FORAGE HARVESTING in the aspen parklands of Western Canada

Agriculture Canada

PUBLICATION 1547 1974

Pub. 1547
1974

FORAGE HARVESTING
IN THE ASPEN PARKLANDS
OF WESTERN CANADA

MELFORT RESEARCH STATION

RESEARCH STATION STAFF

S. E. Beacom, B.Sc., M.Sc., Ph.D.	Director

Forage Production, Harvesting and Utilization

D. A. Cooke, B.S.A., M.Sc. (Program Leader)	Forage and pasture production
W. E. Coates, B.Sc., M.Sc., Ph.D.	Forage harvesting systems
D. H. McCartney, B.Sc., M.Sc.	Pasture management
J. A. Robertson, B.Sc., M.Sc., Ph.D.	Beef cattle nutrition and forage utilization
S. O. Thorlacius, B.Sc., M.Sc., Ph.D.	Sheep nutrition and forage evaluation
J. Waddington, B.Sc., M.Sc., Ph.D.	Forage ecology and weed control

Cereal, Oilseed and Special Crop Production and Utilization

K. E. Bowren, B.S.A. (Program Leader)	Tillage and cropping
A. G. Castell, B.Sc., M.Sc., Ph.D.	Crop utilization (swine nutrition)
W. F. Nuttall, B.S.A., M.Sc., Ph.D.	Soil fertility
D. J. Warnock, B.S.A., M.Sc.	Crop variety evaluation

CONTENTS

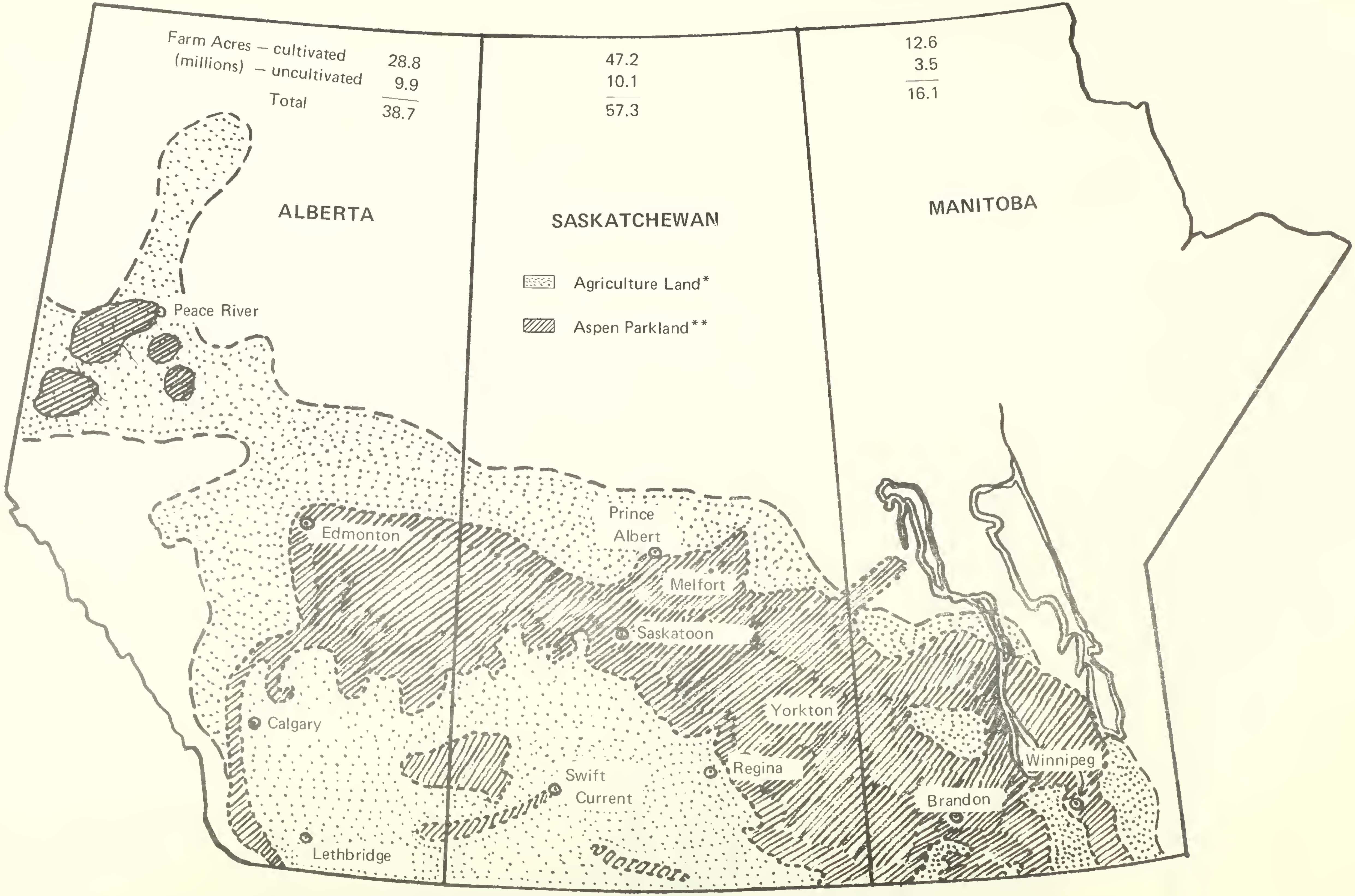

Figure 1 – Estimated extent of aspen parkland in relation to the agricultural area of the Prairie Provinces.

