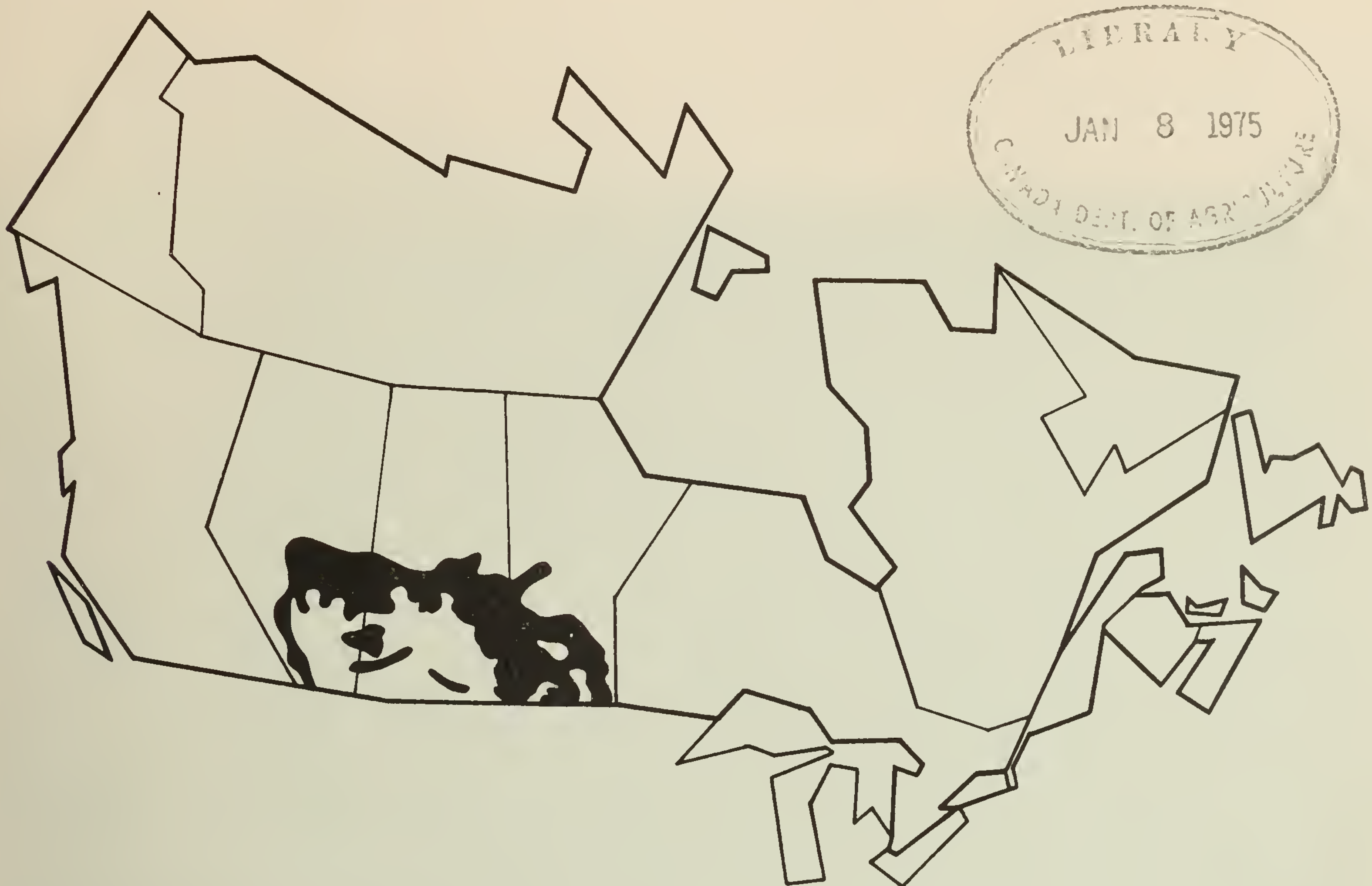

UTILIZING HARVESTED FORAGES in the aspen parklands of Western Canada

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UTILIZING HARVESTED FORAGES IN THE ASPEN PARKLANDS OF WESTERN CANADA

MELFORT RESEARCH STATION
CANADA DEPARTMENT OF AGRICULTURE

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This publication summarizes work done at the Melfort Research Station on the use of harvested forages in growing-finishing rations for beef steers and lambs, and includes information on equipment for storing and feeding forages.

FEEDING VALUE OF HARVESTED FORAGES

Harvested forages usually consist of the whole plant (except lowest part of stem and the roots), whereas grains comprise only one special portion of the plant. Because of this, physical and chemical composition varies much more in forages than in grains.

WHAT DETERMINES FEEDING VALUE?

Kind of forage, stage of maturity, loss of leaf material during harvesting, curing and handling, deterioration due to molding, form in which preserved (silage, hay, haylage), processing, and mixing with other feeds all affect the feeding value of forages.

Kind of Forage

On the whole, legume hays are higher in protein, calcium and carotene than grass hays. Typical analyses of some common forages produced in the Parkbelt are given in Table 1.

Table 1 - Composition of Common Forages, %

	Dry matter	Crude protein	Digestible protein	Total Digestible nutrients	Calcium	Phosphorus	Carotene, mg
Alfalfa	88	15.5	11.0	50	1.6	.26	28
Sweetclover	87	14.2	9.9	49	1.6	.26	30
Bromegrass	90	10.6	6.0	47	.4	.28	16
Crested wheatgrass	90	10	7	51	.3	.2	
Reed canarygrass	91	8.0	5	42	.3	.25	
Timothy	88	7.5	4.2	53	.4	.2	4
Oat hay	88	8.8	5.0	57	.26	.24	

It must be pointed out that the above figures are averages only. Livestock feeders should submit samples of feeds for analysis to obtain precise information on nutritive value.

Stage of Maturity

During the growth of forage plants, yield per acre increases but quality is reduced (Figure 2). As stems grow in proportion and maturity, fiber content increases, leaf proportion decreases, and there is a drop in the content of crude protein (CP) and digestible nutrients (TDN), as shown in Table 2.

As proportion of leaf decreases, forage usually becomes less palatable and consumption tends to decrease. This means that feed required per pound of gain is increased on an all-forage ration, since maintenance requirements are fairly constant and only the extra feed consumed is available for production.

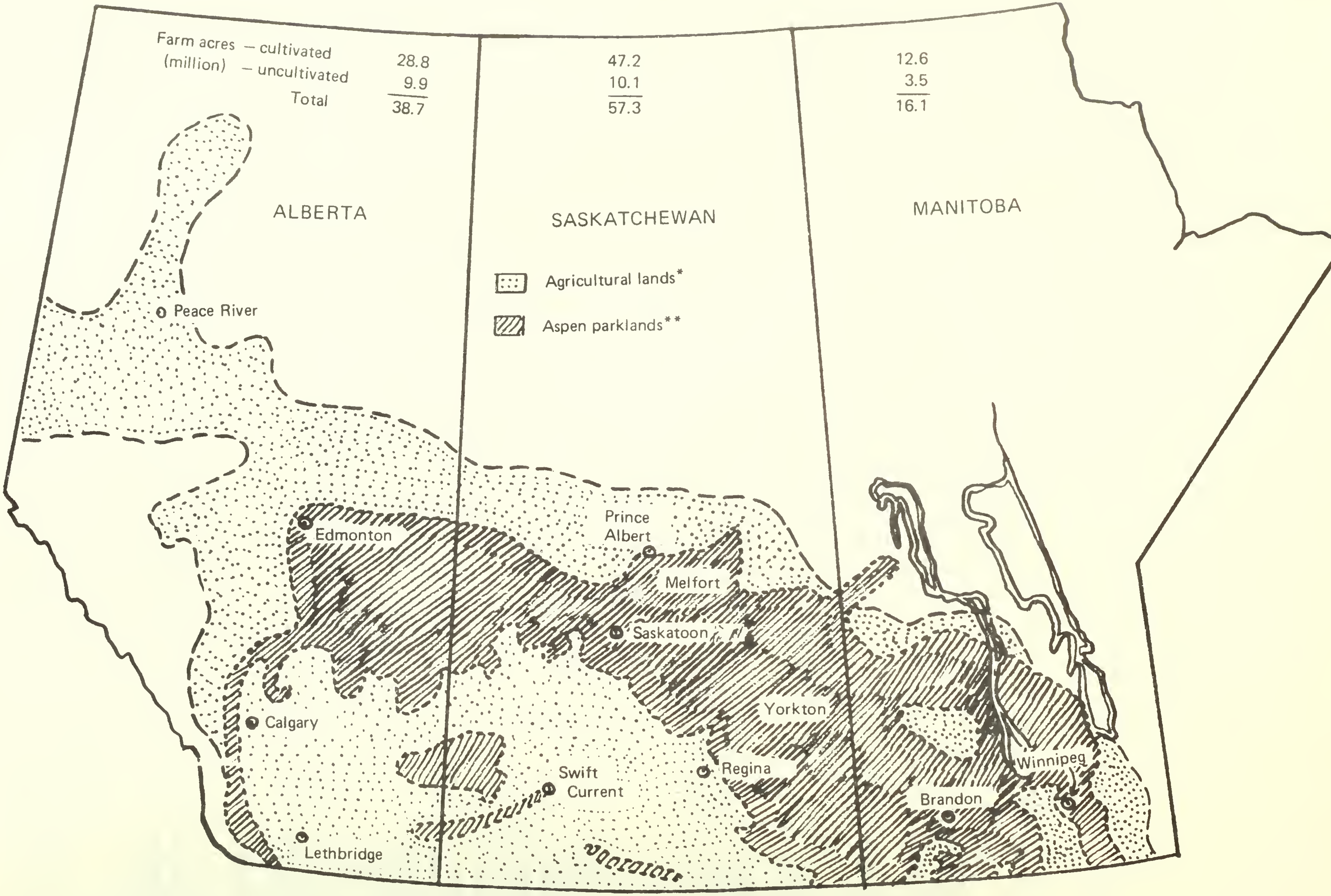


Figure 1 - Estimated extent of aspen parkland in relation to the agricultural area of the Prairie Provinces.

Figure 2 - Effect of date of cutting on yield and protein content of hay.

Table 2 - Changes in Protein and TDN Contents as Hay Crops Mature

	Alfalfa		Bromegrass		Crested wheatgrass		Oat hay	
	CP	TDN	CP	TDN	CP	TDN	CP	TDN
Immature	19.2	50	15.0				12.3	
Early bloom	16.6	51	10.9	50	12.7	50		
Half bloom	15.2	51			9.4			
Full bloom	13.9	48	9.2	49	8.2		7.9	38
Past bloom	13.8	44	5.7	47	6.9	43	8.3	43
Mature	12.4		5.4		3.7		6.2	55
Very mature	10.0							

In practice, farmers must compromise between yield and quality of hay. For excellent, highly palatable hay to creep-feed to lambs or calves, immature alfalfa could be harvested and perhaps artificially dried; a second cutting would help to compensate for the lower yield. For self-feeding to wintering cows, the forage could be cut when very mature, to obtain a higher yield and a protein content more in line with the cows' requirements. Generally, however, the best time to harvest hay, particularly grasses, is as near the early bloom stage as the weather allows. Hay harvested later will not meet the protein requirements of growing-finishing cattle or lambs, and supplements (usually expensive) will have to be fed.

Cutting, Curing and Handling

Because leaves contain two to three times as much protein as stems, any operation resulting in loss of leaves lowers the feeding value of hay. This includes raking too vigorously, raking or baling when too dry, failure to use a hay conditioner (particularly with legumes), excessive handling and failure to prevent loss of leaf when blowing chopped forage into wagons from the forage harvester or during processing (chopping, grinding, blowing into mixers or feeders, etc.)

Leaving bales of hay in the field reduces carotene content and palatability. If hay is baled in good condition and properly stored, it is an excellent feed for cattle and sheep. It also lends itself to chopping, grinding and incorporation into rations, a decided advantage over silage in the production of finished animals.

The form in which forages are preserved also affects feeding value. Haylage in airtight silos is probably the most nutritious forage, provided it was in good condition when put up. Losses due to spoilage are minimal; but the cost of such silos is exceedingly high and there is little information available on the economics of their use. Forage can also be put up as silage, which is fine for wintering cows and ewes or for getting feedlot steers safely onto feed. However, silage is not satisfactory for other operations, such as wintering calves or finishing lambs and steers, where its bulk limits the animals' ability to consume enough nutrients to gain satisfactorily, necessitating the feeding of grain.

Processing

The feeding value of hay can be increased rather remarkably by chopping or grinding. An animal will consume far more feed in this form than it could if unprocessed hay was fed, which means that a larger proportion of the feed is available for putting on gain. It is thus possible for animals to meet protein requirements by eating more forage of a lower protein content. If forage is plentiful and reasonably priced in relation to other feeds, it pays to increase forage intake by grinding and perhaps even pelleting.

At other times it probably is more economical to balance the deficiencies by supplementing with grain, linseed or rapeseed meal, or phosphorus.

<u>Supplementing vs Processing</u> - Usually, forages are deficient in one or more nutrients, such as energy, protein or phosphorus. Since animal performance is determined by the first limiting nutrient, when deficiencies in the hay are made up efficiency of utilization is improved. It may be possible to do this either by supplementing the ration with grain or by increasing the quantity of forage consumed so that it supplies the amount of TDN required.

The TDN requirement of an 800-lb finishing steer is about 15 lb/day - 65% of the ration based on an intake of 23 lb feed/day. This could be supplied by

8 lb hay and 15 lb barley. Assuming that the hay has a TDN content of 50%, it may be possible, by processing the hay, for the steer to consumer 30 lb hay alone, thereby obtaining the amount of TDN required. If the supply of nutrients other than TDN is known to be adequate and the steer can consume 30 lb ground forage, it is possible to determine the price at which it becomes more economical to supplement rather than grind the hay.

For example, if barley is worth $2.40/bu, hay $30/ton and grinding the hay costs $6/ton, then the cost of feeding the hay (8 lb) and barley (15 lb) ration is about 90 cents/day, as against the cost of feeding ground hay alone (30 lb) - 45 cents for the hay and 9 cents for grinding, or 54 cents/day. Thus, in this case, it would be more economical to process the hay than to supplement the ration with grain.

STEER CALF FEEDING EXPERIMENTS

The forage processing program at Melfort developed from steer calf feeding experiments conducted during two successive winters (1960 and 1961). The calves were fed hay or silage to appetite. The daily dry matter intake and average daily gains are shown in Figure 3. It should be noted that, regardless of the hay fed, gains did not exceed 1 lb/head per day; rate of gain was closely related to amount of feed consumed; forage put up as good-quality hay was consumed to a greater extent than the same forage put up as silage; and there was little or no relationship between protein content and gains, provided protein content exceeded 10%. It was concluded that, if forages were to be the main ingredient in rations for rapidly growing ruminants, some method had to be found to increase their intake.

Effect of Processing on Intake

An experiment was conducted using two hays, one a good-quality bromegrass (17% crude protein), the other a poorer-quality green stipa grass (7% CP). Both hays were fed in the long (baled), chopped, ground, and ground and pelleted forms as the sole feed (apart from cobalt-iodized salt and water) to wintering steer calves. The relationship between intake and rate of grain is shown in Table 3.

