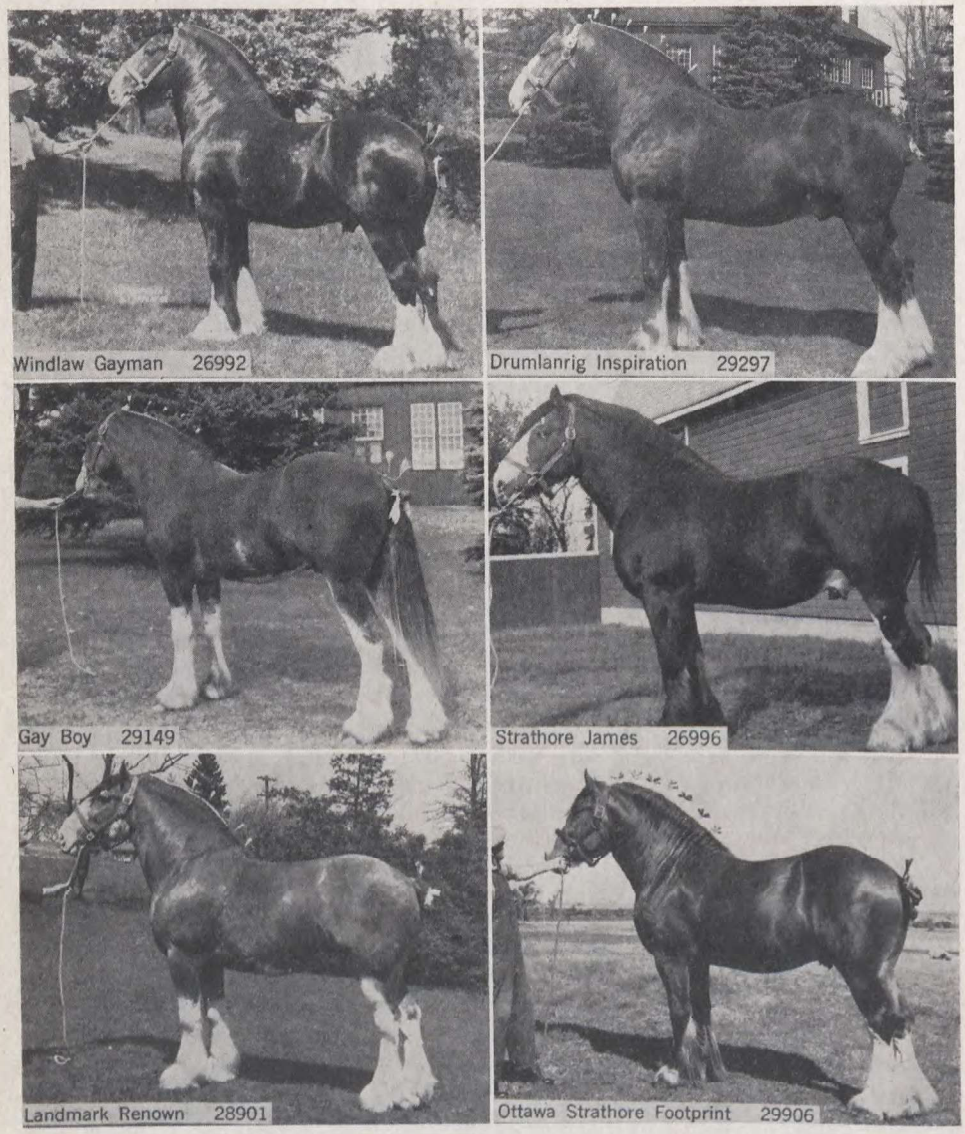

FIG. 13.—Premium Clydesdale stallions used at the Central Experimental Farm, Ottawa.

Tattooing Horses

The positive identification of horses has always been a vexing problem. Since tattooing for registration purposes is practised with almost all other classes of stock a test was conducted to determine the value of this method when used on horses.

Lip Tattooing Satisfactory

In 1940, twenty-two Clydesdale horses were experimentally tattooed in the lip to demonstrate this method for the permanent identification of individual horses. This work was conducted in co-operation with the Chemistry Division, Science Service. Several techniques were employed involving variation in size of dies, type of tattoo needles, astringents, rapid drying, protective coatings, and concentration of pigment in the tattoo compounds. Inspection of twelve of the horses after three years showed results grading from "Fair" to "Excellent". From the stability of these and subsequent tattoos it was concluded that tattooing is a satisfactory means of identifying horses.

Artificial Insemination of Horses

Since artificial insemination would be a means of utilizing to the full advantage the superior qualities of Premium stallions, a project to study methods and techniques was initiated in 1936. Due to the lack of sufficient mares within a reasonable radius this work was discontinued. Later a project covering this field was started at the Experimental Farm at Brandon, Man. The results of this work are to be found in the published reports of that Farm.

SHEEP

S. B. Williams and P. E. Sylvestre

During the period covered by this report the flock size has varied somewhat depending upon the number of trials under way, but the average number of breeding ewes overwintered has been between 350 and 400 head. The composition of the flock has altered over this time but there has always been a nucleus of purebred Shropshires and a somewhat larger group of grade Shropshires. These latter sheep have been used principally for pasture studies and nutritional trials. Several smaller flocks of various types of first-generation cross-bred ewes along with two bands of range ewes, Canadian Corriedale and Romnelet, make up the remainder.

During the grazing season all sheep are pastured on the Rifle Ranges, South March, Ont. The pasture cover is typical of the district. Higher, less fertile areas provide early grass while the heavier, lower portions carry the flocks when hot, dry weather curtails growth on the higher outcrops. The principal pasture species are Kentucky and Canada blue grass, wild white clover, and vetches.

The normal program followed in the sheep flocks is that lambing takes place in late March and throughout April. In May the pasture season starts, prior to which all sheep are treated for internal parasites. As soon as the danger of inclement weather passes the sheep are shorn followed about three weeks later by a treatment for external parasites. Lambs are weaned about mid-August and are marketed as they reach desirable weight and finish. The breeding season starts in late October and the sheep are usually in their winter quarters by the first of December.

Breeding Studies

The breeding work of the sheep section has been principally the production and evaluation for lamb and wool production of certain strains and crosses and the testing for suitability under eastern Canadian conditions of strains of range sheep bred on western Experimental Stations.

Comparison of Western Range and Eastern Domestic Ewes for Market Lamb Production

Experience has shown that ewes of six years of age and older cannot stand up under the severe conditions experienced on the western ranges. At this age the ewe has outlived her usefulness to the western rancher, but in the hands of an eastern farmer and under more favourable conditions, two or three more lamb crops may be obtained. In 1936 a policy to encourage the movement of such cast-for-age ewes from the west to the east was started by the Department of Agriculture. The trial reported here was devised to study the relative value for market lamb production of two types of aged range ewes in comparison with two types of eastern domestic ewes, all lots being bred to a Down ram.

Four lots compared.—The four lots involved in this comparison were as follows:

Lot 1—Forty cast-for-age Rambouillet ewes. On arrival these ewes were in a thin but healthy condition. No information was available on their age but all showed a full mouth.

Lot 2—Forty first-cross Corriedale × Rambouillet ewes. These were the result of a cross between range Rambouillet ewes similar to those in Lot 1 and Canadian Corriedale rams; the latter from the Dominion Experimental Station, Lethbridge, where the breed originated. One-half of this lot were five-year-olds, the remainder being half four- and half three-year-olds.

Lot 3—Forty grade Shropshire ewes from the flock at the Central Experimental Farm. These ewes represented the result of using purebred Shropshire rams for several generations. The age distribution of this lot was identical with that of Lot 2.

Lot 4—Forty first-cross Leicester × Shropshire ewes. These ewes were the product of mating a Leicester ram to grade Shropshire ewes of the same line as those in Lot 3. From the stock available it was not possible to exactly match in age this lot with the previous lot. Its composition was 9 six-year-old, 10 five-year-old, 11 four-year-old, and 10 two-year-old ewes.

All lots were maintained under the same conditions.—The four lots were bred to Shropshire rams, the breeding lots being arranged to ensure that an equal number from each lot were mated to each ram. The rams used were bred and raised on the Central Experimental Farm and were all of similar breeding.

In the grazing season the lots were pastured as one flock while during the winter months they all received the same feeds although the level of feeding varied depending on the condition of the ewes. Complete feed records were maintained. All animals were given regular treatments for the control of external and internal parasites. Lambs were docked at 14 days of age and ram lambs were castrated at that time. All lambs were weaned at the same time and were marketed as they reached desirable weight and finish.

Birth weights and early gains.—Table 21 gives the data on the weight at birth, gains and mortalities up to 21 days, as well as lambing percentages and ewe weight maintenance figures.

TABLE 21—BIRTH WEIGHTS AND EARLY GAINS—WESTERN VERSUS EASTERN EWES—4 YEARS. 1937-40 INCL.

—		Rambouillet	Corriedale × Rambouillet	Grade Shropshire	Leicester × Shropshire
Ewes—					
Bred	No.	129	122	120	110
Lambed	No.	116	116	108	98
Average weight after lambing	lb.	127·5	139·2	138·7	145·9
Average loss (lambing to 3 weeks)	lb.	1·0	3·8	2·4	7·0
Lambing percentage*	%	141·4	132·8	147·2	144·9
Lambs—					
Born	No.	164	154	159	142
Average birth weight	lb.	9·3	8·9	7·9	8·3
Average daily gain to 3 weeks	lb.	0·39	0·42	0·43	0·45
Mortality to 3 weeks	%	15·2	8·4	14·5	15·5

* Based on number of ewes lambed.

In general the differences between the lots were not large but did show definite trends. The cross-bred ewes, whether eastern or western, were heavier than their counterparts. It is possible that their relative milking capacity may be reflected in their loss in body weight to 21 days coupled with the lamb gains since within types the ewes showing the greatest loss in weight were those nursing the lambs that had the highest rate of gain.

The eastern ewes had higher lambing percentages, based on number of lambs born over number of ewes lambed, than the western ewes though the differences were significant only between them and the Corriedale × Rambouillet lot.

The lambs from the two western groups were heavier at birth but made lower gains to 21 days than did the lambs of eastern ewes. Since a lamb is almost entirely dependent on its dam's milk up to this age it would seem that the range ewes were not as heavy milk producers as were the farm ewes.

Lamb mortality rates were essentially the same in all lots, except the Corriedale × Rambouillet group. The lower losses in this lot can be attributed, in part at least, to the lesser number of twins born, since higher mortality rates are experienced in twins than in singles.

Lamb gains and market data.—All lambs were run with their dams on natural pasture until mid-August at which time they were weaned. Lambs not marketed by this time were pastured together and were given a small allowance (¼ to ½ pound per head per day) of a mixture of equal parts of oats and barley along with 10 per cent linseed oilmeal. The lambs were marketed at a live weight of 80 pounds provided they carried sufficient finish. Lambs not finishing at this weight were held until they had an adequate fat covering. The gains and marketing results are reported in Table 22.

TABLE 22—LAMB GAINS AND MARKETING DATA—WESTERN VERSUS EASTERN EWES—4 YEARS. 1937-40 INCL.

—		Rambouillet	Corriedale × Rambouillet	Grade Shropshire	Leicester × Shropshire
Lamb Gains—					
Lambs marketed	No.	132	129	114	108
Age when marketed	days	206	192	204	188
Average market weight	lb.	83·3	84·5	81·1	82·4
Average daily gain*	lb.	0·36	0·39	0·35	0·39
Marketing Data—					
Total weight marketed	lb.	10,195	10,055	8,550	8,220
Dressing percentage	%	46·8	47·3	47·1	48·8
"A" grade carcasses	%	89	94	96	97

* From 21 days to market.

From the standpoint of age marketed, marketing weight, and rate of gain from 21 days of age to market there was little to choose between the lots. The lambs from the cross-bred ewes, whether of eastern or western origin gained somewhat faster and reached market weight and finish earlier. The lambs from the western ewes were somewhat heavier at marketing than those from the eastern ewes.

Dressing percentages varied only slightly indicating that the lambs from all lots were marketed when carrying similar finish. Since all lambs were sired by Shropshire rams the percentage grading "A" did not differ greatly although there was a definite tendency for the lambs from the eastern ewes to have higher average grades. It might be noted that these grades are those of the packing house and are based largely on condition. Had more emphasis been placed on carcass conformation the lambs from the western ewes would have been rated lower. These lambs were relatively long and narrow with high shoulders and with legs lacking in fullness.

One major difference can be seen between the various lots, namely the total weight of lamb marketed. Since all lots started the trial with equal numbers of ewes and no replacement was made of animals lost through mortality or culling, the relative liveability of the ewes of the different lots contributed largely to the differences in amount of lamb sold.

Wool and cull ewes contribute to returns.—In any sheep enterprise there are two sources of revenue in addition to the market lambs, namely wool and cull ewes, the latter being sold for slaughter. Normally these two sources contribute a relatively small proportion of the gross returns but the actual percentage will vary from year to year depending upon price relationships. Table 23 presents the data covering these two sources of return.

TABLE 23—WOOL AND CULL EWE DATA—WESTERN VERSUS EASTERN EWES—4 YEARS, 1937-40 INCL.

——		Rambouillet	Corriedale × Rambouillet	Grade Shropshire	Leicester × Shropshire
Wool—					
Wool marketed	lb.	848	821	772	705
Yearly production per head	lb.	7·1	6·9	6·8	6·8
Cull Ewes—					
Weight marketed	lb.	2,778	3,838	3,482	3,113
Average weight	lb.	111·1	119·8	129·0	124·5

As was the case with total amount of lamb marketed, the ewes of western origin showed a superiority in wool production. The differences in production per head were small but once again the lower wastage rate in these flocks proved to their advantage when totals are considered. While wool production per head seems low, this is due in part to the skirting procedure followed, in that all fleeces were individually skirted and the skirtings were not included with the fleece weight.

As indicated by their average weight, the cull ewes from the eastern flocks had a considerably higher salvage value. The indifferent mutton conformation of the Rambouillet resulted in these sheep bringing very low returns when marketed. The advantage shown by the Corriedale × Rambouillet lot was entirely the result of a lower rate of mortality with a consequently larger number of ewes being culled and marketed.

Western ewes ate more grain.—The feeds differed somewhat from year to year, but in general the roughage was a fair to good quality mixed hay along with either corn silage or chopped turnips. The sheep were fed all the hay

they would eat without waste but the succulents were given at a fixed rate. Grain, which consisted of a mixture of equal parts of oats and bran, was fed as was considered necessary to keep the different lots in equal condition. The grain fed to the lambs represents that amount given to them from weaning until market time while on pasture. Feed consumption data are given in Table 24.

TABLE 24—FEED CONSUMPTION—WESTERN VERSUS EASTERN EWES. 4 YEARS, 1937-40 INCL.

—	Rambouillet	Corriedale × Rambouillet	Grade Shropshire	Leicester × Shropshire
Ewes—				
Average per head per year—				
Hay ..... lb.	613	635	619	656
Succulents ..... lb.	256	258	252	251
Grain ..... lb.	112	112	83	80
Lambs—				
Average per head—				
Grain ..... lb.	36	26	35	22
Feeding period ..... days	53	39	52	35

Some differences existed between the lots in feed consumption as the western ewes had to be given considerably more grain each year in order to keep them in condition equivalent to the others. Certain differences can be noted in hay consumption and since all the hay that the sheep would eat without waste was given, it is of interest that these differences correspond very closely with the differences in average ewe weight.

Since all lambs ran together the feed consumption had to be assumed to be equal for all animals. However, the average number of days during which they were fed grain is indicative of the relative rate of maturity since the later fattening lambs required a longer period of grain feeding.

Longevity aids western ewes.—One of the factors having the greatest effect on the results was the length of useful life of the ewes in the different lots. In all years but the first, 1937, the number of ewes remaining in the eastern lots was considerably less than in those of western origin. The years 1938 and 1939 proved to be particularly disastrous for the Leicester × Shropshire cross-breds. Twelve sheep either died or were culled in the former year and eight in the latter. As a result this lot had only 14 ewes available for breeding in the last year of the trial as compared with 23 in the Rambouillet group. The ewes remaining in the Corriedale × Rambouillet and the grade Shropshire lots were 19 and 16 respectively. It is of interest to note that in the first year of the trial, when the number of ewes per lot was not a factor, the Leicester × Shropshire cross-bred lot excelled all others in pounds of lamb produced and price per pound. It would seem certain that the western ewes were superior to the eastern ones in health, vigour, hardiness, and longevity. These attributes are probably breed characteristics although relative freedom from internal parasites may have been a contributing factor, since at the time of the trial no treatment was available for nodular worm disease, a condition that was common in the eastern ewes and unknown in the western.

Summary and conclusions.—Flocks of four different types, two of western origin, namely Rambouillet and Corriedale × Rambouillet, and two of eastern origin, Shropshire and Leicester × Shropshire, were tested under uniform conditions for market lamb production. All ewes were mated to Shropshire rams.

The eastern ewes were heavier than the western ones and, based on the number of ewes that lambed, were more prolific.

The lambs from the western groups were heavier at birth but made slower gains to three weeks of age. Subsequent to this, lambs from the Leicester × Shropshire and the Corriedale × Rambouillet groups made the best average daily gain followed by those from the Rambouillet and then the Shropshire group.

As measured by the percentage of "A" grade lambs marketed, the lambs from the Leicester × Shropshire ewes excelled in carcass conformation and finish.

The western ewes produced a much greater poundage of lamb and of wool over the four years of the trial. This superior showing could be attributed principally to their lower wastage rate.

It would appear that in flocks in which a normal replacement policy was followed the eastern type ewes would be preferable and that the cross-bred ewes, either eastern or western, excelled those of straight breeding.

In general the results indicate that cast-for-age range-type ewes can be brought from Western Canada to Eastern Canada and when mated to Shropshire rams can compete successfully with eastern domestic-type ewes for the production of market lambs.

Feeder Lambs from Western Breeding Projects

Certain breeding projects are carried out on western Experimental Stations the object of which is to improve the existing breeds and types of range sheep. Under range conditions fat lambs are not normally produced but rather lambs that require a period in the feedlot before reaching a desirable finish. It was decided to test lambs from these projects as feeders under eastern conditions. Two major criteria were used to determine relative excellence, firstly, rate and economy of gain and secondly, body conformation as determined by carcass measurements.

