STUDIES OF THE NUTRITIONAL VALUE OF SOME SELECTED INTERLAKE FORAGES

by

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ABSTRACT

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A survey was made of three areas in the Interlake District of Manitoba to obtain information on cattle and forage production, and to collect forage samples for chemical analyses. Approximately 80 samples of forage from 50 farms were analysed for crude protein, calcium and phosphorus. Digestibility studies with yearling wethers were conducted on five lots of native hay selected from the three areas. In determining digestibility the chromogen method was compared with the conventional method.

The native hays in the Interlake District were generally deficient in digestible crude protein, total digestible nutrients and phosphorus, as well as being of a low palatability. The use of a phosphorus supplement, such as bonemeal or dicalcium phosphate, appears to be required throughout the year. The use of the present low-quality hays requires additional supplementation with protein and cereal grains to ensure a ration adequate in digestible crude protein and total digestible nutrients.

The chromogen method of determining digestibility, as used in these studies, was not applicable to native hays with such low concentrations of chromogen.

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INTRODUCTION

The Interlake District of Manitoba can be broadly defined, for agricultural purposes, as the area of land situated between Lake Manitoba and Lake Winnipeg (Figure 1). Much of this land is unsuitable for cultivation because of either very wet or excessively stony soil conditions. Consequently, the major farming operation, over a large part of the district, is the production of livestock to utilize the available native forages. Little grain and cultivated forage crops are grown in the district and the livestock are produced on a ration composed almost entirely of native herbage.

Malnutrition has long been a major livestock problem in the district, being more pronounced in some areas than in others and varying in severity from year to year. The condition is usually more severe in the late winter and early spring, but it is not confined entirely to that period of the year. The usual symptoms in cattle are a depraved appetite, emaciation and retarded growth rate, and, in extreme cases, debility and death.

The depraved appetite is recognized as an early symptom of a phosphorus deficiency and the area has long been regarded as deficient in this mineral. Despite recommendations for phosphorus supplementation of livestock rations, the symptoms of malnutrition have persisted. Consequently, the farmers have suffered a loss of revenue because of decreased livestock production, with no alternative source of revenue because of unsuitability of the soil to other farming operations.

Longstanding knowledge of the problem resulted in a proposal, by the Division of Animal Science of the University of Manitoba, to initiate a study to obtain more extensive basic information on the nutritive value of the forages available in the Interlake District. The project included a survey of three selected areas (Figure 1) to obtain data on factors concerning livestock and forage production, and to collect forage samples for chemical analyses. This information aided in establishing not only some of the specific problems involved, but also the extent to which they occur in the areas studied.

In digestion studies conducted to determine the nutritive value of selected native forages, the chromogen method was compared with the conventional method of determining digestibility, to see if this method was applicable to studies with Interlake forages.

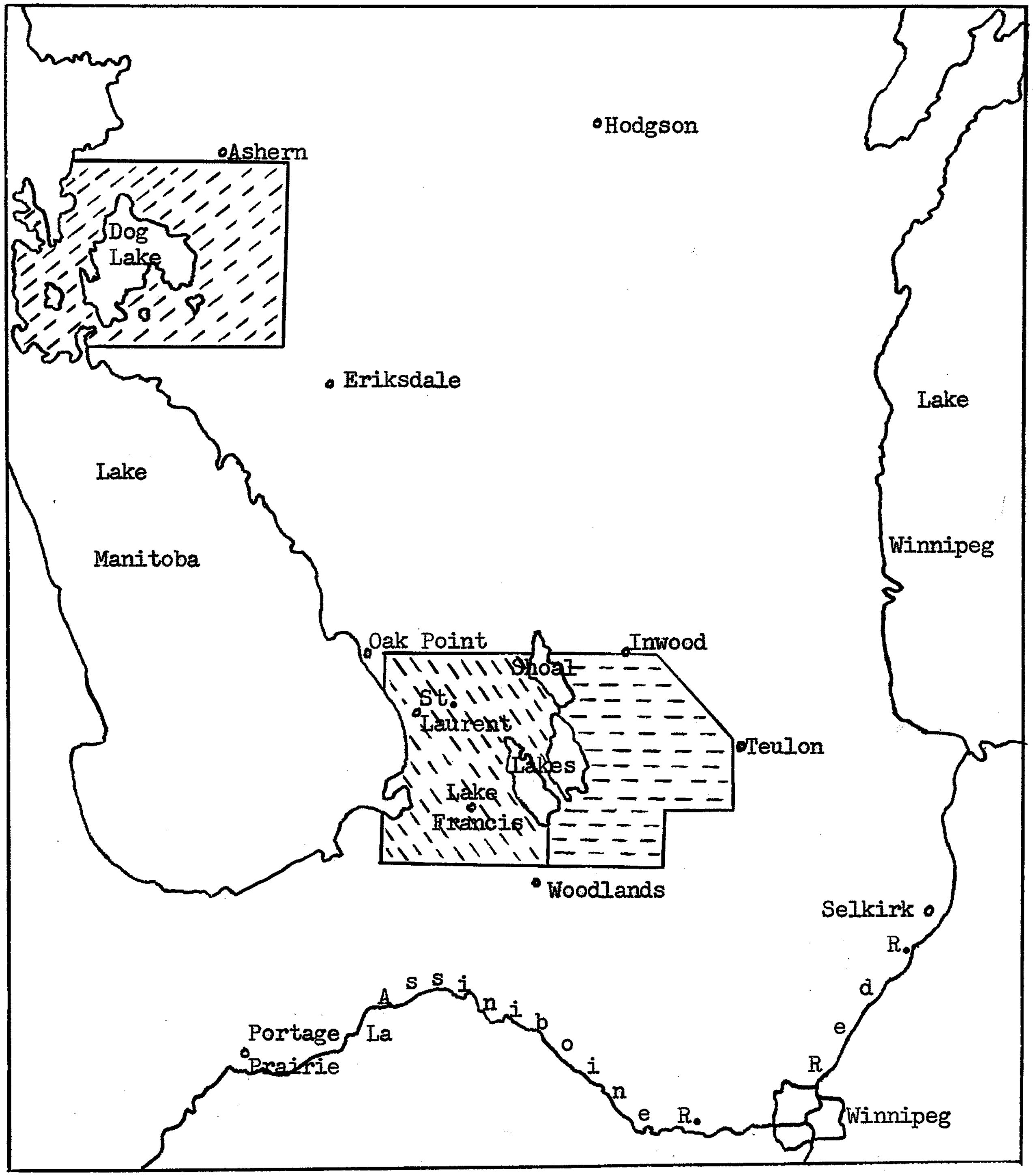
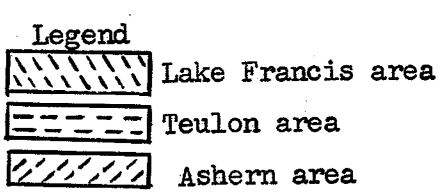


Figure 1: Map of the Interlake District. Scale: 1 inch = 14 miles.



REVIEW OF LITERATURE

Numerous investigations have been made of the major nutrient content of native and cultivated grasses and legumes of the prairie regions of North America, and means of improving their nutritional value. The reports have dealt mainly with protein, total digestible nutrients, phosphorus and calcium. Limited additional information is available on the carotene levels. Studies have also been made on the digestibility of forages determined both by the conventional method and by the use of the chromogen method. Extensive investigations have been reported on trace elements, but these are not considered here, as they are outside the scope of the present investigation.

This review is presented with a general discussion of the nutritive value of prairie forages and the utilization of low-quality roughages. Specific reference is then made to phosphorus, calcium, carotene, digestibility studies and the chromogen method of determining digestibility.

The Nutritive Value of Prairie Forages

The native forage plants of the prairie regions appear to be generally deficient in their content of phosphorus and crude protein, and, to some extent, in total digestible nutrients. The stage of maturity at which the hay crop is obtained seems to be one of the major factors in determining the quality of the hay. A considerable advantage is indicated for early-cut hays in their content of available nutrients, as seen from chemical analyses and animal gains per acre of forage.

In a study of native forage plants in Alberta and Saskatchewan, Clarke and Tisdale (15) reported the content of crude protein to be highest in the leaf stage, dropping sharply thereafter, while the crude fibre content increased with each growth stage. Nitrogen-free-extract also increased, but to a less extent than the crude fibre. The phosphorus content declined throughout growth becoming definitely deficient by the cured stage; calcium was found to be maximum before blossoming and in the cured stage and all grasses were well supplied at all stages. Cultivated grasses were somewhat superior to the native grasses in their nutrient content and, of the native grasses, upland species were more nutritious than lowland species.

Bell et al (3), in central Saskatchewan, found legumes superior to grass hays in their content of digestible crude protein and total digestible nutrients. Grasses were generally higher in nitrogen-free-extract and lower in crude fibre compared to legumes, but consumption of the grass hays was lower than of legumes. Marsh hays were low in nutritive value, being low in protein and high in crude fibre.

Bell et al (4), using forage samples obtained at the early bloom stage, reported that about half the grasses studied were low in protein for domestic animals with higher protein requirements, such as lactating or young growing animals. There was a need for supplemental protein, calcium and phosphorus when cultivated or native grasses were fed without legumes. Alkali soils restricted plant growth and resulted in a decrease of one-third in the amount of protein, making the need for supplemental protein more acute.

Baker et al (2) in Nebraska reported that the content of crude protein and phosphorus decreased as the native grasses matured. The late-cut hays were very short of phosphorus and were deficient in crude protein and total digestible nutrients. Consumption of the late-cut hays by beef steers decreased as compared to early-cut hays, and the intake of nutrients, especially crude protein and phosphorus, decreased markedly; the amount of feed required per hundred pounds of animal gain increased with the late-cut hays. Early-cut hays gave a lower yield of dry matter but gave more pounds of animal gain per acre than the late-cut hays. Staples et al (41) in South Dakota obtained somewhat similar results, with early-cut hays producing greater animal gains and giving lower feed consumption per hundred pounds of gain. The content of digestible protein was found to decrease steadily with increasing maturity of the native prairie hays.

Gallup and Briggs (23) reported that as protein content of prairie hay decreased, there was a decrease in the apparent digestibility of the crude protein, content of total digestible nutrients and crude fibre digestibility. Schneider et al (38) and Crampton and Jackson (16) have also found significant decreases in digestibility with advancing stage of plant maturity. Brannon et al (6) reported that digestibility declined as forage matured and the intake of feed also declined.