Table 3 - Effect of Processing on Forage Feeding Value

	Long	Chopped (2 in.)	Ground (3/16 in.)	Pelleted (7/16 in.)
Bromegrass hay (17% CP 480 lb)				
Av daily DM eaten, lb	10.2	11.3	11.7	12.2
Av daily gain, lb	1.22	1.67	1.73	2.14
DM/lb gain, lb	8.4	6.8	6.8	5.7
Digestible DM, %	68	68	65	64
Green stipa hay (7% CP 425 lb)				
Av daily DM eaten, lb	6.6	7.1	10.6	11.5
Av daily gain, lb	-.12	.16	1.00	1.39
DM/lb gain, lb	neg.	44.5	10.6	8.3
Digestible DM, %	53	55	51	50

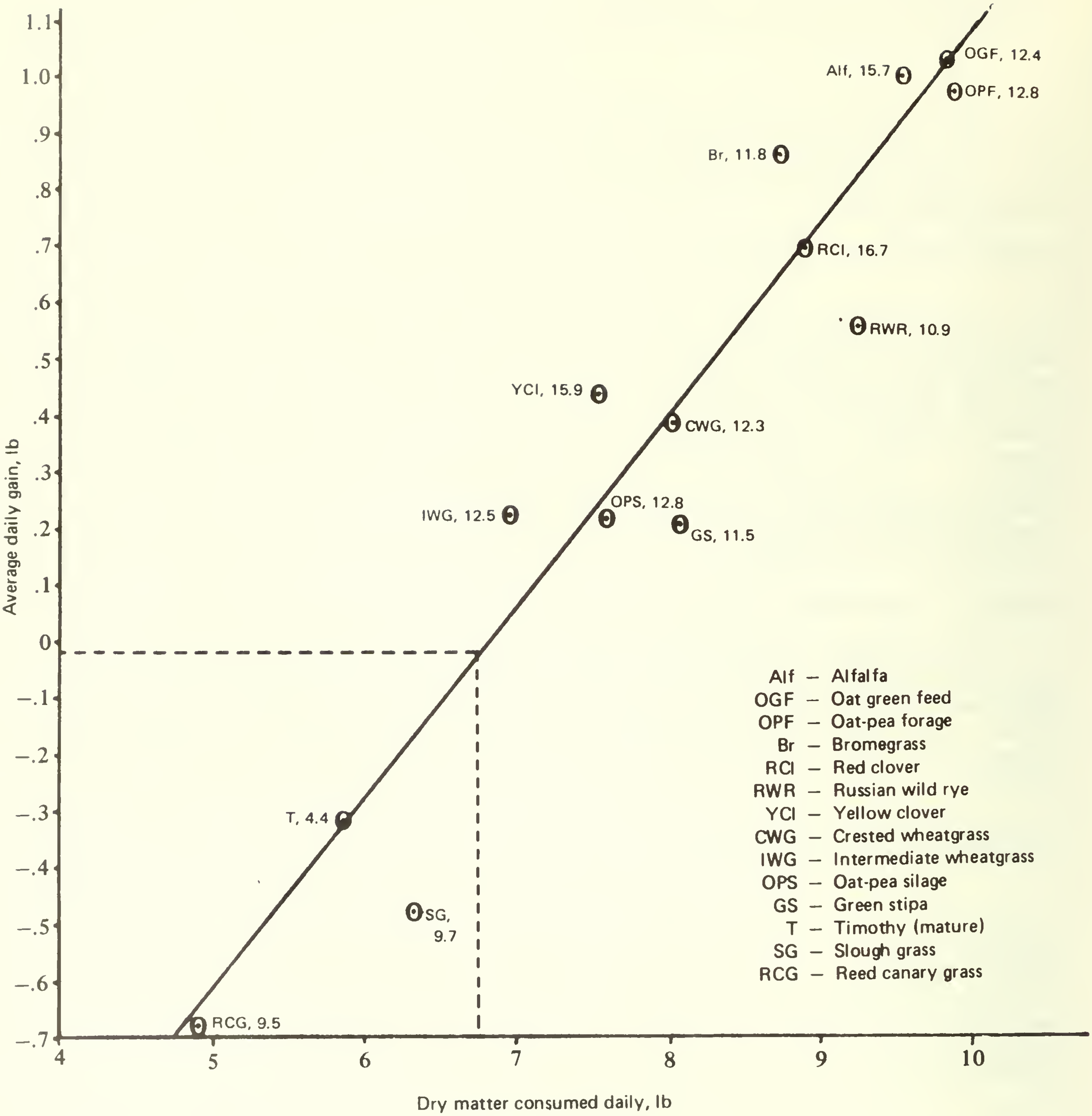


Figure 3 - Relationship between dry matter eaten and steer gains (480-lb calves).

Although this was only an 8-week test, it showed that intake and rate of gain could be considerably increased by reducing the forage bulk by processing. Perhaps because of the difference in quality (protein level) between the two hays, fewer pounds of brome were required per pound of liveweight gain. It is noteworthy that processing had a much greater effect on the feeding value of the poorer-quality forage, 'converting' it from a feed that could not be consumed in sufficient quantity to maintain body weight to one that would support a gain of about 1 1/3 lb per day.

Long-term, more-recent tests on the effects of processing are summarized in the section beginning on page 18.

NUTRITIONAL REQUIREMENTS OF BEEF CATTLE AND SHEEP

Efficient livestock production is not always indicated by the pounds of feed required to produce a pound of gain. It is, for example, now possible to produce a pound of broiler chicken on a pound of feed; not only is the feed an expensive one, but the pound of broiler contains a lot of water. We tend to look down on the steer because it requires 10 lb or more of high-roughage feed to produce a pound of gain, but most of the time it is using a feed or feed by-product that cannot be utilized directly as food for humans and is thus serving a very useful purpose. As long as the cost of producing a pound of meat is less than what the producer receives for it, then it is economically sound to produce. The more the value of the product exceeds the cost of production, the more efficient, economically speaking, is that production.

Before considering the role forages can play in meeting the nutritional requirements of beef cattle and sheep, we should look at the requirements for some of the more common classes of ruminants.

Table 4 - Estimated Nutritional Requirements of Cattle and Sheep

Class of animal	Weight, lb	Expected daily gain, lb	Expected feed intake (90% DM) lb	Total protein, lb	TDN, lb	Ca, g	P, g	Vitamin A, IU
Growing steer or heifer	500	1.00	13	1.3	7.0	13	10	10,000
Growing steer or heifer	500	1.50	14	1.45	7.8	15	12	10,000
Finishing steer	800	2.80*	22	2.2	14.3	20	20	20,000
Finishing steer	1000	2.50*	26	2.6	16.9	20	24	20,000
Wintering pregnant cow	1000	.4	18	1.4	9.0	13	12	20,000
Nursing cow	1000	nil	28	2.3	16.8	30	23	30,000
Growing ewe lamb	80	.2	3.1	.36	1.6	3	2.5	1065
Finishing lamb	60	.35	2.6	.32	1.5	3	2.5	500
Finishing lamb	90	.40	3.7	.35	2.3	3	2.5	825
Pregnant dry ewe (1st 15 wk)	200	.10	4.2	.35	2.3	3.5	3.0	1800
Pregnant dry ewe (last 6 wk)	200	.35	5.5	.40	2.8	5	4.0	4400
Nursing ewe (1st 10 wk)	200	.1	6.2	.50	3.3	7.5	5.5	4400

*These gains are minimal goals to be tolerated only where low-cost feed is used.

In addition to the nutrients shown in Table 4, all livestock require salt, iodine and cobalt. Feeds produced in Western Canada are usually deficient in iodine and may be deficient in cobalt. Therefore, it is recommended that cobalt-iodized salt be included in complete rations or in the concentrate portion of the ration at a level of 0.5% (10 lb/ton), as well as being available free-choice at all times. Be careful when first placing granulated salt out for cattle; if they are salt-starved, they may consume too much and sicken and die of salt poisoning. It is better to use block salt or start with a small quantity of granulated salt and gradually increase the amount daily until some is left in the box just before the next feeding. Then it can be supplied free-choice.

WATER

Water should be available to livestock at all times. This is particularly important in cold weather when cattle are not likely to drink enough in one or two waterings a day unless, of course, the water is warmed to 45-50°F. It has also been shown that, during hot weather, feeder cattle with access to water cooled to 65°F gained 0.3-0.4 lb/head per day more than similar steers receiving water heated to 89°F by the sun.

The amount of water consumed by livestock depends on the ration, the temperatures of the air and the water, the quality of the water, the kind and size of animal, and the availability of water. Table 5 indicates amounts of water required for some livestock enterprises.

Table 5 - Water Consumption of Beef Cattle and Sheep, Imp. gal (10 lb/gal)

	Temperature		
	40°F	60°F	80°F
Class of beef cattle			
500 lb steer (maintenance ration)	3	3½	5
800 lb steer (finishing ration)	9	11½	15½
1100 lb steer (finishing ration)	11¼	14	19
1100 lb pregnant cow	7½	9¼	
Sheep			
On range or dry pasture		0.5 to 1.3	
On range with salted feed		1.7	
On grain and hay rations*		0.6	
On lush pasture		very little	

*At Melfort, 65-lb lambs fed ground hay indoors consumed up to 0.9 gal/day.

USING FORAGES TO MEET NUTRITIONAL REQUIREMENTS

In assessing the possibilities of a forage satisfying the nutritional requirements of beef cattle and sheep, we will consider the crude protein and digestible nutrient (energy or TDN) contents only, since nutrients such as vitamin A and minerals can be provided at relatively low cost. For purposes of this section, we will also assume that the forages in Table 6 (which are typical for

Table 6 - Estimated Nutritional Values of Forages and Quantities of Forages to Meet Protein/Energy Needs of Livestock

				Forage theoretically required to meet protein/energy needs, lb		
				Wintering	Growing-finishing	
	DM, %	CP, %	TDN, %	440-lb calf	860-lb steer	1100-lb steer
Forages						
Alfalfa hay (early bloom)	90	16.6	52	7.4/14.8	12.2/25.3	16.9/35
Alfalfa hay (full bloom)	88	13.9	48	8.8/16.0	14.5/27.5	20.2/37.9
Sweetclover hay (early bloom)	83	14.7	54	8.4/14.3	13.7/24.4	19.1/33.7
Sweetclover silage (full bloom)	28	4.4	18	28.0/42.8	45.9/73.3	63.8/101.1
Bromegrass hay (early bloom)	90	10.9	50	11.3/15.4	18.5/26.4	25.8/36.4
Meadow fescue hay (past bloom)	92	7.2	45	17.1/17.1	28.1/29.3	39.0/40.4
Slough hay (mature)	92	6.9	43	17.8/18.3	29.3/31.4	40.7/43.3
Crested wheatgrass hay (early bloom)	90	12.7	50	9.7/15.4	15.9/26.4	22.1/36.4
Crested wheatgrass hay (past bloom)	93	6.9	43	17.8/17.9	29.3/30.7	40.7/42.3
Oat hay (dough stage)	90	7.6	46	16.2/16.7	26.1/28.7	37.0/39.6

				Forage theoretically required to meet protein/energy needs, lb				
	DM, %	CP, %	TDN, %	Wintering 1100-lb cow	Lactating 1100-lb cow	Finishing 90-lb lamb	Wintering 200-lb ewe	Lactating 200-lb ewe
Forages								
Alfalfa hay (early bloom)	90	16.6	52	6.0/16.3	12.6/25.4	2.1/ 4.4	2.1/ 4.4	3.0/ 6.3
Alfalfa hay (full bloom)	88	13.9	48	7.1/17.7	15.1/27.5	2.5/ 4.7	2.5/ 4.7	3.6/ 6.8
Sweetclover hay (early bloom)	83	14.7	54	6.8/15.7	14.2/24.4	2.4/ 4.2	2.4/ 4.2	3.4/ 6.1
Sweetclover silage (full bloom)	28	4.4	18	22.7/47.2	47.7/73.3	7.9/12.7	7.9/12.7	11.4/18.3
Bromegrass hay (early bloom)	90	10.9	50	9.1/17.0	19.2/26.4	3.2/ 4.6	3.2/ 4.6	4.6/ 6.6
Meadow fescue hay (past bloom)	92	7.2	45	13.9/18.8	29.1/29.3	4.8/ 5.1	4.8/ 5.1	6.9/ 7.3
Slough hay (mature)	92	6.9	43	14.5/20.2	30.4/31.4	5.0/ 5.4	5.0/ 5.4	7.2/ 7.8
Crested wheatgrass hay (early bloom)	90	12.7	50	7.9/17.0	16.5/26.4	2.8/ 4.6	2.8/ 4.6	3.9/ 6.6
Crested wheatgrass hay (past bloom)	93	6.9	43	14.5/19.7	30.4/30.7	5.0/ 5.3	5.0/ 5.3	7.2/ 7.6
Oat hay (dough stage)	90	7.6	46	13.1/18.4	27.6/28.6	4.6/ 5.0	4.6/ 5.0	6.5/ 7.1

the parkland area) are available and that they contain the levels of crude protein (CP) and TDN indicated. Feeds should be analyzed at least for dry matter (DM) and CP, for efficient use in livestock feeding.

The next consideration is whether or not the animal is capable of eating the amount of forage that theoretically meets its nutritional requirements. Table 7 shows the amount of feed needed to meet an animal's requirements on a conventional ration and estimated amounts of forages that could be consumed by various classes of stock, based on experimental findings to date.

Table 7 - Estimated Consumption of Forages Fed in Various Forms

		Estimated possible consumption of hay								Silage
	Conven-tional	Good quality				Poor quality				quality
Class of animal	ration	Long	Chop.	Gr.	Pell.	Long	Chop.	Gr.	Pell.	(30% DM)
Growing steer, 500 lb	13	14	15	16	16.5	10	10.5	14	15	30-40
Finishing yearling steer, 800 lb	22	20	22	26	26	15	17	21	23	40-60
1000 lb	26	25	27	34	35	18	20	28	30	50-70
Pregnant dry cow, 1000 lb	18	30				20				50-70
Nursing cow, 1000 lb	28	30				20				65
Finishing lamb, 90 lb	3.7	2.7	3	4	4.3	1.5	2	3.0	3.5	5
Pregnant dry ewe (1st 15 wk)	4.2	4.3	5.5			3.5	4	5		9
Nursing ewe (1st 10 wk)	6.2	5	5.5			3.5	4	5.5	6	11

GUIDE TO FEEDING FORAGE RATIONS

Table 8 is based on information in the preceding tables. Producers wishing to maximize the use of forages can use the table as a guide in formulating livestock rations.

The following estimates of maximum forage levels are conservative but, because of the wide range in forage quality, feeders should watch their stock closely and be prepared to alter the feeding program as required. If, for example, wintering cows are gaining too fast, the proportion of roughage may be increased or the hay may be ground or chopped less finely. Conversely, if feedlot steers are not gaining fast enough, the proportion of roughage should be reduced or it may be more finely chopped or ground. Remember, also, that the estimates are made with the assumption that other required nutrients are provided - salt, minerals, vitamin A and, for finishing market animals, an antibiotic supplement. It is also assumed that finishing cattle will be implanted.

Table 8 - Forage Rations for Cattle and Sheep

Class of animal	Weight	Expected gain/day	% hay: Good quality %	Good quality Form	Poor quality %	Poor quality Form	Method of feeding
Wintering steer calf	400-600	1.00	90	Long or chopped	80	Ground	Roughage self-fed Grain hand-fed
Growing steer calf	400-700	1.50	80	Long or chopped	65-70	Ground	Ration self-fed
Finishing steer	700-900	2.5	90	Ground	75	Ground	Ration self-fed
	900-1100	3.0	70	Ground	50	Ground	Ration self-fed
Wintering pregnant cow	1000	--	100	Long	80	Chopped	Hand-fed good quality hay; self-fed chopped poor quality hay; hand-fed grain; or self-fed silage and hand-fed grain as required
Nursing cow	1000	--	90	Long	70	Chopped	Self-fed roughage; hand-fed grain
Finishing lamb	65-85	.40	80	Ground	70	Ground	Ration self-fed
	85-110	.50	70	Ground	60	Ground	Ration self-fed
Pregnant ewe (1st 15 wk)	200	.1	100	Chopped	80	Chopped	Grain hand-fed; roughage free-choice
Nursing ewe (1st 10 wk)	200	-.1	80	Chopped	60	Chopped	Roughage free-choice; grain and supp. hand-fed

The example rations in Table 9 theoretically meet the animals' nutritional requirements. For research-proven rations, see sections giving results of beef cattle and lamb finishing tests.

Table 9 - Rations That Theoretically Meet Nutritional Requirements

	Quantity	CP, lb	TDN, lb	Ca, g	P, g
Wintering 500-lb steer (gain 1 lb/day)					
Bromegrass hay long (11% CP)	12.5 lb	1.37	6.2	22	14
Barley, rolled (12% CP)	1.5 lb	.18	1	.4	2.7
Cobalt-iodized salt	31 g				
Vitamin A (10,000 IU/g)	1 g				
Aurofac 10 (10 g/lb)	4 g				
Total	14 lb	1.5	7.2	22	16
Requirements	13 lb	1.3	7.0	13	10
Growing 500-lb steer (gain 1 lb/day)					
Crested wheatgrass hay,* ground (7% CP)	10.5 lb	.74	4.5	14.3	11.9
Wheat, rolled (15% CP, 80% TDN)	4.5	.68	3.6	.8	8.2
Cobalt-iodized salt	31 g				
Limestone (40% Ca)	15 g			6	
Vitamin A	1 g				
Aurofac 10	4 g				
Total	15 lb	1.42	8.1	20.3	18
Requirements	14 lb	1.45	7.8	15	12
Finishing 1000-lb steer (gain 3 lb/day)					
Good-quality brome-alfalfa hay, ground (13% CP, 55% TDN)	24 lb	3.12	13.2	128	26
Barley, rolled (10% CP, 78% TDN)	8 lb	.80	6.2	2.2	14
Cobalt-iodized salt	70 g				
Vitamin A	2 g				
Aurofac 10	4 g				
Total	32 lb	3.92	19.4	130.2	40
Requirements (est.)	26 lb	2.9	19.0	29	29

*Crested wheatgrass is more palatable than some of the other low-quality roughages, such as slough grass.

Table 9 - Rations that Theoretically Meet Nutritional Requirements (concluded)

	Quantity	CP, lb	TDN, lb	Ca, g	P, g
Wintering 1000-lb pregnant cow					
Meadow fescue hay, long (7.2% CP)	16 lb	1.15	7.2	29.0	18.0
Barley, rolled or coarsely crushed (10% CP, 78% TDN)	4 lb	.4	3.1	1.09	7.2
Dry vitamin A	2 g				
+ free access to cobalt-iodized salt and mineral mix					
Total	20 lb	1.55	10.3	30	25
Requirements	18 lb	1.4	9.0	13	12
Finishing 90-lb lamb					
Alfalfa, ground, 3/16-in. screen (14% CP, 50% TDN)	2.8 lb	.39	1.4	18	3
Barley, rolled (12% CP, 78% TDN)	1.2 lb	.13	.9	.3	2.1
Cobalt-iodized salt	8 g				
Vitamin A	0.1 g				
Aurofac 10	1.2 g				
Total	4.1 lb	.52	2.3	18	5
Requirements	3.7 lb	.35	2.3	3	2.5
Wintering 200-lb pregnant ewe					
Bromegrass hay, chopped (10% CP, 50% TDN)	5.0 lb	.5	2.5	9	6
+ free access to cobalt-iodized salt					
Total	5.0 lb	.50	2.5	9	6
Requirements	4.2 lb	.35	2.3	3.5	3.0

FORAGES IN GROWING-FINISHING RATIONS FOR BEEF STEERS

USE OF GROUND FORAGES IN WINTERING STEER CALVES

Quality of roughage fed to steer calves greatly affects their intake, rate of gain and feed efficiency. (Table 10) In tests at Melfort, average daily gain was approximately 0.5 lb higher from good-quality alfalfa than from poor-quality alfalfa processed in the same manner.