All lots were fed alike.—Three lots each of 40 lambs were obtained from Western Canada. The breeding of the lambs was: Lot 1, ordinary range Rambouillet; Lot 2, Romney Marsh × Rambouillet; Lot 3, Canadian Corriedale × Rambouillet. All lots received a ration of second-cut alfalfa hay and grain. The latter was a mixture of oats and barley, predominately oats at first with the percentage of barley being increased as the feeding period progressed until barley alone was fed. Water and salt were available at all times. All feeds were fed up to appetite and complete feed records were maintained. When the lambs were finished they were slaughtered and after 24 hours cooling the carcasses of all lambs were measured, cut into commercial cuts, and the parts weighed.

Cross-bred lambs more efficient.—The relative ability of the lambs in the three lots to put on weight and the economy of this gain in terms of feed is shown in Table 25

TABLE 25—GAIN AND FEED ECONOMY DATA. FEEDER LAMBS FROM WESTERN SHEEP-BREEDING PROJECTS—1937

—		Rambouillet	Romney Marsh × Rambouillet	Corriedale × Rambouillet
Gains—				
Lambs	No.	40	39	39
Average initial weight	lb.	65·8	62·8	62·3
Average gain	lb.	29·5	31·5	32·7
Average daily gain	lb.	0·25	0·27	0·27
Feed per 100 lb. gain—				
Hay	lb.	580	553	511
Grain	lb.	523	475	456

In rate of gain little difference was shown between the three lots. Economy of gain, as measured by the amount of feed required to produce 100 pounds of gain, showed that the Rambouillet lambs were less efficient at converting roughage and grain into gain in weight than were the two types of cross-bred lambs. Of the latter two, the Corriedale × Rambouillet lambs gave the better results. While this higher degree of efficiency in the cross-breds might be associated with their somewhat lighter initial weight, it would seem that the small variations in initial weight would not cause so large an effect and that the greater feed efficiency represented breed characteristics possibly coupled with a certain amount of hybrid vigour.

Little difference in carcass measurements.—After cooling, the carcasses were measured, cut into the three commercial cuts, and the various cuts were weighed and measured. The over-all length was measured from the atlas joint to the distal end of the metatarsus. The cut to separate the front was made between the third and fourth dorsal vertebrae. The leg was taken off in the usual commercial manner, approximately at the juncture of the lumbar and sacral vertebrae. The results are to be found in Table 26.

TABLE 26—CARCASS DATA. FEEDER LAMBS FROM WESTERN SHEEP BREEDING PROJECTS—1937

—		Rambouillet	Romney Marsh × Rambouillet	Corriedale × Rambouillet
Average cold carcass weight	lb.	44·4	44·6	44·9
Dressing percentage*	%	48·1	48·5	49·3
Weight of front	%	35·8	35·7	34·9
Weight of middle	%	31·4	32·0	32·8
Weight of leg	%	32·8	32·3	32·3
Over-all length	in.	53·8	52·2	54·1
Length of front	%	22·8	23·2	22·8
Length of middle	%	28·0	28·4	28·2
Length of leg	%	49·2	48·4	49·0

*Cold weight over live weight on arrival at packing plant.

Differences between the three lots of carcasses both in measurements and weights were surprisingly small and in all cases lacked significance. Visual inspection of the carcasses would have led one to think otherwise, since the Romney Marsh cross lambs appeared much shorter and thicker than the others. It would seem that the association between visual carcass excellence appraisal and the estimation of the economic value of carcasses based on such a cutting and weighing procedure is not great.

Summary and conclusions.—Three lots of lambs from western breeding projects were tested as feeder lambs under eastern conditions. The lambs used were range Rambouillet, Romney Marsh × Rambouillet, and Corriedale × Rambouillet.

Little or no difference was found between the lots in rate of gain or in conformation as judged by certain carcass measurements.

The cross-bred lambs were superior to the range Rambouillet in economy of gain.

Canadian Corriedale and Romnelet Sheep Under Eastern Canadian Conditions

In order to improve the type of sheep carried on the ranges of Western Canada, certain strains have been evolved. Two of these are the Canadian Corriedale, developed at the Dominion Experimental Station, Lethbridge,

Alta., from Lincoln × Rambouillet crosses and Corriedale blood, and the Romnelet from the Dominion Range Experiment Station, Manyberries, Alta., developed from Romney Marsh × Rambouillet crosses. While these types have been bred and selected for their adaptability to range conditions, it was considered advisable to bring some to Eastern Canada in order to determine whether or not they had a place in the sheep economy of the East either as a breed or as a basis for a cross-breeding program.

FIG. 14.—(*Upper*) Canadian Corriedale ewes. This breed is being developed at the Dominion Experimental Station, Lethbridge, Alta., for range conditions. It is being tested at Ottawa for suitability on eastern Canadian farms.

FIG. 15.—(*Lower*) Romnelet ewes. This breed is being developed at the Dominion Range Experiment Station, Manyberries, Alta., for range conditions. It is being tested at Ottawa for suitability on eastern Canadian farms.

Compared first as breeds.—In November, 1944, the following sheep were obtained by the Central Experimental Farm: Canadian Corriedale, 42 breeding ewes and 10 ewe lambs; Romnelet, 51 breeding ewes and 10 ewe lambs. In each case the breeding ewes were of mixed ages ranging from 6 years old downwards. A ram of each breed accompanied the flocks.

Both lots have received identical treatment since their arrival. The usual feeding and management practices have been followed throughout. At first all ewes were bred to rams of their own breeds, but as numbers became available a certain percentage were mated to Shropshire rams. Table 27 gives the summary of five years' results on the first phase of this work, namely the straight breed comparison.

TABLE 27—CANADIAN CORRIEDALE VERSUS ROMNELET.
5 YEARS, 1945-49 incl.

—		Canadian Corriedale	Romnelet
Ewes—			
Bred	No.	201	223
Lambed	No.	187	191
Average weight[1]	lb.	124·1	125·8
Lambing percentage[2]	%	147·6	137·2
Percentage nursed[3]	%	123·5	123·6
Lambs—			
Birth weight	lb.	8·3	8·1
Average daily gain[1]	lb.	0·41	0·47
Mortality[1]	%	16·3	9·9
Market Data—			
Lambs marketed	No.	138	137
Average age at market	days	258	234
Average daily gain[4]	lb.	0·29	0·32
Dressing percentage	%	42·5	45·5
"A" grade carcasses	%	22	44

[1] When lambs 28 days old.
[2] Number born over number of ewes lambed.
[3] Number lambs alive at 28 days over ewes lambed.
[4] Birth to market.

Same percentage of lambs reared.—Since mortality among lambs was concentrated in the first four weeks, the number of lambs alive at 28 days, expressed as a percentage of the number of ewes lambed, is considered to be an adequate measure of the reproductive rate. A more inclusive figure would be obtained if the number of ewes put to the ram were used rather than the number of ewes producing lambs. This was not considered advisable since the percentage of dry ewes was high in the Romnelet lot due to the fact that a ram which proved to be only partly fertile was used one season. When this season is not considered, the percentage of dry ewes is the same for both the Canadian Corriedale and the Romnelet lots, namely 7·6 and 7·2 per cent respectively. Thus, it can be seen that the higher lambing percentage of the Canadian Corriedale was offset by a higher lamb mortality rate resulting in an equal percentage of lambs being nursed at 28 days.

The Romnelet lambs had a higher rate of gain and reached market weight at an earlier age than the Corriedales. In addition they carried more finish as indicated by their higher yield and the greater percentage of "A" grade lambs.

Canadian Corriedales had finer fleeces.—The average clean yield of wool per head showed little difference between the two strains. The Romnelets produced 0·37 pound more grease wool per head than the Canadian Corriedales but a slightly lower clean yield percentage reduced the difference to 0·13 pound

on a scoured basis. The Corriedale fleeces were finer with the diameter of the yearling fleeces averaging 25·2 microns while the Romnelets gave an average of 27·4 microns. This corresponds to a spinning count of 58^s-60^s and 56^s respectively.

FIG. 16.—Sheep shearing, using power-driven clippers. Cross-breeding can mean additional wool.

Results when Shropshire rams used.—By the fall of 1947, the flocks had reached sufficient size to provide some ewes for mating to Shropshire rams. The ewes selected for crossing were not a random sample, but the inferior animals were used while those of better type were mated to rams of their own breed. The results of the Shropshire matings for the two years are given in Table 28.

TABLE 28—CANADIAN CORRIEDALE VERSUS ROMNELET (MATED TO SHROPSHIRE RAMS)—2 YEARS, 1948-49 INCL.

—		Canadian Corriedale	Romnelet
Ewes—			
Bred	No.	40	51
Lambed	No.	36	48
Lambing percentage[1]	%	147·2	135·4
Percentage nursed[2]	%	130·6	125·0
Lambs—			
Birth weight	lb.	8·7	8·8
Average daily gain[3]	lb.	0·39	0·47
Mortality[3]	%	11·3	7·6
Market Data—			
Lambs marketed	No.	46	57
Average age at market	days	236	214
Average daily gain[4]	lb.	0·34	0·36
Dressing percentage	%	46·0	46·0
"A" grade carcasses	%	52	65

[1] Number born over number of ewes lambed.
[2] Number lambs alive at 28 days over ewes lambed.
[3] To 28 days old.
[4] Birth to market.

Shropshire rams improve rate of maturity and carcass quality.—While the number of animals involved is not large, it is of interest to note that the differences demonstrated between the Canadian Corriedale and the Romnelet when mated to rams of their respective breeds were repeated when the ewes were topped with Shropshire rams. The Down rams did have an ameliorating effect in that the number of days to reach market weight and finish was reduced, the dressing percentage increased, particularly in the case of the Corriedale , and the carcass quality, as evidenced by the percentage of "A" grade lambs, was greatly improved. It would seem that these types of ewes would prove suitable for market lamb production in Eastern Canada if mated to Shropshire rams.

Summary and conclusions.—Two types of sheep, Canadian Corriedale and Romnelet, developed expressly for range conditions in Western Canada were tested for suitability under eastern conditions.

Although the Canadian Corriedales produced a somewhat higher percentage of lambs this advantage was lost because of a higher lamb mortality rate. The Romnelet was superior in most of the other economic characters. As straight breeds, slow rates of maturity and indifferent carcass conformation would lessen their usefulness for Eastern Canada.

FIG. 17.—Canadian Corriedale ewe with lambs by Shropshire ram. The use of a Down ram on this breed improved the carcass quality and rate of maturity of the lambs.

When mated to Shropshire rams the relative position of the two breeds was unchanged but rate of maturity and carcass quality in the lambs were considerably improved.

Cross-Breeding Sheep for the Production of Market Lambs

Since no one breed of sheep possesses all the desirable attributes that can be found throughout the breeds, it is possible that characteristics in which one or more breeds excel might be combined with the desirable features of other breeds by the employment of a continuous cross-breeding scheme. At the same time the benefits of hybrid vigour would be exploited.

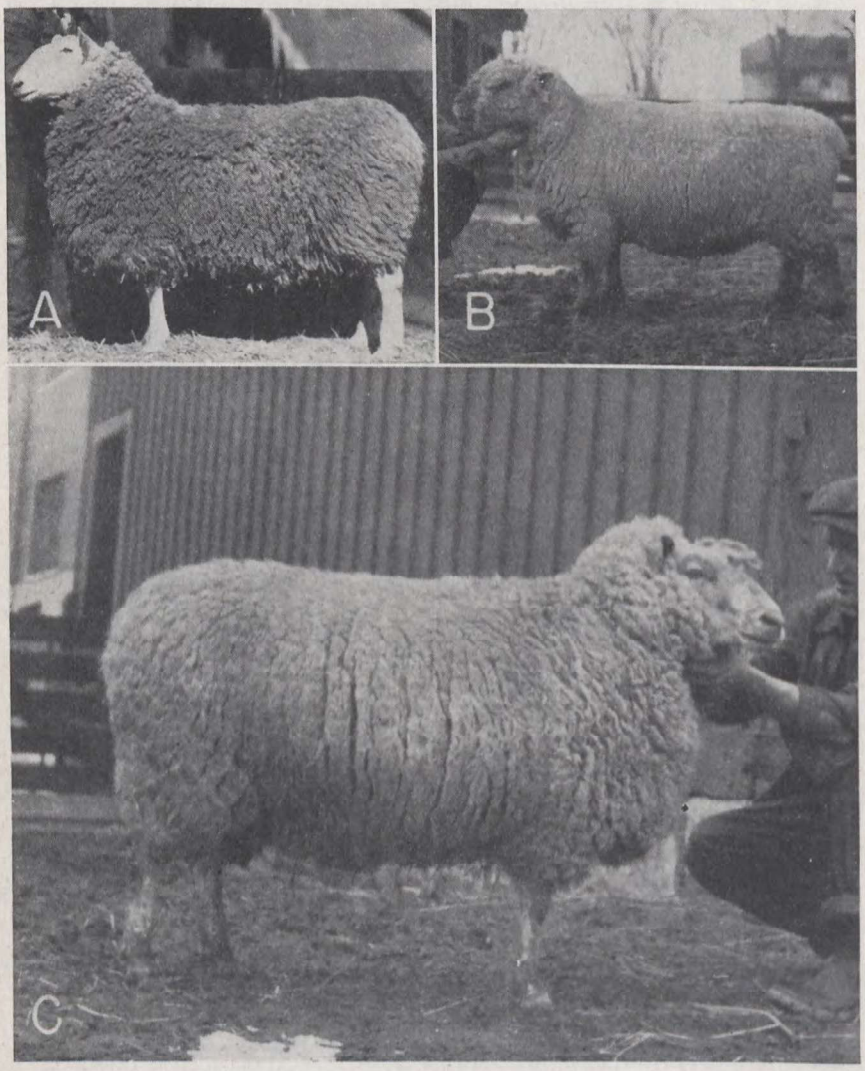

Fig. 18.—Typical animals from the cross-breeding experiment. When a Leicester ram (A) is bred to a Shropshire ewe (B) a Leicester × Shropshire cross-bred ewe (C) results.

In Eastern Canada the primary object of a sheep enterprise is the production of prime market lambs off grass. For such a program a high rate of milk production is essential in the ewe stock but milk production and ideal carcass conformation do not appear to go hand in hand. However, by cross-breeding, the superior milking qualities of one breed and the carcass excellence of another could be utilized. Thus the problem resolves itself into two phases, (1) the production and testing of cross-bred ewes of different breed origin and (2) the determination of the attributes and relative values of various breeds when mated to these cross-bred ewes. In the latter case, the end product, namely, the market lamb, is all that need be considered. In the former, many factors must be evaluated and weighed. Some of these are longevity, fecundity, economy and rapidity of growth to first pregnancy, efficiency of feed utilization, milk yield, temperament, maternal instinct, and wool cover.

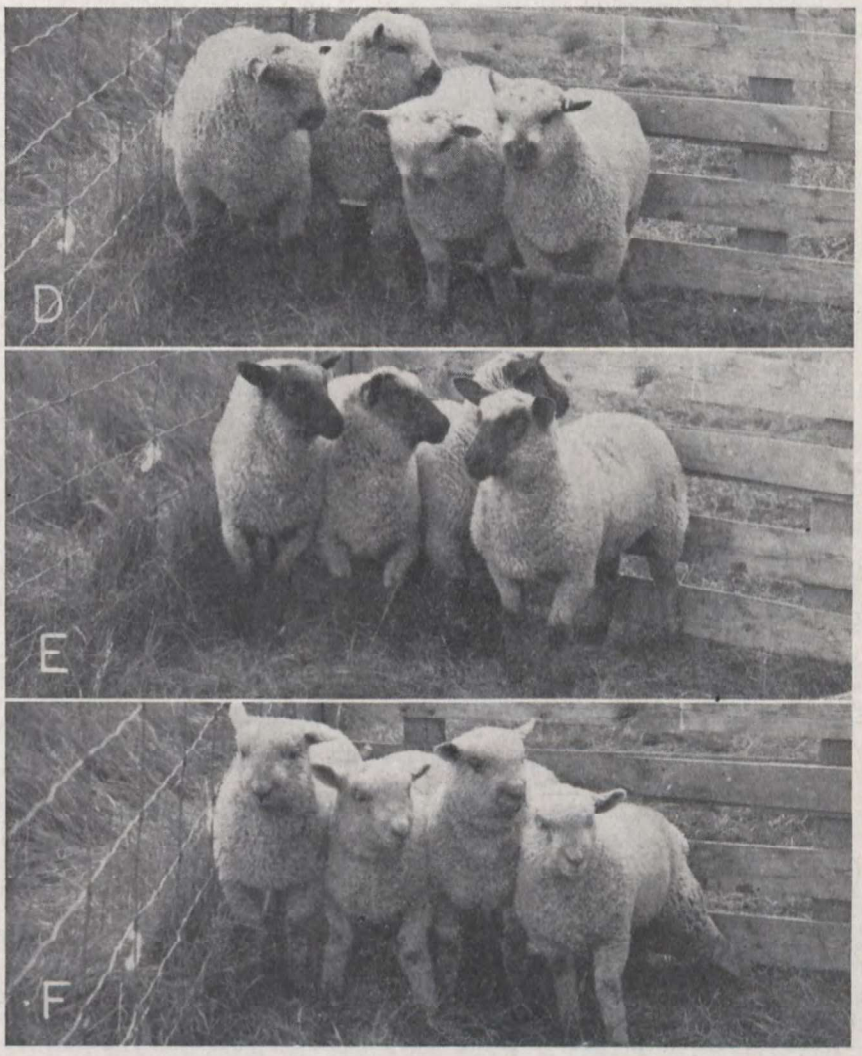

Fig. 19.—These 8- to 10-week-old lambs are all out of Leicester × Shropshire cross-bred ewes. (D) were sired by a Shropshire ram, (E) by a Suffolk ram, and (F) by a Southdown ram.

Several crosses under study.—The crosses selected for study were based on the three breeds most popular in Eastern Canada, the Shropshire, Oxford, and Border Leicester. Three Branch Stations co-operated in this work by rearing the first cross females until approximately six months of age, at which time they were shipped to Ottawa for testing. The crosses involved with the Station from which they came were:

Leicester × Oxford—Experimental Station, Lennoxville, Que.

Oxford × Shropshire—Experimental Station, Normandin, Que.

Border Leicester × Cheviot—Experimental Station, Ste-Anne de la Pocatière, Que.

Cheviot × Border Leicester—Experimental Station, Ste-Anne de la Pocatière, Que.

Leicester × Shropshire—Central Experimental Farm, Ottawa, Ont.