* *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.

FORAGE HARVESTING SYSTEMS

Forage crops can be harvested as hay, haylage, soilage or silage. Hay can be stacked in the long form, baled (using conventional or large round balers), put up in the chopped form (with or without artificial drying), or dehydrated and pelleted.

Forage harvesting systems are studied at the Melfort Research Station to provide information to farmers on costs, labor requirements and effects of harvesting methods on forage quality. This publication describes present knowledge and results obtained in laboratory tests and livestock feeding trials comparing a number of systems.

FORAGE QUALITY

When considering forage harvesting operations, keep the following indicators of quality and feeding value in mind:

1. Leafiness - since most of the feeding value is contained in the leaf, strive to avoid loss of leaf in the harvesting process; avoid raking or baling when the leaf is too dry, particularly with legumes.

2. Color - bright green hay is usually high in carotene (provitamin A) and protein content and has suffered little weathering. Color is also affected by stage of maturity at cutting.

3. Freedom from weeds, brush, stubble from previous crop, and dirt or dust.

4. Palatability - a hard-to-define quality affecting the amount that an animal will consume voluntarily. The more palatable a forage, the more efficiently it can be used in production-type rations. Moisture content of silage is a key factor in determining energy intake of silage-fed animals.

5. Freedom from toxic materials such as poisonous plants or products of molds and other kinds of spoilage (for example, dicoumerol in moldy sweetclover).

SELECTION OF SYSTEM

Choice of a forage harvesting system depends on:

- availability of capital and labor;

- amount of crop to be harvested and expected time available to harvest it to assure quality required;

- kind of livestock to be fed;

- distance from field to place of storage, feeding or market, if sold off the farm;

- skills of operator;

- flexibility of system to handle various feeds and bedding required for the particular operation; and

- storage, feed processing and feeding facilities available.

Obviously the system selected must be appropriate to the farm and farming operation involved. No matter how good the system, its success depends on the abilities and skills of the manager. Failure to cut the crop at the right stage of maturity, putting it up at the wrong moisture content, or leaving the harvested hay exposed to the weather can cause losses of up to 100%, but which are estimated to average 25% across the country as a whole.

CUTTING

The cutting-to-windrowing operation, with or without conditioning (crimping or crushing), is important as it can affect the yield, rate of drying, and quality of hay before baling or stacking. A reduction in drying time of even a few hours can mean an earlier start in the baling or stacking operation and reduce the chances that inclement weather will delay harvest and lead to deterioration of the crop.

The following cutting methods have been compared over a period of years at Melfort:

1. Conventional pull-type mower with reciprocating 7-ft sickle bar, followed by side delivery rake.

2. Mower-conditioner with deflectors removed to leave conditioned hay in a full-width (9 ft) swath, followed by raking.

3. Mower-conditioner set to leave conditioned hay in a windrow, eliminating the need for raking.

4. Self-propelled, $10\frac{1}{2}$- and 16-ft-cut, windrow with conditioner (similar to 3, except hay was conditioned after windrow was formed), with a comparison of crimping vs crushing.

5. Drum mower having two or four rotating discs with free-swinging blades attached, leaving the hay in one or two swaths, respectively (hay can be cut faster by this mower because of its rotary motion).

EFFECT OF CUTTING METHOD ON DRYING RATE

Drying rate was slowest with hay in the windrow (method 4, above) and so there would be a greater probability of getting rain on this hay before baling. Thus, although eliminating raking may improve quality sometimes, the advantages may be eliminated by greater weather damage.

Forage cut by the mower conditioner operated to leave a swath (2) tended to dry faster than the others. Faster drying could mean the difference between baling in the evening or leaving the hay out for another night. Since conditioned hay absorbs moisture faster on wetting, it is important that it be packaged and removed to shelter as soon as it is dry.

Under methods 2 and 4, neither forward speed (3-7 mph) or width of cut affected drying rate. In method 4 there was little difference in drying rate between crimped or crushed hay.

The 1973 hay crop was heavier than those in previous years. However, drying rate test results were similar, except that there was a greater difference in drying rates between hay cut and conditioned under methods 2 and 4. This indicates that with heavy yields narrower cuts (smaller windrows) would speed the drying process.

Raking Losses

Method 2 although producing faster-drying hay, requires a raking operation, which increases operating costs and causes more leaf loss than methods 3 or 4.

