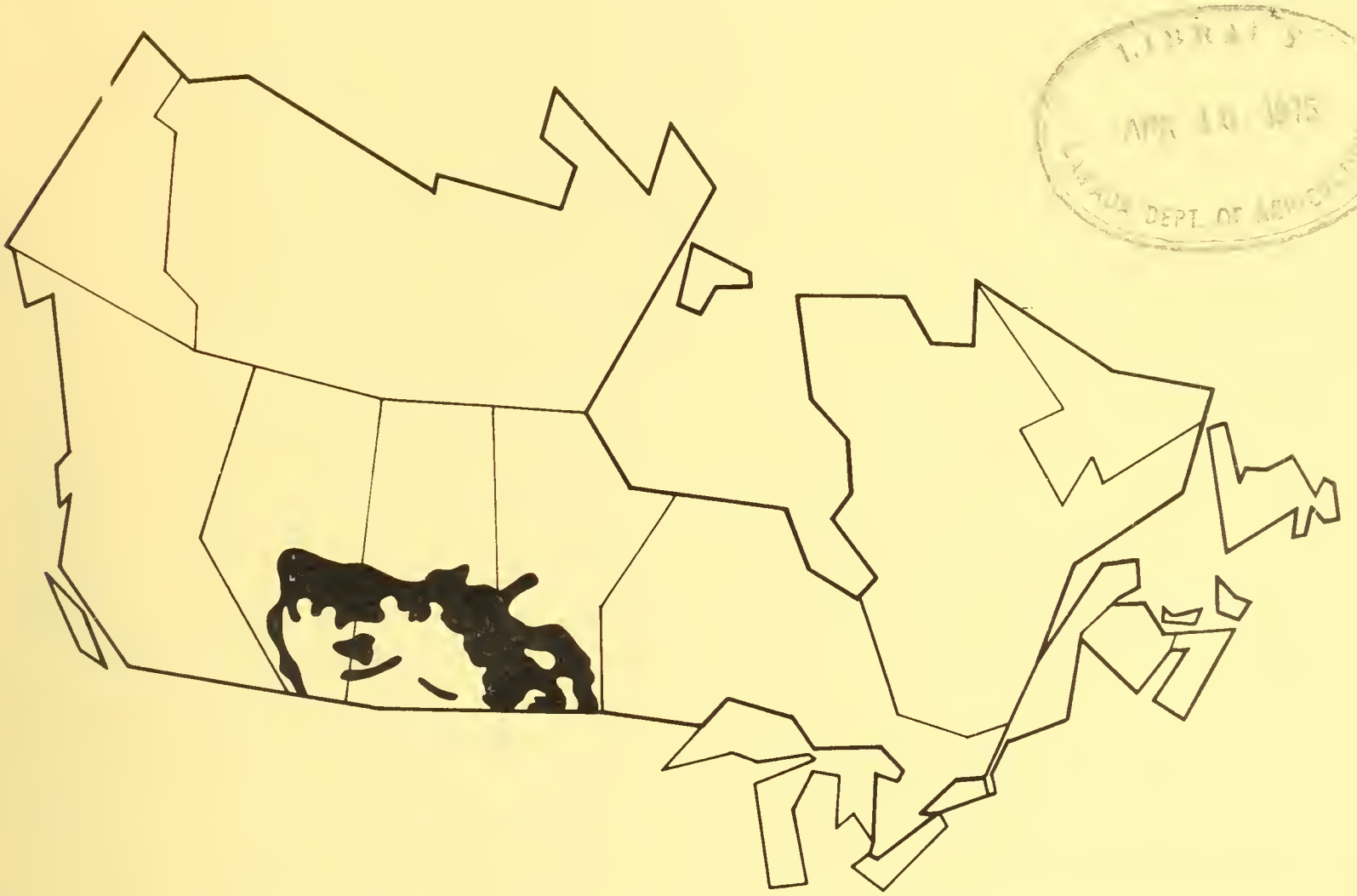

FORAGE CROP PRODUCTION in the aspen parklands of Western Canada

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FORAGE CROP PRODUCTION IN THE ASPEN PARKLANDS OF WESTERN CANADA

MELFORT RESEARCH STATION

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FOREWORD

Forage crop production has a vital role to play in diversifying the agricultural economy of the prairies and maintaining the productivity of the soil. It is fairly safe to say that most farms in the aspen parklands of Western Canada would benefit considerably if more forage was included in the cropping program. This is especially true in areas difficult to work or that regularly experience spring flooding, a short frost-free period or serious soil erosion. There are also advantages in growing forage crops on land suitable for the production of so-called cash crops.

By growing legumes such as sweetclover, the grain farmer can benefit through improved fertility and physical conditions of his soil. He can produce hay as a cash crop, to better utilize his labor supply and diversify his income possibilities. The livestock producer, whether a cow-calf operator or cattle finisher, can benefit by being independent of others for his feed supply. He also has some options available to him in formulating his rations to take advantage of the cheapest feeds available and in being able to take advantage of market demands for hay in times of shortages elsewhere.

The economics of forage crop production has suffered in the past, and still does to some extent, by a shortage of technological input. Perhaps because of this, forages on many farms are grown on the least-productive areas, pastures are mismanaged and haying operations are given a low priority. Even when hay is harvested, it often seriously deteriorates in feeding value because of inadequate protection from weathering during the period from harvesting to feeding. Until recently, the technology of utilizing forages in productive rations for ruminants has been largely ignored.

It is rapidly becoming obvious that if ruminant livestock are to survive as a component of the agricultural industry, their ability to convert plant materials and other sources of nutrients not directly consumable by humans, into meat and milk, must be utilized to the full. For the foreseeable future, it will probably be unacceptable, both economically and morally, to continue to feed high-energy grains as the major component of ruminant rations.

The staff at the Research Station at Melfort has been working for many years to improve the efficiency of forage crop production and utilization. Varieties are continually being tested for yield and winterhardiness. Fertilizer requirements are being determined, methods of establishment evaluated, and harvesting systems devised to optimize yield of forage nutrients per acre and minimize deterioration of forage during storage. Harvested hays are being processed and utilized in production rations for beef cattle and lambs. In addition, pasture production and utilization have received considerable attention in the past and will continue to do so, except that less-productive land will now be utilized and the emphasis will shift from the growing-finishing steer to the beef cow and her calf.

This publication summarizes research carried out at the Melfort Station on the production of forage crops. It is one of a series of publications whose aim is to help farmers grow, harvest and use forage crops efficiently, so that their efforts are financially rewarding. Although much of the material on varieties, fertilizer response and crop establishment is limited to areas with climatic and soil conditions similar to those in northeastern Saskatchewan, the information in subsequent publications on forage harvesting and utilization should have a much wider application.

S.E. Beacom,
Director.

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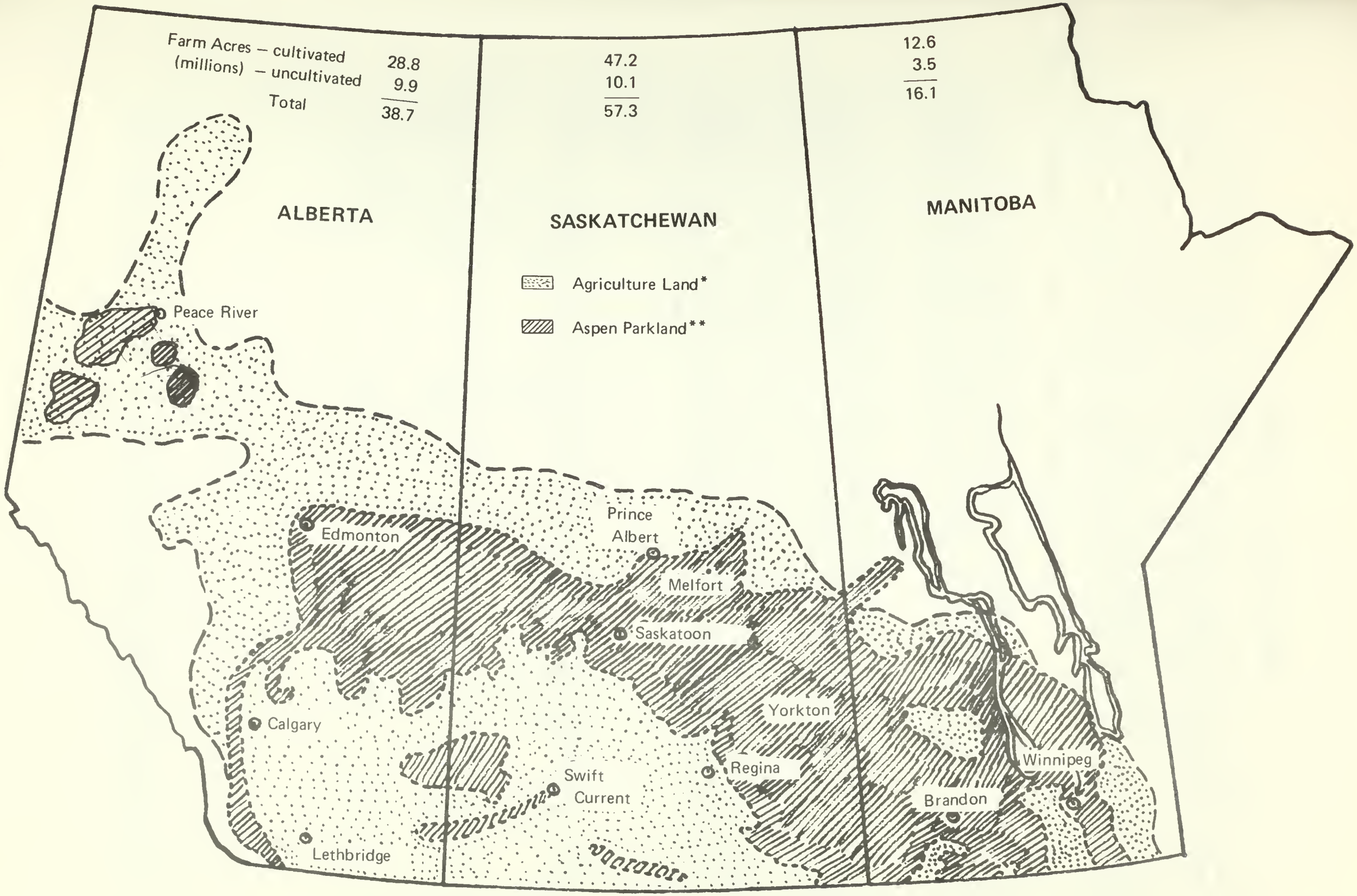

Figure 1 — Estimated extent of aspen parkland in relation to the agricultural area of the Prairie Provinces.