In each case the breed of the ram used to produce the cross-breds is given first.

Different breeds of rams used.—In the original phase of this work Leicester × Shropshire cross-bred females only were used. These were mated to Shropshire, Southdown, Suffolk, and Hampshire rams. Later as cross-bred ewes became available from the Branch Stations, three breeds of rams were used, namely, Suffolk, Shropshire, and Southdown as being representative of the large, medium, and small breeds. All second-cross lambs were marketed and individual carcass weights and grades were taken.

Feeding and management.—The feeding and management regime followed was consistent with what might be called good practice. During the winter months good quality mixed hay plus corn silage or roots was fed along with a little grain around lambing time. A mineral mixture, salt, and water were available at all times. During the summer months the sheep were run as one flock on the Rifle Ranges, South March, Ont. All animals received regular treatment for internal and external parasites. Lambs were docked when 14 days old and ram lambs were Burdizzo castrated at that time.

First generation cross-bred lambs outgain straight Shropshires

In any scheme involving the production of cross-bred ewes the suitability of the first generation cross-bred lambs for market must be considered since all wether and surplus ewe lambs are sold for slaughter. A comparison of the two types is found in Table 29.

TABLE 29—FIRST GENERATION LAMB COMPARISON. GRADE SHROPSHIRE LAMBS VERSUS LEICESTER × SHROPSHIRE LAMBS—6 YEARS, 1940-45 INCL.

—		Shropshire Rams × Grade Shropshire Ewes	Leicester Rams × Grade Shropshire Ewes
Ewes lambed	No.	373	391
Lambing percentage*	%	146·9	151·4
Average lamb birth weights	lb.	8·1	8·8
Lambs marketed	No.	219	281
Average age at market	days	218	191
Average weight at market	lb.	81·1	85·4
Average daily gain	lb.	0·33	0·40
Dressing percentage	%	45·2	45·7
"A" grade carcasses	%	90	80

* Based on lambs born over ewes lambed.

The Leicester × Shropshire lambs demonstrate clearly some of the advantages of cross-breeding. Although both lots of lambs were nursed by the same type of ewe from the same flock, those sired by the Leicester rams were three-quarters of a pound heavier at birth and made much more rapid growth. Their rate of gain from birth to market was 21 per cent higher than that of the grade Shropshires. Due to their Leicester ancestry they were bigger framed and were marketed at a heavier weight. This Leicester parentage is also reflected in the grading percentage, as there were 10 per cent less "A" grade lambs in the cross-bred group. It is evident that in a scheme to produce cross-bred ewes no difficulty should be experienced in marketing the wethers and surplus ewe lambs since they made excellent gains and gave satisfactory carcasses.

Cross-bred ewes proved superior to straight-bred

The first stage of this work was a comparison of straight-bred Shropshire ewes and the first generation cross-bred ewes resulting from the Leicester × Shropshire mating. The two ewe types were mated to purebred Shropshire rams of similar breeding. Thus, as shown in Table 30, in the grade lot the lambs were grade Shropshire while the lambs of the cross-bred ewes were three-quarter Shropshire and one-quarter Leicester.

TABLE 30—GRADE SHROPSHIRE VERSUS LEICESTER × SHROPSHIRE EWES—9 YEARS, 1937-45 INCL.

—		Grade Shropshire Ewes	Leicester × Shropshire Ewes
Ewes—			
Lambed	No.	465	271
Average weight after lambing	lb.	141·6	150·0
Loss in weight[1]	lb.	2·6	4·2
Lambing percentage[2]	%	146·7	160·5
Clean fleece weight	lb.	3·56	4·75
Lambs—			
Average birth weight	lb.	8·0	8·4
Average daily gain[1]	lb.	0·46	0·50
Mortality[1]	%	9·3	9·0
Market Data—			
Lambs marketed	No.	315	323
Age when marketed	days	211	187
Average daily gain[3]	lb.	0·34	0·39
Average weight	lb.	81·0	82·4
Dressing percentage	%	45·8	47·6
"A" grade carcasses	%	91·7	87·6

[1] From birth until lambs were 21 days old from 1937-1940 inclusive, after that until lambs were 28 days old.

[2] Lambs born over ewes lambed.

[3] 1937 to 1940 inclusive—from 3 weeks of age to market, thereafter, 4 weeks to market.

In almost every respect the cross-bred ewes showed superiority. They produced 14 more lambs per 100 ewes and these lambs were not only heavier at birth but made more rapid gains during their first month. Perhaps the higher rate of gain is evidence of a greater rate of milk production in the cross-bred coupled with an increased growth potential since, during the first month, milk is practically the sole source of nourishment for the lamb.

The lambs from the cross-bred ewes reached market weight and finish 24 days earlier and produced heavier carcasses. The reasons for this heavier carcass weight were twofold since the lambs were marketed at a slightly heavier live weight and in addition had a higher dressing percentage. The principal reason for the lower percentage of "A" grade lambs from the cross-bred ewes was that, while well

fleshed, they were somewhat leggy. This doubtless was a legacy from their Leicester grandsires. The discrepancy between number of lambs born and the number marketed was due to the retention of ewe lambs and to the fact that during certain of the war years complete marketing data could not be obtained.

The 33 per cent higher clean fleece production of the cross-breds was due both to a higher production of greasy fleece and a lower loss during scouring.

Cross-bred fleeces were coarser.—The wool of the grade Shropshires ranged from $\frac{1}{4}$ blood to $\frac{3}{8}$ blood in fineness with the preponderance being in the latter class. The cross-bred fleeces ranged from low $\frac{1}{4}$ blood to $\frac{1}{4}$ blood with the majority falling into the latter class. In general the cross-bred fleeces were longer stapled. There was a good demand for both types of fleece and there was little price differential between them.

Leicester × Shropshire ewes mated to rams of various breeds

In the earlier stages of this project the first-cross ewes from the various Branch Stations outlined earlier were not available. Therefore, Leicester × Shropshire ewes bred at the Central Experimental Farm were mated to rams of various breeds, namely Shropshire, Southdown, Hampshire, and Suffolk. Due to limitation of flock size these rams could not be used concurrently, and since there may be wide seasonal differences in nutritional status, reference will be made to the seasonal averages of the other breeds when discussing the Hampshire and the Suffolk. The data from these crosses appear in Table 31.

TABLE 31—SECOND GENERATION LAMB COMPARISON—LEICESTER × SHROPSHIRE EWES MATED TO RAMS OF VARIOUS BREEDS

Sire of lambs Years (incl.)		Shropshire 1941–1945	Southdown 1941–1945	Hampshire 1941–1942	Suffolk 1943
Ewes lambed	No.	159	165	62	31
Lambing percentage	%	167	160	163	171
Birth weight	lb.	8·4	8·4	8·8	8·8
Age at market	days	186	181	139	171
Average daily gain	lb.	0·40	0·39	0·52	0·47
Average live weight at market	lb.	84·3	80·4	82·9	89·2
Dressing percentage	%	46·7	47·3	45·9	45·5
"A" grade carcasses	%	78	89	100	35

When Shropshire or Southdown rams were used to top the cross-bred ewes, the differences between the resulting lambs were small. In general the Southdown-sired lambs reached a desirable finish at a lighter weight than did the Shropshire crosses. The superior conformation and finish of the lambs by the Southdown was evidenced by the high percentage of "A" grade lambs marketed.

Both the Hampshire and Suffolk rams produced heavy lambs which made very rapid gains and reached market at a relatively early age. This was particularly true of the Hampshire. The pasture seasons of the two years to which the Hampshire records apply were extremely good. In these two years the Shropshire- and Southdown-sired lambs made an average daily gain per head of 0·44 and 0·46 pounds respectively which compares much more favourably with the Hampshire average than does the five-year average. While the Hampshire-sired lambs were all "A" grade yet in these two years the Shropshire gave results equally good.

The Suffolk lambs were heavy but left much to be desired from the carcass standpoint. However, the number involved was small and only one sire was used so this may be far from a true picture of the capabilities of this breed. It is of interest to note that in 1943 both Shropshire- and Southdown-sired lambs were comparatively heavy and showed a low percentage of "A" grade lambs, evidence

of a lower level of nutrition during that season, since during seasons of poor feed conditions the tendency is for the lambs to grow rather than to fatten. Consequently they have to be fattened later and finish at a heavier weight.

Other crosses compared.—In the fall of 1946 the first cross-bred ewes produced by the co-operating Branch Stations were available for breeding. Accordingly they were mated, along with Leicester × Shropshire ewes from Ottawa, with respresentative rams of three breeds, namely, Shropshire, Suffolk, and Southdown.

Fig. 20.—Yearling ewes from cross-breeding experiment.
Left to right: Cheviot × Leicester; Leicester × Oxford; Leicester × Shropshire; Oxford × Shropshire; and Leicester × Cheviot.

Table 32 gives the total of four years' results of the ewe comparison in this trial. In each case an equal number of ewes from each lot were mated to rams of each breed. Since there did not appear to be any difference between the Cheviot × Leicester crosses and those originating from the opposite cross, and since there were relatively few of the latter, the data from these two crosses have been combined.

TABLE 32—COMPARISON OF CROSS-BRED EWES AS DAMS OF FAT LAMBS. 4 YEARS, 1946-49 INCL.

Ewe crosses		Leicester × Shropshire	Leicester × Oxford	Oxford × Shropshire	Cheviot × Leicester
Ewes—					
Lambed	No.	96	51	49	86
Lambing percentage[1]	%	164	159	153	158
Weight after lambing	lb.	123·3	138·3	146·5	122·1
Average fleece weight	lb.	7·2	8·6	7·6	7·3
Lambs—					
Birth weight	lb.	8·5	8·9	9·4	9·0
Average daily gain to 28 days	lb.	0·48	0·46	0·49	0·46
Mortality to 28 days	%	13	20	10	8
Market data—					
Average live weight	lb.	83·1	85·1	88·1	84·7
Age when marketed	days	206	200	213	204
Average daily gain to market	lb.	0·36	0·38	0·38	0·37
Dressing percentage	%	45·3	45·0	45·8	46·9
"A" grade carcasses	%	83	82	67	83
Ewe efficiency index		106	96	92	110

[1] Lambs born over ewes lambed.

No great difference between various crosses.—No outstanding differences were demonstrated between the different types of cross-breds. The lambing percentages were good in all lots, and, as might be expected, the heavier ewes gave birth to lambs that were marketed at heavier weights. Possibly the most significant figures are those for "ewe efficiency index". This is an estimate of the over-all efficiency of production and is calculated by adding together the number of pounds of lamb marketed per 100 pounds of ewe and three times the amount of wool produced per 100 pounds of ewe. This calculation removes the effect of ewe size to a large extent and also allows for the fact that on a long-time average basis a pound of wool is worth three times as much as a pound of lamb. These efficiency index figures show that the smaller ewes, namely the Cheviot × Leicester and Leicester × Shropshire ewes, were more efficient producers of lamb and wool than were their larger rivals. However, the relative economy of the large and small ewes will depend upon the relationship between feed prices and lamb and wool prices.

In addition to the usual data that were recorded and which are summarized in Table 32 certain observations were made by the technical workers and shepherds concerned with the handling of these sheep.

Leicester × Oxford crosses were short lived.—It was found, that under the conditions of the experiment, it was impossible to maintain the Leicester × Oxford ewes in adequate flesh. They were always thin in spite of the fact that their recorded hay consumption was 56 per cent higher than that of the other lots while silage and grain consumption was equal. This lack of condition appeared to affect their longevity to such an extent that, over the years, 93 per cent were either dead or had to be culled after three lambings (4½ years old) while the corresponding figures for the other lots ranged from 36 to 44 per cent. Their thin condition at lambing was reflected in the lamb mortality rate which was considerably higher than any other lot. Their fleeces also suffered, for, while their fleece weight was considerably higher than that of the other lots, 51 per cent of the fleeces were graded as "cotted" or as "tendency to cott", while the highest figure recorded for any of the other lots was 20 per cent. It should be pointed out that the average body weight shown for these ewes is not truly indicative of their size since they were much more deficient in fleshing than were the sheep in the comparative lots. As a consequence of their unsatisfactory performance from the standpoint of viability this cross was discontinued.

Cheviot × Leicester ewes excellent mothers.—In addition to their top over-all efficiency, the maternal instinct of the Cheviot × Leicester and Leicester × Cheviot crosses was outstanding. This doubtless accounts for the low lamb mortality rate in this lot since newborn lambs were invariably well looked after and were never deserted. These ewes were high strung and active and had a decided tendency to forage far afield. Under farm conditions this nomadic habit might be an embarrassment unless fences were better than average.

Woolly faces of Oxford × Shropshire crosses not desirable.—The Oxford × Shropshire crosses were a very acceptable type of ewe but had the drawback, from the farmer's standpoint, of carrying excessive face cover which necessitated their being clipped about the eyes several times a year to eliminate wool blindness. To counterbalance this the Oxford × Shropshires had excellent fleeces with a very low percentage falling in the reject grades.

Ram differences more marked.—While the variations between the various types of ewes were not great yet some distinct differences could be attributed to the various breeds of rams used. Table 33 presents the results of this trial grouped by the breed of ram to which the cross-bred ewes were mated. In each case the number of ewes of a particular cross was approximately equal.

TABLE 33—COMPARISON OF THREE BREEDS OF RAMS AS SIRES OF FAT LAMBS OUT OF CROSS-BRED EWES—4 YEARS, 1946-49 INCL.

Breed of Ram		Suffolk	Southdown	Shropshire
Ewe data—				
Lambed	No.	106	105	95
Lambing percentage[1]	%	161	152	160
Lamb data—				
Birth weight	lb.	8·8	9·0	8·8
Average daily gain to 28 days	lb.	0·48	0·47	0·45
Mortality to 28 days	%	14	8	15
Market data—				
Average live weight	lb.	88·2	82·1	83·6
Age when marketed	days	194	212	211
Average daily gain to market	lb.	0·41	0·35	0·36
Dressing percentage	%	46·2	46·3	45·0
"A" grade carcasses	%	74	94	72

[1] Lambs born over ewes lambed.

The Suffolk rams showed their superiority in siring rapidly-developing lambs. While no difference was shown up to 28 days of age, when possibly the milk supply was the limiting factor, yet these lambs excelled the others by 12 to 15 per cent in over-all rate of gain. However, they were heavier than the others when marketed and the carcass grades of the lambs were inferior to those sired by the Southdown. On the other hand, the gains of the Southdown-sired lambs dropped off rapidly once they approached market weight and many lambs were noted as carrying sufficient finish at too light a weight. With the Suffolks, the tendency was for the lambs to be under-finished at bottom market weights, that is 80 pounds live weight. In most respects the Shropshire-sired lambs appeared to be intermediate. Their relatively poor showing in regard to percentage of "A" grade lambs marketed is difficult to understand.

The low mortality rate of the Southdown cross lambs is worthy of note, doubtless the lower lambing percentage in this lot contributed to this, but it may also be a breed characteristic correlated with the relatively large size of the lambs at birth.

Summary and conclusions.—The reported results indicate that first-generation cross-bred ewes are superior to straight-bred ewes for market lamb production and that the cross used is not too important. However, the different types of cross-bred ewes have certain peculiarities and because of these their relative value may vary depending upon the conditions under which they are maintained.

When mated to cross-bred ewes, Suffolk rams sired rapidly growing progeny with a tendency to be under-finished at minimum market weight. This tendency was reversed in Southdown-sired lambs. Shropshire rams produced progeny that were intermediate in most respects to those sired by the other two breeds.

Nutritional Studies

For the period covered by this report the nutritional work has been limited to studies of the proper supplementation of roughage for pregnant ewes along with research into the grass consumption and nutritional requirements of grazing sheep. This latter portion of the work is outlined in the pasture section of this report.

Supplemental Feeding of Pregnant Ewes

Trials previously conducted at the Central Experimental Farm have shown that non-leguminous hay, unsupplemented, is not a suitable feed for pregnant ewes. Since in many areas of this country legume hay is not a certain crop and, where it can be reliably grown, it is often reserved for the dairy herd, information is required on the proper supplementation of grass hays.

The first stage of this work was conducted under the sponsorship of the National Sheep Committee, during the winters of 1946–1947 and 1947–1948 at Ottawa, and at two Branch Experimental Stations as well as at the Universities of Saskatchewan and Alberta. A complete report of this work has been published in Scientific Agriculture 30-1-11, January, 1950.

Three lots were fed.—Briefly, the trial consisted of three lots of pregnant ewes fed from the end of the breeding season until lambing on the following rations:

Lot 1—Legume hay.
Lot 2—Non-legume hay.
Lot 3—Non-legume hay until approximately mid-pregnancy, then legume hay plus oats.

All lots were fed all the roughage they would consume without waste plus a complete mineral mixture. In addition half of each lot received a weekly allowance of 50,000 International Units of vitamin A per head. This was administered orally in capsules and consisted of fortified, high-potency, feeding oil.

Legume hay was best.—The over-all results of this trial showed that:

(a) Legume hay gave more satisfactory results as a feed for pregnant ewes than did non-legume hay as measured by maintenance of ewe body weight, lamb birth weight, and lamb vigour at birth.

(b) If insufficient legume hay is available for the complete winter period, the non-legume hay should be fed during the first half of the pregnancy since the changeover ration gave results comparable with those obtained when legume hay alone was fed.

(c) The addition of a vitamin A supplement to these rations did not bring about any significant improvement.

Experiment revised.—As a result of the findings of the first two years, the trial was revised in the fall of 1948, with the same Universities and Stations co-operating. This newer trial was aimed at determining the relative values of a protein and a carbohydrate supplement to a grass hay. To this end four lots were fed:

Lot 1—Legume hay.
Lot 2—Non-legume hay.
Lot 3—Non-legume hay plus one-half pound of linseed oilmeal per head per day.
Lot 4—Non-legume hay plus one-half pound of oats per head per day until mid-pregnancy, then one pound until lambing.

Preliminary results.—While this work is still being carried on, indications from the first year's results were that a non-legume hay ration can be improved by the supplementary feeding of linseed oilmeal or oats and that the linseed oilmeal was somewhat more satisfactory.

Management Studies

Only one management project was conducted during the period. This was a study of various treatments for the control of internal parasites.