Raking losses of 25% are common. Losses are lower if hay is raked at 40% moisture or more. Raking losses are higher for legumes than for grasses and lower for wild grass than for tame.

EFFECT OF CUTTING METHOD ON QUALITY

The effects of different cutting methods on hay quality have been studied in lamb feeding trials during 3 years for brome-alfalfa and 1 year for sweet-clover. Four of the above cutting methods were compared.

The difference in quality between hay cut by the conventional mower (1) and conditioned hay cut and left in the swath (2) was small. Highest average digestibility and protein content were obtained with the self-propelled windrower (4); next highest with the mower-conditioner set to leave hay in a windrow (3); and lowest with the conventional mower (1). In the lamb tests, the greatest digestible dry matter (DDM) intake of brome-alfalfa occurred with hay cut by method 4, but intake of sweetclover was about the same for methods 3 and 4 (Table 1). These results suggest that windrowing hay at cutting may give an improvement in quality.

Table 1 - Effect of Cutting Method on Hay Quality

	Year	1	2	3	4 (10½ ft)	4 (16 ft)
		Digestibility, %				
Brome-alfalfa	1970	56.0	56.5	56.9	55.7	
	1971	58.0	57.9	60.0	63.2	
	1972	57.1	58.1	57.8	59.0	59.4
Mean	70-72	57.0	57.5	58.2	59.3	
Sweetclover	1971	56.6	58.1	59.0	61.8	
		Protein, %				
Brome-alfalfa	1970	13.2	13.0	13.0	13.6	
	1971	16.5	17.1	16.6	18.2	
	1972	13.6	14.3	14.7	14.6	14.5
Mean	70-72	14.4	14.8	14.8	15.5	
Sweetclover	1971	13.3	12.8	13.2	14.7	
		DDM intake, lb/day				
Brome-alfalfa	1970	0.64	0.63	0.62	0.66	
	1971	1.26	1.17	1.32	1.50	
Sweetclover	1971	1.15	1.29	1.38	1.36	

*Fed coarsely chopped in 1970 and ground (1/4 in.) in 1971.

PACKAGING AND STORING

The following methods have been compared:

1. Baled hay - conventional bales

2. Big package hay systems - (a) large round bales, (b) mechanical stacking wagons

3. Chopped and artificially dried hay (hay-drying tower)

4. Silage

BALED HAY

The conventional baler has been used for many years and is still the most popular method of packaging. Hay is usually baled at 20% moisture if it is to be placed immediately in the stack, hay shed or loft, but can be baled at 25-30% and field-dried in the stook or at 40% and artificially dried.

The lowest-cost method of harvesting up to 50 tons of hay a year involves a mower and rake or a mower-conditioner-windrower, a baler, and the use of either trailing wagons or a bale stooker and front-end stook loader to handle the bales from field to storage. Although the labor requirement is fairly high, this is a convenient package for small feeding operations, grinding and processing in conventional grinder-mixers, or transporting to market. For harvesting less than 100 tons a year, a custom operation should be considered, as this may be more economical in the long run than making a large investment in equipment, labor and time.

Handling

Bale handling methods vary from manually picking up single bales in the field to picking them up with an automatic bale wagon. Methods involving high-cost equipment require less labor and a greater volume of harvested hay to justify the investment. Examples of bale systems are as follows:

1. Drop single bales in field, pick up by hand and load onto a wagon, transport to shed or stackyard and unload onto stack:

- requires three to four men, and is relatively slow;

- low investment in equipment;

- possible exposure of bales to weathering.

2. Load bales from baler directly onto trailing wagons, haul immediately to storage site, unload and stack:

- requires a minimum crew of six and good organization to assure continuous operation of baler and minimal investment in wagons;

- low investment in equipment;

- weathering of bales in field is eliminated.

3. Wagon or truck with bale pickup device; mechanically pick up single bales, manually stack bales on wagon, transport to stacking area, use loading device as bale elevator:

- requires only three men; but slower than 2 as all men travel back and forth with each load;

- faster than 1 (due to mechanization);

- possible exposure to weathering.

4. Stook bales with automatic stooker (six-bale) or by hand (up to 21 bales), pick up with stook fork mounted on tractor, transfer bales to wagon or truck, haul to shed or stackyard and stack.

Variations:

(a) Hand-load bales from stooks to wagon and haul to storage.

(b) Pick up with stook fork, load individual bales onto wagon, haul to storage.

(c) Pick up with stook fork, load stooks intact onto 70-ft wagon (200-bale capacity), haul to stackyard, unload with stook fork and stack bales individually.

(d) Haul stooks to stackyard with stook fork and stack individual bales.

(e) Pick up stooks with fork attachment capable of holding all bales in place and of being rotated; build stack by placing stooks in a row, then fill in space between stooks with inverted stooks; stack can be built as high as fork will reach.