* *1972 Crop Distribution in Alberta, Saskatchewan and Manitoba.* Alberta Agtex 110-01.

** *Ecology of the Aspen Parklands of Western Canada,* 1961, R.D. Bird, CDA pub. 1066; *Prairie Settlement, the Geographical Setting,* (Figure 24), A. Mackintosh; and *Soil Zones in Manitoba,* J.H. Ellis.

FORAGES IN CROP ROTATIONS

Forage crops, both legumes and grasses, should form a definite part of crop rotations in the aspen parklands of Western Canada. Research has shown that the minimum acreage devoted to forage crops should range from 25% on Black soils to 60% on the Gray Luvisol and sandy soils of the area. Crop rotations must be flexible to allow a farmer to adjust his cropping practice to meet market demands and take advantage of special circumstances. Thus, it is not possible to design or follow a rotation that will be satisfactory under all conditions.

COMPARISON OF GRAIN AND GRAIN-FORAGE RATIONS

The following results of research, comparing a commonly used straight grain rotation with a grain-forage rotation on five different soil types, illustrate the main advantages of using forage crops in rotations. Forages not only increase crop yields (Tables 1 and 2) and returns but greatly improve the nutrient content and texture of the soil.

In the 3-year straight grain rotation (fallow, wheat, wheat), the annual allotment for 160 acres is 106.6 ac wheat and 53.3 ac summerfallow. The grain-forage rotation (fallow, wheat, hay, hay, wheat, wheat) covers 6 years and the annual allotment for 160 acres is 80 ac wheat, 53.3 ac hay and 26.6 ac fallow.

The grain-forage rotation can be modified to meet the needs of many farm operations. For example, it can be extended to a longer term; the forage can be used for hay, pasture or seed; and the cereal crop can be replaced by an oilseed, special or feed crop without hindering the benefits of including forage crops in the rotation regularly.

Yields

Table 1 - Average Crop Yields from 3-year Straight Grain Rotation, lb/ac

Location Soil type* Years	Melfort Msic 17	Archerwill WvL 20	Henribourg SbLL 15	Somme Tic 17	White Fox WfVL 28
Wheat on fallow	2457	1788	1928	2477	1269
Wheat on stubble	2038	1249	1256	1625	818
Total annual wheat production, cwt/160 ac	2395	1619	1697	2186	1112

*Soil type - Msic, Melfort silty clay; WvL, Waitville loam; SbLL, Shelbrooke light loam; Tic, Tisdale clay; WfVL, White Fox very fine sandy loam.

Table 2 - Average Crop Yields from 6-year Forage-Grain Rotation, lb/ac

Location Soil type* Years	Melfort Msic 17	Archerwill WvL 20	Henribourg SbLL 15	Somme Tic 17	White Fox WfVL 28
Wheat on fallow	2452	1839	1737	2800	2097
Wheat on stubble	2022	1406	1257	1907	1507
Wheat on sod fallow	2057	1501	1444	2365	1622
Hay 1st year	2079	3062	2319	2396	2891
Hay 2nd year	3329	3067	2969	2539	2832
Total annual production, cwt/160 ac					
- wheat	1737	1262	1181	1881	1390
- hay	1439	1630	1407	1313	1522

Returns

The economic value of including forages in cropping systems fluctuates from farm to farm and from year to year, depending on the use that can be made of the forage crop and the relative market value of forage and grain crops. Table 3 gives the relative value of hay to wheat (per unit of weight) required to provide equal returns per acre from the 6-year grain-forage rotation and the 3-year straight grain rotation at each station.

Table 3 - Relative Value of Hay to Wheat

Station	Ratio
Melfort	0.46 : 1
Archerwill	0.21 : 1
Somme	0.23 : 1
Henribourg	0.36 : 1
White Fox	-0.18 : 1

In other words, if hay was worth at least 46% as much as wheat on an equal-weight basis, the 6-year rotation paid off at Melfort; but at White Fox, the forage in the rotation caused enough increase in wheat yields that it didn't have to be worth anything to justify its inclusion. It has been noticed that when grain prices increase, as they did in 1973, the market value of forage crops also increases, but at a slightly slower rate.

Soil Improvement

Although difficult to assess in economic terms, rotations with forages also have soil improvement value. This soil improvement is generally more pronounced on degraded and Gray Luvisol soils than on Black soils, which have a higher organic matter content.

*Soil type - Msic, Melfort silty clay; WvL, Waitville loam; SbLL, Shelbrooke light loam; Tic, Tisdale clay; WfVL, White Fox very fine sandy loam.

Soil test results reveal that the inclusion of forages in a rotation affects the nutrient content of the soil. Table 4 shows the amounts of nitrogen (in the surface 2-ft layer) and phosphorus (in the surface 6-in. layer) that were measured in the fall before seeding fallow and stubble land at Melfort and Somme.

Table 4 - Soil Nitrogen and Phosphorus, lb/ac

Rotation	Melfort (Msic) (8-yr av)				Somme (Tic) (7-yr av)			
	Fallow		Stubble		Fallow		Stubble	
	NO_3	P_2O_5	NO_3	P_2O_5	NO_3	P_2O_5	NO_3	P_2O_5
3-yr straight grain	77	25	33	22	50	20	17	20
6-yr grain-forage	102	16	52	19	66	18	51	14

The nitrogen content of the soil was higher on fields where a grass-legume forage was included in the cropping program. Also, comparable fields in the grain-forage rotation produced grain with a slightly higher protein content (0.4% on fallow and 0.7% on stubble on a 4-year average at Melfort and Somme, respectively) than fields in the 3-year straight grain rotation.

Legume crops are particularly useful for improving the nitrogen, organic matter content and tilth of soils. A year's growth of sweetclover contains as much nitrogen as $7 to $12 worth of commercial fertilizer. When sweetclover was addded to a 3-year grain rotation and worked down as a green manure crop at the bud stage during the summerfallow year, total grain production and net return per acre were increased by 20%.

In other studies, the amounts of dry matter and nitrogen in legume crops were measured at various stages of growth (Table 5).

Table 5 - Yields of Dry Matter and Nitrogen, lb/ac

	Yield dry matter			Yield nitrogen		
	Alfalfa	Red clover	Sweet-clover	Alfalfa	Red clover	Sweet-clover
Seedling stage	1457	1361	1677	34	28	40
Early-bud stage	2173	1592	2433	62	43	72
Full-bloom stage	4311	3479	4786	84	67	79
Mature-seed stage	4686	4380	4891	88	82	57

If the alfalfa, red clover and sweetclover had been used as green manure at the early-bud to full-bloom stages of growth, they would have returned, respectively, some 62-84, 43-67 and 72-79 lb of nitrogen to the soil. Legumes also add a large amount of dry matter to the soil, which helps increase organic matter content and improve tilth. If hay or seed is removed from the legumes after the bud stage and only the roots are worked into the soil, alfalfa and red clover add proportionately more dry matter and nitrogen than sweetclover.

Experienced farmers agree that both sweetclover and alfalfa make good green manure crops. However, although herbicides can be used safely to control many broad-leaved weeds in seedling stands of alfalfa, they are not recommended in sweetclover. Also, alfalfa stubble supplies more nitrogen and organic matter than sweetclover does. On the other hand, alfalfa is usually more difficult to kill in the plow-down operation.

In addition to providing an important source of feed for livestock, grass crops build up soil organic matter and humus content and assist in controlling erosion. In 3 years, a stand of bromegrass, crested wheatgrass, intermediate wheatgrass or Russian wild ryegrass builds up about 2.5 tons of root fiber in the top 1 ft of soil.

BREAKING GRASS SOD FOR CEREAL SEEDBED

Research on methods of breaking and length of summerfallowing bromegrass sod and intermediate wheatgrass sods revealed that moldboard plowing, though expensive, is effective in breaking grass sod. All methods of breaking produced about the same clod structure, but plowing produced the highest crop yields and retained the least amount of root fiber in the surface soil on both grass sods, as shown in Tables 6 and 7.