Treatments for the Control of Internal Parasites of Sheep

Adequate and convenient control of internal parasites of sheep has always been a problem in Eastern Canada. While certain types of medication provided protection against some parasites others were more useful against other types. It was to determine the over-all efficiency of various mixtures that this trial was conducted in co-operation with the Division of Animal Pathology, Science Service, Department of Agriculture, and the Institute of Parasitology, Macdonald College, McGill University. A complete report of this work was published in the Canadian Journal of Research, Vol. 20, Sec. D, p. 115, May 1942.

Nine experimental treatments used.—During the summers of 1937 and 1938 nine different treatments were used. Weight gain and marketing data were kept on all lambs and immediately after slaughter all abomasa and intestines were tagged, cooled, and shipped to the Institute of Parasitology for complete parasite counts. The following is a brief outline of the types of treatment given. The first five were used in 1937 and the latter four in 1938.

Treatment A —Copper sulphate solution.

Treatment B —Copper sulphate and nicotine sulphate solution.

Treatment C— Capsules of tetrachlorethylene administered with a syringe which simultaneously sprayed the pharynx with copper sulphate solution.

Treatment D —Capsules of tetrachlorethylene.

Treatment E —Copper arsenate, calcium hydroxide, copper tartate and copper sulphate solution.

Treatment F —Copper sulphate and nicotine sulphate solution.

Treatment G —Tetrachlorethylene in capsules.

Treatment H —Tetrachlorethylene emulsion.

Treatment I —No treatment.

All treatments were administered periodically throughout the season. Table 34 gives the marketing distribution of the lambs of the various lots.

TABLE 34—PARASITE CONTROL TRIAL. SEASONAL DISTRIBUTION OF LAMB MARKETING—2 YEARS, 1937-38 INCL.

Treatment	A	B	C	D	E	F	G	H	I
Number lambs marketed—									
First draft	2	2	2	1	2	5	6	10	6
Second draft	11	5	7	10	5	6	7	4	7
Third draft	10	9	12	10	13	16	13	9	17
Fourth draft	2	2	0	3	1	5	5	10	4
Fifth draft	1	1	1	1	1	2	1	3	2
Sixth draft	3	4	2	3	3	—	—	—	—
Seventh draft	1	1	2	1	2	—	—	—	—
Total	30	24	26	29	27	34	32	36	36

No difference between treatments.—The eveness of the distribution of the marketings in the various lots indicates that there was little difference in thrift between the various lots. The visceral examinations had shown that nodular worms appeared to be one of the more important species and these treatments did not control this parasite.

Phenothiazine tested.—Since phenothiazine had been developed as an effective method of controlling nodular worm, further tests were conducted in 1940 and 1941. In 1940 all adult sheep were given 40 grams of phenothiazine in tablet form, four days before being turned out to pasture. In 1941, this was repeated except that the yearlings received only 30 grams and all sheep were confined for only one day after treatment. No other treatment was given throughout the year.

Phenothiazine eliminated nodular worm lesions.—The use of phenothiazine brought about a most decided decrease in the number of nodular worm lesions in the lambs, and in addition reduced significantly the severity of infestation of several other parasites. The great reduction in nodule count following the 1940 and 1941 treatments is shown in Table 35.

TABLE 35—THE EFFECT OF PHENOTHIAZINE ON NUMBER OF NODULAR WORM LESIONS IN LAMBS

Year	No. Lambs Studied	No. Nodules Per Head	Per Cent Reduction from 1938
1938	138	49·4	—
1940	218	5·9	88
1941	84	0·3	99

Since 1941, the annual use of phenothiazine has been continued and at present the occurrence of a nodule on a lamb intestine is unusual and other internal parasites have been kept at a sufficiently low level to prevent the appearance of clinical symptoms.

Summary and conclusions.—As evidenced by lamb thrift, no difference was demonstrated between nine different treatments for internal parasite control.

The treatment of adult sheep only with phenothiazine once annually, before being allowed on pasture in the spring, has, for all practical purposes, eradicated nodular worm disease from the flocks under study. This treatment also has kept other types of internal parasites under control in spite of the fact that the lambs received no medication whatsoever.

SWINE

E. B. Fraser and J. G. Stothart

During the period covered by this report there was a considerable increase in hog production in Canada and a proportionate increase in the demand for information. The studies undertaken to provide some of this information are outlined in this section.

The swine research facilities at the Central Experimental Farm consist of a 50-pen main piggery, a small four-pen piggery, six outdoor winter holding lots, and three sow pastures. In addition to the facilities for experimental trials this accommodation allows for the rearing of approximately 70 litters per year.

Breeding Studies

The objectives of the swine breeding studies reported were:

1. To gather information fundamental to the development of methods of improving the performance of swine.
2. To compare various breeds, lines, and crosses on a performance basis.
3. To develop and test lines of pigs of superior production potential.

Comparison of the Swedish Landrace and the Yorkshire

Since there was considerable difference of opinion on the relative merits of Landrace and Canadian Yorkshires as breeds of bacon pigs, it was considered advisable to determine if this superiority really existed before extensive importations were made. In 1934 an importation of 6 boars and 59 Swedish Landrace sows was made from Sweden. These animals formed the nucleus of test herds at the Central Experimental Farm, Ottawa; and the Experimental Farms at Brandon, Man., Melfort, Sask., and Lacombe, Alta. The data reported here were gathered at all of these Stations.

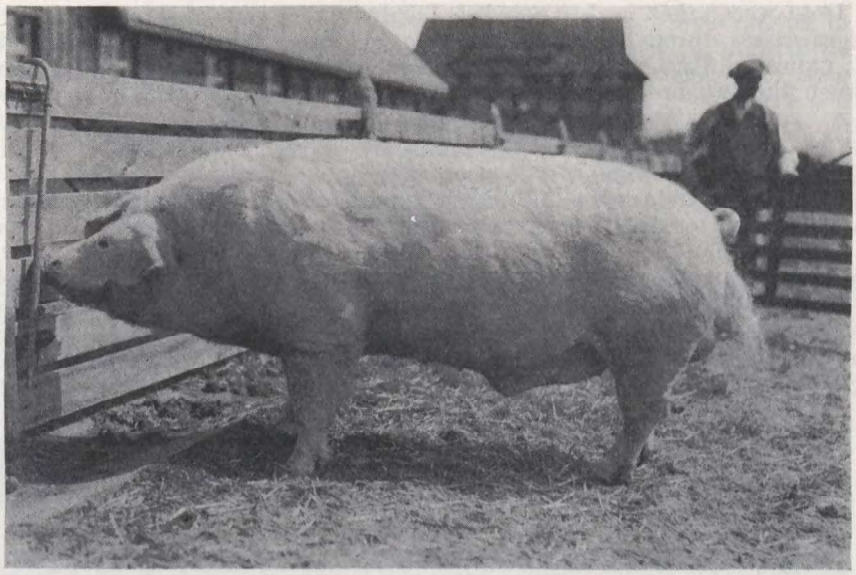

Fig. 21.—Imported Landrace boar used in breed comparison study.

It was decided that the main comparison should be made on the five factors which together determine the success of a swine enterprise on Canadian farms. These five factors are, number of pigs born alive, number of pigs weaned, rate of gain, economy of gain, and carcass quality.

Breeding stock of the two breeds was handled under the same conditions on each of the Farms conducting the tests. Representative pigs from Swedish Landrace, Yorkshire, and cross-bred litters were entered in the Advanced Registry Policy for Purebred Swine, and the comparison of the breeds for feeding performance and carcass quality was made on this basis. Table 36 presents a brief summary of the results up to the end of the feeding trial.

TABLE 36—LANDRACE AND YORKSHIRE LITTER AND FEEDING DATA. 5-YEAR AVERAGE, 1935-39, INCL.

Breed or Cross	Pigs Born Alive	Pigs Weaned	Average Daily Gain	Feed Required Per 100 lb. Gain
	No.	No.	lb.	lb.
Landrace	8·26	5·90	1·36	341
Yorkshire	10·65	8·44	1·33	346
Crossbreds:				
Yorkshire × Landrace	7·83	6·30	1·36	356
Landrace × Yorkshire	8·95	7·50	1·38	354

These data show that the Swedish Landrace sows farrowed fewer pigs on the average than the Yorkshire sows. The complete data indicate that the Landrace sows did an excellent job of nursing their pigs and were equal, or perhaps superior, to Yorkshire sows in this respect. Little benefit was derived from crossing the Swedish Landrace and the Yorkshire to produce market pigs. The data do not indicate any difference in the gains or economy of gains of the two breeds.

Data were taken on 710 Swedish Landrace, 346 Yorkshire, and 199 crossbred carcasses through the co-operation of the Production Service. These data indicated that there were differences in certain carcass characteristics between the two breeds, but, while one breed excelled in some characteristics this was counterbalanced by the superiority of the other breed in other characteristics. The final conclusion drawn was that there was little difference in the carcass quality of the two breeds.

After five years' testing of Swedish Landrace swine and their progeny, their disappointing litter size, the impracticability of procuring further breeding stock, and the fact that they were no better than Canadian Yorkshires in economy of production and carcass quality, led to the decision to conclude the test in 1939.

Complete information on the plan of testing, the detailed data collected by stations and years, and a full discussion of the results are contained in Technical Bulletin 64, "Testing Swedish Landrace Swine in Canada" published in August, 1947, by the Department of Agriculture.

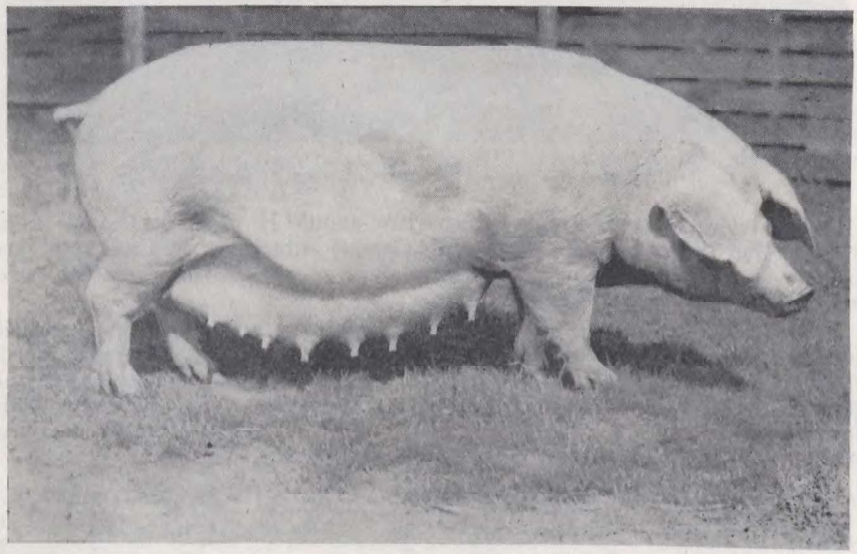

FIG. 22.—Imported Landrace sow. These sows milked well but weaned small litters.

SWINE INBREEDING AND PREPOTENCY PROJECT

There is evidence that inbred lines can be crossed with outbred stock or with each other to yield improvement. In general, the greatest amount of improvement can be attained when inbred lines belonging to different breeds are crossed. The development of superior inbred lines of Yorkshires could, however, be expected to yield some improvement when they are combined.

It is recognized that some decline in the average performance of a line can be expected, due to inbreeding, but it is believed that the added prepotency of inbred boars when used on outcross sows will compensate fully for this decline within the line itself. Inbreeding will also serve as a test for the presence of any undesirable recessive genes which are being carried within the line. In effect, inbreeding is the most powerful tool that a breeder has to "purify" his lines. The difficulty is that it not only "purifies" the line for the desirable characteristics but it also "purifies" it for the undesirable characteristics. In another sense the exposure of these undesirable characteristics is beneficial, as it enables the breeder to select against them.

Inbred lines for swine improvement.—In 1946 a project was started in co-operation with the Production Service of the Department of Agriculture to develop inbred lines of pigs. The aim in this project was to develop, by means of inbreeding and selection, lines of hogs prepotent for desirable commercial characteristics which would cross well with each other and with the average Canadian Yorkshire. Five inbred lines have been started at Ottawa under this project. The plan has been to acquire foundation stock with excellent Advanced Registry records, to inbreed this foundation stock, and to select for the economically important characteristics.

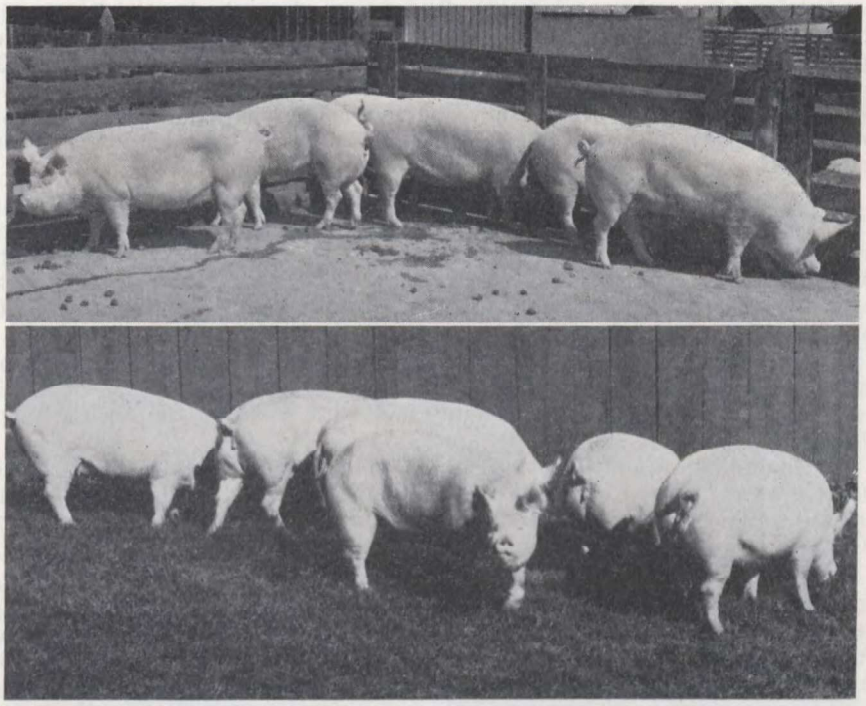

FIG. 23 (*Upper*) Yorkshire gilts of the Ottawa inbred line. The carcasses of this inbred line were too short.

FIG. 24 (*Lower*) Linecross gilts. There was good carcass quality in this combination of the Brandon and Ottawa inbred lines.

The procedure, in most of the lines started during the period covered by this report was, briefly, as follows:

A boar and five or six of his closest available female relatives were chosen on the basis of Advanced Registry records as the foundation for a line. The boar was mated to his full sisters (or daughters) and from then on an inbreeding policy was followed with no outside blood being introduced. Four pigs were placed on Advanced Registry test from each of as many litters as possible. The remaining pigs in each litter were raised as breeding stock, and replacement gilts and boars were chosen from this group on the basis of their littermates' performance on the Advanced Registry test.

Ottawa inbred line too short.—The Ottawa inbred line originated from crosses between two boars and eight sows. One boar was a full brother to the sows (50 per cent relationship). The other boar had a relationship of 31·5 per cent to

the sows. At present this line is entirely free from ruptures and ridglings, and on the average the pigs reach 200 pounds in around 200 days. The average litter size at birth is somewhat low (8·4 pigs per litter) and the losses up to weaning are high. Carcass quality as measured by the Advanced Registry test does not come up to the standard desired, the major fault being that carcasses from this line are short.

It is believed that the somewhat disappointing results in performance of this line are attributable to the fact that little selection for the desirable characteristics was possible. For the first few generations this line was bred on a brother-sister mating basis. This rapid rate of inbreeding of the line is believed to have caused the sudden and severe drop in litter size and survival rate. By the time test pigs had been removed from the litters practically all the remaining pigs had to be saved for breeding in order to maintain the size of the line. Actually, the group selected for breeding was inferior to the average of its generation just as often as it was superior, and in no year was it enough superior so that one could expect a great deal of improvement to take place due to the selection that could be practised.

The linecross inbred line.—The foundation of this line was formed by crossing the Ottawa inbred line with an inbred line being developed at the Experimental Farm, Brandon, Man. The initial cross-bred pigs from this mating were definitely superior to pigs of the parental lines in all factors. It was believed that this cross provided an excellent opportunity to combine the desirable characteristics of both lines into a new line.

Again, in this line there was a decline in litter size, and the same difficulty was encountered in making selections as was faced with the Ottawa inbred line. As a result, it was impossible to counteract with selection the decline in performance due to inbreeding.

In general, this line has better carcass quality than any inbred line that has been started at Ottawa, but there is some indication that it is highly susceptible to rhinitis. The future of this line will depend on the outcome of further performance tests.

Landrace-Chester White inbred line shows promise.—An inbred line was formed from a cross between the Danish Landrace and the Chester White at the Agricultural Research Center, Beltsville, Maryland, U.S.A. This line was backcrossed to the Danish Landrace at that station. The Experimental Farms Service with the co-operation of the Production Service of the Department of Agriculture, secured some of the resulting pigs, and are now in the process of developing this line. As yet it is too early to make any definite statements concerning the desirability of the line itself or its combining ability with the Yorkshire. However, it may be stated that results to date indicate that this line is very promising both from the standpoint of gaining ability and carcass quality. No crossing tests have been made with the Yorkshire, but these are projected.

"R" inbred line too fat.—This line was started from a cross of a boar on six of his full sisters. These animals came from a mating that had previously shown a high average carcass score in Advanced Registry. Early in the inbreeding program carcass tests revealed that this line carried an excessive amount of fat on the rib and also had a very small loin muscle. For these reasons the line was discontinued.

Poor survival in "W" inbred line.—One boar and three sows formed the foundation of this line. The boar was 37·5 per cent related to the sows, and the sows were full sisters.

Litter size and survival have been so severely reduced during the inbreeding process that this line is not considered to be economical to maintain. One more generation will be raised and if improvement is not evident the line will be discontinued.

Rapid rate of inbreeding undesirable.—To date, one method of forming inbred lines has been tested. This method involves the selection of closely related individuals as foundation animals and the rapid inbreeding of them to form a line. Results indicate that this method has some disadvantages. Severe reduction in litter size and survival have made effective selection almost impossible. Future lines will probably be started with somewhat broader foundations, and the rate of inbreeding that is practised will be reduced by mating animals on the basis of performance as well as relationship.

Nutritional Studies

The Canadian swine producer is faced with the choice of a wide variety of rations and of deciding whether or not he will add newly developed supplements to his ration. The determination of the relative value of various rations, the effect of adding new feed supplements to rations, and methods of overcoming nutritional deficiencies have been studied.