With a method using stooks:

- hay can be baled at somewhat higher moisture content, thus reducing possibility of leaf loss when baling dry legume hay (hopefully, hay can be dried in the field and removed to storage before weathering losses occur; if weathering occurs, stooked bales are damaged less than single bales);

- requires one to three men, depending on system;

- some methods require higher investment in equipment;

- operator may leave stooks in field too long, believing they are weatherproof.

5. Bale accumulators or bunchers are used to form a packet of bales to facilitate gathering. An accumulating device, a loading device and wagon or truck are required.

Variations:

(a) Manually load bales from packet of bales onto wagon and haul to storage.

(b) Pick up bale packets with pickup device (fork or clamp) and load onto wagon; transport to storage and transfer to stack with pickup device.

(c) Transport from field to stack with pickup device.

With the accumulator system:

- less manual labor (b and c);

- hay should be dry at baling to allow immediate pickup of bales and removal to storage before weathering occurs;

- requires one to three men.

6. Bale throwers are attached to the baler and toss bales into a trailing wagon with back and sides.

Variations in handling bales once loaded:

(a) Unload and stack by hand.

(b) Unload onto a bale elevator, drop bales in a random stack, cover with plastic.

(c) Unload as in (b), but drop through hole in roof of shed.

With a bale thrower:

- bales are brought in immediately (reducing risk of loss due to weathering) so must be dry at time of baling; there could be some leaf loss in legumes due to shattering;

- bales are smaller and easier to lift but harder to stack;

- requires only one or two men;

- relatively low investment in equipment;

- bales must be well shaped and properly tied to withstand handling.

7. Automatic, self-propelled or pull-type balewagons pick up individual bales and form a stack automatically. With this system:

- requires only one or two men;

- very high investment requiring large volume (about 1200 tons for self-propelled model) to keep cost/ton at reasonable level;

- single bales may be exposed to weathering before being picked up;

- bales must be properly formed to allow handling;

- loads must be carefully handled to form sound stacks that won't topple;

- if square-topped stacks are not placed in sheds, weathering can be more serious than for conventional bale stacks (unless properly topped to allow some shedding of water);

- conventional hay shelters may not be suitable for storing automatically formed stacks.

Bale Storage

The effect of storing hay in the field for a 3-week period in stooks or single bales has been studied by comparing bales stored in these ways with similar bales stored in shelter immediately following baling (Table 2) and by taking samples before and after weathering in the field (Table 3). Deterioration of digestibility of brome-alfalfa stored in stooks was surprisingly small. Intake was reduced in one of the 2 years where this was measured. Storing brome-alfalfa in single bales reduced both intake and digestibility. In contrast, there was a large deterioration in digestibility and intake of sweetclover stored either in stooks or single bales.

Table 2 - Effect of Bale Storage Method on Quality

Hay	Year	Shelter	Stooks	Single bales
		Digestibility, %		
Brome-alfalfa	1970	57.6	55.3	
	1971	60.0	59.9	57.6
Sweetclover	1970	59.0	53.4	53.6
		Protein, %		
Brome-alfalfa	1970	13.2	13.3	
	1971	16.6	15.7	15.0
Sweetclover	1971	13.2	13.8	14.1
		DDM intake, lb/day		
Brome-alfalfa	1970	0.67	0.54	
	1971	1.32	1.34	1.12
Sweetclover	1971	1.38	1.00	1.03

*1970 - 15-bale, handmade pyramid stooks; 1971 - 6-bale automatic stooker.

**DM digestibility measured with lambs.

***Fed coarsely chopped in 1970 and ground (1/4 in.) in 1971.

Table 3 - Effect of Bale Storage Method and Moisture Content at Baling on Digestibility,* 1971 Harvest

Hay	Stooks**				Single bales			
	Moisture, %		Digestibility, %		Moisture, %		Digestibility, %	
	At baling	After weathering	At baling	After weathering	At baling	After weathering	At baling	After weathering
Brome-alfalfa	19	20	60.7	61.3	17	18	61.4	58.3
	20	16	60.9	60.9	20	17	60.2	58.1
	30	16	60.5	61.6	30	18	60.0	57.7
Sweet-clover	17	18	59.2	54.2	20	22	58.1	51.2
	22	19	62.8	59.2	21	21	65.3	55.9
	27	20	63.0	58.5	26	21	63.3	55.3

*Organic matter digestibility (OMD) determined using a laboratory technique (in vitro).

**Six-bale automatic stooker.

Moisture Content at Baling

Digestibility of brome-alfalfa was not affected by moisture content at baling over a moisture range of 17 to 30% (Table 3). In contrast, digestibility of sweetclover was reduced when the moisture content was 20% or less. This was associated with about a 20% greater loss of hay during baling. Note that the higher moisture level at time of baling (Table 3) was probably too high for immediate storage, but the bales dried down to 20% moisture during the weathering period.

BIG PACKAGE HAY SYSTEMS

These systems are based on either the giant round bales, weighing from ½ to 1½ tons, or loose haystacks formed either automatically or with a crib and sweep arrangement and weighing from 1 to 12 tons.