Increase in rate of gain is due mainly to the effect of processing on intake. When roughages of low to medium quality are fed, the intake is limited by the capacity of the rumen. Grinding increases the rate at which food leaves the rumen. Therefore, within a given period of time, the ruminant can consume more of a ground roughage than of the same roughage fed in the long form. As intake increases, rate and efficiency of liveweight gain usually improve as well.

Chopping roughage reduces wastage by the animals but may not have much effect on intake. On the other hand, very fine grinding is probably not necessary and may even reduce intake, gain and feed efficiency compared with that obtained with more coarsely ground roughage. For example, in the test mentioned above (Table 10), steers fed poor-quality alfalfa ground to pass through a 3/16-in. hammermill screen consumed the same amount of feed as those fed the alfalfa ground through a 1/2-in. screen, but gained an average of .12 lb/day less on the finer-ground feed. This may have been due to lower digestibility of the finer-ground roughage brought about by a faster rate of passage through the digestive tract. Factors such as dustiness may lead to a reduction in intake of finely ground roughages.

During the winter of 1969-70, another experiment was conducted on the effects of processing and, in addition to determining rate of gain and feed intake, recorded the time, labor and fuel required to process the roughage. All hay was self-fed. The self-feeder containing long hay was filled by elevating the bales to the top of the feeder, cutting the strings and allowing the slices to fall through a door in the roof. A hay shredder was used for producing the 'chopped' hay, which was then blown into the appropriate self-feeder. Roughage ground through the hammermill was blown directly into the self-feeders. As shown in Table 11, ground sweetclover hay produced the greatest response in terms of increased gain and feed efficiency, and of reduced costs per pound of gain.

For very poor quality forages, grinding alone may not be enough to overcome inadequate intakes of nutrients other than energy. If protein content is less than about 7%, supplement the forage with additional protein, such as rapeseed meal or dehydrated alfalfa. Provide an adequate level of vitamin A and access to a mineral supplement containing cobalt-iodized salt, calcium and phosphorus.

In general, grind poor- to medium-quality roughage through a 1/2-in. hammermill screen, and good- to excellent-quality roughage through a 1-in. screen. This should produce close to the maximum rate of gain possible at less cost in time, labor and fuel than if you used a finer screen. When mixing ground hay with grain, it may be necessary to grind hay more finely to prevent undue separation of grain from hay, which could lead to animals overeating grain, particularly under self-feeding conditions.

Table 10 - Effects of Quality of Alfalfa on Daily Gain, Intake and Net Return of Wintering Steer Calves

Roughage fed	Good-quality alfalfa (14.0% CP)						Poor-quality alfalfa (11.9% CP)					
Physical form	Long	Chopped	Hammered				Long	Chopped	Hammered			
Hammermill screen size, in.			2	1	1/2	3/16			2	1	1/2	3/16
Av initial weight, lb	561	557	556	557	555	552	559	556	558	555	555	557
Av daily gain, lb	1.10	1.15	1.50	1.57	1.57	1.73	0.63	0.66	0.99	1.11	1.36	1.24
Av daily DM intake lb	17.4	17.4	18.7	18.7	18.6	20.7	14.9	14.2	17.3	17.8	19.3	19.4
DM/lb gain, lb	16.2	15.1	12.5	11.9	11.8	12.0	23.7	21.5	17.5	16.0	14.2	15.6
Wt/cu ft, lb	11.1*	6.5	9.3	10.8	11.6	14.0	9.8*	5.2	7.7	7.5	11.2	11.7
Relative value** of hays (assuming long, poor-quality alfalfa @ $30/ton), $/ton	$ 44.44	47.68	57.60	60.52	61.07	60.15	30.00	33.04	41.15	45.02	50.72	46.16
Extra value due to processing, $/ton	$ --	3.24	13.16	16.08	16.63	15.71		3.04	11.15	15.02	20.72	16.16

* In the bale, before feeding.

**Based on the value of the extra gain produced @ 40¢ per lb of gain.

Table 11 - Effects of Processing Roughage on Daily Gain, Intake and Net Return of Wintering Steer Calves

	Sweetclover hay (11.3% CP)				Marsh hay (9.5% CP)				Timothy-alfalfa hay (13.6% CP)			
Physical form	Long	Chopped	Ground		Long	Chopped	Ground		Long	Chopped	Ground	
Screen size, in	-	-	2	1/2	-	-	2	1/2	-	-	2	1/2
Av initial wt, lb	530	529	530	529	596	598	599	597	638	638	638	638
Av daily gain, lb	0.90	1.30	1.52	1.78	.70	.96	1.03	1.20	1.88	2.36	2.27	2.46
Av daily intake, lb (air-dry hay)	12.6	14.9	17.1	18.8	12.0	14.7	15.4	16.4	23.3	23.7	24.8	24.8
Feed/lb gain, lb	14.0	11.5	11.3	10.6	17.1	15.3	15.0	13.7	12.4	10.0	10.9	10.1
Feed processing data - man-hours/ton	1.15	.74	.74	.85	.92	1.14	1.15	1.50	1.04	.67	.62	.74
- tons/hr	1.35	2.73	2.76	2.34	1.55	1.73	1.72	1.31	1.65	2.93	3.17	2.67
- fuel, gal/ton	--	1.61	1.10	1.31	--	2.19	1.67	2.25	--	1.56	1.07	1.21
Processing cost/-steer/day*, ¢	2.2	4.4	5.0	6.4	1.7	6.8	7.1	10.0	3.6	6.4	6.2	7.4
Feed cost/-steer/day, ¢	18.9	22.4	25.7	28.2	12.0	14.7	15.4	16.4	46.6	47.4	49.6	49.6
Total cost/-steer/day, ¢	21.1	26.8	30.7	34.6	13.7	21.5	23.5	26.4	50.2	53.8	55.8	57.0
Initial value of steer @ 40¢/lb, $	212.00	211.60	212.00	211.60	238.40	239.20	239.60	238.80	255.20	255.20	255.20	255.20
Final value** @ 42¢/lb, $	298.20	331.38	351.12	371.70	309.12	331.80	338.10	351.54	425.88	466.20	458.64	474.60
- less feed and processing costs, $	42.20	53.60	61.40	69.20	27.40	43.00	45.00	52.80	100.40	107.60	111.60	114.00
Net returns after feed, $	44.00	66.18	77.72	90.90	43.32	49.60	53.50	59.94	70.28	103.40	91.84	105.40
Relative values of processed hays***,$	30.00	44.26	45.69	51.07	20.00	26.30	27.50	33.34	40.00	57.80	50.21	56.88

*Includes labor @ $3/hr and operating cost of tractors and hammermill @ $10/hr.

**Assuming a 200-day winter feeding period.

***Assuming long hays worth $30, $20 and $40, as shown, and liveweight gains worth 40¢/lb.

FINISHING STEERS ON HIGH-ROUGHAGE RATIONS

Feeding Ground Hay

In 1962, following good results from feeding ground hay to sheep, a test was undertaken to assess the performance of 730-lb Hereford steers hand-fed a finishing ration containing 80% ground medium-quality bromegrass hay and 19% ground barley. A control lot received an 80% ground barley ration containing 19% ground hay; and a third lot of steers received the high-hay ration in ground and pelleted form. The remainder of the ration consisted of 0.5% limestone in the high-grain ration or calcium phosphate in the high-hay ration, 0.5% cobalt-iodized salt, a vitamin A supplement and an antibiotic supplement. Table 12 summarizes the results of the 74-day experiment.

Table 12 - Effects of Feeding Ground Hay in Finishing Rations

	1 80% barley	2 80% hay (ground)	3 80% hay (pelleted)
Av daily gain, lb	2.58	3.02	3.22
Av daily feed eaten, lb	19.9	25.6	25.3
Maximum daily feed intake, lb	23.2	32.3	32.5
Feed/lb gain, lb	8.07	8.84	8.19
Feed eaten/steer, lb			
- grain	1178	360	356
- hay	280	1515	1498
- supplement	15	19	18
Av final wt, lb	923	948	973
Av carcass wt, lb	501	510	529
Dressing %	54.2	53.8	54.3
Carcass grades			
- A1 (Good and Standard)	3	3	3
- A2 (Choice)	3	3	3
Est. returns* to labor/steer, $	19.74	45.07	49.80

*Assuming barley at 5½¢/lb, ground hay at $50/ton (pelleting, $8/ton); steers purchased at 40¢/lb, average finished steer price of 46¢/lb; and a $40/steer miscellaneous cost exclusive of labor.

On the basis of animal performance obtained in this experiment, it was concluded that feeding ground hay in finishing rations could produce good rates of gain and carcasses of acceptable quality; and that further work should be undertaken to develop techniques for using forages more efficiently in steer finishing rations, so that in times of high grain prices beef cattle feeders might have more economical feeds to turn to.

In 1963, another finishing test was carried out with four lots of eight Hereford steers placed directly onto test rations following removal from pasture (Table 13). The four rations contained 20, 50, 80 and 99% ground bromegrass hay, with the remainder of the ration made up of ground barley, minerals, vitamin A and antibiotic supplement. The test showed that, even when fed 99% ground grass hay, it was possible to finish beef steers. However, overall gains were not good perhaps because of weight losses incurred in adjusting from pasture to drylot feeding.

Table 13 - Effects of Feeding Ground Hay at Various Levels in Finishing Rations

	1 (20% hay)	2 (50% hay)	3 (80% hay)	4 (99% hay)
Days on test	77	70	70	63
Av daily gain, lb	1.73	2.21	2.36	2.24
Av daily feed eaten, lb	15.9	21.3	25.4	25.7
Feed/lb gain, lb	9.2	9.7	10.8	11.5
Feed eaten/steer, lb	1224	1491	1778	1619
- grain	967	731	338	0
- hay	245	746	1422	1603
- supplement	12	14	18	16
Av initial wt, lb	878	857	853	867
Av final wt, lb	1011	1011	1018	1008
Av cold carcass wt, lb	543	536	531	510
Dressing %	53.7	53.2	52.2	50.6
Carcass grades				
- A1 (Good and Standard)	5	0	4	6
- A2 (Choice)	3	8	4	2
Est. returns* to labor/steer, $	29.93	31.66	36.86	28.02

*Assuming barley at 5½¢/lb, ground hay at $40/ton; steers purchased at 40¢/lb, an average carcass value of 85¢/lb; and a $25/steer miscellaneous cost exclusive of labor.

Hay Level and Quality

In 1964, eight lots of eight steers each (averaging 850 lb) were weighed directly off pasture and placed on an experiment to investigate the importance of hay quality, when hay was fed at three different levels; and to determine the economics of feeding a molasses-linseed oil meal supplement in a 70% hay ration. Steers were self-fed rations from the start of the test, but those fed the high-grain ration received the 80%-roughage ration for a week, followed by the 50%-roughage ration for a week before getting the high-grain ration. The results of this 61-day test are presented in Table 14, together with an economic assessment based on more-current feed and cattle prices.

Table 14 shows that, at the prices assumed, returns were better when good-quality hay was used except at the 50% level, where lower returns were probably due to the increased tendency for steers to bloat at this level. With poor-quality hay, best returns were obtained at the 50% level, but even at the 80% level returns were better than at 20%. The most economical ration was good-quality hay at 80% level. Adding molasses or linseed oil meal did not pay with either poor- or good-quality hay. On rations containing poor-quality hay, dressing percentage fell as level of hay increased. On rations containing good-quality hay, this effect was essentially eliminated.

In the fall of 1966 and 1967, a large-scale experiment was carried out to further investigate the effects of forage level and quality in steer finishing rations. Good-, medium- and poor-quality forages were ground (5/16-in. screen) and added at levels of 20, 45, 70 and 95% to complete rations for finishing long

Table 14 - Level and Quality of Ground Hay in Finishing Rations, 1964

	1	2	3	4	5	6	7	8
Roughage level	20	20	50	50	80	80	70	70
Roughage quality	Poor	Good	Poor	Good	Poor	Good	Poor	Good
							+ Molasses and linseed meal	
							5%	7%
Av daily gain, lb	2.17	2.68	3.22	2.44	2.51	3.18	2.64	3.18
Av final wt, lb	983	1014	1046	999	1004	1051	1012	1036
Av daily feed eaten, lb	24.4	22.5	29.0	25.1	27.4	28.6	27.8	26.6
Feed eaten/steer, lb	1490	1369	1764	1524	1668	1809	1691	1562
- hay	294	271	873	758	1318	1438	1177	1090
- grain	1178	1083	873	758	330	365	294	273
- molasses (5¢)	--	--	--	--	--	--	85	78
- linseed meal (8¢)	--	--	--	--	--	--	118	109
- other supplement	18	15	18	8	20	15	17	12
Dressing %	54.8	54.4	53.0	54.7	51.8	53.8	52.4	54.0
Cold carcass wt, lb	538	551	554	546	521	567	530	555
- A1 (Good and standard)	6	5	5	6	7	6	8	4
- A2 (Choice)	2	3	3	2	1	2	0	3
Est. returns* to labor /steer, $	22.36	37.00	42.61	38.46	40.52	60.92	35.04	51.86

*Assuming barley at 5½¢/lb, ground poor hay at $35/ton, ground good hay at $50/-ton; steers purchased at 40¢/lb, average cold carcass value of 85¢/lb; and a $25/steer miscellaneous cost exclusive of labor.

yearling steers (four Charolais x Hereford and four Aberdeen Angus in each pen). Various proportions of early, medium and late-cut brome-alfalfa or alfalfa hays were combined with either slough hay or brome hay and wheat straw. Good hay averaged about 16% crude protein, medium about 11½% and poor hay about 9.8%. All steers were implanted and self-fed from the start of the experiment. Results for the 2 years are averaged and summarized in Table 15.

In general, liveweight gain, dressing percentage and feed efficiency decreased with each increase in level of roughage. When good-quality hay was fed, steers fed the 95% level had a higher rate of gain than those fed either 45 or 70% roughage, probably because bloat occurred in the latter groups. Three of eight steers fed good-quality hay at the 45% level bloated repeatedly the first year of the test. The following year, bloat occurred in the groups fed 45 and 70% good-quality forage and caused the death of one animal in each of these groups. This indicates the importance of finding a means of preventing bloat when feeding good-quality (alfalfa) hay in finishing rations. The use of non-bloat-inducing legumes (sainfoin) or the feeding of a chemical agent to counter bloat requires further investigation.

Medium-quality roughage at the 20% level produced the highest rate of gain (4.15 lb/day) and the most efficient feed conversion. However, in general, forage quality became important only when the ration contained more than 70% roughage (except for the bloat problem mentioned above).

Table 15 - Level and Quality of Ground Hay in Finishing Rations, 1966 and 1967

	Good-quality roughage				Medium-quality roughage				Poor-quality roughage			
Level of ground hay in ration	20	45	70	95	20	45	70	95	20	45	70	95
Initial weight, lb	806	803	796	796	791	795	795	799	798	801	798	798
Final weight, lb	1085	1046	1059	1091	1084	1083	1080	1045	1084	1092	1058	985
Days on feed	72	88	91	99	71	83	91	103	74	81	93	113
Av daily gain, lb	3.90	2.88	3.07	2.98	4.15	3.47	2.97	2.39	3.88	3.60	2.92	1.65
Av daily feed eaten, lb	29.67	29.78	32.77	33.67	28.89	30.11	32.22	31.11	32.11	34.56	33.89	28.56
Feed eaten/steer, lb	2135	2620	2983	3333	2051	2499	2932	3296	2396	2799	3152	3226
- grain	1687	1415	865	134	1620	1349	851	132	1893	1511	914	129
- hay	427	1179	2088	3166	410	1125	2052	3131	479	1260	2206	3065
- supplement	21	26	30	33	21	25	29	33	24	28	32	32
Dressed weight, lb	585	569	568	576	581	575	564	531	577	574	543	468
Dressing %	53.9	54.4	53.6	52.8	53.6	53.0	52.2	50.8	53.2	52.6	51.3	47.5
Carcass grades												
- A1 (Good and Standard)	10	10	13	12	7	9	11	12	5	11	11	11
- A2 (Choice)	6	5	2	4	9	7	5	4	11	5	3	1
- Commercial-Utility	--	--	--	--	--	--	--	--	--	--	2	4
Est. returns* to labor/steer, $	29.28	12.54	21.62	41.38	38.05	31.55	30.65	18.57	17.54	22.69	15.79	17.68

*Assuming barley at $5\frac{1}{2}$¢/lb; ground good, medium and poor hays at $50, $40 and $30/ton, respectively; steers purchased at 40¢/lb, average cold carcass value at 85¢/lb; and a $40/steer miscellaneous cost exclusive of labor.