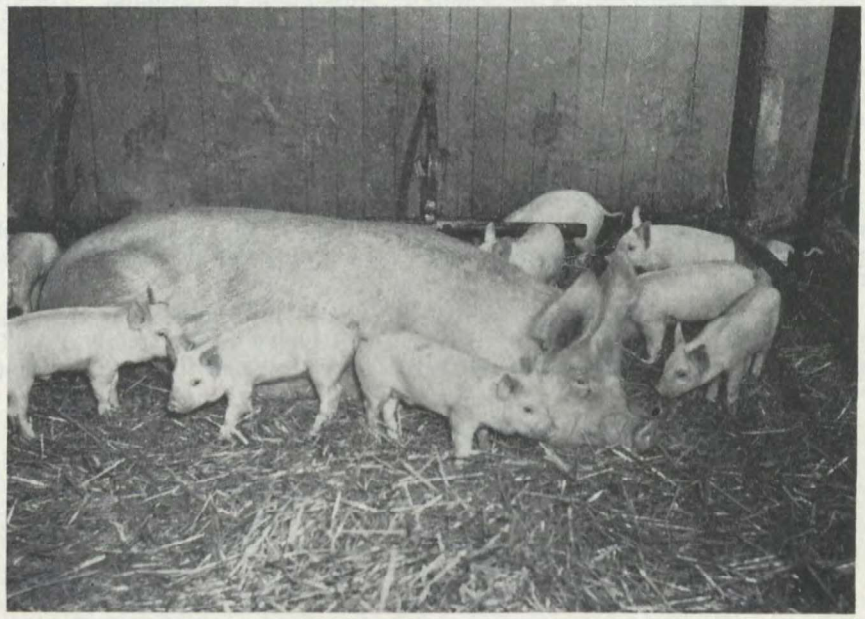

FIG. 25.—Yorkshire sow and litter. Such pigs, if creep-fed, will receive no setback when weaned.

CREEP FEEDING OF SUCKLING PIGS

Up to the time when pigs are three weeks old the sow normally can supply all the nutrients that are required for satisfactory growth and development. As the pigs grow, the sow is less able to fully nourish her litter. For this reason it is considered that some extra feed should be made available to the litter. Actually, the young pigs will start to steal a little of the sow's ration, but it has been found that better results can be obtained if the young pigs are given constant access to feed of a type that they can handle adequately.

Creep feed for better pigs.—Two separate feeding trials were set up to determine the effect of creep feeding, and to investigate the relative suitability of various feed constituents in the creep feed.

These trials indicated that creep feeding of suckling pigs results in heavier pigs at weaning. It was also found that the gains made by creep-fed pigs were very cheap. There was no evidence that there was any difference between tankage and fishmeal as protein supplements in the creep ration. It was also indicated that the addition of five per cent alfalfa leaf meal to the creep-fed ration may be beneficial.

The following ration can be recommended for creep feeding suckling pigs:

Creep Feeding Ration

Middlings	100 lb.
Ground wheat	50 "
Ground oats	100 "
Fishmeal	50 "
Mineral mixture	6 "
Alfalfa leaf meal	15 "

Experience at the Central Experimental Farm has indicated that creep feeding of young pigs means larger and more thrifty pigs at weaning. The creep is very cheaply constructed by boarding off one corner of the pen so that only the little pigs have access to it. A trough with feed and another with water are placed in the creep.

Feed Mixtures for Self Feeding

Most of the feed mixtures for bacon hogs were developed for hand feeding. However, self-feeding is becoming increasingly popular in many areas. In general, swine producers are self-feeding the same or similar rations to those they once hand fed. There is a belief that these rations may tend to produce excessive fatness when self-fed.

Self-feeding trials were conducted to acquire information on this point, using variations of the standard Advanced Registry rations (Lot 1). Two trials of three lots each were conducted (8 pigs per lot) and the data on the two trials were grouped.

The basal feed mixtures for the various lots were as follows:

	1st period Weaning to 100-110 lb.		2nd Period 100-110 lb. to finish	
Lot	1	2	1	2
Barley	50 lb.	40 lb.	60 lb.	50 lb.
Oats	30 "	40 "	10 "	20 "
Wheat	20 "	20 "	30 "	30 "

Lot 3 was the same as Lot 1, but with alfalfa leaf meal added at the rate of five pounds to each 95 pounds of the complete feed mixture (grains plus protein-mineral concentrate).

The following protein-mineral concentrate was included with the basal grain mixture of each lot at the rate of 15 per cent in the first period and 6 per cent in the second period:—

Tankage (60% protein)	50 lb.
Linseed oilmeal	25 "
Fish meal	15 "
Iodized salt	5 "
Ground limestone	5 "

A summary of the results of this trial is given in Table 37.

TABLE 37—MEAL MIXTURES SUITABLE FOR SELF-FEEDING PIGS. GAINS AND FEED REQUIREMENTS—2-YEAR AVERAGE, 1940-41, INCL.

Treatment	Lot 1 Check A.R. Mixture	Lot 2 Higher Oats	Lot 3 5% Alfalfa Leaf Meal
Average daily gain..... lb.	1·43	1·46	1·40
Meal consumed per 100 lb. gain..... lb.	339	340	325
A.R. carcass score.....	72·9	72·3	73·4

The results of this trial did not indicate that there was any appreciable difference between the three rations in their effects on rate of gain, economy of gain, or carcass quality.

Self-Feeding Varying Percentages of the Grains

Since the differences obtained in the preceding feeding trial were so small, another feeding trial was set up in which the rations differed more widely.

It was believed that by increasing the percentage of oats in the A.R. ration, a better ration for self-feeding would be obtained. The rations fed were as follows:

		1st Period Weaning to 100-110 lb.	2nd Period 100-110 lb. to finish
		lb.	lb.
Lot 1 Both periods, high barley	Barley	50	60
	Oats	30	10
	Wheat	20	30
Lot 2			
1st period, high barley	Barley	50	10
	Oats	30	60
2nd period, high oats	Wheat	20	30
Lot 3			
1st period, high oats,	Barley	30	60
	Oats	50	10
2nd period, high barley	Wheat	20	30
Lot 4			
Both periods, high oats	Barley	30	10
	Oats	50	60
	Wheat	20	30

The standard A.R. protein-mineral mixture outlined in the previous trial was included in the ration for periods 1 and 2 at the rate of 15 and 6 per cent, respectively.

Seven pigs were fed in each lot and were started on test at an average weight of 45 pounds, and were finished at an average weight of 203 pounds.

The results of this trial indicated that there might be a disadvantage in self-feeding high oats or high barley from start to finish. Further work is required to confirm this. No differences in economy of gain or carcass quality were found between these rations when self-fed.

Self-Feeding the same Grain Mixture from Weaning to Finish

Market hogs are often fed on the same ration from weaning to finish, but it is generally believed that such a practice results in less than optimum gains.

A feeding trial was set up to compare three rations for their effectiveness when self-fed from weaning to finish, and to gain further information on self-feeding. The same protein-mineral concentrate (A.R. protein-mineral mixture) was fed, and the general procedure was the same as with the previous test. The three groups of pigs in this trial were fed the following rations in a self-feeder:—

	Lot 1	Lot 2 (From weaning to finish)	Lot 3
Ground barley	50 lb.	40 lb.	30 lb.
Ground oats	30 "	40 "	50 "
Ground wheat	20 "	20 "	20 "

It will be noted that Lots 2 and 3 were fed a higher percentage of oats and a lower percentage of barley than Lot 1. Gain, feed, and carcass score records were taken on all pigs. The average daily gain of Lots 1, 2 and 3 were 1·17, 1·30 and 1·31 pounds, respectively. This indicates that there may be an advantage in feeding a higher percentage of oats when the same mixture is to be self-fed from weaning to finish. No significant difference in feed requirements was observed between lots. The complete data indicated that, compared with the previous test, the pigs slowed up in their gains after 100 pounds in weight.

Varying the Percentages of the Grains in Rations for Hand Feeding Hogs

In collaboration with the nutrition section of the Chemistry Division of Science Service, a feeding experiment was conducted to compare different proportions of the various grains in the swine ration.

After determining the digestibility of the individual grains and the supplement, the Chemistry Division conducted a trial to determine the associative digestibility which might be attributed to different combinations of the grains and supplement.

Concurrent with the digestion trial, a feeding experiment was conducted in which three of the combinations were fed to groups of pigs to study the efficiency of the rations and their effect on the carcasses. The particular combinations of grains investigated in the feeding trial were as follows:

Lot 1	Barley 60 lb.	Wheat 20 lb.	Oats 20 lb.
Lot 2	Barley 40 lb.	Wheat 20 lb.	Oats 40 lb.
Lot 3	Barley 20 lb.	Wheat 20 lb.	Oats 60 lb.

The Advanced Registry protein-mineral supplement was used and 15 per cent was fed until the pigs reached 100–110 pounds in weight, and 6 per cent from then until market weight.

The pigs were penned in groups of six and were individually stall fed.

The various rations fed produced no significant differences in rate of gain, economy of gain, or carcass quality. Further, the chemists reported that changing the proportions of the grains in the ration had no effect on the digestibility of the individual constituents of the ration.

Value of Wheat for Market Hogs

With a surplus of wheat on hand in 1942, Canadian farmers were faced with the problem of using it to best advantage. While many swine feeding trials had been conducted with wheat, few of the tests had attempted to find the optimum percentage of wheat and the ideal combination of cereal grains in a swine ration. Therefore, an experiment was undertaken, using wheat in various proportions along with oats and barley. The object was to determine the effects of different percentages of feed wheat, for growing and finishing hogs, on rate and economy of gain, and quality of carcass.

Table 38 shows the basal feed mixtures fed in the various lots.

TABLE 38—LEVEL OF WHEAT FEEDING. BASAL FEED MIXTURES. 1942

Lot	1		2		3		4		5		6	
Period*	A	B	A	B	A	B	A	B	A	B	A	B
Wheat..... lb.	—	—	—	—	25	30	50	60	75	90	100	100
Oats..... lb.	—	—	25	10	25	10	25	10	25	10	—	—
Barley..... lb.	100	100	75	90	50	60	25	30	—	—	—	—

* The "A" ration was fed until the pigs of a lot reached an average weight of 100-110 pounds, after which the "B" ration was used.

The standard A.R. protein-mineral supplement was included with the above grain mixtures at the rate of 15 per cent during the first period and 6 per cent during the second. Cod liver oil was fed at the rate of one-half ounce per pig daily during the first period. All lots were full hand fed.

The pigs of each lot averaged 43 pounds in weight at the beginning of the trial and were slaughtered at an average weight of 204 pounds.

In Table 39 the gains and carcass data for the various lots are given, the grain mixtures indicated being for the first period only.

TABLE 39—RESULTS OF DIFFERENT PERCENTAGES OF WHEAT IN THE MARKET HOG RATION. 1942

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Basal feeds, 1st period:						
Barley..... %	100	75	50	25	—	—
Oats..... %	—	25	25	25	25	—
Wheat..... %	—	—	25	50	75	100
Pigs per lot..... No.	5	5	5	5	5	5
Average daily gain..... lb.	1·23	1·17	1·27	1·27	1·36	1·39
Dressing percentage..... %	72·0	72·9	72·7	73·5	73·4	72·2
A.R. carcass score.....	74	80	70	78	65	69

Wheat substitutes for barley.—The results of this trial do not indicate that there is any significant difference between the rations fed as measured by rate of gains. It is concluded that wheat may be used successfully as a substitute for barley in the swine ration.

The Value of Grain Millet for Hog Feeding

With the development of varieties of millet which yield large quantities of grain or seed, the question arose as to its feeding value for livestock. In order to investigate its feeding value for hogs, a trial was undertaken in which the following rations were full hand fed twice daily from an average weight of 80 pounds to a finished weight of 200 pounds:—

	Lot 1	Lot 2	Lot 3
	lb.	lb.	lb.
Ground oats	100	100	100
Ground wheat	100	100	100
Ground barley	200	100	—
Ground millet seed	—	100	200
Protein-mineral concentrate	35	35	35

The average gains, feed requirements, and carcass scores for each lot are tabulated in Table 40.

TABLE 40—RESULTS OF VARYING PERCENTAGES OF GRAIN MILLET IN THE HOG RATION. 1940

		Lot 1	Lot 2	Lot 3
Millet in grain mixture	%	0	25	50
Pigs per lot	No.	7	7	7
Average daily gain	lb.	1·45	1·60	1·57
Meal consumed per 100 lb. gain	lb.	307	307	301
A.R. carcass score		76·0	74·7	72·2

None of the differences evident in Table 40 are considered to be significant, due to the restricted number of pigs per lot. The results of this experiment need further confirmation, but they indicate that millet grain or seed may be fed advantageously to hogs as a portion of the grain ration.

Proteins of Animal and Vegetable Origin for Hogs

As a result of the rapid increase in hog production as well as increases in production of other classes of stock, the demand for animal protein supplements was greater than the supply available during the war years. Normally, animal protein supplements had made up about 50 per cent of the total protein supplement in the hog ration, the remainder being of vegetable origin. It soon became evident that there was not enough animal protein feed available to supply this proportion.

Previous work had indicated that the best results could not be expected if only vegetable proteins were used to supplement the grain ration. In consequence, it was decided to investigate the effect of replacing varying percentages of animal protein with vegetable protein in the swine ration.

A trial was set up and repeated in the three years 1943 to 1945. Briefly, the treatments were arranged on the following basis:—

Four groups of hogs (seven in each group) were fed out each year. The average initial weight of the pigs of each group was 35 pounds, and the average final weight was 208 pounds. All lots were fed the same basal grain mixture, consisting of barley, wheat, and oats. In each treatment a sufficient amount of protein supplement was fed to maintain the protein level of the complete ration

at 17·7 per cent for the first period, and 14·4 per cent for the second period. The only difference between the treatments was that the percentage of linseed oilmeal in the protein supplement was varied as shown in Table 41, along with a summary of the gains, feed requirements, and carcass quality.

TABLE 41—ANIMAL VERSUS VEGETABLE PROTEIN FOR BACON HOGS. 3-YEAR AVERAGE, 1943-45, INCL.

		Lot 1	Lot 2	Lot 3	Lot 4
Per cent in supplement:					
Animal origin	%	65	50	35	20
Vegetable origin	%	25	40	55	70
Average daily gain	lb.	1·28	1·27	1·28	1·21
Meal consumed per 100 lb. gain	lb.	350	340	329	339
A.R. carcass score		83	81	77	80

In this experiment there was no significant difference evident between lots receiving relatively small amounts of vegetable protein in their ration and those receiving larger amounts. It is indicated that linseed oilmeal may constitute up to about two-thirds of the total protein supplement in the hog ration without adversely affecting daily gains, feed requirements, or carcass quality.

Comparison of Protein Supplement Levels

A comparative feeding trial was conducted in co-operation with a number of Agricultural Colleges and other Experimental Farms to investigate the most suitable levels of protein supplementation for feeding at the Advanced Registry Test Stations.

In this test three lots of pigs were fed out to market weight. The feeding trial was divided into two periods, the first period being from weaning to 100 pounds, and the second from 100 pounds to finish. The following details the percentages of the basal ration and protein supplement that were fed to each lot:—

	1st Period		2nd Period	
	Basal Ration	Protein Supplement	Basal Ration	Protein Supplement
Lot 1	85%	15%	94%	6%
Lot 2	88%	12%	94%	6%
Lot 3	88%	12%	100%	.....

The basal ration for the first period was made up of 50 per cent barley, 20 per cent wheat, and 30 per cent oats. For the second period the proportions were 60, 30, 10.

The protein supplement, a mixture of 50 pounds tankage, 15 pounds fishmeal, and 25 pounds linseed oilmeal, contained 44 per cent total protein. Salt and limestone were each added to the complete ration mixture at the rate of one-half of one per cent by weight. Cod liver oil was fed at the rate of one-half ounce per pig per day during the first period.

When the data from the various co-operating stations were brought together, it was decided that the Lot 1 ration for the first period was the most satisfactory, but that the rate of protein supplementation for the second period should be increased somewhat. The final recommendation which was adopted was that Test Stations should feed 85 per cent of the basal ration and 15 per cent of the protein supplement mixture for the first period, and 92 per cent of the basal ration and 8 per cent of the protein supplement during the second period. These rations can be recommended for good results.

Effect of Adding Fat to the Swine Ration

In recent years there has been a trend towards taking as much vegetable oil or fat out of processed concentrates or by-products as possible. It was believed that there was a possibility that this decrease in the fat content of the ration might have an adverse effect, and that the addition of fat to the swine ration might improve the rate and economy of gain.

The feed mixture fed to all lots was the standard A.R. Feeding Station ration to which was added varying quantities and types of vegetable fats. The following was the plan of treatment:—

Lot 1. Standard A.R. ration.

Lot 2. Standard A.R. ration plus three per cent raw linseed oil.

Lot 3. Standard A.R. ration plus three per cent raw linseed oil until the pigs reached 100 pounds.

Lot 4. Standard A.R. ration except that ground flaxseed was used to replace the linseed oilmeal.

The results of this experiment indicated that little or no improvement in rate or economy of gain can be expected from adding certain fats to the above rations. Tests were made by the Chemistry Division of Science Service to determine what the effect of the above treatments had been on the composition of the fat in the carcass and it was concluded that the addition of raw linseed oil and ground flaxseed tended to produce an undesirably soft fat.

Comparison of Rations for Weanling Pigs

The period immediately following weaning is a critical one in the pig's life. During the last few weeks of the suckling period, the young pigs generally acquire the habit of pilfering a small amount of feed from the sow's trough and they also should be consuming a fair amount of creep feed. Due to the change at weaning, the immediate post-weaning ration should be highly nutritious, palatable, and should not cause any digestive upset.

Considering the importance of the post-weaning ration, a feeding trial was set up at the Central Experimental Farm in which three rations were compared. The main object of this trial was to determine if any appreciable differences in performance could be noticed when the protein supplement portion of the ration was varied.

The following basic ration was fed to each of three lots:—

Bran	50 lb.	Tankage	30 lb.
Oats	500 "	Linseed oil meal	30 "
Middlings	100 "	Ground limestone	24 "
Wheat	100 "	Bonemeal	12 "
Barley	400 "	Iodized salt	12 "

Each of the lots received an additional source of protein:

Lot 1. Skim-milk added at the rate of one-half pound for each pound of meal.