Table 6 - Wheat Yields, lb/ac

Method of breaking and length of fallow	1st crop after breaking			Total of 1st two crops after breaking		
	Brome-grass	Int. wheat-grass	Av	Brome-grass	Int. wheat-grass	Av
Full fallow						
Plow	2060	2120	2090	3400	3450	3425
Discer	1980	1840	1910	3320	3040	3180
Cult. spike	1950	1890	1920	3370	3170	3270
Rotary cultivator	1900	1810	1855	3290	3100	3195
Partial fallow						
Plow	1750	1750	1750	3050	2930	2990
Cult. spike	1760	1500	1630	2950	2790	2870
Rotary cultivator	1680	1490	1585	2900	2740	2820
Av full fallow	1970	1920	1945	3350	3190	3270
Av partial fallow	1730	1580	1655	2970	2820	2895

Full fallow treatments were broken on August 15 and summerfallowed until seeding 22 months later. Partial fallow treatments were broken on July 10, after the hay was harvested, and fallowed until the next spring or seeded 11 months later. As shown in the table, the partial fallow treatments produced, on the average, 400 lb/ac less grain in the first two crops after breaking. In the first 2 years, however, the partial fallow produced more grain (about 1.5 times) than the full fallow, since two crops were grown on the partial fallow (total av 2895 lb/ac) as against one on the yearlong fallow (av 1945 lb/ac).

Table 7 - Condition of Surface Soil (0-1 in.) after Breaking Grass

Method of breaking and length of fallow	Amount of root fiber, lb/ac			Dry aggregates, % under 0.84 mm			Water-stable aggregates, % over 210 microns		
	Bromegrass	Int. wheatgrass	Av	Bromegrass	Int. wheatgrass	Av	Bromegrass	Int. wheatgrass	Av
Full fallow									
Plow	262	836	549	46	45	46	26	27	27
Discer	628	971	800	45	45	45	30	30	30
Cult. spike	811	1267	1039	45	46	46	23	31	27
Rotary cultivator	504	887	696	47	48	48	28	32	30
Partial fallow									
Plow	531	879	705	53	53	53	27	30	29
Cult. spikes	1448	1142	1295	50	55	53	33	37	35
Rotary cultivator	959	1268	1114	51	52	52	31	33	32
Av full fallow	551	990	771	46	46	46	27	30	29
Av partial fallow	979	1096	1038	51	53	53	30	33	32

In the above table, note that surface soil content of root fiber and water-stable aggregates were greater at the end of partial fallow than full fallow. At the end of both periods, the bromegrass sod had less root material in the surface soil than the intermediate wheatgrass sod. This difference was greater after full fallow than partial fallow, indicating that the bromegrass sod decomposed faster.

With grasses like crested wheatgrass and Russian wild ryegrass, which have a bunchgrass root system, more time and tillage are required to break down the sod and prepare a seedbed than with bromegrass or intermediate wheatgrass in a partial fallow system.

CEREAL AND OILSEED CROP PRODUCTION ON SOD

Flax and oats are good crops to grow on a bromegrass-alfalfa sod fallow. Table 8 gives the yields (10-year av) of various crops tested at Melfort.

Table 8 - Crop Yields on Sod, lb/ac

	Check	Fertilized*	Average
Flax	934	958	946
Wheat	1399	1574	1487
Oats	2194	2360	2277
Barley	1824	2124	1974
Argentine-type rape	858	1039	949
Polish-type rape	793	946	870

*Fertilizer supplied 30 lb nitrogen and 30 lb P_2O_5/ac.

Note that fertilizer substantially increased yields of all crops. Soil tests should be used to determine nutrient requirements as these vary, depending on the management and fertility program and the amount of legume in the sward. If soil test information is not available, the fertilizer required for stubble crops on the same farm should be used as a basis for determining what should be added to sod fallow.

Tables 9 and 10 give 3-year-av data for soil analysis of sod fallows and of crop yields on grass sods with two levels of nitrogen.

Table 9 - Soil Analysis of Sod Fallow

	Russian wild ryegrass	Crested wheatgrass	Bromegrass
Ease of breaking and preparing a seedbed	difficult	medium	fairly easy
Soil test data fall after breaking			
- NO_3 (0-2 ft), lb/ac	134	74	104
- P (0-6 in.), lb/ac	16	15	19
Soil moisture total in. (0-4 ft)			
- at breaking time*	11.1	12.2	12.5
- fall after breaking*	15.9	16.6	16.9
- spring at seeding time	14.7	15.8	17.2
Surface soil less than 0.84 mm, %			
- fall after breaking*	50	47	43
- spring at seeding time*	48	51	49

*2-year av only.

Table 10 - Crop Yields on Sod Fallow with Two Levels of Nitrogen, lb/ac

Crop	Nutrient,* lb/ac N	P_2O_5	Russian wild ryegrass	Crested wheatgrass	Bromegrass
Wheat	7	-- 30	2396	2146	2445
	40	-- 30	2430	2519	2546
Oats	7	-- 30	2988	3063	3521
	40	-- 30	3200	3199	3649
Barley	7	-- 30	2528	2667	2671
	40	-- 30	2534	2613	2765
Flax	7	-- 30	1226	1392	1480
	40	-- 30	1398	1380	1509
Target rape	7	-- 30	1720	1981	1862
	40	-- 30	1755	2069	1967
Echo rape	7	-- 30	1442	1467	1351
	40	-- 30	1356	1450	1397

*Fertilizer - 11-48-0 at 63 lb with the seed alone (7 -- 30), plus 100 lb of 33.5-0-0 (40 -- 30).

Because all the sod had a fairly high nitrate nitrogen content to begin with, the additional nitrogen in the 40 -- 30 fertilizer treatment did not consistently affect the yield and often resulted in a reduction in the bushel weight of the grain. The high nitrogen content of the grass sod was due partly to the use of a nitrogen fertilizer (about 60 lb N/ac) for several years before breaking.

A well-worked, firm seedbed into which seeds can be placed at a shallow, uniform depth is very important on grass sod, especially when seeding rapeseed, flax or barley. Also, weed control with herbicides may be more difficult in rapeseed than in the cereal crops.

USE OF BARNYARD MANURE

One ton of manure contains about 10 lb nitrogen, 5 lb phosphorus, 10 lb potassium, some sulfur and a good supply of organic matter. When spread on the land these ingredients become available for crop production. Not only is the supply of plant nutrients increased, but the added organic matter has a beneficial effect on the physical properties of the soil and helps prevent or reduce erosion on sandy or other erodible soils.

The greatest response has been obtained when manure was applied to problem soils, such as Gray Luvisol, which tend to bake and form a hard crust because they lack organic matter. On such a soil at Snowden, Sask., manure applied once every 3 years at 15 tons/ac increased the yield of wheat on summerfallow from 26 to 43 bu/ac over an 11-year period. It also increased the yield of the second crop of oats from 46 to 65 bu/ac. At Star City, a similar rotation (on a lighter-textured Gray Luvisol soil, higher in organic matter) showed a 6-bu/ac increase of both wheat and oats over an 8-year period. The manure was even more effective when used in conjunction with alfalfa as a green manure crop.

On a degraded Black soil at Parkside, manure at 15 tons/ac applied every 5 years over a 37-year period, increased the average yield of wheat in the first and second crops by about 7 bu/ac and increased the yield of each of two hay crops in the same rotation by about 1/2 ton of dry matter/ac. The manure also improved the chemical and physical properties of the soil, particularly the phosphorus content, water-stable aggregate, organic matter content and water-holding capacity.

Removing manure from the feedlot and spreading it directly onto the land is the most economical and practical disposal method; however, this may create a weed problem and piling the manure to allow further rotting may be desirable. Because of its fibrous nature, fresh manure greatly improves the physical structure of heavy-textured soils. Rotted manure, on the other hand, tends to make sandy soils more compact and this often improves their moisture-holding capacity. Manure should be worked into the soil as soon as possible after it is spread, and preferably at the time that forage stands are broken or during the summerfallow year of the rotation. If it is applied before the sod is broken, it can be hauled by manure spreaders even in fairly wet weather. The breaking operation allows excellent incorporation and thereby reduces nutrient loss by runoff or volatilization.

Spreading manure directly onto forage land has some obvious disadvantages: for example, harrowing may be required to break up and spread large lumps, which tend to foul or smother the herbage; and water runoff, particularly in the spring,

may cause considerable loss. However, if it must be done, spread the manure on the forage stand in the late fall or early spring, or on areas that have been grazed down and from which the cattle have been temporarily removed. Set the spreader to deliver a relatively low rate of manure and the beaters to pulverize it as much as possible, so that rain will wash the material off the plants and into the soil before the next grazing. Similarly, when applying manure to hayland, spread it immediately after removal of the hay crop so that rain will work the manure into the soil before the aftermath is grazed or a second hay crop removed.

In a long-term rotation (6-8 years), the summerfallow year is another good time to apply barnyard manure. Spreading and incorporating it in late fall or early spring provides sufficient time to eradicate weed growth. Manure applied at this time increases the organic matter content of the soil and assists in controlling erosion on the summerfallow. Since manure spread in the summerfallow year has longer to decompose than that applied during the sod fallow year, it can contain a higher percentage of undecomposed straw and raw material. This additional trash cover protects the field from erosion during the summerfallow period.

Spreading manure during the winter is not recommended because it may pollute water sources during the spring thaw and, also, nutrients may be lost through volatilization and runoff.

CHOOSING A FORAGE

Most crops are produced for only one purpose, but forage crops are grown for many reasons, including seed production, preservation (as hay, silage, or dehydrated forage) and pasture. These three uses may overlap. For instance, hay can often be made after seed has been harvested, and it is almost a necessity to graze Russian wild ryegrass after a seed crop has been taken. Similarly, after a hay crop has been harvested, the regrowth can sometimes be grazed and, when pasture growth exceeds the grazing animals' requirements, the surplus should be harvested as hay.