Liveweight gains of steers fed good-quality forage were generally lower during the initial weeks of the feeding period than those of steers fed either medium- or low-quality forage. At the 20 and 45% levels, gains on good-quality roughage after the first 60 days on feed remained lower than those attained on medium- and poor-quality forage. However, at the 70 and 95% levels, gains on good-quality forage increased relative to those in the lower-quality roughages and, after 40-50 days on feed, were directly related to forage quality. At the 95% level, the difference in gain due to quality continued to increase rapidly with time.

This suggests that a level of roughage of up to 70% can be incorporated into starter rations for beef cattle, without adversely affecting the performance of the animals over the feeding period as a whole. Also, for best results with good-quality forage, a relatively long feeding period may be preferable to a 60-70 day feeding period. The results also indicate that steers can be adequately finished on rations containing more forage than is usually recommended, provided it is fed in the ground form. This could be of considerable economic importance to the producer who has an abundant supply of low-cost forage for which he may not have an alternate market.

In this test, all rations produced an acceptable rate of gain except the one containing 95% poor-quality roughage. It should also be noted that the final market weight of some of the steers fed high-roughage rations was 40-50 lb less than that of steers fed rations containing lower levels of ground roughage. Had they been fed a few days more, the grades likely would have been better.

Under the economic conditions assumed in the calculation of returns to labor, one could conclude that if high-quality hay is available it should be fed only at a high level (80-95%), if returns are to exceed those attained on a high-grain ration. With medium- and low-quality roughage, some other feeding method must be found to improve efficiency of utilization - perhaps supplementation of some sort is required, perhaps pelleting would help, or perhaps the rations should be varied from a high level of ground forage initially to a lower level during the finishing stages.

Steer Finishing Tests, 1971 and 1972

In 1971 and 1972, two further steer finishing experiments were carried out to evaluate the effect of incorporating 70% ground hay into finishing rations and reducing the level of hay at different rates until the 90% level of rolled grain was reached. During this period, a number of factors were changing which could affect the economics of feeding ground, high-roughage rations. Cattle prices had increased considerably, grain prices were increasing relative to hay prices and the grading system for beef carcasses changed to favor leaner carcasses. In addition, the technology of producing and harvesting forage was improving so that much of the physical work of harvesting and processing hay was being eliminated

Each of the tests involved 48 Charolais x Angus steers averaging 621 lb in the 1971 test and 672 in the 1972 test. The steers were alloted into four groups on the basis of weight and type, and assigned at random to one of four ration treatments:

Lot 1 - fed a 50% ground hay starter ration for 2 days and increasing proportions of the finishing ration, so that by the 9th day they were receiving a 90% grain finishing ration.

Lot 2 - fed 2000-lb increments of 70, 60, 50, 40, 30 and 20% (10% hay, 10% ground straw) ground hay rations in succession, before receiving the finishing ration (90% grain) at 39 days.

Lot 3 - as for lot 2, except that they were fed 4000 lb of each ration before receiving the finishing ration at the 79th day.

Lot 4 - as for lot 2, except that they were fed 6000 lb of each ration before receiving the finishing ration at the 95th day.

All steers had free access to water and cobalt-iodized salt and were self-fed from the start of the test. All roughage was ground through a 1/2-in. screen. In 1971, the grain portion of the ration consisted of equal parts of oats and barley until the steers averaged 800 lb; all barley from 800 to 950 lb; and equal parts of barley and wheat when the steers averaged over 950 lb. In 1972, the grain portion of the ration was made up of equal parts of barley and wheat throughout the test.

Within each of the four groups of 12, three steers were assigned at random to be controls; three were treated with 36 mg diethylstilbestrol (Stimplants, Pfizer & Co.); three with 36 mg Ralgor (Zeranol, Commercial Solvents Corporation); and three with progesterone-estradiol benzoate (Synovex S, E.R. Squibb & Sons).

The results of the two tests are summarized in Table 16.

Table 16 - Steer Finishing Tests, 1971 and 1972

	1	2	3	4
On finisher by days	9	39	74	95
Av initial wt, lb	647	647	646	647
Av final wt, lb	1143	1140	1144	1161
Av daily gain, lb	3.20	3.19	3.23	3.35
Av daily feed, lb	24.2	25.6	26.4	27.3
Feed eaten/steer, lb	3742	3980	4081	4218
- hay	44	433	867	1314
- straw	367	321	249	175
- grain	3257	3174	2905	2663
- supplement	74	52	60	66
Dressing %	56.5	56.4	56.2	56.1
Cold carcass wt, lb	646	643	643	651
Carcass grades				
- A1 and A2	19	20	19	22
- A3 (heavy, Choice)	5	4	5	2
Measurements/100-lb carcass				
- depth of fat cover over eye of lean, in.	.12	.12	.11	.11
- area of eye of lean, sq in.	1.85	1.85	1.85	1.85
Est. returns* to labor/steer, $	58.99	53.57	58.06	65.55

*Assuming grain at $5\frac{1}{2}$¢/lb, ground hay at $50/ton, ground straw at $20/ton and supplement at 10¢/lb; steers purchased at 40¢/lb and sold at 85¢/lb cold carcass (basis lot 1 and av carcass value of other lots kept relative to actual values at time of test); and a $40/steer miscellaneous cost exclusive of labor.

Ration Treatment - In the 1971 test, increasing the amount of ground hay fed to steers during the first part of the feeding period reduced rate of gain somewhat (although not significantly) and had essentially no effect on carcass grades. In 1972, however, rates of gain were generally increased as steers received greater amounts of ground roughage during the first part of the feeding period. This was probably due to the difference in composition of the concentrate portion of the rations between years.

In the first year, steers fed high-grain rations undoubtedly benefitted by being started on an oat-barley grain mixture, which was gradually replaced by barley and wheat as the test progressed. The steers fed the high-ground-roughage ration, on the other hand, would probably have gained faster had the grain portion of their ration consisted of higher-energy grains. In the 1972 test, gains of steers fed the higher energy grain ration were reduced after about 100 days on feed, but gains of those fed the higher levels of ground hay during the first half of the feeding period maintained an excellent rate of gain throughout the test. This resulted in more economical feed conversion and increased returns to labor for steers fed the high level of ground hay, compared with those fed the high-grain ration.

Implant Treatments - In the 1971 test, all implant treatments produced highly significant increases in rate of gain (17-26%). Carcass yields, grades and quality were not adversely affected and carcasses from implanted steers were worth $28-38 more than those from unimplanted ones (controls). Unfortunately, the effect of implants on feed efficiency could not be determined, but faster-gaining steers usually require less feed per pound of gain, other factors being equal. It is reasonable to assume that the increased value of the carcasses would more than cover the cost of the implants (DES 35¢, Ralgro 75¢ and Synovex S $1.35/steer).

In the 1972 test, the response to implant treatments was disappointing, although rates of gain over the test period as a whole were as good as or better than those of the first test. Steers implanted with DES gained 7.5% faster (not significant) than the controls, and those implanted with Synovex S gained 10.5% faster ($P<.05$). Ralgro produced no response. None of the implant treatments caused any reduction in carcass grades. There was a slight tendency for carcasses of implanted steers to carry less fat cover over the eye of lean at the point of quartering and to have a slightly greater lean-eye area. Table 17 gives the results of the two tests.

Steer Finishing Test, 1973

Rations fed to steers in the 1971 and 1972 tests averaged from 10% ground straw to 30% ground brome-alfalfa hay. Applying 1973 grain prices, and allowing for the new grading system which favors leaner carcasses, returns over feed and other costs would be greatest for steers fed the most ground hay. In an effort to determine the maximum level of ground hay that could be fed economically to finishing steers, in 1973 an experiment was designed to include two additional treatments. These involved starting steers at 80 and 90% ground hay and gradually increasing the grain levels to 80 and 70%, respectively. This meant that steers in these lots would consume about 50 and 65% of their ration in the form of ground hay over the total finishing period.

Table 17 - Implant Tests, 1971 and 1972

	Control	DES*	Ralgro	Synovex S
Av daily gain, lb	3.02	3.50	3.25	3.43
Av carcass wt, lb	617	659	646	662
Av dresing %	55.9	56.5	56.5	56.6
Carcass grades				
- A1 and A2	21	20	18	21
- A3 (heavy, Choice)	3	4	6	3
Measurements/100-lb carcass				
- depth of fat cover over eye of lean, in.	1.15	1.10	1.20	1.15
- area of eye of lean, sq in.	1.85	1.88	1.79	1.90

*DES no longer legal for this purpose in Canada.

Because no brome-alfalfa hay was available for this test, a mixed-grass hay, put up in the hay-drying tower in the summer of 1972, was used. It was ground through a 1/2-in. screen.

Charolais x Angus and Charolais x Hereford steers (3:1) were assigned to each of the four experimental rations on the basis of weight and condition and placed on experimental rations June 12. Within each lot of 12 steers, four received a 36-mg implant of Zeranol (Ralgro), four received progesterone-estradiol benzoate (Synovex S) and four remained as unimplanted controls. All steers were self-fed from the start of the test. The 'high-grain' lot received the starter ration for the first 2 days. For days 3 and 4 the starter was mixed with the finisher at 3:1, for days 5 and 6 at 1:1 and for days 7 and 8 at 1:3. From day 9 on the finishing ration was fed. Steers were weighed at weekly intervals and rations were fed according to the schedule in Figure 4. Results are presented in Table 18-21. The test period was 147 days.

Ralgro and Synovex S both increased rate of gain by about 0.4 lb/day and carcass values by $29 and $42, respectively. The implant treatments appeared to have more effect on rate of gain as level of ground grass hay in the ration increased.

The use of good-quality, grass-alfalfa hay probably would have improved the performance of the steers fed high-roughage rations. However, work will be required to develop means of using such hay without running the risk of bloat, which can occur when ground, good-quality alfalfa or alfalfa hay is fed at levels of 30-70% with high-energy grains.

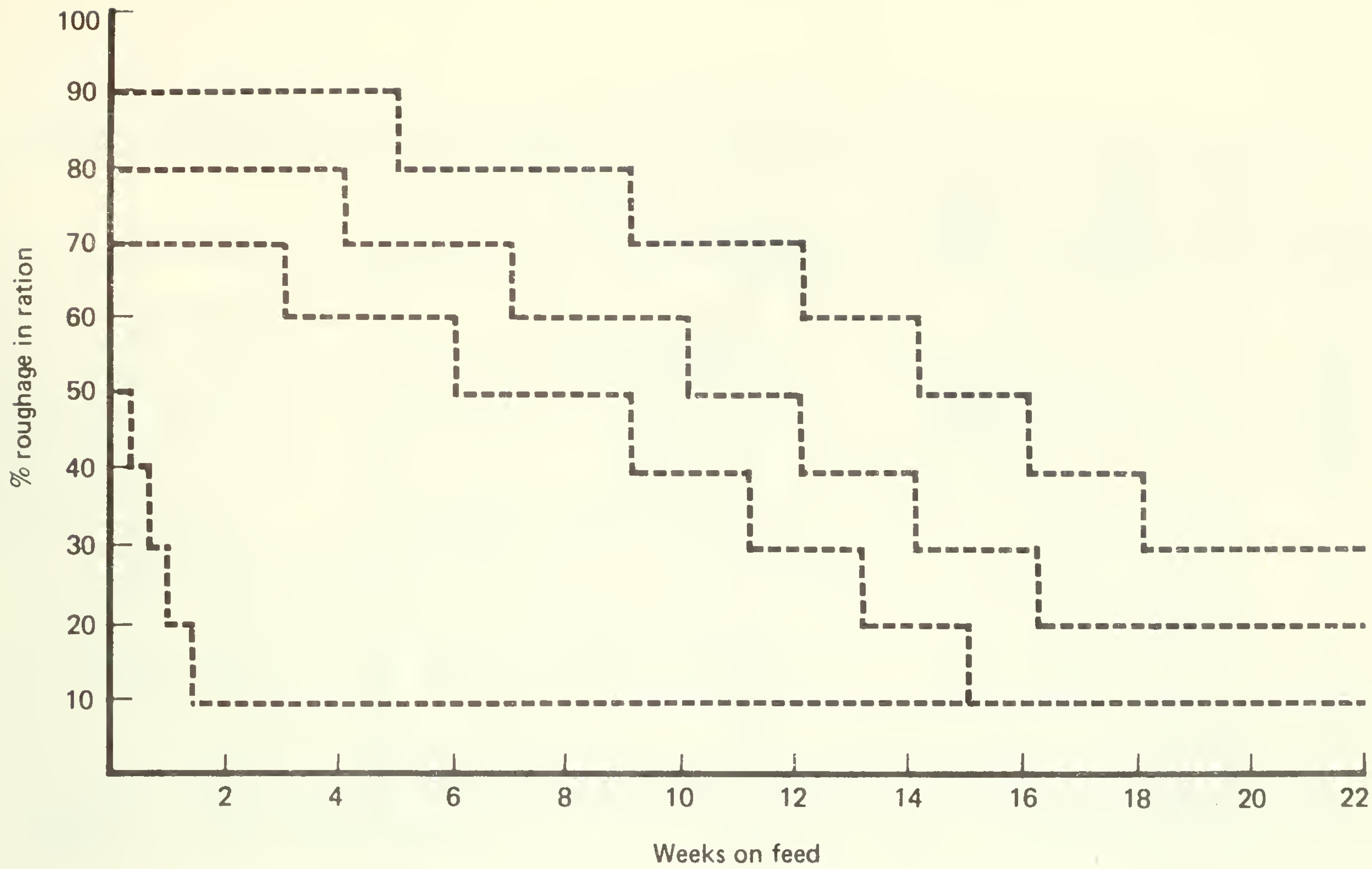


Figure 4 - Ration schedule for 1973 steer feeding test.

Table 18 - Steer Finishing Test, 1973

	1	2	3	4
On 90% grain ration in days	9	105	119 (20%)	126 (30%)
Av ground roughage fed initially, %	50%	70%	80%	90%
Av roughage in ration, %	11	36.8	50.6	65.1
Av initial weight, lb	765	773	767	769
Av final weight, lb	1262	1278	1238	1219
Av daily gain, lb	3.38	3.44	3.20	3.06
Av daily feed eaten, lb	23.62	27.15	27.25	27.01
Feed eaten/steer, lb	3474	3990	4005	3972
- straw	336	147	78	--
- hay	56	1320	1948	2585
- beet pulp	20	--	--	--
- molasses	5	--	--	--
- grain	2949	2399	1854	1260
- tallow (oil)	50	59.9	60.0	59.6
- calcium phosphate	2.5	19.0	27.5	35.2
- limestone	34	20.9	13.2	7.0
- Co-I salt	17.3	20	20	19.8
- dry vitamin A	.7	.8	.8	.8
- Aurofac 10	3.5	4.0	4.0	4.0
Cold carcass wt, lb	710	713	695	689
Dressing %	56.26	55.75	56.1	56.5
Carcass grades				
- A1 and A2	10	10	10	10
- A3	1	1	1	1

Table 19 - Composition of Steer Finishing Rations, lb/1000 lb

	Starter	Ground hay rations (% hay)								
		90	80	70	60	50	40	30	20	Finisher
Ground grass hay (1/2-in. screen)	500	900	800	700	600	500	400	300	100	0
Ground wheat straw (1/2-in. screen)									100	100
Beet pulp	175									
Molasses	46.5									
Rapeseed oil or tallow	--									
Grain (rolled)	250 (oats)	61.8	162.8	263.8	363.8	463.8	563.8	663.7	763.8	863.8
		(equal parts of barley and wheat)								
Ca(18%), P(20½%)	22.5	12	11	10	8.5	7.1	5.0	3.7	2.1	0
Limestone	--	--	--	--	1.4	2.9	5.0	6.4	7.9	10.0
Co-I salt	4.0	5	5	5	5	5	5	5	5	5
Dry vitamin A	.5	.2	.2	.2	.2	.2	.2	.2	.2	.2
Aurofac 10	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Crude protein (90% DM basis)	10.8	10.1	10.4	11.2	11.4	12.0	12.4	13.0	12.4	12.4
Density, lb/cu ft	15.7	12.0	13.6	14.5	16.6	17.5	19.7	21.8	21.8	26.4

Table 20 - Effect of Implant on Steer Performance, 1973

	Control	Ralgro (36 mg)	Synovex S
No. of steers*	16	15	13
Av initial wt, lb	767	767	779
Av final wt, lb	1206	1272	1278
Av daily gain, lb	3.02	3.44	3.39
Av carcass wt, lb	679.8	725.9	724.5
Dressing %	55.5	56.2	56.7
Carcass grade			
- A1 and A2	11	6	5
- A1 and A2 (heavy)	4	7	7
- A3	1	1	
- A3 (heavy)		1	
Av carcass value**, $	565.41	594.88	607.05

*4 steers failed to complete the test; one injured a hip and three, for no apparent reason, began to lose weight and were removed when they failed to respond to treatment. One steer was removed from each of the ration treatments.

**Basis A1 and A2< 700 lb @ 85¢.

Table 21 - Daily Gains of Implanted Steers at Various Hay Levels

	Hay level				
	Low	Medium	Moderate	High	Av
Control	3.25	3.32	2.85	2.66	3.02
Ralgro	3.50 (.25)	3.62 (.30)	3.33 (.48)	3.24 (.58)	3.42
Synovex	3.39 (.14)	3.35 (.03)	3.46 (.61)	3.35 (.69)	3.39
	3.38	3.43	3.21	3.08	

Assuming animal performance attained in the 1973 experiment, Tables 22 and 23 will help determine the returns to labor under various feeder and finished steer prices and various hay and grain prices, and allowing a $40/steer miscellaneous cost exclusive of labor.*

*Estimated miscellaneous costs: buying and trucking, $4.55; bedding $4.50; veterinary, $3; implanting, $1.45; interest on investment in steer, $12; depreciation on facilities, $4.50; death loss (1%), $5; selling and trucking, $5.