Some advantages are:

- high capacity (5-10 tons/hours);

- one-man operation;

- packages may be easily self-fed;

- some stacks and bales are quite weather resistant;

- stacks require no twine, an expensive item with conventional bales and some large round bales.

Some disadvantages are:

- high operator skill required to form weather-resistant package;

- handling of packages poses problems unless special equipment is provided;

- more storage area is required as packages are generally not stackable;

- feeding losses are high (up to 50%) if stacks or bales are fed free-choice.

Giant Round Bales

Giant balers require a relatively low initial investment ($5000-7000 depending on make and model) and their use is economical where 100 tons or more of hay is harvested annually. They consume about a third as much twine as a conventional baler. Some degree of operator skill is required to form a bale of uniform diameter (zig-zagging along narrow windrows may be required). On hilly fields bales must be placed carefully, so as not to roll. Giant balers are of two basic types:

1. Bale is formed by 'rolling up' the windrow along the ground. These bales are looser than those in 2, thus allowing baling at a higher moisture content, but they are less weather resistant.

2. Hay is picked up into baler and rolled between a series of revolving belts or chains. Bales can be transported by baler.

Handling - Use any of the following equipment:

- front-end loader with one or two long spikes attached; these are used to skewer the bale (one spike) or to pass under the bale (two spikes driven in from the end);

- grapple fork;

- one or two spikes attached to a three-point hitch;

- small cart manufactured to pick up and transport bales.

Storage - Bales should be:

- spaced about 1 ft apart to reduce spoilage;

- set on poles or old fence posts to help reduce spoilage and avoid rotting of twine.

Feeding - The following methods can be used:

- set bales in feedlot and allow cattle free access (very wasteful);

- place bales behind or within some form of fence-type feeder;

- unroll bale on the ground with front-end loader;

- unroll bale into a feed bunk or self-feeder.

Loose Hay Stacks

There are two methods of putting up loose hay in stacks:

1. Sweep and crib - consists of gathering up windrowed hay with a hay sweep or fork mounted on the front end of a tractor and carrying it to the stack. Sometimes a crib is used to help form the stack base.

2. Mechanical stacking wagon - relatively new and of two basic types:

- compaction - uses some mechanical force (hydraulically lowered roof or packing arm) to physically compact the hay into a round or rectangular stack.

- noncompaction - chopped material is blown into a loaf-shaped container with the force of the blower and the settling action of the moving load being relied upon for compaction. This wagon requires more operator skill than the compaction type to form a good, weatherable stack.

Experience at Melfort and elsewhere indicates that it is almost impossible to avoid moldy or rotten pockets in mechanically formed stacks, as unevenness in the stack tops tends to funnel water into the stacks.

Moisture Content - Work to determine the optimum moisture level for stacking loose hay using the compaction-type stacking wagon suggests that 25-30% moisture (slightly higher than required for baling) is allowable for most forages. Some forages do not compact as readily as others (wheatgrasses vs bromegrass) and hence can be stacked at somewhat higher moisture levels (up to 35%).

Grass haystacks dry out faster than legume stacks and appear to be more resistant to penetration by rain. This is of special significance for sweetclover, which if moldy can cause hemorrhaging and death.

Feeding - The following methods are used:

- set stacks in pen and allow cattle free access (high wastage, up to 50%);

- set stacks behind or within a feeding fence or gate;

- set stacks in a long row behind an electric fence or movable rail feeding fence to control consumption;

- use a grapple fork to transfer hay to cattle;

- use an automatic stack-feeding device that slices off sections of stack and delivers hay into feed bunks or onto ground; these units, however, add about $3000 to the cost of the stack mover.

Stacking vs Baling of Grass Hays

During 1972, an experiment was carried out to determine the effects on feeding value of stacking vs baling of grass hays at different moisture contents. Using Hesston 30 and McKee 1000 stacking wagons and a conventional baler, hays were harvested at about 20 and 30% for bales and 30 and 40% for stacks. Baled hay was stored in stooks in the field for 2-3 weeks and then placed in a hay shelter. Stacked hay was stored outside. Hay quality was evaluated by determining protein content and organic matter digestibility in vitro at harvest and after storage over winter. In the spring, the hay was fed to lambs and feed intake and dry matter digestibility were determined (in vivo).

After winter storage, all crested wheatgrass was in fairly good condition. Intermediate wheatgrass stacked at 40% moisture was moldy, particularly in center of stacks, and that stacked at 30% moisture contained a small amount of mold. Baled intermediate wheatgrass was in good condition. All bromegrass stacks were moldy. Bromegrass bales harvested at 30% were moldy, but hay baled at 20% was in good condition.

As shown in Tables 4 and 5, digestibility of hay at harvest was similar for all harvesting methods and moisture levels; and decrease in digestibility of crested and intermediate wheatgrass during storage was fairly small. The largest decrease in digestibility was for bromegrass stacks. Differences between bales and stacks were probably partly due to the higher moisture content of the stacks at harvest.