Utilization of Low-quality Roughages

Low-quality roughages appear to be characterized in general by low palatability, decreased content of crude protein and total digestible nutrients, increased content of crude fibre and a lowered digestibility of the nutrients. The problem in using them satisfactorily in rations for ruminant animals involves increasing the consumption to improve the total nutrient intake and increasing the digestibility of the nutrients.

Digestion of cellulose in roughages by ruminant animals is largely dependent on rumen micro-organisms. Roughages of low quality show decreased digestibility apparently because of an inadequate supply of nutrients for the micro-organisms (11). This results in a decrease in the total number and also changes in the species composition of the rumen microflora, causing reduced attack on the cellulose and starch. Low-quality roughages need to be supplemented with nitrogen and complex minerals to increase cellulose digestion. Burroughs et al (12) stated that protein exerted a favorable influence on roughage digestion and that protein was an essential nutrient for the rumen bacteria concerned in roughage digestion. In earlier studies, Burroughs et al (10) determined that there were inorganic nutrients in good quality alfalfa hay or meal essential to rumen micro-organisms. Low-quality roughages seemed deficient in these essential inorganic nutrients and needed special mineral supplementation. Burroughs et al (13) reported that phosphorus and iron were effective in stimulating cellulose digestion, and that energy, protein, ammonia and minerals were required for efficient roughage utilization. Woods et al (45) reported that an increase in protein content above 6.9 percent increased the apparent digestibility of dry matter, organic matter, protein, energy and nitrogen-free-extract, but had no effect on crude fibre digestibility.

Klosterman et al (29) reported that the addition of one pound of cane molasses markedly improved a low-quality hay ration, improving the carcass grade and the rate of gain of beef cattle. Klosterman et al (30) stated that the addition of molasses increased gains in beef cattle when using weathered, late-cut timothy hay with low levels of protein.

The palatability of the molasses counteracted the reduction in appetite on a ration sub-optimal in protein.

Gossett and Riggs (24) found that roughages low in palatability produced slow growth rate in beef cattle, but replacing one to three pounds of the prairie hay with equal amounts of leaf meal gave significant increases in rate of gain and a decrease in the amount of feed required per hundred pounds of gain.

Long et al (31) reported that grinding the ration lowered digestibility, but pelleting the ground ration restored the digestibility to about the same level as the ration in the natural state. Cate et al (14) stated that pelleted rations increased the average daily gains and feed consumption on a timothy roughage. Less feed was required per hundred pounds of gain, but the slight improvement was hardly enough to warrant the cost.

Phosphorus

The clinical symptoms of phosphorus deficiency include retarded growth rate, loss of condition, stiffness, lameness, abnormal skeletal development and fragile bones (42). Riggs (37) stated that bone chewing (depraved appetite) in cattle is accepted as the most common early symptom of a phosphorus deficiency and the condition is responsible for reduced calf crops, retarded growth rate and delayed development of young cattle. Low phosphorus intake depresses the appetite, efficiency of feed utilization and rate of gain.

A deficiency of phosphorus appears to be relatively common in the plains region of North America. Belson (5) reported that phosphorus was the most widespread mineral deficiency in the United States, with extensive areas of alkaline soils in the west being associated with the deficiency. Clarke and Tisdale (15) found that the phosphorus content, in native forage plants of Alberta and Saskatchewan, became low by the seed stage and was definitely deficient in the cured stage. Depraved appetite and urinary calculi were common in cattle, with reduced calf crops and reproductive troubles as milder symptoms. Bell *et al* (4) reported that cultivated and native grasses in Saskatchewan were deficient in phosphorus. Legumes were also deficient, but not to the same extent, and the addition of legumes to the ration reduced the need for supplemental phosphorus.

Ellis and Caldwell (18) stated that Manitoba hays in general were low in phosphorus, with native grasses and sedges containing less than cultivated grasses. Ellis and Smith (19) reported that the phosphorus content of most of the Manitoba hays was generally of a low order, even for legumes and grass-legume mixtures. Samples from Balmoral in the Interlake District were particularly low. Significant increases were obtained with phosphate fertilizers and there was a definite need for phosphate fertilizers to increase the phosphate content and the yield of Manitoba hays.

Calcium

A deficiency of calcium in calves produces the condition known as rickets, characterized by decreased growth, stiffness and enlarged and painful joints (32). In extreme cases the deficiency may result in the birth of weak or deformed calves. In mature cattle the condition is known as osteomalacia and is characterized by mobilization of the calcium from the bones, resulting in a breakdown of the structural portion. In acute cases, particularly during pregnancy and lactation, bone fractures such as broken pelves may occur.

Although the requirements for calcium are higher than for phosphorus in animal nutrition, there appears less likelihood of a calcium deficiency in ruminant animals as forages usually contain a more adequate supply of calcium, depending on the soil conditions (32). Clarke and Tisdale (15) reported the calcium content to be adequate in native forage plants of Alberta and Saskatchewan. Ellis and Caldwell (18) and Ellis and Smith (19) reported that the calcium content of Manitoba hays was satisfactory, with legumes having a higher content than grasses.

However, Bell _et al_ (4) reported the calcium content of cultivated and native grasses in central Saskatchewan could be borderline in comparison to livestock requirements. This suggests occasional requirements for calcium supplementation in some areas.

Carotene

There is limited information on the carotene levels in prairie hays, but it appears that the supply of carotene should be generally sufficient for ruminant animals, although it may be borderline or somewhat deficient in low-quality hays.

Green pasture forage contains an ample supply of carotene which tends to decrease after the bloom stage (32). Large losses of carotene occur in the curing stage of hay because of enzymic and photochemical destruction, and exposure to sun and rain may almost completely remove the carotene (43).

Ruminant animals are able to store vitamin A in the liver and depot fat, and reserve supplies of the vitamin are built up in the animal body during the pasture season (25). This reserve can be utilized to furnish an adequate supply of vitamin A when the ration may be deficient in carotene. Depending on the previous rate of storage, up to two hundred days may be required for the liver to become completely depleted. Morrison (33) states that the feeding of carotene deficient roughages for an extended period can result in a deficient condition in animals as the stores of vitamin A become depleted.

Digestibility Trials

"Chemical analysis is the starting point for determining the nutritive value of feeds, but the actual value of ingested nutrients is dependent upon the use which the body is able to make of them" (32). This is determined by means of a digestion trial which involves a record of the nutrients consumed and of the amounts of them voided in the faeces. This enables the determination of the proportion of the ingested food nutrients that are actually available to the animal.

The use of lambs in digestion studies would often be preferable to steers, as they require less labour, are less expensive to use and appear to give similar results. Forbes and Garrigus (21) found that steers and wethers had similar digestive capacities. Jordan and Staples (26) reported that steers gave slightly less variable results, but that lambs reflected differences between different feeds to about the same extent, so that coefficients obtained from lamb tests could probably be applied to cattle.

The length of the feeding period in digestion studies seems to vary in many cases, but six to seven day periods appear to be satisfactory, depending on the type of trial involved. Staples and Dinusson (40) stated that seven-day collection periods were sufficiently accurate in obtaining digestion coefficients with cattle. Forbes and Garrigus (22) found five- to seven-day preliminary periods adequate for digestibility trials with steers and wethers. Crampton and Lloyd (17) stated that not less than five days must be allowed as a preliminary period, and random faecal samples taken daily for four days and composited for each animal were satisfactory for determining digestibility. Nicholson _et al_ (34) reported that, for rations in which the basic components were constant, a preliminary period of seven days was adequate with steers.

It appears desirable, in using low-quality roughage, to supply the feed _ad libitum_ in digestion studies. Forbes _et al_ (20) found that sheep in metabolism cages did not consume sufficient hay of an excellent quality to maintain their live weight. Forbes and Garrigus (22) stated that wethers had similar digestive capacities over a wide range of feed intake and therefore digestibility of roughage was not influenced by level of intake. Watson _et al_ (44) obtained similar results.

The Chromogen Method of Determining Digestibility

The conventional method of determining digestibility, as outlined above, is a laborious and time-consuming procedure (32). Consequently, attention has been directed to the use of an indirect method of assessing digestibility. This method involves the use of an indigestible material which enables the determination of digestibility without measuring either the food intake or faeces output. Representative samples only of feed and of faeces are required.

The use of plant pigments or chromogens as an indigestible internal indicator in forages was first proposed by Reid et al (35). The method was found to be accurate in pasture studies and had the advantage of not requiring records of total feed consumption or of total faeces excretion in calculating nutrient digestibility. Of the indicator materials that have been tested, chromogen appears to be one of the best because of accuracy of results and ease of determination (27). The chromogen concentration in the feed can be computed from the concentration in the faecal samples, which reduces the number of analyses required. (36).

The best procedure, considering accuracy and labour requirements for the extraction of the faecal samples, involves the use of the continuous-extraction technique developed by Brisson and Hatina (9). The densities of the faecal extracts are then obtained from spectrophotometer readings at a wavelength of 415 mu by the method proposed by Kane and Jacobson (28). The units of chromogen are determined by reference to a 5.05 mg. percent solution of sodium chromate, which is defined as being equivalent to an extract with ten units of chromogen per hundred millilitres, as in the modified method developed by Reid et al (36).

Reid et al (36) found a quantitative relationship between the chromogen concentration of the feed and that of the faeces, so that, having obtained the concentration of chromogen in the faeces, the concentration of the chromogen in the feed could then be computed:

$$\text{Units of chromogen/gm. forage} = (0.0925 + 137.3 \log X) - 242.12$$
$$(X = \text{units chromogen/gm. dry faeces})$$

Nutrient digestibility could then be determined by the ratio method:

$$D = 100 - 100 \left(\frac{\%\ \text{indicator in feed}}{\%\ \text{indicator in faeces}} \times \frac{\%\ \text{nutrient in faeces}}{\%\ \text{nutrient in feed}}\right)$$

At the same time Reid proposed a faecal index method for the determination of dry matter digestibility directly from the faecal analysis, eliminating the necessity for representative feed samples:

$$\text{Digestibility dry matter} = 32.74 + 0.0168\ X + 8.47 \log X$$
$$(X = \text{units chromogen/gm. dry faeces})$$

The method requires only the collection of representative samples of faeces in determining dry matter digestibility, and nutrient digestibility can be determined from representative samples of feed and faeces, eliminating many of the difficulties of the conventional method of determining digestibility.