Choice of a forage crop depends on the purpose of the crop, the length of time it is to be kept down, and the soil and climate in the location to be seeded. Often, a further choice has to be made among the several varieties offered. In recent years, dozens of new forage crop varieties have been licensed for sale in Canada. Be on the lookout for the ones recommended for your area as they are a sure way to increase production. If you plan to seed forage crops, visit your favorite seed company and order Certified seed of the best variety available even if the price is a little higher.

The choice of variety is even more important with alfalfa and other legumes than with brome, crested or other adapted grasses. Although a variety of alfalfa is a good yielder in other parts of Canada, it may be completely unsuited to the prairie area of Western Canada. The varieties Drylander, Rambler, Roamer, Beaver and Kane, developed for use in the West, are recommended over all other varieties, blends or commercial seed lots.

Many forage crop varieties not recommended for hay or pasture may be grown for seed, since thin stands often produce good seed crops and stands harvested for seed are usually more winter-hardy than when harvested for hay or pasture.

The parkbelt area (N.E. Saskatchewan and Peace River districts of Alberta and British Colombia) is by far the most important seed-growing area in Western Canada. Throughout this area, crop residues from the production of forage seed are an important source of roughage for cattle and sheep. For detailed information on forage seed production (not covered in this publication) see Pedigreed Forage Seed Production by J.L. Bolton, distributed by The Canadian Seed Growers' Association, Box 8455, Ottawa, K1G 3T1.

Most of the important forage crops grown in the parkbelt area of Western Canada are described below, along with their strengths, weaknesses and recommended varieties.

GRASSES

1. Bromegrass

A leafy grass reaching a height of 3-4 ft and spreading rapidly by means of underground rhizomes. The creeping tendency varies in degree from variety to variety but eventually results in such a heavy mat of rhizomes that plant vigor is affected and yields are reduced, in severe cases after 2-3 years of growth. The grass is long-lived and with good management will produce satisfactorily for several years. It is very well adapted to the parkland area of Saskatchewan.

Drought resistance	- moderately good
Spring flooding tolerance	- about 2 weeks with cool temperatures
Competitive ability	- moderate to severe, depending on vigor of the creeping habit
Pests and diseases	- several leafspots may reduce quality
Salinity tolerance	- moderate
Palatability	- very good, both as pasture and hay
Varieties	- southern type: Magna, Lincoln, Saratoga - taller, more creeping, less leafy, more disease resistant than northern varieties - northern type: Carlton, Manchar - less creeping, better seed yields than southern type

Productivity

Varieties	Hay, tons/ac	Seed, lb/ac
Carlton	1.80	371
Magna	1.88	341

Time to harvest	- best-quality hay: cut no later than flowering stage - poorer but acceptable hay: cut immediately after seed crop is removed - seed: swath when stem just below seed head has turned brown

2. Crested Wheatgrass

A long-lived bunchgrass growing 2-3 ft tall, with wide-spreading root system, fine stems and fairly narrow leaves. It is well adapted to Brown soil zones but has performed extremely well at Melfort. Spring growth commences very

early. The grass should be grazed or mown before seed heads develop as they are unattractive to stock. It tends to go dormant in dry, hot weather and to recommence growth when moisture conditions improve.

Drought resistance	- very good
Spring flooding tolerance	- about 7 days
Competitive ability	- good; combines well with alfalfa and is a good weed competitor
Pests and diseases	- no serious problems
Salinity tolerance	- fair
Palatability	- excellent when young; seed stems very unattractive as they mature
Varieties	- cristatum type: Parkway - shorter, finer stemmed and longer lived than desertorum type, but generally yields slightly less hay and more seed - desertorum type: Summit

Productivity

Varieties	Hay, tons/ac	Seed, lb/ac
Parkway	2.38	650
Summit	2.49	500

Time to harvest	- hay: cut before flowering - seed: swath when heads are brown but stems still green (seed in medium-dough stage)

3. Russian Wild Ryegrass

A long-lived bunchgrass, producing an abundance of bluish-green basal leaves 1-1 1/2 ft high, topped by seed stalk 3-4 ft high. This grass is the first to start growth in spring and continues to grow until late fall. The leaves remain palatable at all times and provide excellent pasture. For adequate and sustained seed production, the grass must be mown or grazed to the ground immediately after seed harvest; otherwise, growing points develop too far above ground and future seed production is imperiled. Maximum production is not reached until 3rd or 4th year after establishment.

Drought resistance	- excellent
Spring flooding tolerance	- very low
Competitive ability	- weak, slow-growing seedlings make it hard to establish when weed competition is strong; once established, it is very competitive, being able to suppress most weed growth at least 1 ft distant
Pests and diseases	- leaf diseases on some varieties, e.g., Sawki
Salinity tolerance	- excellent tolerance once established
Palatability	- moderately good at all stages of growth
Varieties	- Sawki, Mayak
Productivity	- forage for pasture: about 1.5 tons/ac (not grown for hay) - seed: 300-500 lb/ac common in 2-4-year-old stands when grown in rows 18-36 in. apart
Time to harvest	- pasture: graze early in spring and late in fall - seed: swath just above basal leaves when straw has turned yellow (seed at firm-rough stage) and combine as soon as seed is dry

4. Intermediate Wheatgrass

A tall-growing perennial often exceeding a height of 4 ft. It produces a somewhat stemmy growth, having fewer basal leaves than bromegrass, and looks like quackgrass. It is usually considered a moderately short-lived grass (3-4 years), but at Melfort in mixtures with alfalfa has persisted for 7 years. It is well adapted to the parkland area and with alfalfa provides good pasturage.

Drought resistance	- fair
Spring flooding tolerance	- poor
Competitive ability	- fair; combines well with alfalfa, but is not a vigorous creeper
Pests and diseases	- no severe problems
Salinity tolerance	- poor
Palatability	- excellent
Varieties	- intermediate (Chief) and pubescent (Greenleaf) wheatgrasses are similar enough to intercross and only plants at limits of range of variation are readily distinguished

Productivity

Varieties	Hay, tons/ac	Seed, lb/ac
Chief	2.30 (1965-66)	359
Greenleaf	1.96	280

Time to harvest	- hay: cut when seed head appears - seed: swath when most seed heads have turned light brown (earliest heads will be shattering)

5. Slender Wheatgrass

A short-lived bunchgrass (3 years) producing a stemmy growth 2-3 ft high. Seedlings are vigorous, easily established and under good growing conditions a crop can be taken in the seedling year. Hay is of fairly good quality, provided crop is cut in early heading stage.

Drought resistance	- good
Spring flooding tolerance	- 1-2 weeks
Pests and diseases	- good
Salinity tolerance	- good
Palatability	- fairly good
Varieties	- Revenue
Productivity	- hay: 2.48 tons/ac (4-year av, including year of seeding) - seed: 400-600 lb/ac

6. Reed Canarygrass

A long-lived, creeping-rooted grass, growing 3-6 ft tall. It produces large amounts of leafy forage, which varies in palatability from plant to plant because of differing levels of alkaloids. Palatable forage can be obtained if grass is harvested before flowering. Adapted to long periods of flooding, but also produces good yields under dryland conditions. Because of shattering, this grass is difficult to harvest for seed. It can be straight combined, but timing is very critical.

Drought resistance	- fairly good
Spring flooding tolerance	- excellent
Competitive ability	- good
Pests and diseases	- no severe problems
Salinity tolerance	- low
Palatability	- variable, but is satisfactory if harvested early
Varieties	- Castor, Grove, Rise
Productivity	- hay: 1.75-2.0 tons/ac - seed: 200 lb/ac
Time to harvest	- best hay: cut between boot and early flowering stages (not always possible because of soil moisture where this grass grows) - coarse hay: cut as soon as possible after seed crop is harvested - seed: swath when seeds at top of panicles have turned brown or gray; or straight combine as soon as seeds in top of panicle start to fall out when struck

7. Timothy

A long-lived bunchgrass, producing good-quality hay. The grass is quite shallow rooted and produces high yields of hay only where moisture is plentiful.

Drought resistance	- poor
Spring flooding tolerance	- very good
Competitive ability	- good with adequate moisture; fairly good on dry-land once established
Pests and diseases	- rusts and leafspots occur some years
Salinity tolerance	- very low
Palatability	- fairly good

Productivity

Varieties	Seed, lb/ac
Climax	400
Champ	300
Bounty	340

8. Tall Wheatgrass

A long-lived, coarse bunchgrass growing to a height of 5 ft. It is useful because it is the most saline tolerant of the better quality grasses. Hay is of fair quality, provided it is made before the grass flowers. The grass matures too late for reliable seed production in the parkland area of Western Canada. It is usually grown only on saline soils where other grasses are unsatisfactory. Yields vary, depending on moisture and degree of salinity.

Drought resistance	- fairly poor
Spring flooding tolerance	- 3 weeks
Pests and diseases	- no severe problems
Salinity tolerance	- very good
Palatability	- fair
Varieties	- Orbit
Productivity	- hay; 1.85 tons/ac (3-year av at Melfort on nonsaline dry land)

LEGUMES

1. Alfalfa

A bushy or creeping legume growing to a height of 2-3 ft. Leaves are trifoliate with smooth or slightly toothed margins. Stems are fairly slender, either solid or hollow. Flowers grow from leaf axils and have 10-20, usually blue or purple flowers, although other colors are not uncommon. Seed pods vary in shape from crescent-shaped to three tight whorls, with several seeds per pod. Root systems vary from a branched taproot to a creeping-rooted type, all penetrating deeply. For pasture, alfalfa is usually used with a grass. Seed yields are low if pollinators are scarce; it is advisable to consider using leafcutter bees for pollination.