Table 4 - Quality of Stacked and Baled Hay

Hay	Harvest method	In vitro OMD, % Harvest	In vitro OMD, % Spring	In vivo DMD, %	DM intake, lb/head per day	Digestible DM intake, lb/head per day
Crested wheatgrass	Hesston	60.2	57.2	58.0	1.53	0.89
	McKee	59.6	57.6	57.1	1.57	0.90
	Bales	60.1	59.4	59.6	1.62	0.96
Intermediate wheatgrass	Hesston	59.3	58.1	58.6	1.43	0.84
	McKee	59.3	57.4	57.8	1.39	0.80
	Bales	58.9	57.8	58.5	1.42	0.83
Bromegrass	Hesston	56.1	52.7	53.0	1.34	0.71
	McKee	56.3	51.2	51.8	1.48	0.77
	Bales	56.9	54.1	57.6	1.64	0.94

Table 5 - Effect of Moisture Content at Harvest on Quality

Hay	Harvest method	Moisture, %		In vitro OMD, %		In vivo DMD, %
		Harvest	Spring	Harvest	Spring	
Crested wheatgrass	Stacks	35	18	60.0	57.5	58.2
		29	18	59.8	57.3	56.9
	Bales	34	12	59.4	59.0	60.4
		19	9	60.7	59.7	58.7
Intermediate wheatgrass	Stacks	38	20	59.6	56.0	59.3
		27	21	59.1	59.5	57.1
	Bales	27	12	59.6	58.4	57.5
		22	13	58.1	57.2	59.4
Bromegrass	Stacks	41	19	55.5	50.8	51.7
		31	22	56.9	53.0	53.1
	Bales	30	12	56.1	53.1	57.0
		20	14	57.7	55.0	58.1

DRIED CHOPPED HAY

A hay tower for drying and storing chopped hay was built at Melfort in 1971. It follows the general design of hay towers used in Europe for several years, and is still being developed at Melfort to improve efficiency of operation.

The crop is cut, allowed to field-dry to 40-50% moisture, picked up with a forage harvester, transported to the tower and blown into the structure through the roof. To date, the hay tower has been a success in terms of quality of hay stored. Some structural modifications are being made to reduce labor requirements and facilitate unloading. Once these are completed, the tower may become a very economical way of storing a high quality hay product (suitable for a dairy operation, or for supplementing low-quality roughage for wintering or lactating beef cows).

The tower's 3 years of operation have revealed the following statistics:

Average weight stored	- 70 tons dry matter
	- 105 wet tons
Average dry matter range at filling	- 50-80%
Average dry matter	- 67.3%
Average fuel used/year	- 1173 gal
Average blower time - with heat	- 219 hours
- without heat	- 313 hours

SILAGE OR HAYLAGE

These two systems are largely identical except for moisture content of the crop at time of harvesting. Silage is usually put up at 60-70% moisture and haylage at 50-60%.

Some of the advantages of silage and haylage are:

- less weather dependent at harvest than other systems;

- lower field harvesting losses;

- may be stored for many years if properly sealed.

Some disadvantages are:

- not readily saleable;

- odor of silage may be objectionable;

- usually requires a daily feeding operation;

- high labor requirement at harvest;

- high moisture silage is very bulky, which limits its use in rations for high-producing stock.

Both silage and haylage are stored in silos, which may be either horizontal or vertical. Some points of comparison are:

- horizontal silos much cheaper;

- vertical structures easily automated for feeding;

- vertical silos need specialized equipment at filling, such as a blower and self-unloading wagons;

- smaller storage area needed for vertical silos.

Vertical Silos

Sealed or Airtight - This is a very expensive structure because of construction materials used and erection procedures required. Either top or bottom unloading mechanisms are available. The top unloading system helps pack the silage during filling and increase the silo's capacity.

Unsealed - Usually, the silo is made from wood or concrete staves or poured concrete. It is less expensive than a sealed silo.

Horizontal Silos

Top-of-the-ground - This is the cheapest silo. Silage is simply dumped on the ground, packed, covered with plastic and insulated if required.

Trench - The second-cheapest type of silo consists of a trench dug into the ground or side of a hill. The excavated dirt is often piled along the trench sides to increase capacity economically. Drainage may be a problem.

Bunker - The sides of this silo, built above ground level, are made of wood or concrete.

Feeding from Horizontal Silos - The following methods are suitable:

- use front-end loader to transfer silage from silo into self-unloading wagon or directly into feeder;

- use a mechanical silo unloader to load wagon or truck or deliver to automated bunk feeder;

- self-feeding gates along face of silage;

- electric wire to limit access of cattle to silage;

- automated feeding gate system that cuts into face of silage and knocks it to the ground making it easier for cattle to eat;

- if you intend to let cattle self-feed within a silo the floor of the silo should be hard surfaced (asphalt or concrete) to avoid waste and facilitate cleaning.