Table 22 - Returns to Labor ($/steer) when Hay $30/ton and Grain* 5½¢/lb

Carcass 700** / 690***	Liveweight 1244 / 1182	Cost of feeder steer, ¢/lb: 34	36	38	40	42	44	45	46	48
Selling price/lb, ¢										
65	38	-23.9 / 10.9	-39.1 / -4.3	-54.3 / -19.5	-69.5 / -34.7	-84.7 / -49.5	-99.9 / -65.1	-107.5 / -72.7	-115.1 / -80.3	-130.3 / -95.5
68	40	.6 / 34.5	-14.6 / 19.3	-29.8 / 4.1	-45.0 / -11.1	-60.2 / -26.3	-75.4 / -41.5	-83.0 / -49.1	-90.6 / -56.7	-105.8 / -71.9
71	42	25.1 / 58.2	9.9 / 43.0	-5.3 / 27.8	-20.5 / 12.6	-35.7 / -2.6	-50.9 / -17.8	-58.5 / -25.4	-66.1 / -33.0	-81.3 / -48.2
75	44	49.5 / 81.8	34.3 / 66.6	19.1 / 51.4	3.9 / 36.2	-11.3 / 21.0	-26.5 / 5.8	-34.1 / 1.8	-41.7 / 9.4	-56.9 / -24.6
78	46	74.0 / 105.4	58.8 / 90.2	43.6 / 75.0	28.4 / 59.8	13.2 / 44.6	-2.0 / 29.4	-9.6 / 21.8	-17.2 / 14.2	-32.4 / -1.0
82	48	98.5 / 129.1	83.3 / 113.8	68.1 / 98.6	52.9 / 83.4	37.7 / 68.2	22.5 / 53.0	14.9 / 45.4	7.3 / 37.8	-7.9 / 22.6
85	50	129.0 / 152.7	113.8 / 137.5	98.6 / 122.3	83.4 / 107.1	62.2 / 91.9	47.0 / 76.7	39.4 / 69.1	31.8 / 61.5	16.6 / 46.3
88	52	147.4 / 176.3	132.2 / 161.1	117.0 / 145.9	101.8 / 130.7	86.6 / 115.5	71.4 / 100.3	63.8 / 92.7	56.3 / 85.1	41.0 / 69.9

Table 23 - Returns to Labor ($/steer) when Steer Purchased at 45¢ and Sold at 46¢/lb

Hay Cost, $/ton	Grain* cost, ¢/lb: 2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
15	94.1 / 85.3	79.3 / 79.0	64.6 / 72.7	49.8 / 66.4	35.1 / 60.1	20.3 / 53.8	5.6 / 47.5	-9.2 / 41.2	-23.9 / 34.9
20	93.9 / 78.9	79.2 / 72.6	64.4 / 66.3	49.7 / 66.0	34.9 / 53.7	20.2 / 47.4	5.5 / 41.1	-9.3 / 34.8	-24.1 / 28.5
25	93.8 / 72.4	79.0 / 66.1	64.3 / 59.8	49.6 / 53.5	34.8 / 47.2	20.1 / 40.9	5.3 / 34.6	-9.4 / 28.3	-24.2 / 22.0
30	93.6 / 65.9	78.9 / 59.6	64.2 / 53.3	49.4 / 47.0	34.7 / 40.7	19.9 / 34.4	5.2 / 28.1	-9.6 / 21.8	-24.3 / 15.5
35	93.5 / 59.5	78.8 / 53.2	64.0 / 46.9	49.3 / 40.6	34.5 / 34.3	19.8 / 28.0	5.0 / 21.7	-9.7 / 15.4	-24.5 / 9.1
40	93.4 / 53.0	78.6 / 46.7	63.9 / 40.4	49.1 / 34.1	34.4 / 27.8	19.6 / 21.5	4.9 / 15.2	-9.9 / 8.9	-24.6 / 2.6
45	93.2 / 46.6	78.5 / 40.3	63.7 / 34.0	49.0 / 27.7	34.2 / 21.4	19.5 / 15.1	4.8 / 8.8	10.0 / 2.5	-24.8 / -3.8
50	93.1 / 40.1	78.3 / 33.8	63.6 / 27.5	48.9 / 21.2	34.1 / 14.9	19.4 / 8.6	4.6 / 2.3	-10.1 / -4.0	-24.9 / -10.3
55	92.9 / 33.6	78.2 / 27.3	63.5 / 21.0	48.7 / 14.7	34.0 / 8.4	19.2 / 2.1	4.5 / -4.2	-10.3 / 10.5	-25.0 / -16.7
60	92.8 / 27.2	78.1 / 20.9	63.3 / 14.6	48.6 / 8.3	33.8 / 2.0	19.1 / -4.3	4.3 / -10.6	-10.4 / -16.9	-25.2 / -23.1
65	92.7 / 20.7	77.9 / 14.4	63.2 / 8.1	48.4 / 1.8	33.7 / -4.5	18.9 / -10.8	4.2 / -17.1	-10.6 / -23.4	-25.3 / -29.7

*Equal parts of barley and wheat.
**Steers on high-grain ration (lot 1) in upper LH corners of cells.
***Steers on high-roughage ration (lot 4) in lower RH corners of cells.

Examples - Buy @ 47¢, sell @ 50¢; hay @ $40/ton, grain @ 5.5¢/lb.

(a) For returns on steers fed high-hay ration (Lot 4):

Table 23 - Return to labor (with hay $40 and grain 5.5¢) = $8.90.

Table 22 - Buying at 45¢ and selling at 46¢ would give return to labor of $21.80; but buying at 47¢ and selling at 50¢ gives return to labor of $53.90, or $32.10 more per steer. (Interpolated between buying at 46 and 48¢; $\frac{61.5 + 46.3}{2} = 53.9$

Add $8.90 + $32.10 for total return to labor of $41.00/steer.

(b) For returns on steers fed high-grain ration (Lot 1):

Table 23 - Return to labor (with hay $40 and grain 5.5¢) = $-9.90.

Table 22 - Buying at 45¢ and selling at 46¢ would give return to labor of $-9.60; but buying at 47¢ and selling at 50¢ gives return to labor of $24.20, or $33.80 more per steer.

Add $-9.90 + $33.80 for total return to labor of $23.90/steer.

USE OF DEHYDRATED ALFALFA IN RATIONS FOR BEEF CATTLE

Dehydrated Alfalfa vs Rapeseed Meal

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 24.

Table 24 - Steer Performance on Dehy Alfalfa vs Rapeseed Meal in Maintenance-grower Rations

Wheat straw or rapeseed meal Rolled barley, lb/head per day	Dehydrated alfalfa lb/head per day				Rapeseed meal lb/head per day			
	2.5		5.0		1.25		2.5	
	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 25 - 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¢, S	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 25, 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.

ROLE OF FORAGES IN GETTING ONTO HIGH-ENERGY RATIONS

When feed grains are plentiful and relatively low in cost compared with hay, feedlot operators like to maximize the level of grain in finishing rations. However, rations for growing-finishing beef cattle must be adjusted with considerable care to avoid digestive disturbances (overeating disease, rumen overload or grain poisoning), which can cause death or seriously set back performance. Such losses can easily upset any economic advantages in getting cattle onto high-energy rations quickly.

Two experiments have been completed with Charolais x Angus steers on methods of getting steers onto rations containing very high levels of grain. At the time, wheat prices were relatively low and it made good economic sense to maximize the use of this grain in cattle finishing rations, provided, of course, that digestive disturbances could be avoided or at least minimized. The first experiment was carried out to study the effects of rate of increasing wheat content of the ration; the second compared two methods of getting steers onto two finishing rations, one containing barley and the other wheat.

Rate of Increasing Wheat Content

This test was carried out to determine the performance of steers when the wheat content of their self-fed, high-roughage starter ration was increased at two different rates to a level of 70%.

On July 15, 24 steers (averaging 700 lb) were removed from pasture and placed in the feedlot. They were fed for 10 days on a ration containing 90% ground (1-in. screen), good-quality (10.1% CP) brome-alfalfa hay and about 10% dry-rolled wheat (15.2% CP). At the end of 10 days, the steers had eaten 24.5 lb feed daily and gained 5.5 lb/day. Some of this gain was due to fill, but it indicated that steers could reach full feeding levels quickly. At this time, the steers were divided into two groups of similar breeding, type, weight, and rate of gain. The wheat content of the ration of one group was increased by 10% increments every 8-10 days and of the other by 20% increments every 8-10 days (Table 26). After being fed 70% wheat for several weeks, half the steers were removed from each of the two groups and fed a 75% wheat ration for 7 days and then an 80% wheat ration. During the last 12 days, all steers were placed in one lot and fed the 80% ration. At the end of the 119-day test, all steers were marketed. Carcass yields and grades were obtained and livers, kidneys and rumens were inspected for abnormalities. Table 27 summarizes the results of the experiment.

Table 26 - Ration Formula

	% wheat								
	10	20	30	40	50	60	70	75	80
Brome-alfalfa hay (ground 1-in. screen), lb	900	750	600	450	300	150	0	0	0
Wheat straw (ground 1-in. screen), lb	0	50	100	150	200	250	300	250	200
Dry-rolled wheat, lb	95	195	295	395	495	592	688	738	788
Cobalt-iodized salt, lb	5	5	5	5	5	5	5	5	5
Limestone, lb	0	0	0	0	0	3	7	7	7
Dry vitamin A (10,000 IU/g), g	40	43	46	50	53	56	60	60	60
Aurofac 10 (10 g/lb), g	150	150	150	150	150	150	150	150	150
	1000	1000	1000	1000	1000	1000	1000	1000	1000

Table 27 - Effect of Rate of Increasing Wheat on Steer Performance

	1 10% increments	2 20% increments
No. of steers	12	12
Av daily gain, lb	3.25	3.20
Feed eaten/steer, lb		
- hay	767	430
- straw	641	719
- wheat	1806	1947
Av daily feed, lb	27.0	26.0
Feed/lb gain, lb	8.3	8.1
Dressing %	56.9	56.7
Carcass grades		
- Choice	7	9
- Good	4	3
- Standard	1	0
Condemned livers	2	1
Abnormal kidneys	2	1
Rumen ulcers	5	3
Estimated returns* to labor/steer, $	37.47	33.71

*Assuming ground hay at $50/ton, ground wheat straw at $25/ton and wheat at 6¢/lb; steers purchased at 40¢/lb and sold at 46¢/lb; and a $40/steer miscellaneous cost exclusive of labor.

Steers in lot 2 became sick when the wheat level was increased from 50 to 70% of the ration. Two required treatment and the remainder developed severe cases of diarrhea but recovered without treatment.

The test showed that wheat can constitute a major portion of the finishing ration for steers. However, care must be taken in getting the steers safely onto feed and they must not be fed too high a level of wheat for too long a period. In this test, performance was starting to slip during the last 10 days of the test.

Two Methods of Increasing Barley and Wheat Contents

A method developed at the Lethbridge Research Station for getting steers onto two finishing rations was compared with one developed at Melfort. The Lethbridge method uses a special starter ration containing 50% ground grass hay, 25% rolled oats, 17½% dried molasses beet pulp, about 5% molasses, plus mineral, vitamin A and antibiotic supplements. This ration is self-fed for 2 days, then mixed at 3:1 with finisher ration for 2 days, at 1:1 for the next 2 days, at 1:3 for the next 2 days and on the 9th day the animals are on the finishing ration only.

The Melfort system uses a starter ration of 70% ground hay with the remainder comprising rolled grain, minerals, vitamin A and an antibiotic. Each steer is fed about 175 lb of this feed, or enough for 8-9 days. Each subsequent mix contains 10% less ground hay and is fed for a 5-6-day period until the 90% level of grain is reached, at about the end of the 6th week.

In the test, crossbred Charolais x Angus steers averaging 765 lb were used. Eight steers were fed each of the four rations. The results are summarized in Table 28, and Table 29 shows the rates of gain of the four lots of steers over the period of the test. Steers fed the Melfort rations required more feed per pound of gain, since their ration contained less available energy per pound.

At the 104th day, the test was concluded and representative steers from each treatment were marketed. The grades, dressing percentages and weights of the steers marketed were used to calculate the average value of the remaining steers. On examination of the livers, rumens and kidneys of steers marketed at this stage of the test, one liver was condemned (Lethbridge treatment), but there were no serious abnormalities and certainly no indication that any of the treatments had a notable effect on these organs.

The selection of method of starting steers on feed would seem to depend almost entirely on the relative costs and availability of feeds involved and the availability of a means of incorporating roughages into rations. This test showed that a considerable amount of roughage can be incorporated into the starting ration without adversely affecting either animal performance or economic returns. As a matter of interest, steers fed according to the Melfort system 'marketed' about 650 lb of roughage each. but those fed according to the Lethbridge method marketed only about 300 lb of roughage apiece over the entire test.

In assessing the results of this experiment, it should be borne in mind that a fairly growthy type of crossbred steer was used which could stand being fed to weights up to 1100 lb or so without becoming unduly overfinished. Also,

Table 28 - Ration Composition and Consumption

	Lethbridge method, %					Melfort method, %						
Days no.	1 + 2	3 + 4	5 + 6	7 + 8	9 - 104	1 - 9	10 - 15	16 - 21	22 - 28	29 - 35	36 - 42	43 - 104
Roughage level, %					10%	70%	60%	50%	40%	30%	20%	10%
Wheat (rolled) or barley (rolled)		22.1	44.2	66.25	88.4	28.4	38.36	48.36	58.36	68.36	78.36	88.4
Oats (rolled)	25.0	18.75	12.5	6.25	--							
Grass hay (good quality)	50.0	37.5	25.0	12.5	--							
Sweetclover hay (poor quality)		2.5	5.0	7.5	10.0	70.0	60.0	50.0	40.0	30.0	20.0	10.0
Dried molasses beet pulp	17.5	13.13	8.75	4.38	--							
Molasses (beet)	4.65	3.5	2.33	1.18	--							
Calcium phosphate (18% Ca, 20% P)	2.25	1.69	1.13	.56	--	1.0	.85	.71	.50	.36	.21	--
Limestone		.25	.50	.75	1.0	--	.14	.29	.50	.64	.79	1.0
Cobalt-iodized salt	.4	.43	.45	.48	.5	.4	.5	.5	.5	.5	.5	.5
Vitamin A (10,000 IU/g), D and E	.05	.04	.03	.04	.02	.05	.044	.038	.032	.025	.018	.02
Aurofac 10	.15	.14	.13	.11	.10	.15	.14	.13	.12	.11	.11	.10
Feed eaten/steer, lb												
- fed barley ration	54.8	32.2	37.8	35.4	2351	175	175	175	175	175	175	1681
- fed wheat ration	53.1	29.5	35.8	35.2	2335	175	175	175	175	175	175	1723
Weight/cu ft, lb												
Barley		12.6	26.6	30.5	33.8	13.4	14.0	14.7	19.0	21.9	26.4	33.8
Wheat		15.8	28.0	32.3	37.3	15.4	16.1	17.4	19.5	24.3	30.0	37.3

Table 29 - Steer Performance and Economics

	Melfort method		Lethbridge method	
	Barley finisher	Wheat finisher	Barley finisher	Wheat finisher
Av final weight, lb	1112	1140	1117	1113
Av daily gain, lb	3.34	3.61	3.39	3.34
Av daily feed eaten, lb	26.3	26.7	24.1	23.9
Feed eaten/lb gain, lb	7.87	7.39	7.11	7.16
Feed eaten/steer, lb				
- grain	2046	2083	2152	2135
- hay	641	645	294	290
- molasses and beet pulp	--	--	24	22
- minerals, vitamins, antibiotics	45	45	42	41
Feed cost/lb gain, ¢	10.9	11.0	10.6	11.4
Dressing % warm * / off-farm	58.5	57.7	58.2	58.1
Carcass grade*				
- Choice	3	3	2	3
- Good	0	1	2	1
- Standard	1	0	0	0
Measurements/100-lb carcass				
- depth of fat cover over eye of lean, in.	.11	.12	.14	.12
- area of eye of lean, sq in.	1.85	1.87	1.71	1.96
Est. carcass gain**. lb	195	205	191	185
Est. TDN consumed/lb of carcass gain, lb	9.7	9.6	9.6	9.8
Est. returns*** to labor/steer, $	32.46	32.79	36.95	25.65

*Based on four steers marketed and assuming similar grades and dressing % on remainder.

**Assuming initial dressing % of 60%.

***Assuming barley at $5\frac{1}{2}$¢/lb, wheat at 6¢/lb, ground hay at $50/ton, molasses and beet pulp at 4¢/lb. m.v.a. supp. at 10¢/lb; steers purchased at 40¢/lb and sold at 46¢/lb, (assuming no economic differences in grades); and a $40/steer miscellaneous cost exclusive of labor.

an antibiotic was included in all rations and this is supposed to have the effect of reducing liver damage in steers fed high-grain rations.