Drought resistance	- very good
Spring flooding tolerance	- 1 week
Competitive ability	- good to very good, increasing with proportion of creeping-rooted plants
Pests and diseases	- the most serious pests are plant bugs that damage flower buds and reduce seed yields - forage fields seldom suffer seriously from pests and diseases - several leaf spots and stem blights can weaken plants by causing early leaf death but rarely kill plants - winter crown rot weakens plants and makes them unproductive - most modern alfalfa varieties are resistant to bacterial wilt - burning an alfalfa seed field in early spring helps control most diseases and insects
Winterhardiness	- excellent in recommended varieties, but types from warmer areas may winterkill
Salinity tolerance	- moderate
Palatability	- very palatable; excellent pasture on hay, but may cause bloat

Productivity (1968-70)

Varieties	Hay tons/ac	Seed lb/ac
Beaver	1.64	287
Drylander	1.61	291
Rambler	1.56	352
Roamer	1.48	219
Kane	1.52	321

Time to harvest	- pasture: do not overgraze; allow regrowth to reach early-bud stage; avoid heavy grazing between 1st week of September and freeze-up - hay: cut between late-bud and 10%-bloom stages (usually late June - early July) - seed: straight combine after severe frost dries out stems; or swath when 3/4 of seed pods have

- turned black or dark brown and combine when stems have dried out (swath when the crop is slightly damp from dew as seed pods are less likely to break off and be lost)

2. Sweetclover

An upright biennial (or occasionally annual) legume reaching a height of 5-7 ft. Leaves are trifoliate with distinctly toothed margin and bitter taste. Spikes of flowers grow from leaf axils and, after pollination, are replaced by small pods each containing one seed. The stems are succulent at first, but turn woody as plants mature. There is some danger from badly cured hay of some varieties due to the formation of a blood anticoagulating substance. To avoid this, try to ensure the crop is cured rapidly and stored to prevent mold formation.

Drought resistance	- good
Spring flooding tolerance	- very poor (less than 1 week)
Competitive ability	- as seedling, fair; as mature plant in 2nd year, good.
Pests and diseases	- no serious diseases - main pest is sweetclover weevil, which can eat seedlings to the ground in a short time (2nd-year plants usually grow fast enough to withstand infestation)
Winterhardiness	- excellent in recommended varieties
Salinity tolerance	- moderate
Palatability	- fairly palatable when young and succulent
Varieties	- white-flowered: Polara - low in coumarin, the substance from which the blood anticoagulant is formed, and therefore safer for forage than other varieties - yellow-flowered: Yukon - finer stems and leaves, more spreading growth and less woody than white-flowered varieties

Productivity (1968-70)

Varieties	Hay tons/ac	Seed lb/ac
Yukon	2.83	624
Polara	2.66	401

Time to harvest	- pasture: graze in 2nd year when growth reaches 12-18 in. - hay: cut at early bud stage - seed: when 2/3 of seed pods have turned brown

3. Sainfoin

A tall, perennial legume reaching a height of 3-4 ft. The plant has pinnately divided leaves, which resemble those of vetch without tendrils; and coarse, succulent, hollow stems, which are terminated by long spikes of pink flowers. The seeds are smooth, kidney-shaped, olive to dark brown, about 1/8 in. long and usually enclosed in pods the shape of a flattened hemisphere with a raised

network of veins on the surface. A deeply penetrating, branched taproot makes the plant drought resistant. Spring growth starts very early. Regrowth after a harvest is uaully slow. Leaf retention is good and quality loss with increasing age is slower than for alfalfa. This legume does not cause bloat.

Drought resistance	- very good
Spring flooding tolerance	- very poor
Competitive ability	- fairly poor; because of its open growth, weeds can become established easily but are tolerated well because the crop is tall
Pests and diseases	- no problems at present
Salinity tolerance	- not established
Palatability	- very palatable, both as hay and pasture
Winterhardiness	- good, provided crop is well established (do not harvest in year of establishment until after freeze-up)
Varieties	- Melrose
Productivity (1966-70)	- hay: 1.69 tons/ac - seed: 853 lb/ac
Time to harvest	- pasture: graze at bud or early bloom stage to allow good regrowth - hay: cut at 50% bloom; or at more mature stage (little reduction in quality) - seed: swath when lowest seed pods on heads have turned brown and are about to break off; combine several days later (seed should not be threshed free of pod)

4. Red Clover

A short-lived perennial with many stems arising from a crown, which has a fairly deep, branched taproot. The stems are succulent and bear trifoliate leaves with a distinct pale V marking on each leaflet. The flowers are pink and are in compact heads at the tips of the stems. The whole plant is often very hairy. Red clover is not grown for forage in northeastern Saskatchewan because alfalfa and sweetclover produce higher yields.

Drought resistance	- fairly poor
Spring flooding tolerance	- 1-2 weeks
Competitive ability	- fairly good, but deteriorates as stand thins after 3rd year
Pests and diseases	- several diseases (mildews, leaf spots, northern anthracnose, clover sclerotinia rot) alone do not kill plants but together weaken them too much to survive winter
Salinity tolerance	- very low
Winterhardiness	- fair under dryland conditions; good when soil moisture plentiful
Palatability	- very palatable, but may cause bloat
Varieties	- single-cut type: Altaswede, Norlac - produces one hay crop and some regrowth; generally longer lived than double-cut type - double-cut type: Lakeland

Productivity

Varieties	Hay, tons/ac	Seed, lb/ac
Norlac	2 (where moisture is good)	350-600
Altaswede		350-600
Lakeland		250-500

5. Alsike Clover

A perennial, tillering profusely from the crown and producing slender, somewhat prostrate stems 2-3 ft long. Leaves are trifoliate and heads of pinkish-white flowers are produced in leaf axils. The plant is completely hairless. Alsike clover is often grown for seed in northeastern Saskatchewan, but seldom for forage as alfalfa and sweetclover outyield it. The legume combines well with timothy or reed canarygrass in areas too wet for more productive legumes.

Drought resistance	- fairly poor
Spring flooding tolerance	- several weeks
Competitive ability	- good
Pests and diseases	- no serious problems
Salinity tolerance	- low
Palatability	- very palatable, but can cause bloat
Winterhardiness	- poor, but generally reseeds itself
Varieties	- Dawn, Aurora, Tetra
Productivity	- seed: 450 lb/ac

6. Birdsfoot Trefoil

A perennial, producing many fine stems 1-2 ft long. Leaves appear to have five leaflets, two close to the stem and three on a short stalk. Flowers are fairly large and bright yellow in clusters of 5-7. The plant does not cause bloat. It yields less than alfalfa in northeastern Saskatchewan and so is not usually grown for forage.

Drought resistance	- fairly good
Spring flooding tolerance	- 2 weeks
Competitive ability	- poor
Pests and diseases	- no serious problems
Salinity tolerance	- low
Palatability	- very palatable
Winterhardiness	- fair in Leo; poor in others
Varieties	- Leo
Productivity	- hay: 1.8 tons/ac (where moisture is good)
	- seed: potential 700 lb/ac, but lucky to get 200-300 (seed set usually good but shattering can quickly reduce yields)

ESTABLISHING AND MAINTAINING A FORAGE STAND

During seedbed preparation and seeding, everything should be done to conserve soil moisture, especially that near the surface. Forages sown deeper than 1 in. have poor emergence, because the seeds are so small they do not contain enough food to enable developing seedlings to grow for very long without photosynthesis. On the other hand, seeds broadcast on the surface or sown too shallowly die if the soil dries out too rapidly. Once seeds have germinated, seedlings are sensitive to drying out, also.

Packing or rodweeding before seeding usually firms up the seedbed, which is essential to keep moisture available for seed germination and seedling growth. A firm seedbed also makes it easier to control depth of seeding. Although a fine tilth is best for forage seedlings, it can cause erosion and crusting problems in some soils. Generally, lumps 1/2-1 in. in diameter are a good compromise.

SEEDING

The best time to sow is as early in spring as possible, to ensure relatively high moisture levels for the maximum period without relying on rain. Forages can also be sown in late fall, so that the seeds germinate early in the spring when moisture is plentiful. Seeding must be late enough to avoid fall germination. Another seeding time for grasses is the second half of August, as they usually can become well established before freeze-up. Legumes sown at this time, however, often winterkill.

Calendar for Seeding

Seeding time	Overall rating	Comments
Late April-mid-May	- Fair to very good	Excellent moisture and cool temperatures are good for forage establishment. Limited opportunity for preseeding weed control may lead to problems later. Frost hazard.
Mid-May-mid-June	- Very good to fair	Good moisture and cool temperatures are good for forage establishment. Opportunities for preseeding weed control. Probably the best time of year for seeding, especially last half of May.
Mid-June-mid-August	- Poor	Moisture can be variable, leading to patchy germination. High day temperatures can desiccate seedlings. Rapid growth of annual weeds can cause problems in control.
Mid-August-early September	- Good, except legumes	Moisture can be good and cool temperatures, especially at night, are good for grass establishment. Legumes may winterkill due to insufficient time for them to become properly established. Weeds not usually a problem.

Seeding time		Overall rating	Comments
Early September-mid-October	-	Very poor	Poor time. Insufficient growth before winter results in winterkilling.
Mid-October-after freeze-up	-	Fairly good	Germination takes place in spring when moisture is usually plentiful. Erosion may be a problem depending on cover, soil condition, and topography. Spring weed control is often difficult.