Results of Feeding Experiments with Silage

One of the recommendations always included in bulletins on silage making is that silage should be well packed, particularly in horizontal silos. However, in areas with a severe winter climate, the amount of freezing that occurs in the silo is directly proportional to the density of the silage, other factors being equal. Following a report that unpacked silage had remained in excellent condition, a series of experiments were undertaken to determine if and under what conditions silage could be preserved without packing.

Two horizontal bunker silos, 18' x 46' x 7' were filled each summer with chopped (3/16-1/4 in.) material. Forages tested included sweetclover, sweetclover treated with formic acid, and brome-alfalfa. The silage in one silo was packed with a front-end loader and, in the other, left unpacked. Both silos were sealed immediately after filling with polyethylene, held in place with large mesh fish netting. After filling during the 3rd year of the test, a layer of bales was placed on top of the polyethylene as well as around the outside walls of the silo.

Freezing and Spoilage - Most of the spoilage and all of the freezing occurred at the top and sides of the silos. During the first year, spoilage in the packed silo was limited to a 4-6-in. layer across the top but the top 30 in. had to be discarded because of freezing. The depth of the frozen layer decreased with warmer weather. In the unpacked silo, spoilage and frost both penetrated to a depth of 12-18 in. Losses approximated 20% in both silos by the end of the feeding period.

During the second year, cold weather during the feeding period increased losses of packed silage. Frost penetrated to depths of 3-5 ft. Much of this material was fed but most of the top 18 in. had to be discarded. Spoilage was limited to less than 4 in. across the top of the silo. In the unpacked silo, mold was present in the top 6-8 in. and in small packets throughout. Frost was found to a depth of about 12 in.

During the 3rd year, a mild winter and the layer of bales practically eliminated freezing in both silos. Spoilage accounted for losses of 25-30% in the unpacked silo compared with only 6-13% in the packed material.

Effects of Packing - Daily gains and the efficiency of feed conversion of steer calves fed packed silage were consistently higher than gains of steers fed unpacked material (Table 6). This occurred in spite of the fact that any obviously spoiled material was not fed. Since, on average, there was little difference in intake between the two types of silage, the effect on gain and feed efficiency must have been due to a difference in the quality of the two silages. Feeding 3-4 lb grain with the silage generally resulted in marked increases in liveweight gain.

Formic Acid - Although there was a trend toward higher gains and feed intakes and improved feed efficiency when formic acid-treated silage was fed, the effects were not consistent except when acid-treated silage was fed with 3 lb barley. Formic acid may be of more benefit with direct-cut, higher-moisture silage.

Supplemental Grain - In 1970 it was noted that those cows going on test in thin condition and fed no additional grain ran into trouble following calving. The onset of milk production was just too much for some of them and several deaths occurred. Similarly fed cows going onto test in good condition did not suffer from this problem. The need to consider the condition of the cow when determining the need for supplemental grain in a silage-feeding program is essential.

EVALUATION OF HARVESTING SYSTEMS

The forage harvesting system that is best for a certain farm depends on the size of the operation, what the hay is being used for, and other variables including costs and weather. Although it is relatively simple to calculate the cost per ton of using a specific system, the feeding value of that ton of forage may vary considerably depending on which system is used. Also, variations in weather both during and following harvest may alter the relative feeding values of forage preserved by various systems from one year to the next.

FEEDING EXPERIMENTS WITH BEEF CATTLE

Comparisons are currently under way at Melfort to determine the quality of forage preserved by each of four systems:

1. Silage - crop field-wilted in windrow to 65% moisture, chopped and ensiled in bunker silo

2. Chopped hay - crop field-wilted to 40% moisture, chopped, dried artificially and stored under shelter (hay tower)

3. Stacked loose hay - crop field-dried to 30% moisture and stacked with a noncompaction type of mechanical stacking wagon

4. Baled hay - crop field-dried to 20% moisture, baled and moved into hay shelter

Forage from each system was fed to one of four groups of about 20 crossbred steer calves during the winter months for 24 weeks. In addition to hay or silage, dry-rolled barley was fed at the rate of 2 lb/head per day.