Lot 2. Skim-milk added at the rate of one and one-half pounds for each pound of meal.

Lot 3. Fifteen pounds of tankage, 10 pounds of linseed oilmeal, and 15 pounds of fishmeal added to 300 pounds of the meal mixture.

All rations proved palatable and no trouble was experienced with digestive upsets. The average daily gains for Lots 1, 2 and 3 were 0·67, 0·72, an 0·77 pounds per day, respectively. The interpretation placed on these results is that this trial provided no evidence that skim-milk is essential in the post-weaning diet.

Anemia Control in Suckling Pigs

Various treatments have been recommended for the control of anemia in suckling pigs. A trial was conducted to demonstrate any differences which might exist in the effectiveness of several treatments. The treatments were as follows:—

1. Each pig dosed with three grains of reduced iron orally by capsule at 1, 8, and 15 days of age (one No. 5 capsule of reduced iron).

2. Each pig dosed with 15 grains of powdered ferrous sulphate orally by capsule at 1, 8, and 15 days of age (two No. 1 capsules of ferrous sulphate).

3. Each litter given daily in a creep until three weeks of age a clean sod (approximately one foot square) fortified with iron by sprinkling with four tablespoonfuls of the following solution: six ounces of powdered ferrous sulphate dissolved in one gallon of soft water.

4. The udder and teats of each sow in this lot painted once daily from the birth of the litter until 21 days of age with the following solution: six ounces of powdered ferrous sulphate dissolved in one quart of soft water.

5. Check lot—untreated.

Because of a considerable number of losses from undetermined causes this experiment did not give conclusive results. Hemoglobin determinations did, however, clearly indicate that treatment of pigs with iron assists in preventing anemia.

At the present time the reduced iron treatment is favoured over the others because of simplicity and because a very small quantity is required. Ferrous sulphate, too, has been found very effective, but some difficulty has been encountered because of the large amount that is required per dosage. The provision of sods fortified with ferrous sulphate and painting sows' udders and teats with a ferrous sulphate solution are also considered to be effective, but both require considerably more time than the first two treatments.

Feeding for More Meat in the Bacon Pig

As stated earlier, the "R" strain of inbred pigs was disappointing in carcass score. In particular the pigs were definitely low in area of loin muscle and in proportion of lean to fat. This was the case with all six litters tested in 1945 and whereas the average of most litters tested in Advanced Registry is over 5·0 square inches of loin, (length × width at the last rib), the "R" strain averaged only 4·4.

To study the effect of feeding on this important character a feeding test was conducted with pigs of the "R" strain as follows:—

Lot 1. Check lot. A.R. Feeding Station ration.

Lot 2. Under the premise that fishmeal has a higher biological value than tankage and, hence, should be more readily used by the animal for the purpose of promoting development of muscle, this lot received the same mixture as Lot 1 except that the relative proportions of these two feeds were reversed, that is, fishmeal made up 50 per cent of the protein-mineral concentrate and tankage 15 per cent.

Lot 3. Same as Lot 1 except vitamins added. Certain fractions of vitamin B have to do with the utilization of feed in the animal body and pantothenic acid (calcium pantothenate dextrorotatory) and pyridoxine (vitamin B6, pyridoxine hydrochloride) were added to determine if they would promote a greater growth of lean tissue. These vitamins were fed in solution at the rate of 8 and 2 milligrams, respectively, per 100 pounds live weight.

No significant differences were observed between the three lots in daily gains, economy of gains, or in carcass quality. There was no indication that the amount of lean meat in the carcass could be influenced by feeding fishmeal or the vitamins indicated above.

Digestibility Studies with Swine

One of the important measures of the value of the individual constituents of swine rations is the digestibility of those constituents.

During the period covered by this report, studies were conducted by the Chemistry Division of Science Service on the digestibility of various swine feeds. The Animal Husbandry Division co-operated in these experiments. A brief description of the method of determining digestibility is given in the Beef Cattle Section of this progress report.

The digestibility coefficients determined are too numerous and detailed to reproduce here, but are available on request. Aside from the digestibility coefficients, there were two main questions to be answered in these experiments. Do individual pigs differ markedly in their ability to digest feeds? Is there any change in a pig's ability to digest feed as it increases in weight? The experiments indicated that there was no marked difference between pigs in their ability to digest feed, and that their ability to digest feed did not change as the pigs grew. The complete results of these experiments are published in "Scientific Agriculture".

PASTURE

P. E. Sylvestre and S. B. Williams

The ever increasing importance of pasture in the agricultural economy of Eastern Canada has resulted in a demand for information on its production and utilization. Consequently, a great deal of attention has been paid to this problem and considerable investigational work has been conducted either independently or in co-operation with other Divisions. Work of both a fundamental and a practical nature has been done. The main problems studied have been the effect of fertilizers on permanent pasture, the value of newly established pastures as compared with old ones, methods of grazing, pasture management, and the determination of the digestible nutrient consumption of grazing animals. In this work beef cattle and sheep have been used either singly or together.

System of reporting results.—As different classes of stock were used for grazing, a uniform system of arriving at the carrying capacity of a pasture was necessary. This was obtained by converting the maintenance and gain of the animals into total digestible nutrients by the reverse use of the feeding standards. In addition, a "Standard Animal" was defined for each species and its total digestible nutrient requirement calculated. For beef cattle, a "Standard Animal" was a steer starting at 600 pounds and finishing at 930 pounds after 150 days of grazing. This is equivalent to 1,744 pounds of total digestible nutrients. For sheep, it was a ewe weighing 130 pounds, maintaining her weight and raising 1·3 lambs, each lamb starting at 20 pounds and finishing at 80 pounds after 150 days. This is equivalent to 545 pounds of total digestible nutrients. In certain cases this "Standard Animal" was a yearling ewe, weighing 100 pounds and gaining 22·5 pounds in 150 days, with a total digestible nutrient equivalent of 292 pounds.

By dividing the calculated total digestible nutrients that the pasture produced by the requirements of the standard animal, the number of standard animals that could be carried per acre was obtained. In all cases the carrying capacity is expressed as the number of standard animals per acre for a season of 150 days.

Rainfall an important factor in pasture production.—The 57-year average precipitation at the Central Experimental Farm, Ottawa, for the summer months, May to October, is 15·87 inches. During the period 1937 to 1949, the precipitation in the summer months was below the average in six years out of thirteen, 1941, 1944, and 1948 being the worst with a rainfall of 9·57, 11·72 and 11·81

inches respectively. The three highest precipitations, recorded during the summer months occurred in 1943, 1945, and 1947 with 20·34, 21·47, and 20·68 inches respectively. Such variations in summer precipitation have a considerable influence on pasture production. These effects were noted in the experiments to be discussed, but are not apparent in the data reported as these are averages for several years.

Beef Cattle Pasture Studies

The pasture studies with beef cattle consisted of fertilizer and pasture management studies. They were conducted with the dual objective of raising the general level of production and maintaining this level throughout the grazing season.

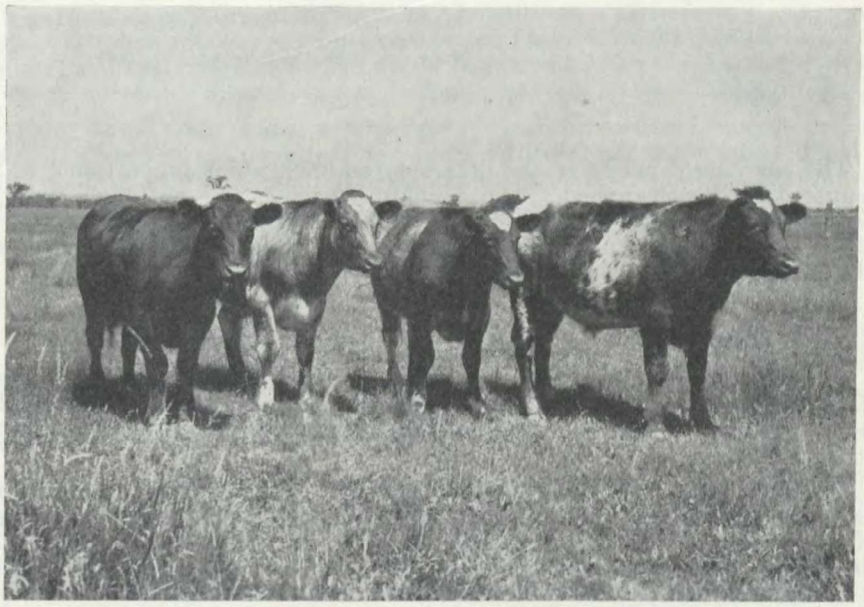

FIG. 26.—Yearling steers on experimental permanent pasture. An average gain of 2 pounds per day or over is not uncommon where pasture is abundant.

RATES OF FERTILIZER APPLICATION FOR PERMANENT STEER PASTURE

There are, throughout the country, many old, permanent pastures which are in a run-down condition. Although some of these would benefit by being reseeded, others cannot be renovated in this manner. Therefore, it is of some importance to determine if these pastures can be improved by fertilization and the most suitable amount of fertilizers to apply.

For this purpose, a sixteen-acre block of land of the North Gower clay type, was divided into four-acre fields. This land had been in pasture for over twenty years. Field 1 received no fertilizer; Field 2 received 300 pounds of superphosphate every four years and 50 pounds of sulphate of ammonia annually. This was considered a light application. Field 3 received an application of 300 pounds of superphosphate and 75 pounds of muriate of potash every four years as well as 100 pounds of sulphate of ammonia every year. This amount was considered a medium application. Field 4 received the heaviest application,

450 pounds of superphosphate, and 100 pounds of muriate of potash every four years in addition to 200 pounds of sulphate of ammonia every year. All applications were made in the spring.

Grazing was done with steers and the experiment was carried for seven years.

The results calculated on a per-acre basis are summarized in Table 42.

TABLE 42—EFFECT OF DIFFERENT RATES OF APPLICATION OF FERTILIZERS ON STEER GAIN AND CARRYING CAPACITY (PER ACRE). 7-YEAR AVERAGE 1931-37 INCL.

Treatment	Nil	Light	Medium	Heavy
Gain..... lb.	180	209	248	269
Carrying capacity..... No	0·54	0·63	0·75	0·81
Increase over check..... %	—	16	36	50

The carrying capacity of the different treatments was proportional to the amount of fertilizer applied. The absolute increase was not high and was barely sufficient to pay for the cost of the fertilizers. It is possible that the fertilizer formulae adopted were not the best for the heavy soil on which these pastures were located.

Commercial Fertilizer Formulae for Steer Pasture

In view of the fact that the previous fertilizer applications used had not given as large differences as had been hoped for, the following trial was designed to test the efficiency of different fertilizer formulae for economical grass production on the same soils.

Four-acre fields were used for this purpose. Field 1 received no fertilizer; Field 2 received 600 pounds of superphosphate per acre every three years; Field 3 the same amount of superphosphate plus 100 pounds of muriate of potash every three years; Field 4 the same amount of mineral fertilizers as in Field 3, but in addition, 100 pounds of sulphate of ammonia annually.

Twelve years' grazing results with steers are summarized on an acre basis in Table 43.

TABLE 43—STEER GAINS (PER ACRE) ON PASTURES TREATED WITH DIFFERENT COMMERCIAL FERTILIZERS. 12-YEAR AVERAGE, 1938-49 INCL.

Treatments	Field 1 (Nil)	Field 2 (P.)	Field 3 (P.K.)	Field 4 (N.P.K.)
Gain..... lb.	228	373	330	353
Carrying capacity..... No.	0·69	1·13	1·00	1·07
Increase over check..... %	—	63	45	55

Superphosphate gives highest results.—It will be seen that the superphosphate alone has given the best results followed by the complete fertilizer. Considering the fact that superphosphate is generally cheaper than the other fertilizers, it is decidedly the most economical to use on North Gower clay soil.

From a pasture management point of view, the superphosphate alone presents certain advantages. It encourages the production of clovers and as a result the growth is not nearly so rapid in the spring, but lasts longer into the summer. Rapid spring growth is especially noticeably where the complete fertilizer is applied. Grass growth is stimulated to such an extent by the nitrogen in the complete fertilizer that control and efficient utilization of the grass is difficult. As Kentucky blue grass predominates in this field, the carrying capacity drops considerably in the middle of the summer because of the poor growth of that grass during the hot dry weather.

Permanent Pasture Versus a Rotation of Pasture Crops

Uniformity of production throughout the summer is very important. In the Ottawa Valley and elsewhere, such uniform production cannot be achieved with permanent pasture under ordinary conditions. Therefore, it was found desirable to determine if a crop rotation for pasture would provide a greater and more uniform production than would permanent pasture. For this purpose, four three-acre fields were selected and a four-year rotation established as follows:

First year.—Oats seeded at the rate of one and one-half bushels per acre and Sudan grass at ten pounds to the acre; seeded down to a mixture of clover, alfalfa, and timothy; six hundred pounds of superphosphate, 100 pounds muriate of potash and 100 pounds ammonium sulphate applied the same year; grazing of the oats and Sudan grass.

Second year.—Half the area grazed all summer and the remaining half cut early for hay and the aftermath grazed.

Third and fourth years.—Area grazed in the same manner as in the second year; sulphate of ammonia at the rate of 100 pounds per acre applied in the spring.

The number of fields left in hay varied from year to year, depending on the quality of the sward in the grazing area.

This system of providing pasturage was compared with a four-acre field of permanent pasture similarly fertilized. The summarized data on a per-acre basis, for twelve years, will be found in Table 44.

TABLE 44—STEER GAINS (PER ACRE) ON PERMANENT PASTURE AND A ROTATION OF CROPS PASTURE. 12-YEAR AVERAGE, 1938-49 INCL.

Kind of pasture		Permanent Pasture	Rotation of Crops
Gain	lb.	353	343
Carrying capacity	No.	1·07	1·04
Decrease from check	%	—	3

A more uniform production is obtained.—The gain and carrying capacity per acre of the rotation-of-crops pasture were slightly lower than that of the permanent pasture. Although not shown in the table, the rotation produced in addition, an average of five tons of hay per year on 2·7 acres which were reserved for aftermath. The second objective of the trial, that of levelling the production, was obtained. The permanent pasture produced 74 per cent of its total production in the first eight weeks of the summer season, and 26 per cent in the last twelve weeks. On the other hand, the rotation of crops pasture produced 50 per cent in the first eight weeks, and 50 per cent in the last twelve weeks.

One of the reasons for the lower yield and probably one weakness of a rotation of crops for pasture is the difficulty of getting a good catch of clover and grass from year to year. It is believed that such difficulty could be reduced to a minimum by providing good drainage and selecting a soil not too heavy, which could be easily worked in the spring.

Pasture Studies with Sheep

The pasture studies using sheep as the grazing animals, cover both management and fertilization trials. Certain of these have been concluded while others are still in progress. In each case the status of the project is indicated.

Continuous versus Rotational Grazing

It is generally conceded that for sheep, short grass is better utilized and more valuable than longer growth. As a consequence, in most major fat-lamb growing countries, it is usual to practise sub-division of the pasture area and rotational grazing of the sheep, with each sub-area being heavily grazed for a short period. However, in Canada, this is not a common practice and it was to investigate the possible value of this grazing method under Canadian conditions that this experiment was undertaken.

Two fields, each of four acres, were selected. Both were fertilized and one was divided into three sections. This latter field was grazed rotationally, the stock being transferred from one section to another at approximately weekly intervals while the other field was not sub-divided and was grazed continuously. The trial was run for eight years. A summary of the results is given in Table 45 on a per-acre basis.

TABLE 45—SHEEP GAINS (PER ACRE) ON CONTINUOUS AND ROTATIONAL GRAZING OF FERTILIZED PASTURE. 8-YEAR AVERAGE, 1930-37 INCL.

Treatment		Continuous Grazing	Rotational Grazing
Gain	lb.	193	204
Carrying capacity	No.	2·48	2·61
Increase over check	%	—	5

Rotational grazing was not worthwhile.—The five per cent advantage shown by rotational grazing is small, and insufficient to pay for the cost of the extra fencing. It would seem that under the conditions of the trial, unless natural sub-divisions and watering facilities existed, rotational grazing was not economically sound. It may be that the species predominating in the sward, Kentucky and Canada blue grass, are not suited to a rotational grazing regime.

Effect of Resting Pastures for Periods of Different Lengths and at Different Seasons of the Year

With the rotational grazing study under way it was considered desirable to obtain information on the effect on the yield and carrying capacity of pastures, of resting them for periods of varying lengths, and of resting them at different seasons of the year. This work was conducted on quarter-acre plots which were grazed with yearling sheep. In the trial covering the length of rest period, the procedure was to graze all plots for one week, then remove the sheep for the

required period, after which the plots were again grazed for one week, this sequence then being repeated as often as necessary. On the other hand, the seasonal rest period plots were grazed continuously except that each was rested for a different 28-day period. That is, the first plot was rested for the first period, then grazed, the second plot was grazed for the first period, rested for the second, then grazed for the remainder of the season. The remaining plots were rested in their turn. When the sheep were not on the experimental areas they were pastured in an adjacent similar plot.

The results are given in Tables 46 and 47. All results are expressed on a per-acre basis.

TABLE 46—EFFECT OF RESTING SHEEP PASTURE FOR PERIODS OF DIFFERENT LENGTHS (PER ACRE BASIS). 5-YEAR AVERAGE, 1933-37 INCL.

Treatment		Rest One Week	Rest Two Weeks	Rest Three Weeks
Gain	lb.	104	99	86
Carrying capacity	No.	4·6	4·4	3·8
Increase over "Three Weeks Rest"	%	21	15	—

TABLE 47—EFFECT OF RESTING SHEEP PASTURES AT DIFFERENT SEASONS OF THE YEAR (PER ACRE BASIS). 6-YEAR AVERAGE, 1933-38 INCL.

Treatment		Rest 1st Month	Rest 2nd Month	Rest 3rd Month	Rest 4th Month	Rest 5th Month	No Rest
Gain	lb.	81	104	97	97	90	99
Carrying capacity	No.	3·6	4·6	4·3	4·3	4·0	4·4
Increase over "No Rest"	%	−18	5	−2	−2	−9	—

Rest periods for pasture were of no value.—It would seem that there were definite disadvantages to not grazing pasture early in the season. Table 46 shows that a long rest period was undesirable because total production was reduced. Table 47 further shows that resting a pasture at the start of the season for 28 days reduced the total carrying capacity of the pasture. It is felt that this is due to the grass being allowed to become too long after which it is imperfectly utilized by the sheep.