Companion Crops

A companion crop, sometimes misleadingly called a nurse crop, is often sown with forage. The main advantage is that you do not lose a year's cropping, as some return is obtained while the forage is establishing itself. Companion crops also help control erosion and make conditions less favorable for weed growth. On the other hand, strong competition from a companion crop has been known to delay proper establishment of forage by a year or more. In addition, weed control is more difficult and there may be harvesting problems because of the forage in the cereal or oilseed crop.

The order of preference for companion crops in northeastern Saskatchewan is: flax, wheat, barley, oats and rapeseed. To avoid impeding forage growth, seed the companion crop at about half the normal seeding rate. If solid seeding of the forage is required, seed the companion crop first and then cross-seed the forage, either through the drill spouts in the usual way or by pulling the spouts from between the double discs to spread the seed around more. Another method worth considering, if the forage is to be grown for seed, is to block off every third or fourth grain drill and seed forage in the blank space. It is important to harvest the companion crop as soon as possible to allow maximum time for forage growth in late summer and fall.

If the forage is sown without a companion crop, it is a good idea to mix in a few pounds (10) of wheat. This marks the rows at an early stage and, by breaking any soil crust that may have formed, makes it easier for the forage crop to emerge.

Seeding Rates (Northeastern Saskatchewan)

Sow at the following rates (lb/ac) in rows 12 in. apart, except where otherwise indicated:

Forage	For hay	For pasture	For seed
Grasses			
Bromegrass	8 lb	8 lb	5 lb (1-ft rows) 2 lb (3-ft rows)
Crested wheatgrass	7 lb	7 lb	3 lb (2-3-ft rows)
Intermediate wheatgrass (pubescent wheatgrass)	12-14 lb	12-14 lb	5 lb (3-ft rows)

Forage	For hay	For pasture	For seed
Russian wild rye-grass	not recommended	7 lb (1-ft rows) 4 lb (2-ft rows)	2 lb (3-ft rows)
Tall wheatgrass	12 lb	12 lb	not recommended
Slender wheatgrass	10 lb	10 lb	10 lb
Reed canarygrass	5-7 lb	5-7 lb	2 lb (3-ft rows)
Timothy	5 lb	5 lb (6-7-in. rows)	5 lb (6-7-in. rows)
Creeping red fescue	not recommended	not recommended	1 lb (2-ft rows)
Meadow fescue	not recommended	not recommended	7 lb
Legumes			
Alfalfa	5-7 lb	not recommended	1-2 lb (3-ft rows)
Sweetclover	12 lb	12 lb	5-6 lb
Birdsfoot trefoil	not recommended	4 lb	4 lb
Sainfoin	20-40 lb	20-40 lb	10 lb (2-3-ft rows)
Red clover	not recommended	not recommended	4 lb
Alsike clover	recommended in hay mixtures on land subject to relatively long periods of flooding (4 lb)	recommended in pasture mixtures on land subject to relatively long periods of flooding (4 lb)	4 lb
Grass-legume mixtures			
Bromegrass-alfalfa	8 lb + 2 lb	8 lb + 1 lb	not recommended
Crested wheat grass-alfalfa	7 lb + 2 lb	7 lb + 1 lb	not recommended
Intermediate wheat-grass-alfalfa	12-14 lb + 2 lb	12-14 lb + 1 lb	not recommended
Reed canary-alsike clover	6 lb + 2 lb	not recommended	not recommended

USE OF FERTILIZERS

Preseeding Application

In northern Saskatchewan, forages seeded on summerfallow usually do not require fertilizer in the establishment year. However, a soil test is recommended, particularly on Gray Luvisol soils, to determine if nitrogen, phosphorus, sulfur or potassium is deficient.

If soil tests less than 20 lb of available phosphorus/ac, broadcast 30-40 lb of phosphate (P_2O_5)/ac and till it into the soil before seeding. If soil is deficient in nitrogen (N), apply at least 20 lb N/ac for legumes and grass-legume mixtures or 30 lb N/ac for a pure stand of grass. Before growing crops on soil low in sulfur, apply ammonium sulfate (21-0-0) or calcium sulfate (gypsum) fertilizer at 20 lb S/ac.

Do not apply fertilizers with seed as this may injure it and produce a poor stand.

Fertilizing Established Stands

A good crop of hay or pasture removes considerable amounts of nutrients from the soil, as indicated in Table 11.

Table 11 - Soil Nutrients in Hay Crops

	Yield dry matter, tons/ac	Soil nutrients in the crop, lb/ac			
		Nitrogen	Phosphate	Potash	Sulfur
Alfalfa[1]	2	124	20	86	10
Sweetclover[1]	2	90	21	95	5
Bromegrass	2	60	25	100	5

[1]Fixes nitrogen from the air.

Legumes have the ability to fix nitrogen from the air (through the action of symbiotic bacteria in the root nodules), but other plants obtain nitrogen that is released from organic matter in the soil. Phosphorus and potash are released from mineral and organic constituents of the soil. Where quantities of these released nutrients are insufficient to meet the needs of high yielding forage crops, established stands usually repond to commercial fertilizers or barnyard manure. A soil test will reveal any deficiencies.

Fertilizers produce a much greater response under favorable moisture conditions than during a dry year.

Legumes - If a test shows soil contains less than 20 lb P/ac, broadcast phosphate fertilizer, such as 11-48-0 or 11-55-0, at a maximum rate of 40 lb P_2O_5/ac. Response may be obtained the 2nd year after application, presumably because the phosphorus has moved further into the root zone.

On some sulfur-deficient soils, particularly Gray Luvisols, alfalfa responds to an application of sulfur in the form of gypsum or 21-0-0 at 20 lb S/ac.

Grass and Grass-Legume Mixtures for Hay and Pasture - One sure sign that fertilizer is needed in a pasture is taller, greener herbage growing near cattle droppings. However, to find out just what is missing and how much you should add, have the soil tested.

Established stands of grass are usually deficient in available nitrogen. The same is true of old stands (4 years or older) of grass-legume mixtures, which usually contain more grass than legume. As a general rule, fertilize stands containing less than 30% legume with 30-90 lb N/ac. For best results, apply nitrogen fertilizer in late fall or early spring. It is a good idea to leave a few check strips unfertilized to assess crop response.

Effects of nitrogen and phosphate fertilizer on dry matter yields of alfalfa and bromegrass pasture are shown in Table 12. The nitrogen fertilizer was first applied in spring 1970, the 4th year of grazing, and phosphate was applied in spring 1971. The fertilizer was applied every year at the same rate. The value of extra pasture over fertilizer cost proved to be substantial.

Table 12 - Effects of NP Fertilizer on Yields and Returns of Pasture

Pasture management	P_2O_5, lb/ac	Nitrogen, lb/ac 0	40	80	120	160	Av
1971-73		Yield, lb/ac					
Put and take stocking	0	2220	2720	3000	3360	3420	2960
	40	2820	3800	4200	4240	4600	3940
Fed barley	0	2640	3580	4020	4040	4260	3700
	40	3560	4160	4780	4700	5060	4440
Average	0	2440	3160	3520	3700	3840	3340
	40	3200	3980	4500	4480	4840	4200
	Av	2820	3580	4020	4100	4340	3780

	Value of hay, ¢/lb	P_2O_5,* lb/ac	Nitrogen,* lb/ac 0	40	80	120	160
			Return, $/ac				
Average 1971-73	1.5	0		6.80	8.20	6.90	5.00
		40	7.40	15.10	18.90	14.60	16.00
	1.25	0		5.00	5.50	3.75	1.50
		40	5.50	11.25	13.75	9.50	10.00
	1.0	0		3.20	2.80	.60	-2.00
		40	3.60	7.40	8.60	4.40	4.00

*10 cents/lb.

The value of nitrogen fertilizer for 6-year-old pasture stands was demonstrated in the summers of 1960 and 1961 (Table 13), when bromegrass-alfalfa and intermediate wheatgrass-alfalfa pastures received 0, 75 and 150 lb N/ac. In 1960, the precipitation from April to August, inclusive, was 9.13 in., but during the same period in 1961 it was only 3.34 in.

Table 13 - Forage and Animal Response to Nitrogen Fertilizer on 6-year-old Pastures

	Bromegrass-alfalfa			Int. wheatgrass-alfalfa		
	Check	75 lb N	150 lb N	Check	75 lb N	150 lb N
1960 (98 days)						
Steers/ac	.8	1.3	1.6	.9	1.3	1.3
Average daily gain, lb	2.25	2.10	2.17	2.27	2.30	2.34
Gain/ac, lb	165	265	325	185	283	289
Forage dry matter/ac, lb	1938	3532	4054	2912	3678	2674
Estimated value of gain/ac @ 45¢/lb	74.25	119.25	146.25	83.25	127.35	130.05
Fertilizer cost @ 12¢/lb N and application cost, $	0.00	11.00	20.00	0.00	11.00	20.00
Net return, $/ac	74.25	108.25	126.25	83.25	116.35	110.05
1961 (46 days)						
Steers/ac	.7	1.1	1.5	.7	.9	.8
Average daily gain, lb	2.45	2.77	2.39	2.58	2.28	2.57
Gain/ac, lb	78	141	164	82	95	93
Forage dry matter/ac, lb	445	1214	1851	539	1525	796
Estimated value of gain/ac @ 45¢/lb, $	35.00	63.45	73.80	36.90	42.75	41.85
Fertilizer cost @ 12¢/lb N and application cost of $2/ac, $	0.00	11.00	20.00	0.00	11.00	20.00
Net return, $/ac	35.00	52.45	53.80	36.90	31.75	21.85

Seed Production - Fertilizer rates for seed production are similar to those for pasture and hay. Fall application of nitrogen gives the best seed production for most grasses. For Russian wild ryegrass, early fall application is advised; and for timothy seed, late fall or early spring application of nitrogen gives maximum yield.