However, Reid et al (35) stated that the chromogen method was inaccurate in determining digestibility of feeds with small or large concentrations of chromogen, and Reid et al (36) proposed a modified method in an attempt to overcome this difficulty. Brisson et al (8) found the plant pigment method was not applicable to feedstuffs which contained small amounts of chromogen.

EXPERIMENTAL PROCEDURE

Areas Investigated

Three areas, devoted largely to the production of livestock and considered fairly typical of the Interlake District in general, were selected for the investigation. The Lake Francis area is bounded on the west by Lake Manitoba and on the east by the Shoal Lakes. It includes Townships 15, 16 and 17 in each of Ranges 2, 3 and 4 west of the Principal Meridian (Appendix 1). The Teulon area is the land lying between Teulon, Inwood and the Shoal Lakes and includes Townships 15, 16 and 17 in Range 1 west and Townships 16 and 17 in Range 1 east of the Principal Meridian (Appendix 11). The Ashern area is the land surrounding Dog Lake and is situated in Townships 22, 23, 24 and 25 in each of Ranges 7, 8 and 9 west of the Principal Meridian (Appendix 111).

The Survey

A survey was conducted of the three areas commencing on 19th July, 1957. Fifty representative farms were included in the investigation, twenty being in the Lake Francis area, sixteen in the Teulon area and fourteen in the Ashern area. Data on the following were obtained by means of a questionnaire (Appendix 1V): land acreage, land utilization, number and type of cattle, supplemental feeding, and management practices used in relation to livestock and forage production.

Sixty-three samples of native hay and twenty samples of cultivated hay were obtained from the farms. At least one sample of native hay was obtained from each farm; cultivated hay samples were obtained only where available. The method of collection consisted of clipping samples from random locations and bulking to make one composite sample from each field. This procedure was followed to ensure samples representing low and high locations and the various forage species available. It was believed that this method of sampling accurately reflected the typical forage actually supplied to the livestock. Where the hay had already been removed from the field, the samples were taken from the stacks.

The samples were dried in an air-oven at 100' C., ground in a Wiley Laboratory Mill with a 1 mm. screen and stored in sealed jars. In 1958 the forage samples were analysed for crude protein, calcium and phosphorus by the methods of the Association of Official Agricultural Chemists (1).

Digestibility Studies

It was considered desirable to use native hays that were fairly low in crude protein to give a better indication of possible protein deficiencies. Five representative hay samples from each area were analysed for crude protein. On the basis of low protein content two lots of native hay, designated N1 and N2, were obtained from the Lake Francis area, two lots, N3 and N4, from the Teulon area and one lot, N5, from the Ashern area. These were used in feeding trials with sheep to determine digestibility of the major nutrients in the native hay. Two lots of alfalfa hay, A1 and A2, selected from feed available on the University Farm, were used as controls for comparison purposes. Two lots of alfalfa hay were required because the first lot selected proved insufficient and an additional supply was unavailable when it became apparent more would be required in order to obtain data for a more satisfactory statistical analysis. The hays were coarsely chopped in a cutting box into approximately three inch lengths to facilitate feeding in the metabolism cages and to reduce sorting by the sheep.

Six yearling wethers, three of Suffolk breeding and three Suffolk-Oxford crossbreds, were used in the trials. They ranged in weight from 116 to 131 pounds with an average weight of 121 pounds at the beginning of the trials. The digestion studies were conducted with the wethers confined in individual metabolism cages. The cages were constructed locally from plans obtained from the Animal Nutrition Department at Macdonald College, Quebec. They were similar to the type described by Bratzler (7), but were of all-metal construction and the legs, feedboxes, floors and chamber for separation of faeces and urine were removable.

A series of four trials was conducted with the first, third and fourth trials involving seven-day preliminary and seven-day collection periods. In the second trial a six-day preliminary and a six-day collection period was used to compare accuracy with the seven-day trials. All six wethers were used in the first three trials and three were used again in the fourth trial. The source of the hay supplied each sheep was varied for each trial, each lot of hay being fed to three different animals during the series of trials (Table 1). This permitted determining digestion coefficients by averaging data from three animals as was done by Forbes and Garrigus (22). The wethers were supplied hay <u>ad libitum</u> to allow maximum consumption by each animal. Water and cobalt-iodized salt were constantly available.

During the collection periods daily records were kept of the total feed consumed and faeces excreted by each sheep. Representative samples were obtained daily and, at the conclusion of each trial, these were bulked to make composite samples of feed and of faeces from each sheep. The faecal samples were dried in an air-oven at 100' C., and both feed and faecal samples were ground in a Wiley Laboratory Mill with a 1 mm. screen and stored in sealed jars. The feed and faecal samples were analysed for dry matter, crude protein, crude fibre, nitrogen-free-extract, ether extract and total ash. The feed samples only were analysed for calcium and phosphorus. The feed samples from the second trial were also analysed for their content of carotene, the density readings being taken at a wavelength of 436 mu in a Hilger Colorimeter. All methods of analyses were from the Association of Official Agricultural Chemists (1).

Table 1 Plan of Digestibility Trials Showing the Ear Tag Number of the Sheep Receiving Each Lot of Hay in each Trial

	A1	N5	N3	N1	N2	N4	A2
Trial 1	3	2	4	6	5	1	
Trial 2	4	3	2	5	1	6	
Trial 3	2	4	3	1	6	5	
Trial 4							6,5,1

In order to compare digestion coefficients obtained by the conventional and the chromogen methods, the analysis of the faecal samples for chromogen was undertaken. Composite samples of the fresh faeces were stored at 0' F. and later analysed for their concentration of chromogen, using the continuous-extraction technique developed by Brisson and Hatina (9). The density readings of the faecal extracts were obtained by measurement in a Hilger Uvispek Photoelectric Spectrophotometer. The extracts gave a maximum absorption peak at 412 mu, instead of the recommended 415 mu, so all density readings were taken at 412 mu.

The units of chromogen per gram of dry faeces were determined by reference to a 5.05 mg. percent solution of sodium chromate, which was defined as being equivalent to an extract containing 10 units of chromogen per 100 ml. This data was then applied to the equations developed by Reid *et al* (36):

$$\text{Units chromogen/gm. forage} = (0.0925 + 137.3 \log X) - 242.12$$
$$(X = \text{units chromogen/gm. dry faeces})$$

and

$$\text{Digestibility of dry matter} = 32.74 + 0.0168\, X + 8.47 \log X$$
$$(X = \text{units chromogen/gm. dry faeces})$$

RESULTS

The Survey

The average acreage per farm and the data for land utilization are shown in Table 2. The three areas are fairly similar in the average acres of owned land with the overall average being 529 acres per farm. There was considerable variation in the amount of rented land, however, resulting in a fairly large difference in the average total size of farm for each area. The overall average was found to be 769 acres per farm, with the Teulon area having an average of 685 acres per farm, the Lake Francis area 772 acres per farm and the Ashern area 860 acres per farm.

Table 2 Land Utilization in the Interlake District (average acres per farm)

Area	Owned	Rented	Grain	Tame Hay	Native Hay	Native Pasture	Number Farms
Lake Francis	518	254	10	5	522	235	20
Teulon	540	145	13	26	303	343	16
Ashern	533	327	27	19	439	375	14
Average	529	240	15	16	429	309	50

The data for land utilization indicate the small amount of land used for both grain and cultivated hay crops. The survey shows that on the average only 31 acres, or approximately 4 percent of the total acreage per farm, were used for cultivated crops. The remaining 96 percent is used as native hay and native pasture with 429 acres and 309 acres in each group respectively. Many of the farmers pasture the hay-land after the hay crop is removed, which may be partly responsible for the greater amount of land used for hay in the Ashern and Lake Francis areas. The data for the Lake Francis area indicate an unusually large proportion of the land used for hay, which may be largely accounted for by the fact that many of the farmers in this area produce surplus hay for sale in other districts.

It was observed that most of the hay was cut when very mature and haying proceeded from about the middle of July into September. Stands of alfalfa were usually left until a crop of seed had been obtained before cutting for hay. There was virtually no rotation of pastures or hayland, and most of the pastures had been badly overgrazed, so that weeds, shrubs and trees occupied much of the land and were apparently increasing steadily year by year.

The cultivated hayland varied from small areas seeded down quite recently to fields seeded down as many as twenty years ago and now scarcely recognizable from the native hayland. Alfalfa and brome grass were the species usually found, with some clovers, fescue, alsike and wheatgrasses. Usually a poor stand was obtained, probably due to difficulties in cultivation, so that couch grass and other native grasses appeared in fairly large quantities.

On the upland soils the most common species of native grasses were blue grasses (*Poa* sp.), red top (*Agrostis alba*) and wild barley (*Hordeum jubatum*). Other common species were couch grass (*Agropyron repens*), green needle grass (*Stipa spartea*), brome grasses (*Bromus* sp.), big bluestem (*Andropogon furcatus*) and June grass (*Koeleria cristata*).

On the lowland soils the common species were slough grass (*Beckmannia syzigachne*), sedges (*Carex* sp.), switch grass (*Panicum* sp.), prairie cord grass (Spartina pectinata) and northern reed grass (Calamagrostis inexpansa).

The data concerning the cattle population are shown in Table 3. The number of cows per farm is very similar for each of the areas. The Lake Francis and Teulon areas are also very similar in the total number of cattle per farm, with an average of 53 head per farm in both areas. However, the Ashern area was found to have considerably more cattle per farm with an average of 83 head. This difference in cattle population is reflected to some extent in the size of farm. The Ashern area had a larger average size of farm and considerably more cattle per farm. The Lake Francis area, although having a larger size of farm compared to the Teulon area, had the same number of cattle, probably because of the use of surplus land for the production of hay for sale elsewhere.