Table 6 - Comparison of Packed and Unpacked Silage in Horizontal Silos

	1970		1971				1972			
	SC		SC		BA		SCT		SC	
	P	UP	P	UP	P	UP	P	UP	P	UP
Silage:										
DM stored, tons	34.6	32.9	15.9	15.4	16.6	15.9	18.7	19.9	19.3	19.3
Losses, %	20	20	34	20	35	26	13	25	6	29
Density (DM/cu ft), lb	13.3	8.7	14.9	10.9	13.3	10.7	14.2	11.4	14.2	11.4
Av dry matter content, %	27	27	36	36	49	45	30	32	31	32
Feeding trials:										
Calves										
Av initial animal wt, lb										
- no grain	533	528	618	613	614	616	601	600	598	601
- grain	529	536	617	618	614	613	603	599	600	600
Av daily DM intake, lb										
- no grain	9.8	9.4	10.8	12.5	14.0	13.2	17.2	16.5	16.6	13.6
- grain	9.4	9.4	14.6	12.9	13.8	14.7	14.4	16.5	15.5	15.3
Av daily gain, lb										
- no grain	0.76	0.34	1.11	0.88	1.39	1.24	1.82	1.41	1.96	1.33
- grain	1.68	1.54	1.73	1.44	1.96	1.60	2.33	2.17	2.03	1.86
Feed efficiency (DM/1b gain), lb										
- no grain	12.9	27.7	9.8	14.3	10.1	10.7	9.4	11.7	8.4	10.2
- grain	7.7	8.4	8.4	8.9	7.0	9.2	6.2	7.6	7.6	8.2
Yearling steers (845 lb)										
Av daily gain, lb										
- no grain	.58	.69								
- 4 lb oats/day	1.55	1.60								
Silage DM eaten daily, lb										
- no grain	13.1	12.5								
- 4 lb oats/day	12.8	13.6								
Bred cows (1100 lb)										
Av daily gain before calving, lb										
- no grain	.58	.72								
- 4 lb oats/day	1.58	1.54								
Silage DM eaten daily, lb										
- no grain	12.8	15.3								
- 4 lb oats/day	16.0	14.1								

BA - brome-alfalfa
SC - sweetclover
SCT - sweetclover, treated
P - packed
UP - unpacked
DM - dry matter

Gains

The amount of weight gain per ton of dry matter harvested is perhaps the single most important factor for assessing forage harvesting systems. Using this criterion, the chopped artificially dried hay from the hay tower scored highest, showing an average of 228 pounds gained per ton of hay harvested. The similar figure for baled hay in this study was 222 pounds gained, for stacked hay 203 pounds gained, and for silage 173 pounds.

Hay from the tower also produced the highest average daily gains (1.8 lb/day) (Table 7), followed by that stored as bales and stacks (1.6 lb/day) and as silage (1.4 lb/day). Artificially dried hay was also utilized most efficiently - 8.7 lb DM required/lb gain, compared with 9.1, 9.8 and 10.3 for bales, stacks and silage, respectively.

Waste

Of the original forage harvested by each system, 98.9% of the silage was accounted for when fed (included 18% frozen or spoiled material), compared with 96.2% (bales), 93.4% (stacks) and 92.7% (chopped).

Quality

Definite differences between quality of forage produced by the different systems were found; 1973 results suggest that quality of hay conserved as stacks is lower than for any other system. Spoilage, as a result of wet weather during and following harvest, is believed to have caused reduced animal performance.

Table 7 - Effect of Forage Harvesting System on Beef Cattle Performance

	Silage		Chopped dried hay		Mechanically stacked hay		Baled hay	
	1972-3	1973-74	1972-3	1973-74	1972-3	1973-74	1972-3	1973-74
Total DM harvested, lb	48870	64386	52122	59295	54666	58550	48557	59549
Moisture at harvest, %	63	64.9	36.4	37.5	27.9	26.0	17.0	14.4
Total DM, lb								
- offered	39501	35828	43043	44308	44437	43591	41807	36463
- consumed	38894	35313	41360	43287	42193	38619	38819	35998
- wasted or spoiled	8893	11384	-	-	-	4972	-	465
- left over	-	7164	5278	7510	6640	6507	4894	16478
Original DM accounted for, %	98.9	84.5	92.7	87.4	93.4	85.6	96.2	88.9
Average daily gain, lb	1.41	1.33	1.77	1.44	1.60	0.79	1.59	1.13
Average daily DM intake, lb								
- forage	12.8	10.2	13.7	12.5	13.9	11.1	12.8	10.4
- grain	1.8	1.7	1.8	1.7	1.8	1.7	1.8	1.7
Total	14.6	11.9	15.5	14.2	15.7	12.8	14.6	12.1
DM/lb gain, lb	10.3	8.9	8.7	9.8	9.8	16.2	9.1	10.7
Gain/ton DM harvested, lb	173	165	228	197	203	108	222	192
Protein (DM basis), %	13.5	12.6	13.0	11.9	11.8	13.1	12.9	11.8
OMD (in vitro), %	58.5	52.1	59.9	52.0	58.0	49.6	57.0	56.1

*A comparison of precipitation during the period from harvesting to feeding in the 2 years of this test to date is as follows (Test 1, June 1972 - May 1973; Test 2, June 1973 - May 1974):

	June**	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total (yr)	Total (from time of harvest
Test 1	2.40	2.12	.75	1.65	.21	.55	.44	.19	.65	.04	1.11	2.52	12.63	8.60
Test 2	6.77	5.16	2.53	2.13	.56	1.54	.94	1.10	.41	.82	.53	--	22.49(+)	13.90

**Actual harvesting did not occur until July; see last column for rainfall occurring from harvesting to feeding.

INFORMATION
Edifice Sir John Carling Building
930 Carling Avenue
Ottawa, Ontario
K1A 0C7