Commercial Fertilizer for Sheep Pastures

It is not common practice to fertilize the pasture areas devoted to sheep production, and it was to determine the economy of such a practice that this trial was started in 1930.

Two fields, as uniform as possible and each of four acres, were selected on North Gower clay. One field received applications of 100 pounds of ammonium sulphate annually plus 300 pounds of superphosphate and 75 pounds of muriate of potash per acre every three years. The other field received no fertilizer. Both fields were grazed with nursing ewes and their lambs. A summary of the results, on a per-acre basis, is reported in Table 48.

TABLE 48—SHEEP GAINS (PER ACRE) ON FERTILIZED AND NON-FERTILIZED PASTURE. 20-YEAR AVERAGE, 1930-49 INCL.

Treatment		Fertilized	Non-fertilized
Gain	lb.	191	121
Carrying capacity	No.	2·5	1·6
Increase over "Non-fertilized"	%	58	—

Fertilization gave much greater returns.—Fertilization gave a marked improvement in the carrying capacity of the pasture and in the gain produced per acre. The increased return was more than sufficient to pay for the cost of the fertilizer and its application. At present it would seem that the production level is stabilized. However, the trial is being continued in order to study long-time trends in production and in sward composition.

FIG. 27.—Ewes and lambs on fertilized permanent pasture. Fertilization of permanent pasture increased carrying capacity 58 per cent.

PERMANENT PASTURE VERSUS A ROTATION OF PASTURE CROPS

One of the greatest pasture problems is that of levelling out the seasonal curve of production. For a period in the spring, grass growth is extremely rapid, but during the hot, drier summer months most pasture species tend to become dormant. The advent of the wetter fall weather then brings on a new flush of growth. This experiment was designed to fill in this period of low production in the summer and at the same time to extend the pasture season.

The trial was conducted on two fields, each of four acres, which received a regular application of a complete fertilizer. One field was maintained in a permanent blue grass pasture while the other field, in which the sequence of crops was grown, was divided into four one-acre plots. The rotation was as follows:

First year —Oats and Sudan grass seeded down to a mixture of clovers and timothy.

Second year—Clover.

Third year —Timothy with some clover, ploughed in fall and sown to fall rye.

Fourth year—Fall rye, ploughed in late spring and sown to rape.

In 1948 the sowing of the rye was discontinued since it was felt that insufficient value was obtained from it because of the difficulty of grazing it with sheep under the muddy, wet conditions of late fall and early spring. The pastures were grazed with nursing ewes and their lambs. A summary of the 11 years' results is given in Table 49 on a per-acre basis.

TABLE 49—SHEEP GAINS (PER ACRE) ON PERMANENT PASTURE AND A ROTATION OF PASTURE CROPS. 11-YEAR AVERAGE, 1939-49 INCL.

Treatment		Permanent	Rotation of Crops
Gain	lb.	190	258
Carrying capacity	No.	2·4	3·3
Increase over "Permanent"	%	—	36

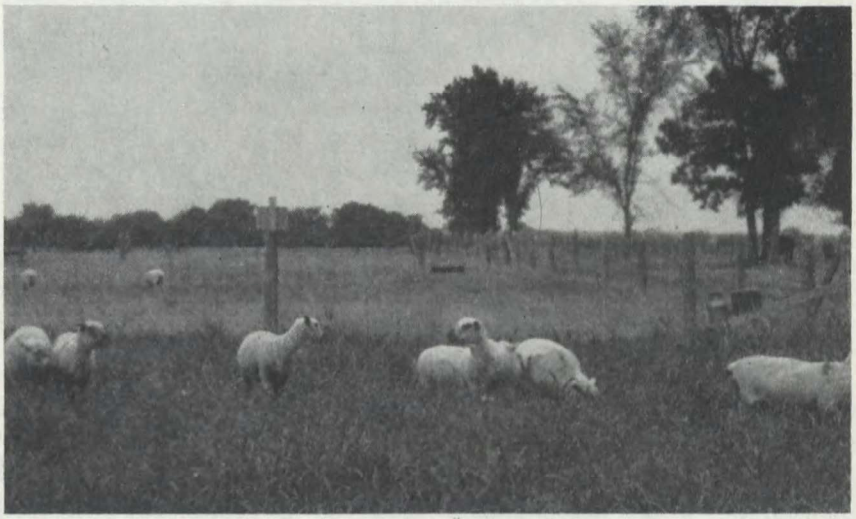

FIG. 28.—Sheep on Sudan grass. A rotation of crops for pasture increased the carrying 36 per cent. capacity

Rotation of pasture crops improved distribution of production.—Not only has the rotation of crops given a 36 per cent higher yield, which is more than enough to pay for the increased cost of seed and tillage operations, but it also has shown a much more favourable production curve throughout the season. The permanent pasture gave 48 per cent of its total production during the first pasture month and only seven per cent during the fourth month. Comparable figures for the rotation of crops were 30 and 15 per cent. Undoubtedly, a rotation of pasture crops could be of value to the sheepman since it not only increases total production but distributes that production more evenly throughout the season, and in this manner helps solve the problem of supplying good grazing during the hot dry period.

THE DETERMINATION OF THE DIGESTIBLE NUTRIENT CONSUMPTION OF GRAZING SHEEP

Little or no information is available on the nutritive requirements of grazing sheep, and, for the proper evaluation of experimental pastures, accurate information on this subject is essential. In order to study this, as well as seasonal variations in the digestibility of a mixed stand of herbage, this trial was undertaken.

The work is based upon the premise that, on a given ration, the feed-dry-matter-intake/feces-dry-matter-output ratio is constant or very nearly so. Accordingly yearling wethers fitted with feces collection bags were grazed in small plots and all feces were collected. Grass was clipped daily from similar plots and was fed to similar sheep in digestion cages and digestion coefficients were determined. At the same time the feed-intake/feces-output ratio was determined and since the feces output of the grazing sheep was known, their grass consumption could be calculated. Botanical analyses of the grazing plots were made before and after grazing, and these were compared with the botanical analyses of the clippings fed to the sheep in the digestion crates. This provided a check on whether both lots of sheep were eating forage made up of the same species in the same proportions.

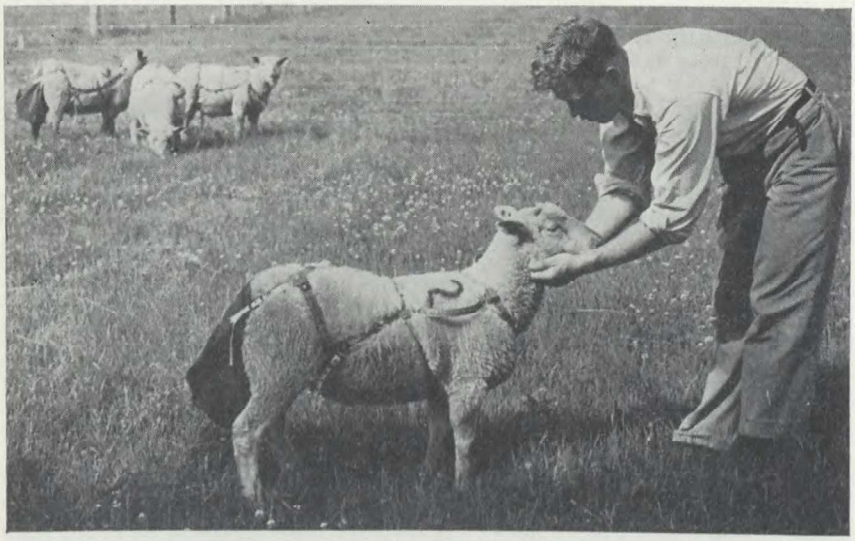

FIG. 29.—Wether fitted with harness and bag for feces collection on pasture. By this means grass consumption can be studied.

The first three years of this trial have been devoted to the development of the techniques and procedures involved. The work will now proceed in order to build up sufficient data to obtain a reliable measure of the fraction of the total digestible nutrients consumed that go toward maintenance and of the proportion that is left for gain.

Data have been obtained on the variation in the digestion coefficients of the herbage and the general finding has been that considerable differences exist both between and within years. In the latter case the pattern has been high coefficients of digestibility in the spring, 70 to 72 per cent for dry matter, which gradually taper to 50 to 55 per cent in midsummer followed by some slight rise with the new fall growth.

MANURE VERSUS CHEMICAL FERTILIZER

SHEEP ALONE VERSUS SHEEP AND CATTLE

On many farms with extensive cattle feeding in the winter, there is considerable manure available. Therefore, it seemed advisable to determine if manure could replace chemical fertilizers for pasture improvement. It has also been noticed that cattlemen are reluctant to graze sheep with cattle on the grounds that sheep will either starve the cattle or ruin the pasture because of their close grazing ability.

To find an answer to these two questions, a block of 16 acres of old permanent pasture was divided into four-acre fields. Field 1 received no fertilizers; Fields 2 and 3 received each an application of ten tons of manure every four years; Field 4 received 100 pounds of sulphate of ammonia annually plus 300 pounds of superphosphate and 75 pounds of muriate of potash every four years.

Fields 1 and 2 were grazed with sheep, and Fields 3 and 4 with sheep and beef cattle in the proportion of three to four ewes and their lambs to each two-year-old steer.

A summary of the results per acre will be found in Table 50.

TABLE 50—MANURE VERSUS CHEMICAL FERTILIZER. MIXED GRAZING VERSUS SINGLE GRAZING. 8-YEAR AVERAGE, 1933-40 INCL.

Class of Stock			Sheep		Sheep and Cattle	
Fertilizer treatment			Nil	Manure	Manure	Chemical Fertilizer
Gain	Sheep	lb.	159	192	126	152
	Steers	lb.	—	—	145	165
Carrying capacity (Standard Animal)	Sheep	No.	2·03	2·46	1·62	1·95
	Steers	No.			0·44	0·50
Carrying capacity (Animal Unit)		No.	0·46	0·56	0·69	0·80
Increase over check (Animal Unit)		%	—	21	50	75

Manure better than no manure.—Manure gave a small increase over the non-manured field. However, this was not sufficient to pay for the cost of applying the fertilizer. Possibly the real difference was greater than was measured, since one part of the check field was inundated several years by overflow from the creek that watered these fields. It was observed that as a consequence, greater growth took place in this flooded portion than in the remainder of the two fields.

Commercial fertilizers superior to manure.—A higher carrying capacity was obtained with chemical fertilizer in comparison with manure when both fields were grazed with sheep and cattle. The average rate of gain of the animals in both fields was the same, but the number of head carried per acre and the total gain differed. The sward in the chemically fertilized field was denser, although the botanical composition was about the same in both fields.

Mixed grazing superior to single grazing.—Grazing with cattle and sheep resulted in a definite increase over grazing with sheep alone. This was not only due to the greater number of stock carried on that pasture but also to the higher daily gains of the lambs in the mixed-grazed field. There was a better utilization of the grass available. Little of the herbage was noticed going to seed in the mixed-grazed field, while there was considerable waste on that account in the field grazed by sheep alone. The quality of the sward was also improved. The mixture of clovers and grasses was considered almost ideal in the mixed-grazed field, while there was little improvement in the other field. A certain amount of care must be exercised, however, in the proportion of sheep to cattle. Three ewes and their lambs to one two-year-old steer gave excellent results.

ORGANIZATION OF INVESTIGATIONAL ACTIVITIES

It is the aim of the Animal Husbandry Division in its investigational activities to study and solve the breeding, feeding, and management problems of the livestock producers of Canada.

Livestock producers are faced with many and varied problems throughout the vast area of this country with its great range of soils and climates. In the more humid, more thickly populated regions of Canada, conditions differ widely from those in the less humid, less settled areas of the Prairie Provinces. Consequently, it is necessary in many cases to study separately the different problems in these two regions. Depending on many factors, such as climate, soils, proximity to markets, and the ability and training of the farmers of the area, the relative importance of the different classes of livestock varies from one region to another. In many parts of the Eastern Provinces and British Columbia, dairying is an important aspect of livestock production. In the rangelands of Saskatchewan, Alberta, and British Columbia, beef cattle and sheep production are important. In the dairy regions of Ontario and Quebec, and in Alberta, Saskatchewan, and Manitoba, where coarse grain feeds are produced abundantly, swine production is emphasized.

Investigations on livestock problems are conducted at Ottawa, and on most of the Branch Experimental Farms with all the main classes of livestock—beef cattle, dairy cattle, horses, sheep, and swine. Other fields of work include dairy research at the Central Experimental Farm, Ottawa; fox and mink fur production at the Experimental Fur Ranch, Summerside, P.E.I.; and the development of crosses between domestic beef cattle and the American bison, at the Cattalo Enclosure, Wainwright, Alta., and latterly transferred to the Range Experiment Station, Manyberries, Alta.

For the efficient direction and conducting of this large and varied research program with livestock, the investigational activities are organized on a project basis. Projects covering all the phases of Animal Husbandry work currently under investigation on Experimental Farms are listed on the following pages.

LIST OF ANIMAL HUSBANDRY PROJECTS

Central and Branch Experimental Farms

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
BEEF CATTLE																															
Genetical—																															
A 1.532-1. (Policy)—Breeding Shorthorn cattle					×						×			×		×	×		×	×			×	×	×			×			×
A 1.532-2. Establishing a range herd of bison-domestic cattle.																					×										
A 1.532-3. The domestic × bison cross.																					×										
A 1.535-1. (Policy)—Record of Performance.																×															
A 1.635-1. Preliminary feeding trial with steer calves.																×	×		×	×				×							
Nutritional—																															
A 1.442-1. Protein supplements in the winter maintenance of calves.—The use of																					×										
A 1.442-2.[1] Biological values of feed proteins.—The determination of,	×																														
A 1.442-3. Supplemental feeding of yearling cattle on grass.																					×										

[1] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
BEEF CATTLE—*Continued*																															
Nutritional—Continued																															
A 1.443-1. Different roughages for the winter feeding of range calves.—The use of,																					×										
A 1.443-2. Rescue wheat straw and hollow-stemmed wheat straw as a feed for wintering calves.—The comparative value of,																					×	×									
A 1.445-1. Protein level in range grasses and rate of gain in yearling cattle.—Relationship between,																					×										
A 1.544-1[1]. Ensiling various crops.—Losses in,																				×											
A 1.544-2. Steer gains realized through a two-field system of deferred and rotational grazing.—A study of,																					×										
A 1.545-1[1]. Permanent pasture with a rotation of crops for pasture.—Comparison of,	×				×														•												

A 1.545-2[1].	*Cultivated* pasture *mixture* vs. permanent pasture.—Comparison of,	×																													
A 1.545-3.	Marshland and upland unimproved pasture for livestock grazing.—Comparative value of,					×																									
A 1.545-4[1].	Chemical fertilizer treatments for steer pastures.—Value of,	×										×																			
A 1.545-5[1].	Commercial fertilizer formulae for permanent pastures.	×				×									×																
A 1.545-6[1].	Continuous and rotational fertilized pastures for steers.—Value of,											×																			
A 1.545-7[1].	Mowing and harrowing pastures.	×																													
A 1.545-8[1].	Medium grazing vs. heavy grazing.	×																													
A 1.545-9.	Perennial and biennial grasses and legumes for pasture (beef cattle).			×																											
A 1.546-1.	The use of minerals for range cattle																					×									
A 1.546-2.	Minerals for range cattle.																					×									
A 1.549-1[2].	Associative digestibilities,—Determination of,	×																													
A 1.549-2[2].	Plane of nutrition,—The effect of upon digestibility of a constant ration.	×																													
A 1.644-1.	Sugar beet tops as a feed for fattening cattle.—Value of,																						×								
A 1.647-1.	Vitamin A supplements for range feeder steers.																						×								
Physiological— A 1.353-1.	Castration and dehorning on the weaning weights of calves.—Influence of time of,																					×									

[1] Co-operative project with Division of Field Husbandry.

[2] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
BEEF CATTLE—*Continued*																															
Physiological—Continued																															
A 1.452–1. Studies of causes of sterility in hybrids, second-cross and cattalo cattle.																					×										
A 1.452–2. Fertility of hybrids.—Studies in the,																					×										
A 1.452–3. Breeding yearling heifers.—The effect of,																					×										
A 1.453–1. Wintering out calves of domestic-bison extraction.—Experiments on,																					×										
A 1.653–1.[1] Castration of cattle at different ages on carcass conformation and meat quality.—Effect of,																					×	×									
A 1.654–1. Cattalo, part Brahman, and Hereford calves.—A feeding and carcass study of,																					×										

Management—																																
A 1.564-1.	Beef cattle production in Canada.—Improvement of,	×										×																				
A 1.566-1.	Grazing upon the breeding herd and the calf crop.—The effect of different rates of,																					×										
A 1.566-2.	Carrying capacity of range.																													×		
A 1.566-3.	Range management.																													×		
A 1.667-1.	Winter finishing of steers.													×																		
Economic—																																
A 1.172-1.	Dairy, dual-purpose and beef cattle. —Relative economy of returns from in Kapuskasing district.														×																	
A 1.472-1.	Periodic costs of rearing females.														×			×														
A 1.472-2.	Periodic costs of rearing males.														×																	
A 1.572-1.	Cost of maintaining breeding cows.																	×														
A 1.572-2.	Feed cost of milk and butterfat production.																×															
A 1.574-1.	Timber milk vetch poisoning in the range areas of interior British Columbia.—A study of the incidence of,																													×		
A 1.672-1.	Cost of beef production.					×																										
Disease and Parasite—																																
A 1.482-1.[2]	Urinary calculi investigations.																					×	×									
A 1.485-1.[2]	(Policy) Vaccination (calfhood) for contagious abortion.	×				×						×			×		×	×		×	×	×		×	×	×			×	×		×
A 1.584-1.	Pine needle poisoning.—A study of the cause, symptoms, effects of,																						×							×		

[1] Co-operative project with Livestock and Livestock Products Division, and Consumer Section, Marketing Service.
[2] Co-operative project with Division of Animal Pathology, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
BEEF CATTLE—*Concluded*																														
Disease and Parasite—Continued																														
A 1.584–2. Astragalus serotinus in beef cattle.—A study to confirm the toxicity of,																												×		
A 1.585–1. (Policy) Tuberculosis in cattle.—Control of,	×				×						×			×		×	×		×	×			×	×			×			
A 1.585–2. (Policy) Serum test for contagious abortion.	×				×						×			×		×	×		×	×			×	×			×			
DAIRY CATTLE																														
Breed and Strain Testing—																														
A 2.522–1. (Policy) Comparative testing of Ayrshire cattle.	×																													
A 2.522–2. (Policy) Comparative testing of Holstein cattle.	×																													
A 2.522–3. (Policy) Record of Performance.			×		×	×	×		×	×	×	×	×	×	×							×				×	×			×	

Genetical—																															
A 2.432-1.	(Policy) Breeding Ayrshire cattle.	×		×					×	×				×	×											×				
A 2.432-2.	(Policy) Breeding Holstein-Friesian cattle.	×					×					×										×							×	
A 2.432-3.	(Policy) Breeding Jersey cattle.				×						×		×												×					
A 2.432-4.	(Policy) Breeding Guernsey cattle.					×																								
A 2.433-1.	Development of a Polled Ayrshire herd.	×							×																					
A 2.434-1.	Progeny testing of purebred Ayrshire sires by means of artificial insemination.			×																										
Nutritional—																														
A 2.144-1[1].	Ensiling various crops.—Losses in,					×			×	×		×																		
A 2.347-1.	Dietary penicillin for young dairy calves.—The effect of,	×																												
A 2.347-2[2].	Antibiotic supplement on the growth and thrift of dairy calves.—The effects of,	×																												
A 2.444-1.	Utilization of legume silage in the ration of the growing dairy heifer.	×																												
A 2.543-1.	Field baled vs. loose hay for dairy cows in milk,—Comparison of,						×																							
A 2.543-2.	Legume silage—Value for dairy cows as hay replacement.																					×								
A 2.544-1.	Corn silage vs. alfalfa silage for dairy cows.	×																												
A 2.544-2.	Grass ensilage,—Optimum amount for dairy cattle.					×																								
A 2.544-3.	Turnips and potatoes for dairy cows, —A comparison of,			×																										

[1] Co-operative project with Division of Field Husbandry.