Frequency of Application

For a number of reasons, such as topography and labor supply, it would be advantageous to be able to apply 2 or 3 years' supply of fertilizer at one time. Although information of this kind is limited, a number of studies indicate the possibilities under some circumstances.

In Garrick Community Pasture, for example, a residual effect from nitrogen fertilizer applied at 90 lb N/ac was obtained for 2 years (Table 14). A residual effect from phosphate fertilizer, at 47 lb P_2O_5/ac, was still apparent after the

3rd year and may have shown a yield increase the 4th year had yields been measured. Similar response has been noted at Brandon, Saskatoon and Swift Current research stations.

Table 14 - Effect of Fertilizer on Yield of Forage Dry Matter, Garrick Community Pasture*

Check		33.5-0-0	27-14-0
		Yield, lb/ac	
		67 lb N/ac in July 1962	65 lb N + 34 lb P_2O_5 in July 1962
1962	520	1196	1239
1963	3464	5230	6521
1964	2938	2880	2931
		90 lb N/ac in April 1965	90 lb N + 47 lb P_2O_5 in April 1965
1965	3652	5627	7525
1966	2366	3380	3543
1967	4108	4614	4476
1968	2872	2920	3441

*Waitville loam soil.

In other studies on the effects of annual versus large single applications of nitrogen fertilizer on bromegrass hayfields, dry matter (DM) yield increases were comparable. On Loon River loam soil, three annual applications of 80 lb N/ac produced an average annual yield increase of 2136 lb DM/ac, whereas a single application of 240 lb N/ac gave an average annual increase of 2006 lb/ac. On Whitewood loam, the average annual yield increase from a single application of 240 lb N/ac actually was greater than that obtained from three annual 80-lb applications, that is, 2587 lb DM/ac as against 1960 lb/ac.

The economics of applying fertilizer once every 3 years instead of every year must take into consideration the topography of the land (stony, hilly pasture vs level, stone-free cultivated land), availability and cost of labor, interest on fertilizer investment and, perhaps, the effect on variability of pasture production from year to year (after a large application of N, the yield could be much higher in the 1st year than in the 2nd or 3rd).

For example, assuming that 80 lb N/ac is applied each spring for 3 years, its cost is 12¢/lb, and the cost of application is $2/ac per year, then the return/$ invested is: $\frac{\text{Yield increase x price of hay (1.5¢/lb)}}{(80 \times 3 \times 12¢) + (3 \times \$2)}$

or, for the Whitewood loam experiment mentioned above: $\frac{3 \times 1960 \times 1.5¢}{\$34.80} = \$2.54.$

If we apply 240 lb N/ac once in the 3 years, as in the Whitewood loam experiment, the cost, including 10% interest on investment in fertilizer (80 lb N for 2 years and 80 lb N for 1 year) and the price of 1 application, is:

$(240 \times 12¢) + (10\% \times 80 \times 2 \times 12¢) + (10\% \times 80 \times 1 \times 12¢) + \$2 = \$33.68;$

and the return/$ invested: $\frac{3 \times 2587 \times 1.5¢}{\$33.68} = \$3.46.$

Both the interest charges and the variability in pasture production could be overcome by purchasing the amount of fertilizer normally required each year but applying it at three times the normal rate to only one-third of the forage acreage each year.

WEED CONTROL IN FORAGES

Clean Land

Forage seedlings are small, relatively slow growing and poor weed competitors. This makes seeding on clean land a necessity for good forage establishment. Grasses and legumes are very different in their reactions to weed control practices.

Mowing

Weed control by mowing is often satisfactory, particularly with grasses. With legumes, some problems arise. Most forages (except alfalfa and sweetclover) have their seedling growing point at or near ground level. This applies for most of the establishment year. Consequently, mowing removes only a certain amount of leaf area and leaves the growing point unharmed. Provided the forage is healthy and the cut is made more than about 4 in. above the ground, little harm is done to the forage crop. Annual weeds, on the other hand, must produce a flower and therefore tend to be upright in growth and have the main growing point elevated well above ground level. Mowing sets back such weeds considerably more than it does the forages.

Some weeds either have their main growing point at ground level (dandelion, grassy weeds) or develop flowers close to the ground after mowing (barnyard grass, redroot pigweed) and cannot be controlled by cutting.

Herbicides

Registered Uses - Agricultural chemicals including herbicides must be registered by the Control Products Section, Plant Products Division, Production and Marketing Branch, Canada Department of Agriculture, before their use can be recommended. New or modified uses of herbicides are published from time to time in memoranda issued by the Department's Control Products Section and usually also in Canadex (CDA technical information leaflets). At all times, current uses are described fully on the labels of products put out by manufacturers.

Herbicide recommendations for weed control in forage crops are made by provincial departments of agriculture on the advice of provincial committees consisting of research and advisory personnel familiar with the area of work. In Saskatchewan, for example, advisory bulletins are issued, usually each year, summarizing recommendations for using herbicides in this province. The herbicides and their uses described in these bulletins have been extensively tested in Western Canada and have been found satisfactory and safe enough when used as described.

For the most recent recommendations, consult your nearest agricultural representative.

Nonregistered Uses - The information provided below is to acquaint farmers with the current status of weed control in alfalfa and sainfoin at the Melfort

Research Station. The uses described have not been cleared with CDA's Plant Products Division because favorable results are not extensive enough, or because residue studies have not been conducted, or because the expected use does not justify the expense encountered in meeting registration requirements.

Consequently, the risks associated with using the herbicides in the ways described below are much higher than with registered uses; in particular, manufacturers will not guarantee the safety of their products for nonregistered uses.

Test Results

Nonregistered Uses of Herbicides on Alfalfa - 1. 2,4-DB (Embutox E) at rates up to 30 oz/ac, applied in spring to control broad-leaved weeds. Seedling alfalfa apparently tolerated Embutox up to this rate with no permanent damage. Some wilting occurred, particularly when the herbicide was applied to large seedlings (six leaves or more). Spring applications to established alfalfa have been made at Melfort. Damage increased as the rate of 2,4-DB increased and as the alfalfa height at time of application increased. Forage production from the first cut decreased as damage increased. Seed production showed inconsistent responses, probably because of the interactions of herbicide effect, weather, and pollinator's activity. Until research clarifies alfalfa response to 2,4-DB, it is advised that farmers follow the recommendation not to spray alfalfa with this herbicide in the spring of a year in which seed is to be harvested.

2. 2,4-D at rates up to 8 oz/ac, applied in late fall, to control perennial and winter annual broad-leaved weeds. Applied when the alfalfa was dormant, 2,4-D killed hawksbeard, stinkweed and other biennial weeds, and provided some control of dandelion and other perennial weeds that were still green. In the spring following a fall application of 2,4-D, the plants were darker green, fiber content was increased and some plants were stunted.

3. Trifluralin (Treflan) applied at 3/4 - 1¼ lb/ac and worked in before seeding. Counts of alfalfa seedlings established in ground treated with Treflan just before seeding have indicated that rates of chemical greater than recommended severely reduce alfalfa establishment. Observations suggest that fewer seedlings establish on areas treated with Treflan at 1 lb/ac. It is advised that Treflan not be used before seeding alfalfa.

Nonregistered Uses of Herbicides on Sainfoin - 1. MCPB:MCPA, 15:1 (Tropotox Plus). In several years' experiments at Melfort, sainfoin seedlings were tolerant to this herbicide mixture applied to plants at growth stages up to late bud at rates as high as 48 oz/ac. The Canada Weed Committee has supported a recommendation that Tropotox Plus be registered for use on seedling sainfoin at rates of 16-20 oz/ac, but this use has not yet been approved by the Plant Products Division.

2. 2,4-DB (Embutox). Similar experiments to those mentioned above for Tropotox Plus have been conducted with 2,4-DB. Moderate to severe seedling damage was encountered at herbicide rates greater than 6 oz/ac, although most seedlings eventually recovered. It is advised that farmers not apply 2,4-DB to seedling sainfoin.

3. Nitrofen (Tok). This herbicide has been applied at rates up to 48 oz/ac to sainfoin seedlings. The most severe effect encountered was moderate leaf spotting and there was little evidence of a check in growth. However, there was

little beneficial effect unless the herbicide was applied when weeds were small, that is, when the sainfoin was at the one true leaf stage.

4. Trifluralin (Treflan). Sainfoin has been successfully established at Melfort on soil treated shortly before seeding with rates of Treflan up to 4 lb/ac. This suggests that sainfoin is tolerant to Treflan. The Canada Weed Committee has supported a recommendation that Treflan at 12-16 oz/ac be registered for use before seeding sainfoin, but this has not yet been approved by the Plant Products Division.

GROWING ALFALFA FOR THE DEHYDRATING INDUSTRY

In Western Canada, the alfalfa dehydrating industry dates back to the 1950's when two or three small dehydrators produced a limited amount of alfalfa-leaf meal. Demand for their product was neither strong nor constant and, although some was exported, most of the meal was sold in Canada.

Recently, the 'dehy' industry has experienced spectacular growth. Harvesting and processing equipment has improved and the demand for high-quality dehy alfalfa pellets has exceeded the supply. It is estimated that by 1976, 15 to 20 dehydrators will be operating in the parkbelt of Western Canada with at least nine of them situated in northeastern Saskatchewan.