The similarity in cattle population for the Lake Francis and Teulon areas is further emphasized by the type of cattle operation being carried on in these two areas. A larger proportion of the farmers are conducting a dairy operation, selling either fluid milk or cream, as compared to the number with a beef cattle operation. As a result, a fairly large proportion of the farmers sell their young stock as veal, which helps to account for the smaller number of cattle per farm as compared to the Ashern area. In the Ashern area only one of the farms visited maintained a dairy herd, as compared to thirteen with beef herds, although some of the farmers with beef-type cattle were selling cream. Only two of the fourteen farms visited in the Ashern area sold their young stock as veal compared to fifteen of the thirty-six farms in the other two areas.

Table 3 Number and Type of Cattle per Farm in the Interlake District

Area	No. Cows	Total No. Cattle	Farms With Dairy Cattle	Farms With Beef Cattle	Farms Selling Feeder Cattle	Farms Selling Finished Cattle	Farms Selling Veal Calves	Average Milk/Cow*
Lake Francis	26	53	10	9	9	4	6	6,500(9)
Teulon	22	53	9	7	4	3	9	7,700(9)
Ashern	25	83	1	13	9	3	2	4,800(1)
Average	24	62						7,000

*Estimated production in pounds per year. Number of farms averaged is placed in brackets.

Relatively few finished cattle are produced in the three areas. Only ten of the fifty farms visited reported the sale of finished cattle, and these made up only a part of their total sales, as they also disposed of a considerable proportion as feeder cattle.

The data for milk production indicate an overall estimated average of 7,000 pounds milk per cow per year. The highest production reported was 11,000 pounds per cow per year. Production for the Ashern area seems very low, but none of the herds there were of pure dairy breeding, but were a cross of Holstein with Shorthorn and Hereford. In most cases the data for milk production were estimates only, as very few farmers kept production records.

Grain supplementation was practiced mainly by those farmers with dairy cattle and selling fluid milk. This usually consisted of a mixture of oat and barley chop, with some wheat and screenings occasionally used. Calves received little grain supplementation, some farmers supplying small amounts of oat chop or whole oats during the winter. Beef cattle seldom received any grain supplement at all.

No protein supplementation was used, except where a commercial calf meal was used for young calves by those farmers selling fluid milk.

Bonemeal was used as a mineral supplement by the majority of the farmers. Only seven of the fifty farms visited were not using a mineral supplement at all. The amount of supplementation varied very greatly with some using as much as two pounds per cow per month during the winter and spring, and others using less than one pound. Some supplied a mineral supplement only when their cattle showed a deficiency of phosphorus by a depraved appetite.

Chemical Composition of the Hay Samples

The forage samples were analysed for their content of crude protein, calcium and phosphorus, and the average, minimum and maximum values obtained for each area, for both cultivated and native hays, are shown in Table 4. It would appear that the cultivated hays are superior to the native hays in their content of all three nutrients, having higher average, minimum and maximum values in almost all cases. The one exception was the Lake Francis area, where the minimum content of phosphorus is the same for both cultivated and native hays.

Table 4 Chemical Composition of Native and Cultivated Hay Samples from the Interlake District (percent air dried basis)

Nutrient		Lake Francis Native	Lake Francis Tame	Teulon Native	Teulon Tame	Ashern Native	Ashern Tame
Protein	average	7.30	10.65	7.07	10.55	8.69	10.49
	minimum	4.75	7.62	5.15	7.73	6.17	8.09
	maximum	9.20	17.68	8.74	17.34	10.48	12.31
Calcium	average	0.18	0.44	0.27	0.58	0.27	0.72
	minimum	0.10	0.28	0.13	0.26	0.16	0.43
	maximum	0.31	0.86	0.54	1.25	0.49	1.19
Phosphorus	average	0.11	0.16	0.11	0.17	0.09	0.13
	minimum	0.07	0.07	0.07	0.10	0.07	0.10
	maximum	0.17	0.28	0.19	0.27	0.11	0.18
No. of Samples		24	6	22	8	17	6

The data indicate little difference between the three areas as to the content of protein and phosphorus in the hays, as very similar results were obtained from the samples of native hay and also of the cultivated hay from the three areas. However, the calcium content appears to vary somewhat, with the Teulon samples possibly being slightly higher than the Lake Francis hays and the Ashern samples of cultivated hay possibly having a higher average value than the Teulon samples.

The average nutrient content for all the samples of native hay and of cultivated hay are compared in Table 5 with the nutrient requirements for yearling lambs, yearling beef cattle and dairy heifers, as recommended by the National Research Council. It appears from this comparison that, on the average, cultivated hays are quite adequate in their content of protein and calcium, but contain just enough phosphorus to meet the requirements of the livestock used in the comparison. The average native forages, however, appear to be adequate only in calcium and are deficient in their content of phosphorus and crude protein. They contain only 0.11 percent phosphorus as compared to requirements of 0.15 percent, and contain only 7.72 percent crude protein as compared to requirements of 8.0 and 8.5 percent for growing beef and dairy cattle respectively.

Table 5 Comparison of Nutrient Content of Hay Samples from the Interlake District with Recommended Requirements (as percent of the ration)

	Protein	Calcium	Phosphorus
Native hay (all samples)	7.72	0.24	0.11
Tame hay (all samples)	10.17	0.58	0.16
Lambs and yearlings (120 lb.)*	7.2	0.17	0.15
Yearling beef cattle (800 lb.)**	8.0	0.20	0.15
Dairy heifers (800 lb.)*	8.5	0.15	0.15

*National Academy of Sciences - National Research Council. Nutrient Requirements of Domestic Animals. No. 111, 1956 and No. V, 1957.

** National Academy of Sciences - National Research Council. Recommended Nutrient Allowances for Beef Cattle. No. 1V, 1950.

In three instances samples were obtained from the same site one to two months apart. As can be seen in Table 6, the analyses indicate a marked decrease in protein, particularly when comparing samples cut in late September with samples obtained in late July or early August. The phosphorus content also showed a decrease in each instance, but the calcium content, although showing some decrease in two samples, showed a considerable increase in the other. This seems to indicate that hay cut in late August and September would be lower in protein, phosphorus and possibly calcium, as compared to hay cut earlier in the season. As many of the samples used in the analysis were obtained before the hay had been cut, it is possible that the actual hays obtained would be lower in their nutrient content than indicated by the average values in Tables 4 and 5.

Table 6 A Comparison of Nutrient Content of Hay Samples Collected at Different Stages of Maturity from Selected Sites*

Area	Date	Protein	Calcium	Phosphorus
Lake Francis	23/7/57	6.05	0.11	0.08
	21/9/57	4.75	0.23	0.07
Lake Francis	24/7/57	6.59	0.16	0.17
	22/8/57	6.48	0.12	0.11
Teulon	1/8/57	7.81	0.35	0.12
	21/9/57	5.15	0.30	0.07

*Duplicate determinations on single samples.

Digestibility Trials

The average chemical composition of the hays used in the trials, as determined by three duplicate analyses of each hay, is shown in Table 7. An analysis of variance (39) indicated the alfalfa hays, A1 and A2, used as controls differed significantly in nutrient composition. A1 was significantly higher than A2 in dry matter ($P = 0.01$), crude protein ($P = 0.01$), nitrogen-free-extract ($P = 0.01$), calcium ($P = 0.01$), phosphorus ($P = 0.01$) and ether extract ($P = 0.05$); no differences were found in crude fibre and total ash. Consequently, because of inability to remove animal differences, in subsequent comparisons of digestibility coefficients and available nutrient content of the hays, a more reliable statistical analysis is obtained by grouping the hays. The first group comprises the alfalfa hay, A1, and the native hays, N5 and N3, as these were all fed to the same animals (Table 1). The second group comprises the alfalfa hay, A2, and the native hays, N1, N2 and N4, as these were all fed to the same wethers. Although all seven hays could be compared statistically in Table 7, it was considered desirable, for purposes of uniformity, to use the same grouping as required in subsequent tables.

In the first group the alfalfa hay, A1, was found to be significantly higher than the native hays, N5 and N3, in crude protein and calcium at the one percent level, and in phosphorus at the five percent level. It was significantly lower in nitrogen-free-extract and ether extract. No significant differences could be detected between the two native hays.

In the second group, the alfalfa hay, A2, was significantly

Table 7 Chemical Analysis of Hays Used in Trials (percent of dry weight)

Type of Hay	Dry Matter	Crude Protein	Crude Fibre	N.F.E.	Ether Extract	Total Ash	Ca.	P.
A1 (alfalfa)	88.66	13.74	36.53	29.74	1.19	7.46	1.05	0.18
N5 (native)	89.25	6.99	33.66	39.81	1.68	7.11	0.26	0.07
N3 (native)	89.13	5.35	34.11	40.46	1.75	7.20	0.29	0.05
L.S.D. (0.05)								0.03
L.S.D. (0.01)		2.12		4.60	0.28		0.18	
A2 (alfalfa)	85.70	10.64	40.03	26.76	0.98	7.29	0.84	0.11
N1 (native)	89.25	6.99	33.15	40.00	1.88	7.24	0.25	0.07
N2 (native)	89.29	6.24	36.39	35.87	1.73	9.06	0.16	0.04
N4 (native)	89.03	5.92	34.97	37.17	1.53	9.11	0.25	0.05
L.S.D. (0.05)			1.37		0.20			0.01
L.S.D. (0.01)	2.67	0.67	2.08	4.71	0.30	1.45	0.07	0.02
Alfalfa hay, stemmy*	90.5	12.3	35.9	33.4	1.4	7.6	1.07	0.19
Alfalfa hay, good*	90.5	14.6	29.6	36.5	1.8	8.0	1.22	0.22
Native hay, matured and weathered*	90.0	3.9	33.6	43.6	1.4	7.5	0.53	0.07
Native hay, good*	93.3	8.5	30.7	44.8	2.2	7.1	0.53	0.16

* Morrison, Frank B. Feeds and Feeding, 22nd edition, 1957. Appendix, Table 1.

higher than the three native hays in crude protein, crude fibre, calcium and phosphorus. It was significantly lower in dry matter, nitrogen-free-extract and ether extract and was lower than the native hays, N2 and N4, in total ash. In comparing the native hays in this group, N1 was found significantly higher than N2 and N4 in crude protein and phosphorus and lower in total ash. N1 was also significantly lower than N2 in crude fibre and higher than N4 in ether extract. Both N1 and N4 were significantly higher than N2 in calcium.