Effect of Forage Quality, Level and Fineness of Grind in Starting Rations

Good-quality (brome-alfalfa) and poor-quality (intermediate wheatgrass hay and wheat straw) roughages were ground through 1/2-in. and 1-in. hammermill screens and incorporated at levels of 40, 60 and 80% (by weight) of starting rations for beef steers. Dry-rolled wheat and mineral-vitamin A and antibiotic

Table 30 - Composition of Rations, %

	Initial						Final	
Roughage level, %	80		60		40		10	
Roughage quality	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Brome-alfalfa hay	80	--	60	--	40	--	10	--
Intermediate wheatgrass hay	--	80	--	45	--	30	--	--
Wheat straw	--	--	--	15	--	10	--	10
Wheat	18.5	18.5	38.5	38.5	58.5	58.5	88.5	88.5
Calcium phosphate	1.0	1.0	0.75	0.75	0.5	0.5	--	--
Limestone	--	--	0.25	0.25	0.5	0.5	1.0	1.0
Cobalt-iodized salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vit A (10,000 IU/g)	.022	.022	.022	.022	.022	.022	.022	.022
Aurofac 10	.035	.035	.035	.035	.035	.035	.035	.035
Crude protein	12.1	9.7	13.1	9.8	15.4	12.1	17.2	16.4

supplements constituted the remainder of each ration (Table 30). Each ration was self-fed to six steers (three Aberdeen-Angus and three Hereford), with an average initial weight of 756 lb. The wheat content of all rations was gradually increased to 90% (by weight) over a period of about 8 weeks. All steers were implanted with 24 mg of diethylstilbestrol. The steers were marketed when judged to carry a sufficient degree of finish to grade Canada Choice or Good. The average period on feed was 102 days.

As indicated in Table 31, steers fed good-quality roughage had higher rates of gain and required less feed per pound of gain when the roughage was ground through a 1-in. screen than through a 1/2-in. screen; the same was true for steers started on 40% poor-quality roughage. However, at the 60% level of poor-quality roughage the finer grind increased gain and at the 80% level there was no difference due to grind size. In general, the coarser grind is probably more beneficial in high-energy rations, at the roughage levels used, than it would be in high-roughage rations over a longer period of time.

The best treatment under the conditions of this test was the combination of good hay ground through a 1-in. screen and used as 60% of the starting ration. No apparent reason can be given for the much-better performance of the steers fed this ration than for those fed any other ration, except that the daily dry-matter intake of this group was about 2.8 lb higher than the average.

Fineness of grind and initial roughage level appeared to have an effect on the incidence of abscessed livers. Abscesses were found in five steers fed rations containing 40 and 60% good- and poor-quality roughages ground through a 1/2-in. hammermill screen but, with the exception of one steer, were not present in steers whose roughages were ground through a 1-in. screen. There were no abscesses

Table 31 - Effect of Forage Quality, Level and Fineness of Grind on Steer Performance

Initial roughage level, %	40				60				80			
Roughage quality	Good		Poor		Good		Poor		Good		Poor	
Hammermill screen size, in.	1/2	1	1/2	1	1/2	1	1/2	1	1/2	1	1/2	1
Av initial wt , lb	759	751	758	753	754	758	760	754	755	760	755	753
Av final wt , lb	1060	1058	1055	1056	1043	1120	1074	1039	1047	1078	1043	1031
Av daily gain, lb	3.04	3.06	2.86	2.90	2.91	3.70	3.04	2.66	2.91	3.14	2.80	2.68
Av daily feed (90% DM)	24.9	24.9	24.4	24.1	25.6	28.7	25.3	24.8	26.3	27.1	25.3	25.0
Feed eaten/steer, lb	2464	2489	2542	2532	2607	2809	2634	2651	2633	2738	2609	2600
- hay (good	500	501			775	744			935	950		
- hay (medium			24	24			200	200			514	510
- straw			484	482			527	529			424	421
- wheat	1926	1949	1995	1987	1792	2021	1866	1881	1657	1746	1630	1628
- mineral, vitamin A and antibiotic supp.	38	39	39	39	40	44	41	41	41	43	41	40
Cold carcass wt	581	593	570	589	577	622	581	570	571	588	562	562
Carcass grades												
- Al and A2 (Choice and Good)	6	6	6	6	5	6	6	6	6	6	6	6
Est. returns* to labor/steer, $	18.39	30.28	11.17	29.82	17.95	29.90	23.20	15.33	16.45	22.99	18.22	19.36

*Assuming wheat at 6¢/lb, ground good hay at $50/ton, ground medium hay at $40/ton, ground straw at $25/ton, m.v.a. supp. at 10¢/lb; steers purchased at 40¢/lb and sold at 85¢/lb (cold carcass); and a $40/steer miscellaneous cost exclusive of labor.

in steers started at 80% roughage. Although a liver that is abscessed is condemned and represents a loss to the meat packer, there does not appear to be any consistent relationship between the presence of an abscess and the performance of the affected steer in the feedlot.

GUIDELINES FOR USING GROUND HAY IN STEER FINISHING RATIONS

Obviously, more research is required before all the answers on utilizing forages in steer finishing rations are known. Until further work is done, the following comments are offered as tentative recommendations to feeders wishing to use forages more effectively in steer finishing operations. It is important to watch the performance of the cattle closely (check weights, watch for evidence of digestive disturbances or onset of bloat) and gradually change rations (hay:grain ratio, fineness of grind or level of supplementation) if such change is required to improve animal performance.

1. As a feedlot operator, you must be in a position to use all sources of feed available to you for lowest-cost rations. To use roughages efficiently, you need equipment that will grind whole bales and mix the ground roughage with grain and other supplements. A rugged grinder-mixer and a 100-HP tractor are minimum requirements. A mixer equipped with a hammermill to take full bales and a roller to process the grain are recommended.

2. Avoid using ground, good-quality alfalfa or alfalfa-brome hay at levels of 35-65% of rations containing high-energy grains. In moving from high to low levels of hay during the finishing period, either dilute the hay with ground straw or use a grass or poorer-quality hay.

3. When formulating rations using ground hay and grain, check on the protein levels of the ingredients. If the ration contains less than 10½-12% protein (depending on hay:grain ratio and quality of hay and grain), it may be economically sound to raise the CP level by adding protein supplement. Check our test rations for suggested levels of minerals, vitamin A and antibiotic for rations of different hay:grain ratios. If in doubt about formulating rations, consult your nearest ruminant nutritionist or feed lab.

4. If roughage is limited or if grain is cheap in relation to hay, use ground hay in the early stages of the feeding period at a level of at least 50% to assist animals to get safely onto feed and then gradually reduce it to 10% and replace it with ground (1-in.) straw.

5. If roughage is limited and grain cheap, and if steers are light or have a tendency to finish at too light a weight, use roughage (50-70%) in rations to promote growth rather than fattening during the first part of the feeding period. Then switch to a high-grain ration so that the animals will be finished within 100 days. There is some evidence that feeding high-grain rations for more than 100 days leads to increased liver and rumen damage and poor performance.

6. When hay of good quality is plentiful and cheap in relation to grain, feed at a high level (80-95%) for as long as good rates of gain are obtained (2½-3 lb/head per day). Increase the level of grain fed gradually, as required to maintain gains, watching for bloat once the level of hay drops below 65-70%. Unless grain is very expensive, it is probably advisable to feed at least a 50%-grain ration for the last 3 weeks of feeding.

7. When hay is plentiful and cheap in relation to grain, but quality is poor to medium: grind through a 1/2-in. screen; start out with levels of 60-80%; supplement with protein (rapeseed meal) if required; and gradually increase the level of grain, as required to maintain satisfactory rates of gain.

8. Grind hays through a 1/2-in. screen. Coarser grinding of high-quality hay may be adequate sometimes, but difficulties may be experienced in keeping hay and grain mixed during augering or self-feeding and this could lead to digestive disturbances. When roughage is to be fed at a low level or for a short period, coarser grinding helps prevent overeating of grain.

9. Always use a growth-promoting implant (as long as their use is legal). There may be more benefit when rations containing high levels of good-quality ground grass hays are fed than when high-energy rations are fed, but in both cases their use should be profitable.

FORAGES IN GROWING-FINISHING RATIONS FOR LAMBS

At the Melfort Station, lambs are fed chopped, artificially dried alfalfa hay and a special creep-fed ration from the time they are about a week old until turned out to pasture about the 3rd week in May. During the period on pasture (when the creep feed is also fed), lambs gain 2/3-9/10 lb a day. When they reach a weight of 60-65 lb, they are weaned off pasture and finished in confinement.

LAMB PERFORMANCE ON VARIOUS FINISHING RATIONS

Effects of Forage Species, Moistening and Supplemental Concentrate

Lambs were individually stalled and fed one of four ground (3/16-in. screen) forages — alfalfa (16½ CP), bromegrass (13½% CP), crested wheatgrass (15½% CP) and meadow fescue (9% CP) — as the only diet (other than salt and water) for 8 weeks. Half the lambs on each kind of hay were fed the forage moistened with water (50:50 by weight). Following the growing period, the forages (dry and moistened) were fed with 20% concentrate (barley + minerals, vitamin A and an antibiotic supplement).

This experiment showed that it was possible to produce finished lambs (about 75% Choice) by feeding rations containing high levels of ground roughage. However, most lambs gained very little during the final week or two of the test. Unless grain is expensive in relation to forage, it is recommended that the level of grain be increased gradually to around 50% of the ration during the last 2-3 weeks of the finishing period.

Moistening some rations was beneficial, mainly because it increased feed intake by reducing the dustiness of the ground forage. In this test, crested wheatgrass was freshly harvested and less dusty than other forages. Alfalfa was particularly dusty because grinding had reduced the leaves to a fine powder. The practicality of moistening ground forage depends on how easily it can be mixed with water each day and kept from freezing during winter.

Table 32 - Lamb Performance on Moist and Dry Hays

	Alfalfa		Brome		Crested wheat		Meadow fescue	
	Dry	Moist	Dry	Moist	Dry	Moist	Dry	Moist
Growing (8 wk)	No concentrate feed							
Av daily gain, lb	.28	.36	.27	.31	.44	.36	.23	.36
Av daily feed , lb	2.69	3.13	2.62	2.82	2.90	2.74	2.46	2.81
Feed/lb gain, lb	9.6	8.7	9.7	9.1	6.6	7.6	10.7	7.8
Finishing	20% concentrate fed							
Av daily gain , lb	.37	.49	.31	.34	.30	.46	.34	.37
Av daily feed , lb	3.92	3.87	3.50	3.84	4.34	4.55	3.26	3.96
Feed/lb gain , lb	10.6	7.9	11.3	11.3	14.5	9.9	9.6	10.7
Final weight , lb	93	95	95	95	91	96	93	94
Carcass grades								
- Choice	5	5	4	4	3	6	5	3
- Good	1	1	2	2	3	0	1	3

Effects of Hay Level and Molasses and Linseed Meal Supplements

Thirty-six crossbred lambs (av 65 lb) were weaned off pasture and divided into six groups of six lambs each (three ewes and three wethers). They were hand-fed to appetite until marketed. Medium-quality mixed brome and meadow fescue hay, ground through a 3/16-in. screen, was fed at levels of 20, 50 and 80% of the ration. The 80% ration was also fed with 5% molasses, 10% linseed meal, or 5% molasses plus 7% linseed meal. Supplements replaced an equal weight of hay in the ration formula. The remainder of the ration was comprised of barley, cobalt-iodized salt (0.5%), a mineral supplement (if required), vitamin A and an antibiotic supplement.

Long hay was fed for 2 days before lambs were placed on test rations. Lambs started on the 20% hay ration required 3 weeks before gains occurred and appeared to tire of their ration after 12 weeks of feeding (gains for those remaining averaged only 0.12 lb/head per day during latter part of test). An initial weight loss occurred in all lots and was probably partly due to an adjustment in rumen fill following removal of lambs from pasture. However, lambs fed the 80% level of roughage, alone or with any of the supplements, made good gains after the 1st week. The results of the test appear in Table 33.

At the prices of feed prevailing at the time of the experiment, returns were increased when either molasses or linseed meal was added to the 80%-roughage ration. Adding both supplements decreased returns. It is probable that returns over feed costs for lots 4, 5 and 6 could have been increased by marketing the lambs at heavier weights, since rates of gain were still very good at the end of the test.

Table 33 - Lamb Performance at Various Hay Levels

	1	2	3	4	5	6
	20% hay	50% hay	80% hay	75% hay 5% molasses	70% hay 10% linseed meal	68% hay 5% molasses 7% linseed meal
Crude protein %	14.2	12.3	11.2	11.2	11.3	13.8
Av daily gain, lb	.31	.43	.42	.49	.55	.55
Av daily feed, lb	2.30	2.92	3.41	3.45	3.67	3.69
Feed/lb gain, lb	7.5	6.9	8.1	7.1	6.8	6.8
Final wt, lb	91	94	93	96	96	93
Dressing %	47.3	46.6	45.9	46.5	46.9	46.7
Carcass grade						
- Choice	4	3	2	5	3	1
- Good	1	3	4	1	3	4
- Commercial	1	0	0	0	0	1

Using Slough Hay

Thirty-two crossbred lambs were weaned off pasture at an average weight of 74 lb and hand-fed to appetite in individual stalls. Four rations, all containing 0.5% cobalt-iodized salt, 0.2% calcium phoasphate (19% Ca, 19% P), 0.22% vitamin A supplement (10,000 IU/g) and 0.80% antibiotic supplement were formulated to contain the percentages of basal feeds shown in Table 34. All rations were fed both ground (12.3 lb/cu ft) and pelleted (3/16-in. diameter, av 40.5 lb/cu ft). The results appear in Table 35.

Table 35 - Slough Hay in Lamb Finishing Rations, %

	Control	5% molasses	10% alfalfa meal	5% rapeseed meal
Slough hay (11% CP) (ground 3/16-in. screen)	69.5	66.1	59.5	66.1
Wheat (15.5% CP) (coarsely ground)	29.8	28.1	29.8	28.1
Beet molasses		5		
Alfalfa meal			9.9	
Rapeseed meal				5
Crude protein, %	12.5	12.5	12.6	13.5

Table 35 - Lamb Performance on Slough Hay Rations

	Control		5% molasses		10% alfalfa meal		5% rapeseed meal	
	Ground	Pelleted	Ground	Pelleted	Ground	Pelleted	Ground	Pelleted
Av daily gain, lb	.46	.48	.30	.61	.40	.60	.40	.55
Av daily feed, lb	2.96	3.07	2.40	3.15	2.80	3.30	2.86	3.48
Feed/lb gain, lb	6.64	6.74	9.07	5.27	7.51	5.58	7.25	6.47
Final wt, lb	98.85	100.29	89.17	108.29	95.92	107.79	95.48	108.29
Dressing %	46.88	46.75	47.83	46.00	47.33	47.23	46.43	48.28
Carcass grade								
- Good	4	4	1	4	3	4	3	4
- Commercial			3		1		1	

A surprising finding was that pelleting had no effect on feeding value of the unsupplemented slough grass ration. Addition of any of the supplements to the ground form of the control ration reduced rate of gain and feed efficiency. In contrast, inclusion of a supplement in pelleted rations increased rate of gain and feed efficiency.

The ability of finishing lambs to perform so well on a ration comprising such a high percentage of slough hay once again demonstrates the role roughages can play in ruminant rations, provided they are processed and used in conjunction with other feeds and supplements required to balance the deficiencies of the roughages.

Using Crested Wheatgrass

Crested wheatgrass is well adapted to the Melfort area and has yielded well, both as pasture and hay. Its use in lamb finishing rations was assessed in a 1969 test comparing rations containing 50, 70 and 90% ground (3/16-in. screen) crested wheatgrass and one in which the level of hay started at 90% and was reduced by 5% a week to 50%.

Crossbred lambs were weaned off pasture at an average weight of 67 lb and hand-fed to appetite once daily in individual stalls. Cobalt-iodized salt and water were available at all times. The ration contained equal parts of Fairway and Parkway varieties of crested wheatgrass and analyzed 10.8% CP on a 90% DM basis. The remainder was mainly rolled wheat (16.8% CP). Three of the rations are given in Table 36; the fourth, varying from 90 to 50% crested wheatgrass, was prepared by using these rations or various proportions of them as required.

Each ration was fed both ground and pelleted. Ewe and wether lambs were equally represented in all ration treatments; and half of each were implanted with Synovex S, using a quarter of the recommended heifer and steer doses, respectively. All lambs were marketed and carcass grades and measurements obtained.