Japan has been the main customer, purchasing over 90% of the total production in some years. Market demand is expected to increase, especially from countries along the Pacific rim. The continued success of the industry will depend on its ability to produce protein at a competitive price. Fortunately, our production costs are much lower than those of most other producing areas of the world.

Although the future looks bright, it is extremely important that a strong domestic market be developed for alfalfa dehy and sun-cured products to bring more stability to the industry.

In the parkbelt area of Western Canada, alfalfa is grown on nonirrigated land. Yields of $1\frac{1}{2}$ to $2\frac{1}{2}$ tons of dry matter/ac are usual, depending on rainfall, age of stand, number of cuts, variety, management and other factors. Unfortunately, wide fluctuations in yield and quality occur between fields and from year to year, making management of the fields and the dehy plant extremely difficult.

If you plan to produce alfalfa for sale to a dehydrating plant, the following suggestions are presented for your consideration.

SEED

Seed only recommended varieties. Beaver is the best variety. If Beaver is not available, Ladak, Grimm and Vernal are recommended in that order.

Experience has shown that the creeping-rooted varieties are unsatisfactory because they tend to be high in fiber and regrowth is slow.

LAND PREPARATION

Use only fields free from perennial and hard-to-kill annual weeds to produce alfalfa dehy. You may remove excess trash or stubble by burning in the spring, provided the burning is done early enough to prevent damage to the alfalfa crowns. Ideally, this is in late April when the ground is still wet and the stubble or trash dry enough to carry a fire.

Obtain a soil test to determine the amount of phosphorus that the alfalfa will require for the lifetime of the stand. Apply the phosphorus at time of seeding. Nitrogen fertilizer is generally not required because alfalfa is capable of hosting nitrogen-fixing bacteria in its roots.

HARVEST

Research has shown that if a stand is harvested three times per season for 2 consecutive years, it won't likely produce a satisfactory yield the following year. If possible, allow stands that have been harvested three times to recoup by letting them reach 20-50% bloom before being harvested the following year. Conversely, fields that were harvested only once (sun-cured) will likely provide the best stands for two or three cuts of dehy the next season.

The height at which the second and third cuts are harvested affects regrowth and persistence. Take the first cut as low as possible, especially in dense stands, because shading accelerates senescence. However, for the second and third cuts, it is suggested that high rather than low-level mowing enhances quality and persistence. Stubble leaves provide a photosynthetic area that supports regrowth without depletion of root reserves.

The tendency to subject fields nearest the dehydrator to more frequent harvests than fields farther away may eventually result in having the dehydrator surrounded by low-yielding fields. For this reason, it is important to establish new stands each year.

DEHY ALFALFA AS PROTEIN SOURCE

Rapeseed Meal vs Dehy Alfalfa as Supplements in Rations for Beef Cattle

The dramatic increase in the cost of protein recently has caused many livestock producers to carefully evaluate sources of supplementary protein. Two such sources produced in the Melfort area are rapeseed meal and dehydrated alfalfa. The following experiment has been conducted for 2 years to evaluate these products as supplements in maintenance, grower and finisher rations for beef cattle.

Maintenance-grower Rations - Sixty-four long-yearling Hereford steers were divided into eight equal groups. Each group was fed chopped wheat straw free-choice, plus either dehy (2.5 or 5.0 lb/head per day) or rapeseed meal (1.25 or 2.5 lb/head per day). Dry-rolled barley was fed at 3 lb/head per day to one of the two groups receiving each level of dehy or rapeseed meal. The trial was conducted for a period of 77 days. The results, averaged for the 2 years, appear in Table 15.

Table 15 - Steer Performance on Dehy Alfalfa vs Rapeseed Meal in Maintenance-grower Rations

	Dehydrated alfalfa lb/head per day				Rapeseed meal lb/head per day			
	2.5		5.0		1.25		2.5	
Rolled barley lb/head per day	0	3	0	3	0	3	0	3
Initial weight, lb	721	720	722	721	723	723	719	720
Av daily gain, lb	.29	.89	.89	1.33	-.14	.85	.23	.97
DM consumed/day, lb								
- dehy	2.24	2.24	4.47	4.47	--	--	--	--
- rapeseed meal	--	--	--	--	1.14	1.14	2.28	2.28
- barley	--	2.67	--	2.67	--	2.67	--	2.67
- straw	6.86	7.12	6.63	7.17	7.32	7.27	7.50	7.30
Total	9.10	12.03	11.10	14.31	8.46	11.08	9.78	12.25
DM consumed/day, lb	34.1	13.6	12.8	10.8	--	13.1	138.4	12.7
Feed cost*/day, ¢/head								
- dehy	11.3	11.3	22.5	22.5	--	--	--	--
- rapeseed meal	--	--	--	--	8.8	8.8	17.5	17.5
- barley	--	15.0	--	15.0	--	15.0	--	15.0
- straw	6.1	6.3	6.0	6.4	6.5	6.5	6.7	6.5
Total	17.4	32.6	28.5	43.9	15.3	30.3	24.2	39.0
Cost/lb gain	60.0	36.6	32.0	33.0	--	35.6	105.2	40.2

*Feed costs - dehydrated alfalfa, $90/ton; rapeseed meal, $140/ton; barley, $2.50/bu; wheat straw (chopped), $16/ton.

Steers fed dehy gained more and had a lower cost per pound gain than steers fed an equivalent amount of supplementary protein as rapeseed meal (2.5 lb dehy contains the same amount of protein as 1.25 lb rapeseed meal). This suggests that the additional energy or TDN available from the greater quantity of dehy was used to advantage by steers on maintenance-grower rations. Based on protein content, dehy is worth about 50% of rapeseed meal (by weight) but, for maintenance-grower rations where energy can be deficient, the relative nutritive value of dehy probably increases to at least 60% of the value of rapeseed meal.

Since this experiment was conducted during spring and early summer and the animals weighed less than average cows, somewhat higher levels of supplementation would be required to maintain a cow herd during winter. The addition of approximately 2 lb grain/head per day to each ration, or the use of low-to-medium quality hay in place of straw, should produce similar results during winter, except perhaps in extremely cold weather.

Finishing Rations - Thirty-two long-yearling Angus steers (average initial weight, 820 lb) were divided into four equal groups and fed (1) a basal ration of 10% wheat straw and about 90% barley; (2) the basal ration plus 1 lb of 32% beef supplement/head per day; (3) the basal ration plus 1 lb rapeseed meal/head per day; or (4) the basal ration plus 2 lb dehy/head per day. Steers were shipped for slaughter when judged to be sufficiently finished to grade A1 or A2.

Table 16 - Steer Performance on Three Protein Supplements in Finishing Rations

	Basal	Basal plus rapeseed meal	Basal plus 32% supplement	Basal plus dehy
Initial weight, lb	817	821	819	818
Av days on feed	73	72	72	72
Av daily gain, lb	2.8	3.3	3.2	3.4
Final weight, lb	1019	1062	1049	1064
DM consumed/day, lb	19.0	21.8	21.5	22.3
DM/lb gain, lb	6.9	6.6	6.8	6.5
Dressing %	56.1	56.0	56.0	56.4
Grade - A1	11	11	11	11
- A2	5	4	3	5
- A3	--	1	2	--
Initial value of steers @ 50¢, $	408.50	410.50	409.50	409.00
Feed cost*/steer, $	68.31	77.43	74.12	82.09
Av carcass value**, $	487.89	506.01	502.81	508.11
Net/steer (after feed cost), $	11.08	18.08	18.19	17.02
Crude protein (as-is basis), %	11.5	12.5	11.7	12.3

*Feed costs - oats, $1.50/bu; barley, $2.50/bu; wheat straw, $16/ton; rapeseed meal, $140/ton; 32% beef supplement, $98/ton; dehydrated alfalfa, $90/ton.

**Carcass value - A1, 87¢; A2, 86¢; A3, 83¢.

As shown in Table 16, each of the three sources of supplementary protein added to the basal finishing ration increased gains, reduced the amount of feed required per pound of gain and increased the net return per steer by an average of $6-7. Although steers fed dehy had the highest rate of gain and the best feed conversion, net return was slightly lower than when the other two supplements were fed. This was due to the higher feed cost for the dehy ration. Because of the similarity between the production criteria measured for the three supplemented rations, minor changes in the relative costs of the supplements would alter the ranking of the net returns of steers fed those rations.

When selecting a source of protein to supplement high-energy finishing rations, it is probably best to choose the least-expensive source per pound of protein. It should be kept in mind that dehy and commercial 32% beef supplements are good sources of vitamin A, but rapeseed is not.

Dehydrated alfalfa products may also have potential to replace a large proportion of the ration normally fed to growing and finishing beef cattle. However, results of one test in which sun-cured alfalfa pellets and cubes made up 40% and 70% of the total ration (with the balance mainly dry-rolled barley) were not encouraging. There was a problem with bloat, gain and feed efficiency were reduced, and cost per pound of gain increased.

Sun-cured pellets fed at the 10% level (90% barley) produced gains similar to those for steers fed 10% wheat straw (90% barley) and improved feed efficiency by about 5%. Bloat was not a problem and, compared with straw, the use of pellets at this level offered some handling advantages.

It is unlikely that bloat would be a problem if alfalfa pellets or cubes constituted 80-100% of a ration for growing calves.

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IF UNDELIVERED, RETURN TO SENDER EN CAS DE NON-LIVRAISON, RETOURNER À L'EXPÉDITEUR