Table 7 also compares the chemical composition of the hays with average data quoted from Morrison's Feeding Standards for alfalfa and western native hays of good and poor quality. The alfalfa hays used in the trials compare quite closely with data for stemmy alfalfa hay. The native hays used, although higher in crude protein, compare quite closely in other nutrients with matured and weathered native hay. This comparison indicates that the hays used in the trials were all of low quality.

The faecal samples were analysed for dry matter, crude protein, crude fibre, nitrogen-free-extract, ether extract and total ash, to enable determination of the undigested nutrients in the faeces. Digestibility coefficients and total digestible nutrients were calculated by the method described by Maynard and Loosli (32). No significant differences could be detected between the digestion coefficients obtained from the second trials and those from the first and third trials ($P>0.05$). This indicates the length of preliminary and collection periods, comparing six-day with seven-day periods, had no marked influence on the accuracy of the digestion coefficients obtained. An average of the results of three trials with each type of hay is shown in Table 8.

Table 8 Digestibility Coefficients (percent dry weight)

Type of Hay	Dry Matter	Crude Protein	Crude Fibre	N.F.E.	Ether Extract	TDN
A1 (alfalfa)	55.05	62.74	46.76	58.30	0.00	43.04
N5 (native)	48.57	41.08	53.11	42.00	30.21	38.61
N3 (native)	38.76	19.10	45.00	32.71	41.31	31.23
L.S.D. (0.05)						9.43
L.S.D. (0.01)	10.62	24.84		12.09		
A2 (alfalfa)	50.90	48.81	48.92	52.39	0.00	38.79
N1 (native)	53.40	45.49	63.61	45.85	30.25	43.89
N2 (native)	52.23	36.58	65.87	39.89	31.15	41.77
N4 (native)	43.28	22.85	55.31	31.84	29.62	33.54
L.S.D. (0.05)						
L.S.D. (0.01)						
Alfalfa hay, stemmy*		67	45	64	18	46.3
Alfalfa hay, good*		70	46	69	31	50.3
Native hay, matured and weathered*		40	46	43	25	36.6
Native hay, good*		60	62	62	39	53.8

*Morrison, Frank B. Feeds and Feeding, 22nd edition, 1957. Appendix, Table 1.

In the first group, the alfalfa hay, A1, was found significantly higher than the native hay, N3, in digestibility of dry matter, crude protein, nitrogen-free-extract, ether extract and in total digestible nutrients. It was significantly higher than the native hay N5 in nitrogen-free-extract and ether extract. No differences were found between the two native hays. In the second group no significant differences could be detected.

Digestibility coefficients of zero were obtained for ether extract in the alfalfa hays probably because the ether extract in these hays consists largely of unsaponifiable constituents which are not digested (32). However, the ether extract is not of great importance as it makes up such a small proportion of the nutrients in most roughages.

In comparing the native hays, although significant differences could not be detected because of the great variability in the data, the low digestibility of dry matter in N3, crude protein in N3 and N4, and the low content of total digestible nutrients in N3 and N4 are most marked.

The limited significant differences between the alfalfa and native hays can probably be attributed to the low quality of all the hays and to the great variability between the samples. A comparison with average digestion coefficients quoted from data in Morrison's Feeding Standards, and listed in Table 8, once again indicates that the alfalfa and native hays used in the digestion studies were of low quality, as they correspond fairly closely with stemmy alfalfa hay and matured and weathered native hay respectively.

A comparison of the nutritive values for the hays used in the digestion studies is given in Table 9. In the first group of hays used in the studies, the alfalfa hay, A1, was found to be significantly higher than both native hays in crude protein, digestible crude protein, calcium and phosphorus. It was also significantly higher than the native hay, N3, in total digestible nutrients.

Table 9 A Comparison of Some Nutritive Values for the Hays Used in the Feeding Trials with Recommended Requirements

	Allowance as Percent of Ration					
	Crude Protein	Digestible Protein	TDN	Ca.	P.	Carotene Mg./lb.
A1 (alfalfa)	13.74	8.62	43.04	1.05	0.18	2.1
N5 (native)	6.99	2.87	38.61	0.26	0.07	2.1
N3 (native)	5.35	1.02	31.23	0.29	0.05	4.3
L.S.D. (0.05)	1.28		9.43		0.03	
L.S.D. (0.01)	2.12	2.35		0.18		
A2 (alfalfa)	10.64	5.19	38.79	0.84	0.11	2.1
N1 (native)	6.99	3.18	43.89	0.25	0.07	3.6
N2 (native)	6.24	2.28	41.77	0.16	0.04	2.6
N4 (native)	5.92	1.35	33.54	0.25	0.05	0.8
L.S.D. (0.05)					0.01	
L.S.D. (0.01)	0.67	1.99		0.07	0.02	
Lambs and Yearlings (120 lb.)*	7.2	4.0	52	0.17	0.15	0.8
Yearling Beef Cattle (800 lb.)**		4.5	50	0.20	0.15	2.7
Dairy Heifers (800 lb.)*		4.7	53	0.15	0.15	1.7

*National Academy of Sciences - National Research Council. Nutrient Requirements of Domestic Animals. No. 111, 1956 and No. V, 1957.

**National Academy of Sciences - National Research Council. Recommended Nutrient Allowances for Beef Cattle. No. 1V, 1950.

In the second group the alfalfa hay, A2, was significantly higher than the three native hays in crude protein, digestible crude protein, calcium and phosphorus. In comparing the native hays in this group, N1 was found to be significantly higher than N2 and N4 in crude protein, and higher than N4 in digestible crude protein and phosphorus. Both N1 and N4 were significantly higher than N2 in calcium.

The nutritive value of these hays may be compared with the requirements recommended for three classes of livestock by the National Research Council (Table 9). The alfalfa hays appear adequate in crude protein, digestible crude protein and calcium for animals in all three classes. Both alfalfa hays are deficient in total digestible nutrients, one appears deficient in phosphorus, and both appear deficient in carotene for growing beef cattle.

All of the native hays are low in crude protein, digestible crude protein, total digestible nutrients and phosphorus. One of the native hays, N2, appears slightly deficient in calcium, and one, N4, seems to be deficient in carotene.

It may be noted that the daily feed consumption by the wethers was low in comparison to the amounts they should have consumed, particularly for the native hays (Table 10). The daily intake of certain nutrients by the wethers was calculated, using the average values for feed consumption during the trials, the chemical composition of the hays and the digestibility coefficients obtained. In the first group the alfalfa hay, A1, was found to supply a significantly higher daily intake of dry matter, crude protein, digestible crude protein, total digestible nutrients, calcium and phosphorus than the native hay, N3. It also provided a significantly higher daily intake of crude protein, digestible crude protein, calcium and phosphorus than did the native hay, N5. No significant differences were found between the two native hays.

Table 10 Daily Consumption of Certain Nutrients by Wethers Compared with the Recommended Requirements

	Daily Feed lb./Animal	Protein lb.	D.P. lb.	TDN lb.	Ca. gm.	P. gm.	Carotene mg.
Lambs and Yearlings (120 lb.)*	4.2	0.31	0.17	2.2	3.2	2.9	3.4
A1 (alfalfa)	3.0	0.41	0.26	1.29	14.1	2.7	6.3
N5 (native)	2.5	0.17	0.07	0.97	3.2	0.9	5.3
N3 (native)	2.1	0.11	0.02	0.66	2.7	0.5	9.0
L.S.D. (0.05)	0.6						
L.S.D. (0.01)		0.14	0.09	0.55	4.28	1.06	
A2 (alfalfa)	3.0	0.32	0.16	1.16	11.3	1.4	6.3
N1 (native)	1.9	0.13	0.06	0.83	2.3	0.5	6.8
N2 (native)	1.8	0.11	0.04	0.75	1.4	0.4	4.7
N4 (native)	1.6	0.09	0.02	0.54	1.8	0.4	1.3
L.S.D. (0.05)	0.4	0.02	0.02	0.20	0.81		
L.S.D. (0.01)		0.04	0.04	0.30	1.22	0.30	

*National Academy of Sciences - National Research Council. Nutrient Requirements of Domestic Animals. No. V, 1957.

In the second group the alfalfa hay, A2, was found to supply a significantly higher daily intake than did all three native hays in dry matter, crude protein, digestible crude protein, calcium and phosphorus. It provided a significantly higher daily intake of total digestible nutrients than did the native hays, N2 and N4. The daily intake of crude protein, digestible crude protein and total digestible nutrients from N1 was significantly greater than from N4.

Comparing the daily intake of these nutrients by the wethers in the trials with the daily requirements for sheep of similar weight by the National Research Council, the alfalfa hays, A1 and A2, appear adequate in crude protein, digestible crude protein, calcium and carotene. They supply a ration apparently deficient in total digestible nutrients and phosphorus, although improved consumption would have largely eliminated these deficiencies.

The rations consisting of native hays were very deficient in crude protein, digestible crude protein, total digestible nutrients and phosphorus. Four of them appear somewhat deficient in calcium and one shows a deficiency in carotene.

The daily nutrient consumption, expressed as a percentage of the recommended requirements, is presented in Table 11. The data in this table can be used to illustrate the lowered feed consumption and the deficiencies of the rations of native hay in protein, digestible crude protein, total digestible nutrients, calcium and phosphorus. An increased consumption of dry matter, which might be expected under a more normal environment, might have largely eliminated the deficiencies in calcium and reduced the deficiencies in digestible crude protein and total digestible nutrients. However, all the native hays would still be supplying rations very deficient in phosphorus, and three would remain very deficient in digestible crude protein and total digestible nutrients. Two of the hays, N2 and N4, would probably supply insufficient calcium and one, N4, would supply insufficient carotene.

Table 11 Daily Nutrient Consumption as a Percentage of the Recommended Requirements

	Daily Feed Per Animal	Crude Protein	D.P.	TDN	Ca.	P.	Carotene
Lambs and Yearlings (120 lb.)*	100	100	100	100	100	100	100
A1 (alfalfa)	71.4	132.2	152.9	58.6	440.6	93.1	185.3
N5 (native)	59.5	54.8	41.2	44.1	100.0	31.0	155.9
N3 (native)	50.0	35.5	11.8	30.0	84.4	17.2	264.7
A2 (alfalfa)	71.4	103.2	94.1	52.7	353.1	48.3	185.3
N1 (native)	45.2	41.9	35.3	37.7	71.9	17.2	200.0
N2 (native)	42.9	35.5	23.5	34.1	43.8	13.8	138.2
N4 (native)	38.1	29.0	11.8	24.5	56.3	13.8	38.2

*National Academy of Sciences - National Research Council. Nutrient Requirements of Domestic Animals. No. V, 1957.