[2] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
DAIRY CATTLE—*Continued*																															
Nutritional—Continued																															
A 2.544–4. Potatoes in dairy cattle ration.—Value of cull,																						×									
A 2.545–1[1]. Permanent pasture vs. pasture in a crop rotation.					×				×																						
A 2.545–2[1]. Methods of grazing dairy cows on alfalfa pasture.	×																														
A 2.545–3[1]. Rates of applying commercial fertilizer for pasture.										×																					
A 2.545–4[1]. Manure vs. commercial fertilizer for pasture.									×																						
A 2.545–5[1]. Fertilizer for pastures.—Rates of applying,					×																										
A 2.545–6[1]. Commercial fertilizer formulae for pasture.						×																									

A 2.545-7[1]. **Sprinkler irrigation of fertilised pastures as related to grazing capacity, yields and quality of forage.**																														×
A 2.546-1. Minerals to milk cows.—Feeding of,																					×									
A 2.547-1. Kelp for dairy cattle.—Value of,						×																								
A 2.548-1. Comparing roughage and meal combinations as to their relative economy for milk production of dairy cows.	×																													
Management— A 2.364-1. Feeding milk to young dairy calves.—Methods of,	×																													
A 2.562-1[1]. Loose housing vs. standard stall stabling of dairy cattle.											×																			×
A 2.562-2[1]. Loose housing dairy barns.—Survey of,	×																													
A 2.863-1[2]. Tattooing dairy animals.—Comparison of methods and inks for,	×																													
Economic— A 2.472-1. Periodic costs of rearing dairy females.			×		×	×	×		×					×												×	×			×
A 2.472-2. Periodic costs of rearing dairy males.						×			×					×												×	×			×
A 2.572-1. Feed cost of milk and butterfat production.	×		×		×	×	×		×	×	×	×	×	×	×							×				×	×			×
A 2.572-2. Cost of maintaining dairy herd sires.			×			×				×																×	×			×
Disease and Parasite— A 2.485-1. (Policy) Tuberculosis in dairy herds.—Control of,	×		×		×	×			×	×	×	×	×	×	×							×				×	×			×

[1] Co-operative project with Division of Field Husbandry.
[2] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
DAIRY CATTLE—*Concluded*																															
Disease and Parasite—Continued																															
A 2.485–2. (Policy) Vaccination (calfhood) for contagious abortion.	×	×	×		×	×	×		×	×	×	×	×	×	×			×				×				×	×			×	
A 2.585–1. (Policy) Serum test for contagious abortion.	×		×		×	×	×		×	×	×	×	×	×	×							×				×	×			×	
A 2.585–2[1]. (Policy) Eradication of mastitis in the dairy herd.	×																														
HORSES																															
Genetical—																															
A 3.532–1[2]. (Policy) Breeding Clydesdale horses.	×				×											×	×						×							×	
A 3.532–2[2]. (Policy) Breeding Percheron horses.							×		×	×																					
A 3.532–3. (Policy) Breeding Belgian horses.											×																				
A 3.532–4. (Policy) Breeding French-Canadian horses.									×																						
A 3.536–1. Crossbreeding to produce Hunter and saddle type horses.	×																														

Economic—																																
A 3.472–1.	Feed requirements for rearing and maintaining draft horses.							×																								
A 3.472–2.	Periodic costs of rearing draft horses.								×								×													×		
A 3.572–1.	Cost of horse labour.			×					×					×																×		
A 3.572–2.	Cost of maintaining work horses.			×			×		×					×			×													×		
A 3.572–3.	Wintering horses in barn vs. outside.—Cost of,								×								×															
A 3.572–4.	Cost of maintaining brood mares.																×													×		
	SHEEP																															
Breed and Strain Testing—																																
A 4.522–1.	Open-faced vs. close-faced Shropshires.	×																														
A 4.522–2.	Breeds of range sheep.—A comparison of certain,																					×	×									
A 4.522–3.	Canadian Corriedale and Romnelet sheep under eastern Canadian conditions.	×																														
A 4.523–1.	Romnelet sheep.—The adaptability of,																					×										
A 4.523–2.	Romeldale sheep under farm flock conditions.—Testing the suitability of,																	×														
Genetical—																																
A 4.532–1.	(Policy) Breeding Leicester sheep.								×																							
A 4.532–2.	(Policy) Breeding Shropshire sheep.	×			×																											
A 4.532–3.	(Policy) Breeding Oxford Down sheep.										×																					

[1] Co-operative project with Division of Bacteriology and Dairy Research, Science Service.

[2] Co-operative project with Livestock and Poultry Division, Production Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
SHEEP—*Continued*																															
Genetical—Continued																															
A 4.532-4. (Policy) Breeding Dorset sheep.																														×	
A 4.532-5. (Policy) Breeding Rambouillet sheep.																		×				×									
A 4.532-6. (Policy) Breeding Corriedale sheep.																						×									
A 4.532-7. (Policy) Breeding Hampshire sheep.																							×				×				
A 4.532-8. Romney-Rambouillet breeding.																		×			×										
A 4.532-9. (Policy) Breeding Canadian Corriedale sheep.																						×									
A 4.532-10. (Policy) Breeding North Country Cheviots.										×																					
A 4.532-11. (Policy) Breeding Romeldale sheep.																		×													
A 4.532-12. Cross-breeding Romeldale and Romney Marsh sheep.																		×													
A 4.532-13. Breeding Romney Marsh Sheep.																		×													

A 4.533-1.	Paralysis in lambs.—The cause and inheritance of,																					×									
A 4.536-1.	Cross-breeding for the production of market lambs.	×								×	×	×																			
Nutritional—																															
A 4.442-1.	Rapeseed meal as a protein supplement for sheep.—Value of,																					×									
A 4.442-2.	Legume seed screenings in livestock rations.—Value of,																					×									
A 4.445-1.	Corn as fall pasture for ram lambs.—The use of field,																				×										
A 4.543-1.	Paralysis among lambs from ewes fed pea vine silage.																					×									
A 4.545-1[1,2]	Rate of applying commercial fertilizer.	×																													
A 4.545-2[1,2].	Permanent pasture vs. a rotation of crops for pasture for sheep.	×																													
A 4.545-3.	Carrying capacity of short grass range for sheep.—Determination of,																				×										
A 4.548-1[3].	Digestible nutrients.—Determination of by freely grazing sheep.	×																													
A 4.548-2.	Level of protein in the ration of the mature ewe on clean wool production, weight of lamb at birth, milk production of the ewe, and maintenance of body weight.—The effects of,																					×									
A 4.548-3.	Lifetime performance of range ewes as affected by various planes of nutrition during their first winter.																					×									
A 4.548-4.	Supplemental feeding of pregnant range ewes.																				×	×									

[1] Co-operative project with Division of Field Husbandry.
[2] Co-operative project with Division of Botany and Plant Pathology, Science Service.
[3] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
SHEEP—*Continued*																															
Nutritional—Continued																															
A 4.548–5. Supplementary feeding of pregnant ewes.	×																	×													
A 4.549–1[1]. Digestibility studies with sheep.	×																														
A 4.641–1. Forage crops and cereal crops as influenced by irrigation.—Nutritional value of,																						×									
A 4.643–1. Sugar beet tops as a feed for fattening lambs.—Value of,																						×									
A 4.644–1. Potatoes in lamb fattening ration.—Value of cull,																						×									
A 4.645–1. Supplementing native grass with irrigated pastures for market lambs.																		×													
A 4.646–1. Cobalt for fattening lambs on a non-leguminous ration.—The value of,																		×			×	×							×		

A 4.647-1.	Vitamin A reserves of feeder lambs from the range areas of Western Canada and the value of alfalfa hay, pea vine silage, and oat straw as sources of vitamin A in the lamb fattening ration.																					×										
Physiological— A 4.653-1.	Growth rate of single and twin lambs.																					×										
A 4.754-1.	Clean fleece weight to body weight in range sheep.—The determination of the relationship of,																		×			×	×									
A 4.754-2.	Wool production studies.																						×									
A 4.754-3.	Periodic yield of wool in relation to body growth during the first year of a sheep's life.																						×									
A 4.754-4.	Fibre diameters in range sheep flocks.																						×									
A 4.754-5.	Yield determinations of range wools.																						×									
A 4.754-6.	Clean fleece (yearling) weight as an index of maximum mature clean wool production.																		×			×	×									
A 4.854-1.	Techniques for fibre diameter measurements.—A study of,																						×									
Management— A 4.363-1.	A new method for castrating lambs.																						×									
A 4.664-1.	Early vs. late lambs for market.—Economy of,																													×		
Economic— A 4.472-1.	Rearing ewe lambs to breeding age.—Cost of,					×																										

[1] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse
SHEEP—*Continued*																														
Economic—Continued																														
A 4.572–1. Maintaining breeding ewes.—Cost of,					×					×																				
A 4.572–2. Maintaining breeding rams.—Cost of,					×					×																				
A 4.774–1. Clean fleece weights and shrinkages of southern Alberta range wools.—The determination of grease and,																						×								
Disease and Parasite—																														
A 4.381–1. Mortality in lambs from birth to weaning.—Causes of,																						×								
A 4.686–1. Parasitic treatment of range lambs going into feedlots.																						×								
A 4.687–1. Infestation of sheep with the sheep ked (Metophagus Ovinus L) and the nutritional status of the sheep.—The relationship between,																						×								

SWINE																																
Breed and Strain Testing—																																
A 5.522–1[1].	Breeding Minnesota No. 1 swine.																									×						
Genetical—																																
A 5.532–1.	(Policy) Breeding Yorkshire swine.	×				×		×		×	×	×			×		×	×		×	×			×	×		×			×	
A 5.532–2.	(Policy) Advanced Registry Policy for purebred swine.	×				×		×		×	×	×					×	×		×	×				×					×	
A 5.532–3[1].	Development of prepotent inbred lines of Yorkshires.	×						×				×					×								×						
A 5.532–4[1].	Development of new inbred lines of bacon pigs from cross-bred foundations.	×																							×						
A 5.833–1.	Backfat thickness measurement as determined from live hogs.	×																													
Nutritional—																																
A 5.346–1.	Anemia in young pigs.—Control of,														×																	
A 5.646–1.	Kelp meal as a source of minerals in the hog ration.					×																										
A 5.647–1.	Animal protein factor supplement in hog rations (Lederle Aureomycin by-product).					×																										
A 5.647–2[1,2].	APF (Lederle) as a supplement in the bacon hog ration.	×																														
A 5.649–1[2].	Digestibility studies with swine.	×																														
Physiological—																																
A 5.551–1.	Fecundity and nursing capacity in swine.—Study of,					×				×	×	×			×							×									×	
Management—																																
A 5.363–1.	Farrowing crate investigations	×																														

[1] Co-operative project with Livestock and Poultry Division, Production Service.

[2] Co-operative project with Division of Chemistry, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que	Normandin, Que.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
SWINE—*Concluded*																															
Management—Continued																															
A 5.664–1. Economy of spring vs. fall litters.																														×	
A 5.664–2. Self- versus hand-feeding of swine on Advanced Registry test.	×				×												×							×					×	
Economic—																															
A 5.572–1. Cost of maintaining brood sows.					×					×																					
A 5.572–2. Cost of maintaining herd boar.					×					×																					
A 5.672–1. Cost of raising pigs to time of weaning.					×					×				×																	
A 5.672–2. Cost of pork production.					×																										
DAIRY RESEARCH																															
A 6.743–1. Ingested feed and water on the solids-not-fat and mineral salt composition of cows' milk.—The effects of,	×																														

A 6.792-1[1].	*(Policy)* Controlling the bacterial count in milk.	×																													
A 6.795-1[1].	Fruity flavours in cheddar cheese.	×																													
A 6.795-2[1].	Rind rot or "Wet Ends" in Canadian cheddar cheese.	×																													
A 6.795-3[1].	Rancidity in cheddar cheese.—Studies on,	×																													
A 6.795-4[1].	Cheesemaking from mastitis milk.—Studies in,	×																													
A 6.795-5[1].	Mechanical openness in cheddar cheese.—Studies on,	×																													
A 6.795-6[1].	Roquefort type cheese.—Manufacture of,	×																													
A 6.799-1.	Milk strainers.—Studies on the efficiency of,	×																													
	FUR-BEARING ANIMALS																														
Genetical—																															
A 7.532-1.	Breeding systems and combinations of such methods with standard silver black foxes.				×																										
A 7.532-2.	Crossbreeding of two recessive Blue Mutant strains to produce a new type fox.				×																										
Nutritional—																															
A 7.641-1.	Determination of economical rations for foxes.				×																										
A 7.642-1.	Relative quality of fish available in the three Maritime Provinces for mink kit rations.—Study of the,				×																										
Physiological—																															
A 7.754-1.	Variation in the characters of fox fur under standard ranch practices.				×																										

[1] Co-operative project with Division of Bacteriology and Dairy Research, Science Service.

LIST OF ANIMAL HUSBANDRY PROJECTS—Continued

Central and Branch Experimental Farms—Continued

Animal Husbandry Division	Ottawa, Ont.	St. John's West, Nfld.	Charlottetown, P.E.I.	Summerside, P.E.I.	Nappan, N.S.	Kentville, N.S.	Fredericton, N.B.	St. Charles de Caplan, Que.	Ste. Anne de la Pocatière, Que.	Normandin, Qus.	Lennoxville, Que.	L'Assomption, Que.	Harrow, Ont.	Kapuskasing, Ont.	Morden, Man.	Brandon, Man.	Indian Head, Sask.	Swift Current, Sask.	Melfort, Sask.	Scott, Sask.	Manyberries, Alta.	Lethbridge, Alta.	Beaverlodge, Alta.	Lacombe, Alta.	Fort Vermilion, Alta.	Summerland, B.C.	Prince George, B.C.	Smithers, B.C.	Kamloops, B.C.	Agassiz, B.C.	Whitehorse, Y.T.
FUR BEARING ANIMALS—*Concluded*																														
Physiological—Continued																														
A 7.754-2. Hereditary and environmental factors affecting color in fox fur.				×																										
Management—																														
A 7.162-1. Methods of housing foxes.				×																										
LABORATORY ANIMALS																														
Disease and Parasite—																														
A 8.584-1. Timber milk vetch poisoning.—An attempt to develop in laboratory animals by feeding *Astragalus Serotinus*.																												×		
OTHERS																														
A 9.142-1. Frosted cereal grains.—The nutritional value of,																						×								

EXPERIMENTAL FARMS SERVICE

Director, E. S. Hopkins, B.S.A., M.Sc., Ph.D.
Central Experimental Farm, Ottawa, Ontario

Division	*Head*	*Title*
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Cereal	C. H. Goulden, B.S.A., M.Sc., Ph.D.	Chief
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Superintendent, Experimental Fur Ranch, Summerside, C. K. Gunn, B.Sc., M.Sc., Ph.D.

NOVA SCOTIA

Superintendent, Experimental Farm, Nappan, W. W. Baird, B.S.A.
Superintendent, Experimental Station, Kentville, A. Kelsall, B.S.A.

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Superintendent, Experimental Station, Fredericton, S. A. Hilton, B.S.A., M.S.A.

QUEBEC

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Superintendent, Experimental Station, Ste.-Anne-de-la-Pocatiere, J.-R. Pelletier, B.S.A., M.A., M.Sc.
Superintendent, Experimental Station, L'Assomption, R. Bordeleau, B.S.A.
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Officer-in-Charge, Experimental Substation, Ste-Clothilde, F. S. Browne, B.S.A.

ONTARIO

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Superintendent, Experimental Station, Kapuskasing, F. X. Gosselin, B.S.A.
Superintendent, Experimental Station, Harrow, H. F. Murwin, B.S.A.
Officer-in-Charge, Experimental Substation, Delhi, L. S. Vickery, B.S.A., M.Sc.
Officer-in-Charge, Experimental Substation, Smithfield, D. S. Blair, B.S.A., M.Sc.
Officer-in-Charge, Experimental Substation, Woodslee, J. W. Aylesworth, B.S.A., M.S.

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Superintendent, Experimental Farm, Brandon, R. M. Hopper, B.S.A., M.Sc.
Superintendent, Experimental Station, Morden, W. R. Leslie, B.S.A.
Officer-in-Charge, Pilot Flax Mill, Portage la Prairie, E. M. MacKey, B.S.A.

SASKATCHEWAN

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Superintendent, Experimental Station, Swift Current, G. N. Denike, B.S.A.
Superintendent, Experimental Station, Scott, G. D. Matthews, B.S.A.
Superintendent, Experimental Station, Melfort, H. E. Wilson, B.S.A.
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