Table 36 - Crested Wheatgrass in Lamb Finishing Rations, lb

	90%	70%	50%
Crested wheatgrass	891.8	693.6	495.4
Rolled wheat	99.0	297.2	495.4
Cobalt-iodized salt	5.0	5.0	5.0
Limestone	--	1.6	3.2
Calcium phosphate (19% Ca, 19% P)	3.2	1.6	--
Vitamin ADE supplement (10,000 IU A, 1000 IU D, 10 IU E/g)	.2	.2	.2
Aurofac 10	.8	.8	.8
	1000.0	1000.0	1000.0

Table 37 - Lamb Performance on Crested Wheatgrass Finishing Rations

	90%		70%		50%		90 → 50%	
	Ground	Pelleted	Ground	Pelleted	Ground	Pelleted	Ground	Pelleted
Av daily gain, lb	.29	.48	.32	.45	.33	.49	.34	.45
Av dail feed consumed, lb	2.70	3.34	2.64	3.11	2.64	3.04	2.67	3.12
Feed/lb gain, lb	10.8	7.2	8.8	7.0	8.3	6.3	8.1	7.1
Final wt , lb	93.3	103.5	96.1	102.2	96.3	102.9	97.8	101.9
Dressing %	44.0	45.7	46.3	46.0	46.8	47.1	45.9	47.6
Carcass grade - Choice	5	8	7	7	7	8	5	8
- Good	3	0	1	1	1	0	3	0
Est. returns* to labor/lamb, $	3.88	7.29	4.38	5.72	2.88	4.73	3.82	6.87

*Assuming a standard total gain for all lambs at rates and feed efficiencies obtained in test; and assuming feeder lambs at 35¢/lb, finished lambs at 85¢/lb (cold carcass); hay at $30/ton, wheat at 6¢/lb, supplements at 10¢/lb; grinding at $3.00, $3.50 and $4.00/ton for the 50, 70 and 90% roughage rations, respectively; pelleting at $5.00, $6.70 and $8.00/ton for the 50, 70 and 90% roughage rations, respectively; and 3¢/lamb per day for overhead expenses.

As indicated in Table 37, pelleting was beneficial in all treatments. The 70% roughage ration was most economical if rations were not pelleted, and the 90% one most profitable if rations were pelleted. When ground rations were fed, there was a slight increase in rate of gain, feed efficiency and dressing percentage as hay level decreased from 90 to 70% and from 70 to 50% of the ration. Pelleting increased rate of gain by an average of 47%, the greatest increase (66%) occurring with the 90% hay ration and the least (33%) with the ration in which hay content was reduced from 90 to 50%. Pelleting improved feed efficiency (22%), with the greatest improvement (32%) occurring with the 90% hay ration.

Averaging all rations, pelleting improved dressing percentage (46.6 vs 45.8%), grades (97 vs 75% Choice) and returns ($6.15 vs $3.74). The advantage of pelleting depends on the cost and convenience of having the ration pelleted. In this test, pelleting and handling costs of $8.00, $6.70 and $5.00/ton were allowed for the 90, 70 and 50% hay rations, respectively.

Performance was about the same for ewe and wether lambs. Hormone implant improved rate of gain and feed efficiency, but the cost of the implant was not covered by improved performance. It should be noted that hormone implants for feeder lambs have not been approved for use in Canada by the Food and Drug Directorate and, therefore, feeders are advised not to implant feeder lambs.

Using Good-Quality Alfalfa

This experiment was conducted to determine the effects of hay:grain ratio, pelleting and the addition of tallow or rapeseed oil on the utilization of excellent-quality, ground (3/16-in. screen) alfalfa hay 16¼% CP). The grain in the rations was barley (12% CP); and 20% ground wheat straw was included to lower the protein level of the rations and thus reduce feed costs. Four levels of ground alfalfa were used — 10, 30, 50 and 70% — and at each level the ration was supplemented with 5% tallow or 5% rapeseed oil or no fat. All 12 rations were ground and pelleted (1/4-in. diameter) and fed to crossbred lambs weaned off pasture at 65 lb and placed in individual stalls. Lambs were fed to appetite daily and given access to cobalt-iodized salt and water at all times.

Digestibility of the rations was determined, both with the lambs (in vivo) and by means of an artificial rumen technique (in vitro). The rations and results are given in Tables 38 and 39, respectively.

Table 38 - Alfalfa in Lamb Finishing Rations

	30% roughage		50% roughage		70% roughage		90% roughage	
	Check	+ Fat	Check	+ Fat	Check	+ Fat	Check	+ Fat
Alfalfa hay (ground 3/16-in. screen), lb	99	94	298	283	496	471	695	660
Wheat straw (ground 3/16-in. screen), lb	199	189	198.5	188.5	198.5	188.5	198	188
Barley (rolled), lb	693.5	658.5	496.5	471.5	298	283	99	94
Tallow rapeseed oil, lb	--	50	--	50	--	50	--	50
Cobalt-iodized salt, lb	5	5	5	5	5	5	5	5
Phosphorus supplement (25% P), lb	.5	.5	1	1	1.5	1.5	2	2
Limestone, lb	2	2	--	--	--	--	--	--
Vitamin ADE supplement (10,000 A, 1000 D, 10 E/g), lb	.2	.2	.2	.2	.2	.2	.2	.2
Aurofac 10, lb	.8	.8	.8	.8	.8	.8	.8	.8
Total, lb	1000	1000	1000	1000	1000	1000	1000	1000
Crude protein, %	10.6	10.1	11.5	10.9	12.3	11.7	13.1	12.5
Est. TDN, %	67	74	62	69	57	64	51	59

Table 39 - Lamb Performance on Alfalfa Rations

	% roughage				Form		Supplemental fat		
	30	50	70	90	Ground	Pelleted	None	Tallow	Rapeseed Oil
Av daily gain, lb	.44	.55	.54	.56	.48	.56	.52	.53	.51
Av daily feed, lb	2.33	2.72	2.94	3.12	2.65	2.82	2.38	2.72	2.67
Feed/lb gain, lb	5.3	5.0	5.4	5.6	5.5	5.0	5.4	5.1	5.2
Final weight, lb	99	102	100	102	99	102	100	101	100
Dressing %	46.7	47.8	48.6	47.7	47.5	47.9	47.3	48.0	47.8
Carcass grade									
- Choice	9	16	17	5	22	25	14	19	14
- Good	15	8	7	7	20	17	14	9	14
Organic matter digestibility, %									
- in vivo	67	66	63	61	66	63	65	65	64
- in vitro	66	64	61	59	62	62	65	61	62
Est. returns* to labor/lamb, $	5.66	8.60	9.72	9.88	8.51	9.22	9.44	8.39	8.00

*Assuming feeder lambs at 35¢/lb, finished lambs at 85¢/lb (cold carcass); alfalfa at $35/ton, straw at $12/ton, barley at $2.40/bu, tallow at 25¢/lb, rapeseed oil at 25¢/lb; roll and mix grain at $3/ton, grind and mix roughage at $6/ton, pellet 30, 50, 70 and 90% roughage rations at $5, $6, $7 and $8/ton, respectively; and 3¢/lamb per day for overhead expenses.

The level of roughage (alfalfa and straw) had no adverse effect on rate of gain; in fact, at the higher levels (50-90%), rate of gain was better than at the lowest level (35%) of roughage. Feed required per pound of gain was lowest when roughage was fed at 50%, but dressing percentage and carcass grades were equally as good at the 70% roughage level.

Pelleting increased the rate of liveweight gain by an average of 17% and improved feed:gain ratios by about 9%. It also improved dressing percentages, grades and market returns. The most marked effect of pelleting on rate of gain and feed efficiency occurred in the low-roughage ration without supplemental fat. Thus, it appears that rations containing high levels (50-70%) of ground, good-quality alfalfa with or without added fat may not be markedly improved by pelleting.

Averaging all hay:grain ratios, the addition of tallow or rapeseed oil had no effect on rate of gain but did improve feed efficiency and dressing percentages slightly. However, adding tallow or oil to the low-roughage ration reduced rates of gain on ground and pelleted rations by 15 and 20%, respectively. Adding tallow or oil to the 50 and 70% rations, whether ground or pelleted, had little effect on animal gain; but with the 90% rations, tallow or oil improved rate of gain by 46% on the ground ration and 17% on the pelleted ration. This was probably due to the effect of the added energy in improving the protein:energy ratio of the high-roughage ration.

If feed efficiency is expressed in terms of pounds of digestible nutrients per pound of gain, then lambs fed the 30, 50, 70 and 90% roughage rations required 3.8, 3.4, 3.3 and 3.2 lb TDN/lb gain. This indicates that under the conditions of this experiment, the level of roughage had no adverse effect on the efficiency of energy utilization.

GUIDELINES FOR USING GROUND HAY IN LAMB FINISHING RATIONS

It will be noted that the results obtained in experimenting with the different kinds of hay were quite variable. For example, finishing lambs appeared to tire of the high-grain ration in one experiment; but, in another, lambs fed all-roughage rations showed little gain during the latter part of the test. Other rations supported good gains throughout the feeding period; and pelleting improved animal performance with some of them. Using the information gained to date, the following tentative guidelines are suggested:

1. A higher percentage of forage may be included in the ration if the quality is good than if it is poor. When forage quality is low, it may be satisfactory to start lambs on ground rations containing up to 70% roughage, provided the grain content of the ration is increased gradually so that during the final 2 weeks or so the level of hay is 40-50%.

2. Pelleting high-roughage rations containing poor- to medium-quality forage tends to increase rate of animal gain and feed efficiency. In the slough-hay tests pelleting was beneficial only if the roughage was supplemented. Pelleting tends to equalize the feeding values of rations containing different hay:grain ratios.

3. Check rate of gain of lambs periodically. If there is poor performance, alter the ration either by increasing the grain content, by supplementing with molasses, protein, etc., or by pelleting, whichever is most economical. It is suggested that available feeds be analyzed to provide some guidance on how to best utilize the forage in formulating rations. Help is available at the Melfort Research Station if you require it, so long as you provide the information on your feeds (at least crude protein content).

EQUIPMENT FOR STORING AND FEEDING FORAGES

Over the course of several years, various structures have been designed at the Melfort Station to improve the efficiency of storing and feeding forages or rations containing large amounts of ground hay. Plans of some of these structures and of others that may be of interest to people getting into the production and utilization of forage crops are presented here. We would particularly like to emphasize the importance of a good hay shelter. Weathering not only reduces the feeding value of hay, but often good hay is spoiled and completely lost because it was not protected. Over the years, a well-constructed hay shelter will more than pay for itself in hay saved.

All of the structures illustrated here are in use at the Melfort Research Station and are available for inspection anytime.

HAY STORAGE SHELTER

The shelter shown in Figure 5 will hold 200 tons alfalfa, 180 tons grass hay or 116 tons straw. Its overall dimensions are about 78' x 39'.

Materials Required

1. 3 yd concrete (footings)
2. 150 yd stone fill
3. 14 - 30 ft pressure-treated poles (6 - in. tops)
4. 14 - 25 ft pressure-treated poles (6 - in. tops)
5. 168 - 2" x 6" x 16' fir (rafters and rafter ties)
6. 2 - 214 lineal ft 2" x 4" nailing girts
7. 164 lineal ft 2" x 8" eave boards
8. 16 - 2" x 12" x 16' plus 32 - 2" x 12" x 15' purlins
9. 28 - 2" x 6" x 8' rafter support scabs
10. 56 - 2" x 6" x 12' braces
11. 4 - 2" x 8" x 14' end ties
12. 18 - 2" x 6" x 10' end plywood girts
13. 10 - 4' x 8' x ½" plywood
14. 246 sheets galvanized roofing (24' x 10')
15. 82 ft of ridgecap
16. 164 ft of eave starter
17. 56 machine bolts, ½" x 12"
18. 180 lb nails
19. 180 plank holders
20. 90 - 2" x 8" x 14' wall planks

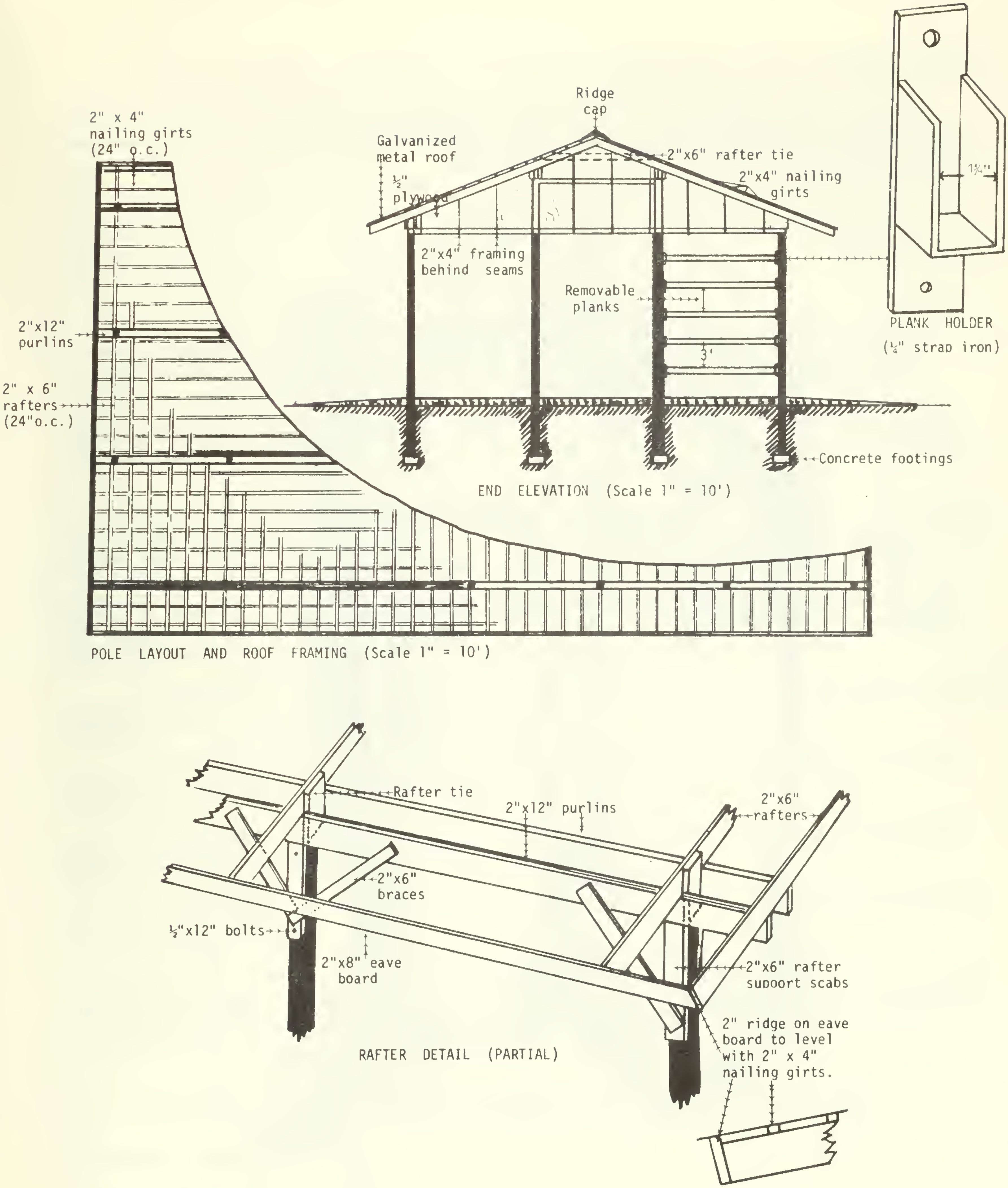


Figure 5 - Hay storage shelter.

DRYING TOWER

In 1971, a hay-drying tower was constructed at the Melfort Station to test a new system of haymaking. The tower holds about 90 tons of dry hay. The design was adapted from one used in Europe (Figure 6).

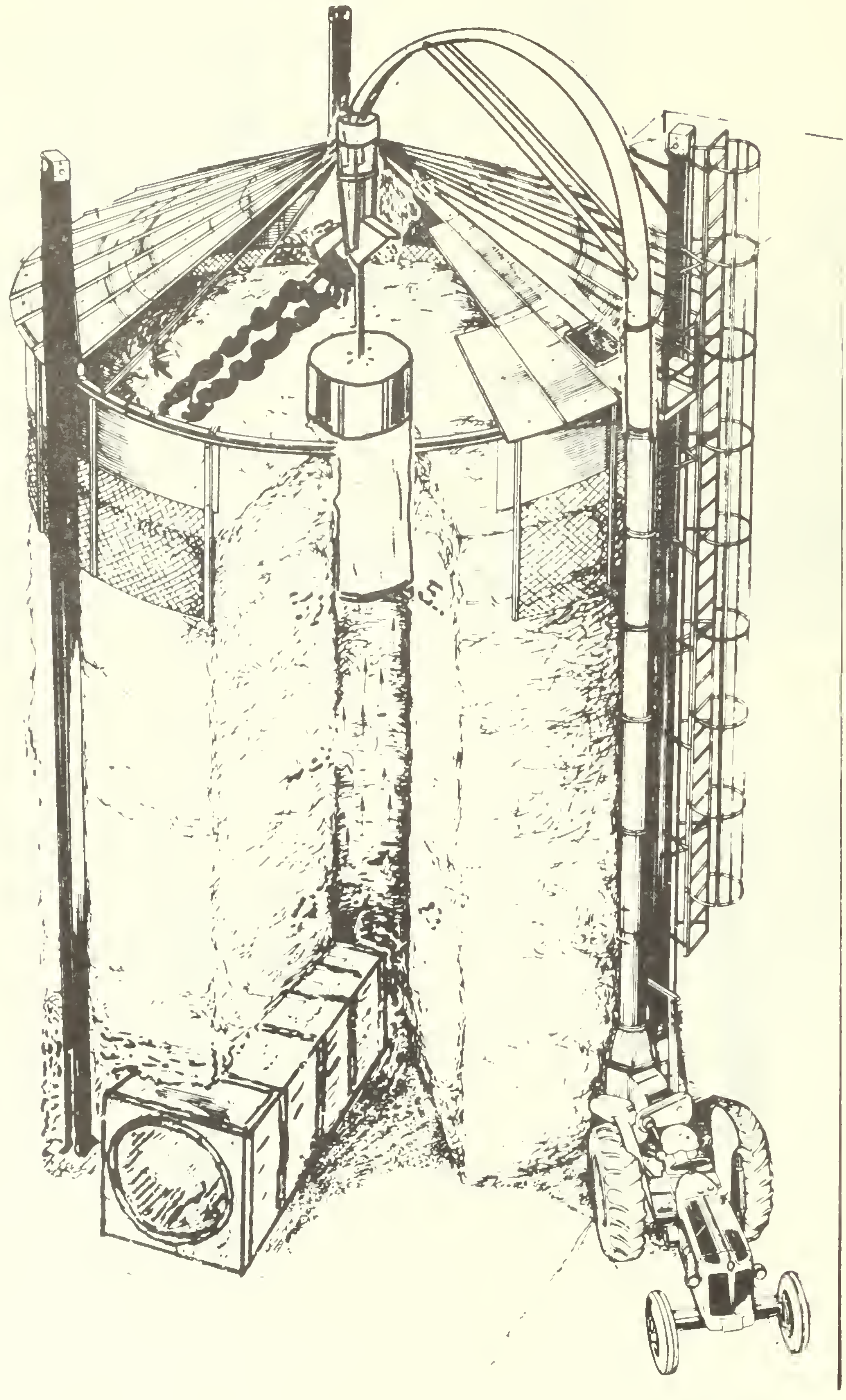


Figure 6 - Drying tower for chopped hay.