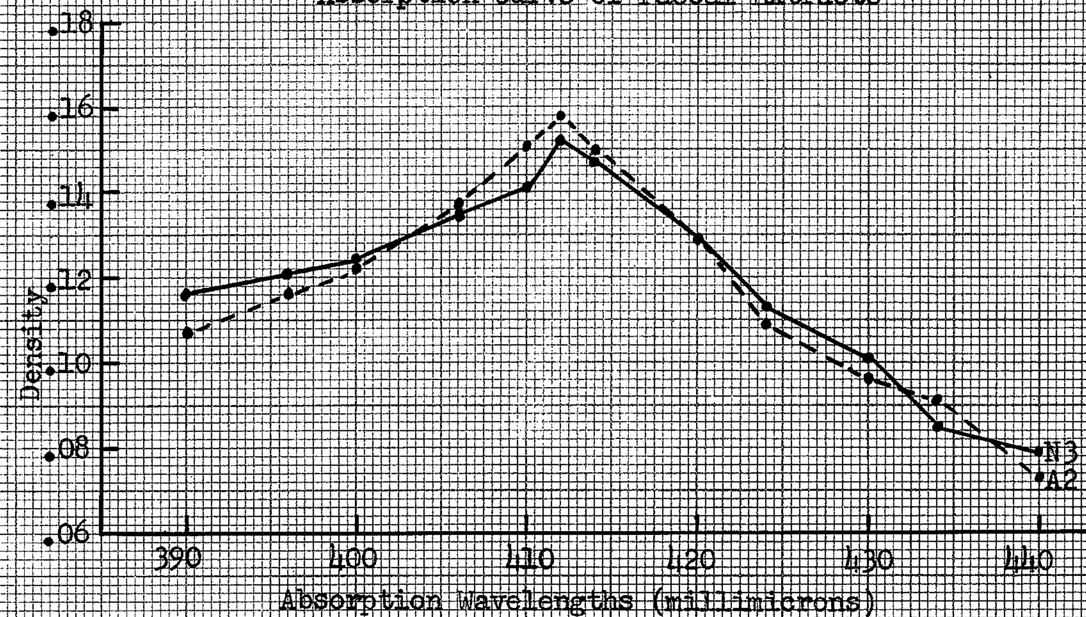
The Chromogen Method of Determining Digestibility

The faecal extracts were found to give a maximum absorption peak at a wavelength of 412 mu (Graph 1), so all density readings of the faecal extracts were obtained at this wavelength. The density readings were converted to units of chromogen per gram of dry faeces by reference to a 5.05 mg. percent solution of sodium chromate, which was defined as being equal to 10 units of chromogen (Graph 2). The density readings obtained appeared to be very low, ranging from 0.338 down to 0.116, and consequently the concentration of chromogen was also very low, ranging from 13.4 units down to 4.6 units per gram of dry faeces (Table 12).

Because of the low concentration of chromogen, it was found that the data did not fit the equations developed by Reid et al (36) for

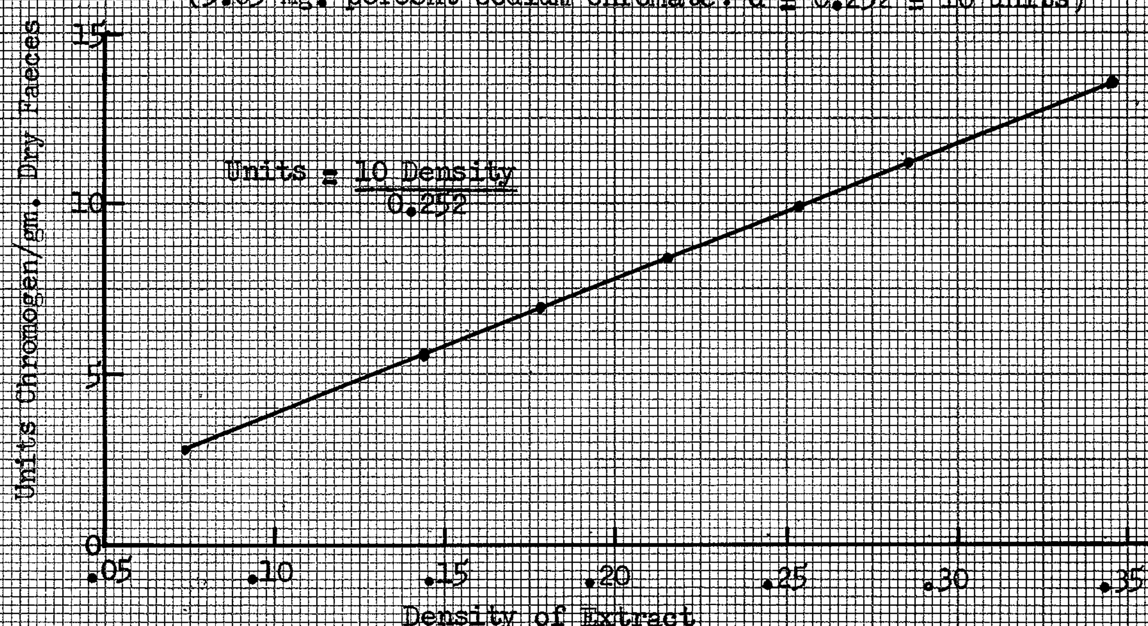
GRAPH 1

Absorption Curve of Faecal Extracts



GRAPH 2

Standard for Determining Units Chromogen from Density of Extract
(extract of faeces from N2 successively diluted)
(5.05 mg. percent sodium chromate: d = 0.252 = 10 units)



computing the units of chromogen in the forage, and for determining the dry matter digestibility from the concentration of chromogen in the faeces. These equations, therefore do not seem applicable to dried forages containing such low concentrations of chromogen.

An alternative procedure would have been to obtain feed extracts and determine the concentration of chromogen in the feed, so that digestibility could have been determined by the ratio method. However, in testing a few forage samples, the extracts gave concentrations of chromogen much lower than expected, leading to very high digestibility coefficients as compared to data obtained by the conventional method. This was probably because of selective feeding by the wethers, which made it impossible to obtain representative samples of the feed with chromogen concentrations comparable to that of the faeces. It must also be considered that, with the low concentrations of chromogen that were found in the feed and faeces, incomplete recovery of the chromogen from the feed samples would cause considerable error in the calculation of digestibility.

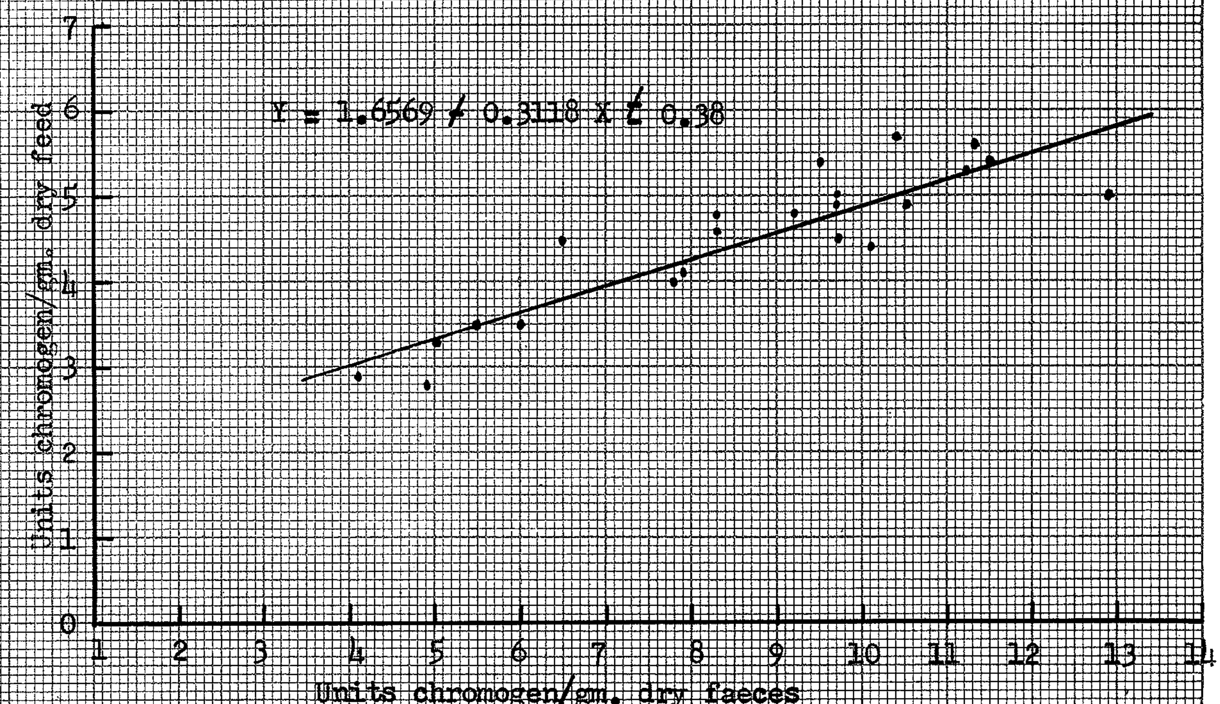
Since the chromogen concentration of the faeces is quantitatively related to the chromogen concentration of the feed (36), it was possible, knowing the chromogen concentration of the faeces, the total feed consumption and the total faecal excretion, to compute the units of chromogen per gram of dry forage (Table 12). The units of chromogen per gram of dry faeces and the units of chromogen per gram of dry feed were plotted (Graph 3). A prediction equation was obtained, using this data, for computing the concentration of chromogen in the feed from the concentration in the faeces:

Table 12 Concentration of Chromogen in Feed (computed)

Faecal Sample	Trial No.	Density	Units Chromogen per gm. Faeces	Feed D.M.	Faeces D.M.	Units Chromogen per gm. Feed
A1	1	0.293	11.6	7483	3408	5.3
	2	0.257	10.2	8456	3750	4.5
	3	0.276	11.0	10802	4858	4.9
N5	1	0.222	8.8	7645	4181	4.8
	2	0.274	10.9	6156	3198	5.7
	3	0.295	11.7	9123	4348	5.6
N3	1	0.139	5.5	6592	3986	3.3
	2	0.151	6.0	6149	3586	3.5
	3	0.177	7.0	5961	3871	4.5
A2	4	0.257	10.2	8909	4283	4.9
	4	0.212	8.4	9542	4731	4.2
	4	0.244	9.7	10299	5112	4.8
N1	1	0.256	10.2	6934	3399	5.0
	2	0.208	8.3	6350	3142	4.1
	3	0.268	10.6	4283	1769	4.4
N2	1	0.251	10.0	5889	3170	5.4
	2	0.338	13.4	3720	1379	5.0
	3	0.222	8.8	6530	3423	4.6
N4	1	0.164	6.5	3792	2025	3.5
	2	0.136	5.4	4464	2352	2.8
	3	0.116	4.6	6118	3919	2.9

GRAPH 3

Chromogen Concentration in Feed and Faeces



$$Y = 1.6569 + 0.3118 X \pm 0.38$$

Further work would be required to test the validity of this equation, and it could be expected to apply only to similar mature hays with corresponding digestibilities and concentrations of chromogen.

DISCUSSION

It seems that a large proportion of the cattle in the Interlake District are raised almost entirely on native roughages, because only an average of four percent of the land is utilized in the production of cereal grains and cultivated forages. The supply of cereal grains is, therefore, very limited, and grain supplements are used mainly by dairy farmers for their milking cows.

The nutritive value of the native forages, then, is of great importance in assessing nutritional deficiencies for this district. The analyses of the native forage samples indicated the native hays were low in phosphorus and also slightly deficient in protein for growing cattle, whereas the cultivated hays were adequate in protein and just barely adequate in phosphorus. The native hays used in the digestibility trials were low in their content of protein, nitrogen-free-extract and phosphorus, and high in crude fibre. The digestibility of the major nutrients was also found to be low, resulting in low total digestible nutrient content in the hays studied. In comparing the content of digestible nutrients in the hays with the nutrient requirements of some domestic animals, the native hays appear to be quite deficient in digestible crude protein, total digestible nutrients and phosphorus. They are generally adequate, although fairly low in calcium and carotene.

The consumption of the hays used in the trials was also very low, ranging from sixty percent to as low as thirty-eight percent of an expected normal consumption for sheep of that weight range. It would be expected that animals confined in metabolism cages would eat less than in a normal environment (20), but from the variation in the feed consumption, it is certainly indicated that the native hays were not as palatable as the alfalfa hays used as controls, and that some of the native hays were less palatable than others.

From the data on daily nutrient consumption, in Tables 10 and 11, it can be shown that a 100 percent increase in the consumption of the native hays used would still leave deficient intakes of digestible crude protein, total digestible nutrients and phosphorus. The deficiencies would be quite serious for phosphorus in all of the native hays, and for digestible crude protein and total digestible nutrients in at least three of the hays.

The factors of major importance then, are deficiencies in phosphorus, digestible crude protein and total digestible nutrients, as influenced by low content of these nutrients in the hays, low digestibility, and reduced feed consumption. These findings are in keeping with results obtained by Clarke and Tisdale (15), Bell _et al_ (4) and Baker _et al_ (2).

The deficiency in phosphorus seems to be the most severe. It is not likely that improved cultural practices, with the possible exception of the application of phosphate fertilizers to the soil, will eliminate this deficiency entirely. The native hay samples were all low in this nutrient, and even the cultivated hay samples were fairly low in phosphorus. The survey indicated the deficiency symptoms in cattle were most noticeable in the late winter and early spring. However, it seems that phosphorus is likely to be deficient in the feed over a major part of the year, since forage samples obtained in July were then low in phosphorus. It was found in the survey that many of the farmers were using bonemeal as a phosphorus supplement, but it is doubtful whether a large proportion of them are using it constantly or in sufficiently large amounts. The data of this investigation indicate the need for a phosphorus supplement, such as bonemeal or dicalcium phosphate, constantly supplied *ad libitum* to the livestock. Phosphorus supplements contain fairly large amounts of calcium, and, because some of the native hays studied appeared somewhat deficient in this mineral, phosphorus supplementation would also ensure an adequate supply of calcium.

The deficiencies of digestible protein and total digestible nutrients could be considerably reduced through increased consumption. This is mainly a matter of improving the palatability of these low-quality hays, and, as noted in the review of literature, the use of cane molasses, pelleting the ration, or replacing part of the ration with leaf meal or high quality legume hay should aid considerably in increasing feed consumption and the rate of animal gains. However, it is doubtful in every case whether the improvement resulting from these methods would justify the expense involved, particularly with respect to present pelleting costs.

Even with increased consumption of these low-quality hays, it seems that additional supplementation would be required. The rather serious deficiency of digestible crude protein indicates the need for a protein supplement such as soybean oil meal, especially for young growing animals. Increasing the protein in the ration would probably also increase the total feed consumption and the digestibility of the other nutrients (11). The need for an increased use of cereal concentrates is also indicated, to ensure an adequate supply of total digestible nutrients. It must be realized that with such a small production of cereal grains in the Interlake District, most of the cereal concentrates required will have to be brought in from other districts, making them more expensive. But it is only by feeding a ration adequate in the supply of digestible protein and total digestible nutrients that good results can be expected in cattle production.

Further investigations would be desirable through additional feeding trials of a longer duration, to obtain feed consumption data under a more normal environment to assess the effects of protein supplementation and cereal concentrates, before establishing a supplementation regime for these native hays.

The best approach to the problem of improving nutrition for livestock production in the Interlake District, is probably through the production of hays of a higher quality, which would be more readily consumed and have a higher nutrient content. Cutting the forage at an advanced stage of maturity, as is currently practiced, must be an important factor in obtaining unpalatable and less-nutritious hays, because of the low content of crude protein and the high content of crude fibre in the native forages.

As noted in the review of literature, other investigations have found mature forages to be low in crude protein and high in crude fibre, resulting in low nutrient digestibility. It was found that hays cut at an earlier stage of growth, although containing possibly less total dry matter per acre, actually gave greater animal gains per acre of forage and required less feed per hundred pounds of gain. This indicates that a possible approach to the problem here would be cutting the forages at an earlier stage of growth to secure a more palatable and more nutritious feed.

In addition, the increased use of cultivated forages must be considered. The analysis of the cultivated hay samples indicated a higher nutrient content for protein, calcium and phosphorus. Clarke and Tisdale (15) and Bell et al (3) also reported cultivated forages to be somewhat superior to the native forages in their nutrient content. This indicates that, where the land is at all suitable, increased use of cultivated grasses and legumes would help to produce more nutritious roughages, and reduce the need for supplementation. Again, cutting these forages at an earlier stage of growth than is currently practiced, would also be of considerable value in increasing still further the palatability and nutritive value of these roughages.

The plant pigment method of determining digestibility was not found applicable to mature dry forages with low concentrations of chromogen, such as were used in these digestion studies. The concentrations obtained were found to be too low to be used in the formulas developed by Reid et al (36). Although a prediction equation was developed as a possible means of calculating feed chromogen from faecal chromogen, to enable determining digestibility by the ratio method, it would require considerably more investigation with similar types of hays, with low concentrations of chromogen, to determine its accuracy and possible usefulness.

SUMMARY

The investigation brought out the following facts of importance:

1. The native hays in the Interlake District are generally deficient in digestible protein, total digestible nutrients and phosphorus, as well as being of a low palatability.
2. The use of a phosphorus supplement, such as bonemeal or dicalcium phosphate, appears to be required throughout the year.
3. The use of the present low-quality hays requires additional supplementation with protein and cereal grains to ensure a ration adequate in digestible crude protein and total digestible nutrients.
4. The chromogen method of determining digestibility, as used in these studies, was not applicable to native hays with such low concentrations of chromogen.

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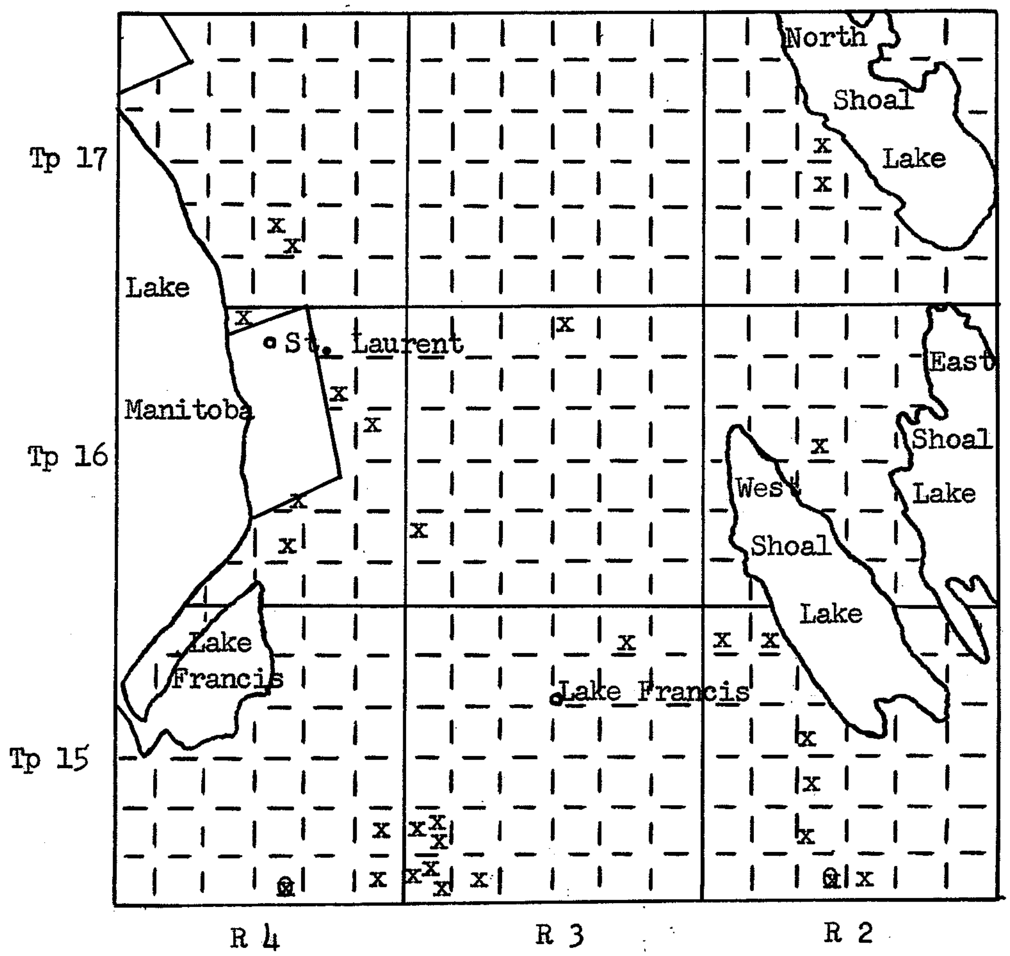
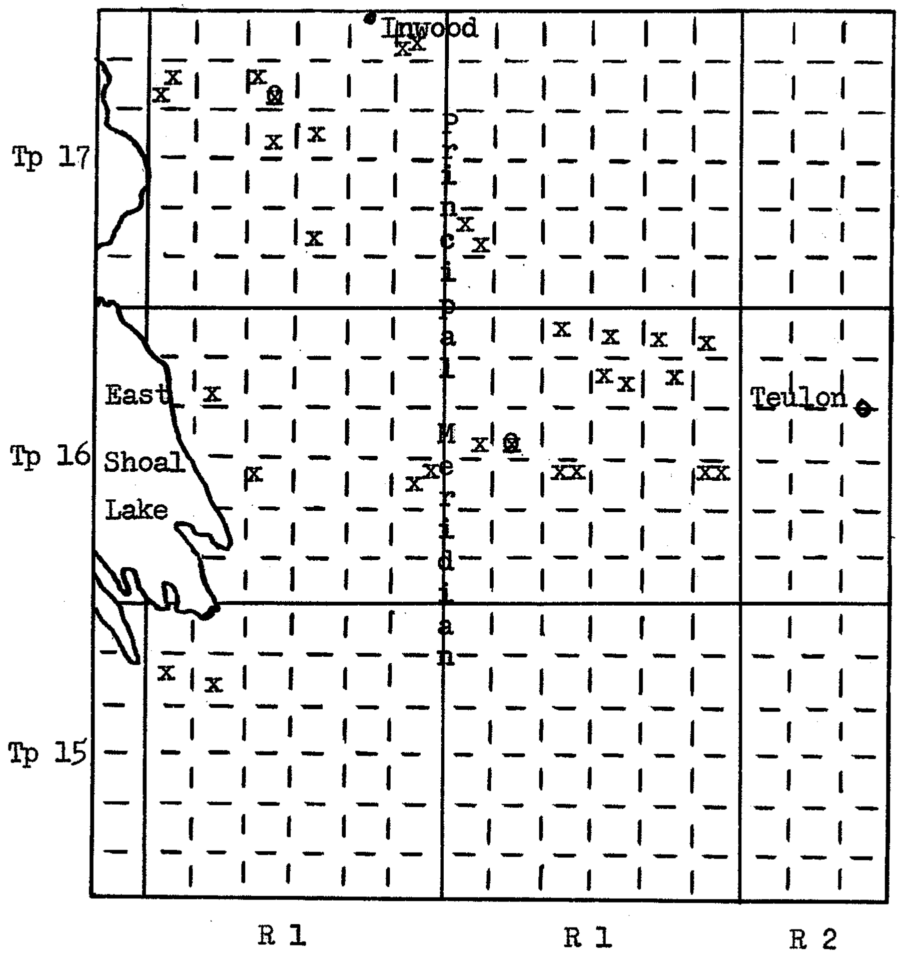
APPENDIX 1



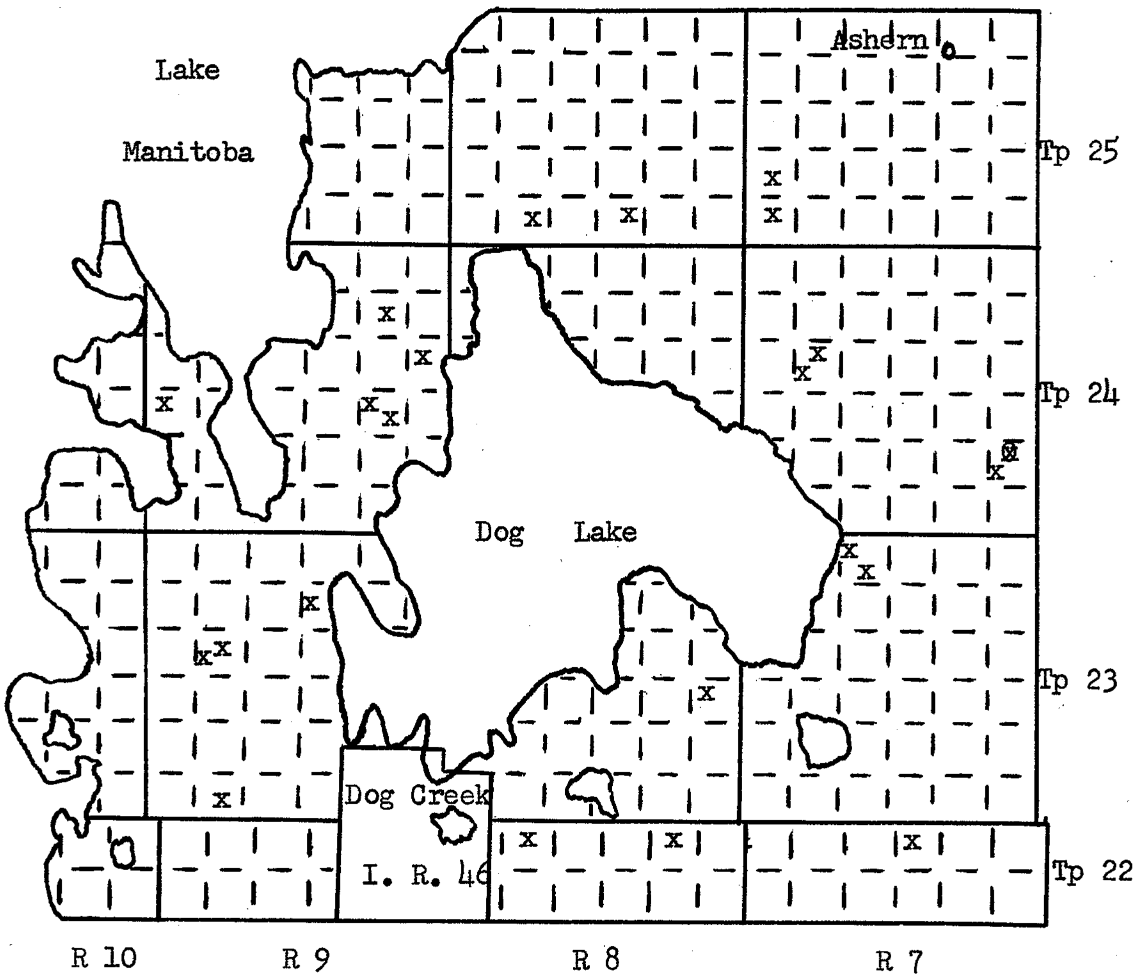
Map of Lake Francis area.
Scale: $\frac{1}{4}$ inch = 1 mile
x: locations of hay samples
⊗: locations of hays used in digestibility trials

APPENDIX 11



Map of Teulon area.
Scale: $\frac{1}{4}$ inch = 1 mile
x: locations of hay samples
⊗: locations of hays used in digestibility trials

APPENDIX 111



Map of Ashern area.
Scale: $\frac{1}{4}$ inch = 1 mile
x: locations of hay samples
ⓧ: location of hay used in digestibility trials

APPENDIX 1V

INTERLAKE CATTLE SURVEY, 1957

NAME: ______________________________ Sec. _____ Twp. _____ Rg. _____

P. O. ______________________________ Date ______________

Ac. owned ____________ Ac. rented ______ Ac. leased ______ Total ______

Ac. Barley ______ Wheat ____ Oats ______ Others ______ Total ______

Ac. Cultivated Pasture ______________ Species ______________

____

Samples ______________________________ Conditions ____________

____

Ac. Cultivated Hay ____________________ Species ______________

____

Samples ______________________________ Conditions ____________

____

Ac. Native Pasture ____________________ Species ______________

____

Samples ______________________________ Conditions ____________

____

Ac. Native Hay ________________________ Species ______________

____

Samples ______________________________ Conditions ____________

____

CATTLE

TYPE: Beef ______________ Dual-Purpose ______________ Dairy ______________

Breed ____

No. Bulls ______________ Age ______________ Breed ______________

No. Cows ______________ Av. Age ______________ Milk Yield ______________

No. 2 year old heifers ______________ No. yearling heifers ______________

No. 2 year old steers ______________ No. yearling steers ______________

No. calves ______________ Remarks ______________________________

____

____

____

____

Age of Castration ______________ Method ______________________________

Age of Dehorning ______________ Method ______________________________

Time calves dropped ____

Time calves weaned ____

Surplus: 1. Feeders ______________ Age ______________

Weight ____

Grade ____

2. Finished ______________ Age ______________

Weight ____

Grade ____

WINTER FEEDING PROGRAM

A. Breeding Herd:

Type Hay ______________ lb. Grain ______________

Mixture ______________________________

Amt. Protein Supplement ______________ Brand Name ______________

Amt. Mineral Supplement ______________ Brand Name ______________

Remarks ______________________________

____

____

B. Young Stock:

Type Hay ______________ lb. Grain ______________

Mixture ______________________________

Amt. Protein Supplement ______________________________

Amt. Mineral Supplement ______________________________

Remarks ______________________________

____

____

C. Feeder Calves:

Type Hay ______________ lb. grain ______________

Mixture ______________________________

Amt. Protein Supplement ______________________________

Amt. Mineral Supplement ______________________________

Remarks ______________________________

____

____

HOUSING AND MANAGEMENT

A. Housing

Size ____

Type of Construction ______________________________

____

____

____

B. Pasture Management

____

____

____

____

____

C. Disease Problems

No. deaths in 1956 - 1957 __________________________

Apparent causes ___________________________________

____

____

Veterinarian's Diagnosis ____________________________

____

____