The tower consists of three 45-ft-high "I" beams bolted to concrete pilings spaced equidistant around a circle 25 ft in diameter. A cone-shaped roof (similar to that of a metal granary) supporting a double-auger, hay-spreading mechanism is suspended between the three legs and raised manually by means of three winches. The roof has a sheet metal skirt about 3 ft high attached to it and to this in turn is attached a woven-wire skirt also about 3 ft high. A plywood duct runs from the outside of the circle, at ground level, to a $4\frac{1}{2}$ ft diameter 'bung' at the center of the stack. The bung consists of a metal cap section to which is attached a canvas duct about 6 ft long. The lower edge of the canvas is sewn to a metal hoop to keep the circular form.

As the chopped hay is blown in through the peak of the roof, the auger moves it to the outside of the tower and spreads it by revolving around the circumference of the roof. As the roof is raised, it lifts the bung with it, leaving a vertical duct in the middle of the stack. An oil-fired dryer is attached to the plywood duct and the air is forced through to the central duct and out through the hay carrying moisture with it. As the stack dries, moisture drips from the outside of the tower. Once the dripping ceases, the stack is dry.

Hay is taken from the tower by removing the bung from the top of the central duct and reversing the direction of the auger so that the forage is drawn to the center and dropped down the duct. A conveyor inserted through the horizontal plywood duct at the base of the tower moves the hay from the bottom of the vertical duct to the outside of the tower. This can lead directly into a self-feeder or to another conveyor for loading into a self-feeding wagon, truck, grinder-mixer, etc.

The plan for the hay-drying tower is being revised to overcome some of the problems that have arisen. The main changes will be as follows:

1. Support roof on four rather than three legs, tie legs together at top for better bracing and to facilitate modification #2.

2. Redesign so that roof can be raised by one hydraulically powered winch rather than three hand-powered winches.

3. Place tower on a 4-ft-high platform so that it can be completely emptied by unloading machinery.

4. Attach 4-ft hinged sections of plywood to metal skirt under roof section to allow descending roof section to 'pull in' edges of the hay stack expanded on settling and which otherwise would either fall out during the unloading process or block the descent of the roof and unloading mechanisms.

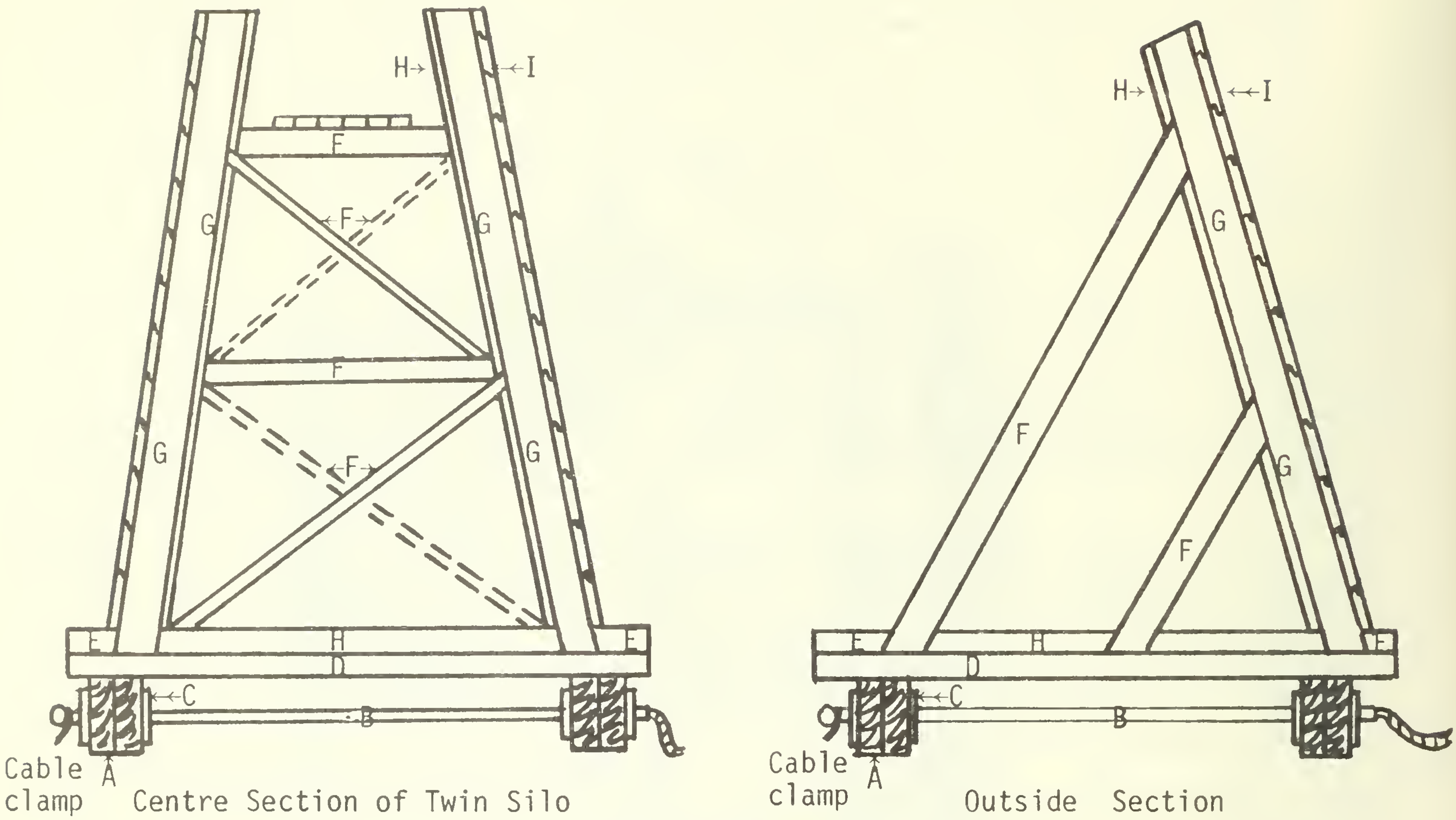
5. Install a one-piece unloading mechanism to bring material out from under the tower and elevate it to allow loading into wagons, grinder mill, etc.

PORTABLE BUNKER SILO

The plan for this silo does not indicate any insulation on the walls but, in the Melfort area, bunk silos should be insulated to prevent losses due to freezing, which can run to 10% or more of a packed, high-moisture silage.

PORTABLE BUNKER SILO

Scale: 1" = 2'



END ELEVATIONS

Figure 7 - Portable bunker silo for silage.

Freezing can occur in the outside top 12 - 18 in. of an uninsulated silo. Although much of this material could be fed if broken into chunks, too often this is not possible and the feed is discarded and lost. Insulation can be accomplished by using straw bales, a layer of earth over a sheet of plastic, or any other suitable material that can be held in place.

Construction

1. Tie together two 24-ft 6" x 8" pressure-treated skids (A) using three sections of 1½ - in. pipe (B), to which two shoulders (C) have been welded 4 ft apart. Thread both ends of each pipe and screw large nuts onto each end to hold the skids firmly in place.

2. Space seven 6-ft-long, pressure-treated 3" x 6" boards (D) along the skids starting 6 in. in from each end (approx. 4 ft o.c.).

3. Join the ends of the 3 x 6's using two 2 x 6's (E) running the full length of the section (24 ft). These can be bevelled to the angle of the upright members they support.

4. Place 4" x 4" brace units (F) and 7-ft wall studs (G) on 3" x 6" cross members (D) and use 2 x 4's (H) to hold the braces firmly in place.

5. Nail pressure-treated 2" x 6" tongue and groove (24 ft long) (I) onto the 7-ft 4" x 4" uprights (G). The lower plank rests on the top of the treated 2 x 6's running along the inside ends of the 3" x 6" cross members.

6. Nail short pieces of 4" x 4" between the 3" x 6" cross members to close the gaps over the inside skid (A).

7. The skids should not protrude beyond the ends of the walls, so that units may be placed end to end snugly if a long silo is required. When adding another unit, nail a piece of plywood over the join to support the plastic liner.

8. For a twin silo, build a center A-frame as shown above. The walkway on top provides a handy place to put the top part of the plastic liner during the filling operation.

EAT-THROUGH FEEDER

Most of the self-feeders available on the market today are designed for feeding high-concentrate rations. The 'eat-through' feeder shown in Figure 8 was designed for self-feeding of feeds varying from bale slices to all-grain rations. Regardless of the design, self-feeders require regular inspection and adjustment to be sure that feed is not being wasted.

Construction

1. Prepare two 6" x 6" treated skids 22 ft long (could laminate treated 2 x 6's).

2. Place 4 ft apart (outside measurement*) and tie together with three $1\frac{1}{2}$ - in. spacer pipes.

3. Construct two wall frames using 2" x 6" material (16 ft high, 20 ft long, with studding 16 in. o.c.). Attach plywood sheeting either before raising or as in 7. If you do it here, leave openings for cross ties at top. Frame a 30" x 30" opening at middle of one side for an access door.

4. Attach walls to skids with spikes or lag bolts. Tie together at top with six 2" x 4" ties (ends and at 1/5 intervals) and at bottom with 2" x 4" fir sills cut long enough to extend 9 in. past the studs, one across each set of studs. Nail the sills in place, 3 in. from bottom of studs and brace as required.

5. Fit 1 - in. plywood floor over sills.

6. Set and attach rafters with collar braces; nail on 1" x 3" nailing girts.

7. Line inside of wall sections with 3/8 - in. plywood sheeting to within 24 in. of floor.

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*This probably could be 4 ft inside to increase capacity without impairing efficiency of feeder.

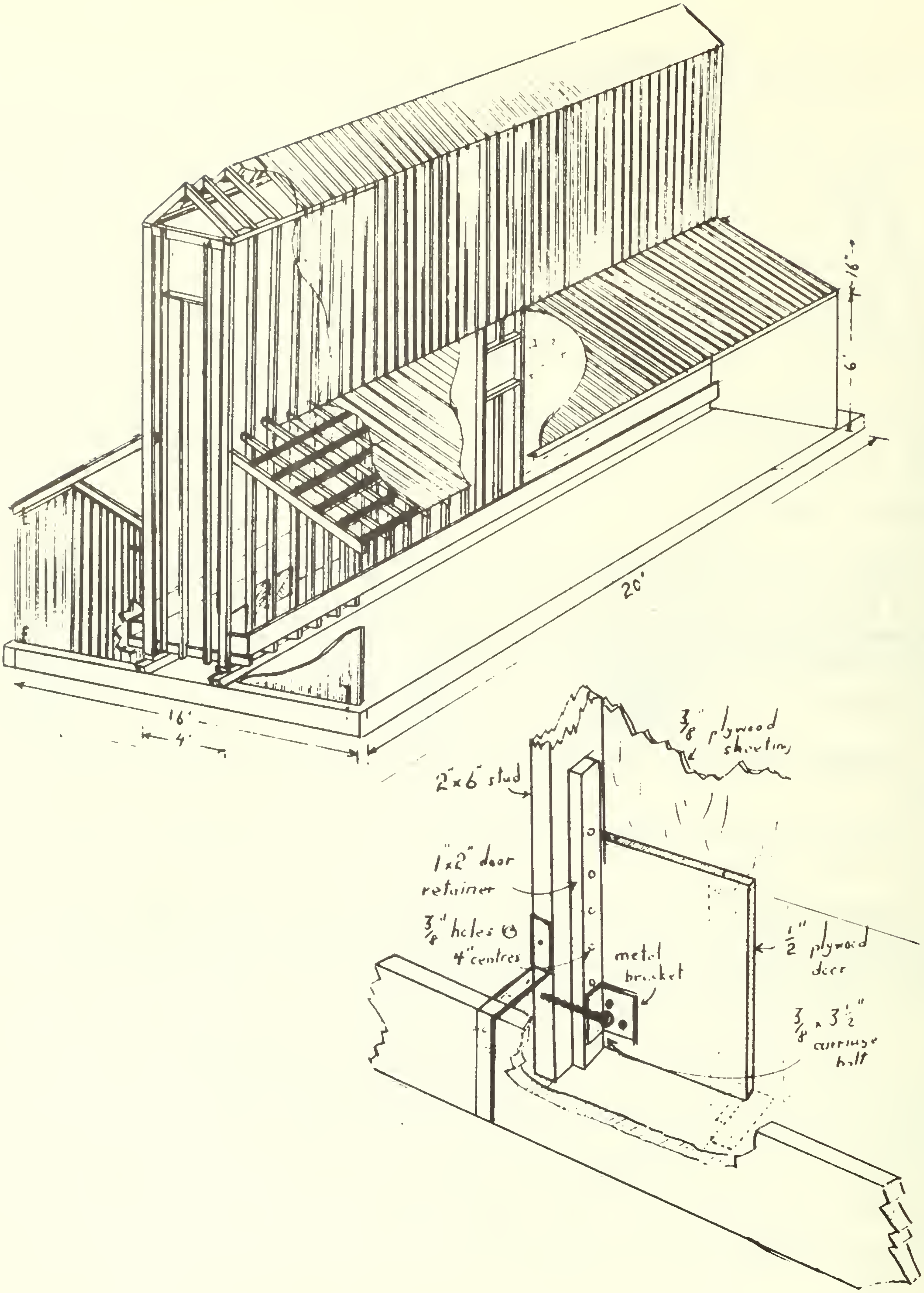

Figure 8 - Eat-through self-feeder for chopped roughage or conventional steer rations.

8. Attach end 2" x 4" studs, allowing for a hatch at the top of each end for filling blower or auger. This hatch should be fitted with a sliding door which can be opened (up and down) with a pulley and rope.

9. Line inside of end sections with plywood sheeting.

10. Fit side bottom openings with plywood doors at least 24 in. high. To keep them from moving inwards, nail $\frac{1}{2}$ - in. plywood strips, 4 in. wide, to inside bottom of each stud, extending 1 in. past the stud on each side. Strips of 1" x 2" material can be nailed along inner sides of studs to hold doors from pushing outwards (see diagram for details on construction and mechanics to control opening).

11. Place 2 x 10's along sides of feeder floor to form side of feeding trough, $7\frac{1}{2}$ in. from outer edges of studs. Nail $7\frac{1}{2}$ - in. pieces of 2" x 10" material at every fourth or fifth stud to hold edge of trough in place. For best fix, attach a piece of strap iron to stud and run it across tops of short 2" x 10" blocks and down outside edge of 2" x 10" forming the trough (see diagram).

12. Frame and attach braced rafters (2 x 4's) to studding to support protective roof sections. Attach nailing girts for metal roofing.

13. Attach metal roofing-siding to roof, to protective roof sections and walls above them, and to end sections. Treated wooden sheeting can be used instead, to reduce construction costs, but the metal reduces upkeep costs and improves appearance. Attach frame at upper ends to hold sliding doors to cover filling hatches.

14. Frame end sections to fit under overhanging protective roof. Make frame of 2" x 6" material, line inside with plywood sheeting and outside with metal siding, preferably backed by plywood. Attach these end sections by heavy hinges to the feeder, and anchor on other side to protective roof and concrete pad by means of a heavy barrel bolt. To provide added protection against being pushed out by feeding cattle, a heavy angle iron bar can be placed right across end of structure about 4 ft off the ground and held in place with angle-iron brackets (this allows bar to be lifted out easily when structure is to be moved).

PORTABLE SELF-FEEDER FOR HIGH-ROUGHAGE RATIONS

Figure 9 shows a portable self-feeder for rations high in roughage.

PORTABLE BUNK FEEDER

The high sides of this feeder (Figure 10) help to retain good capacity and prevent cattle from getting into the feeder. Because smaller cattle have difficulty in reaching the bottom of the feeder, semicircular notches have been cut in the sides. It may be necessary to reinforce the sides between notches, particularly if the planks are cracked or split. Long screws or pieces of strap iron screwed to the inside of the top plank would serve this purpose. Note that each partition consists of only one plank at the top, to allow easier cleaning of the bunk.

Scale: 1" = 2'

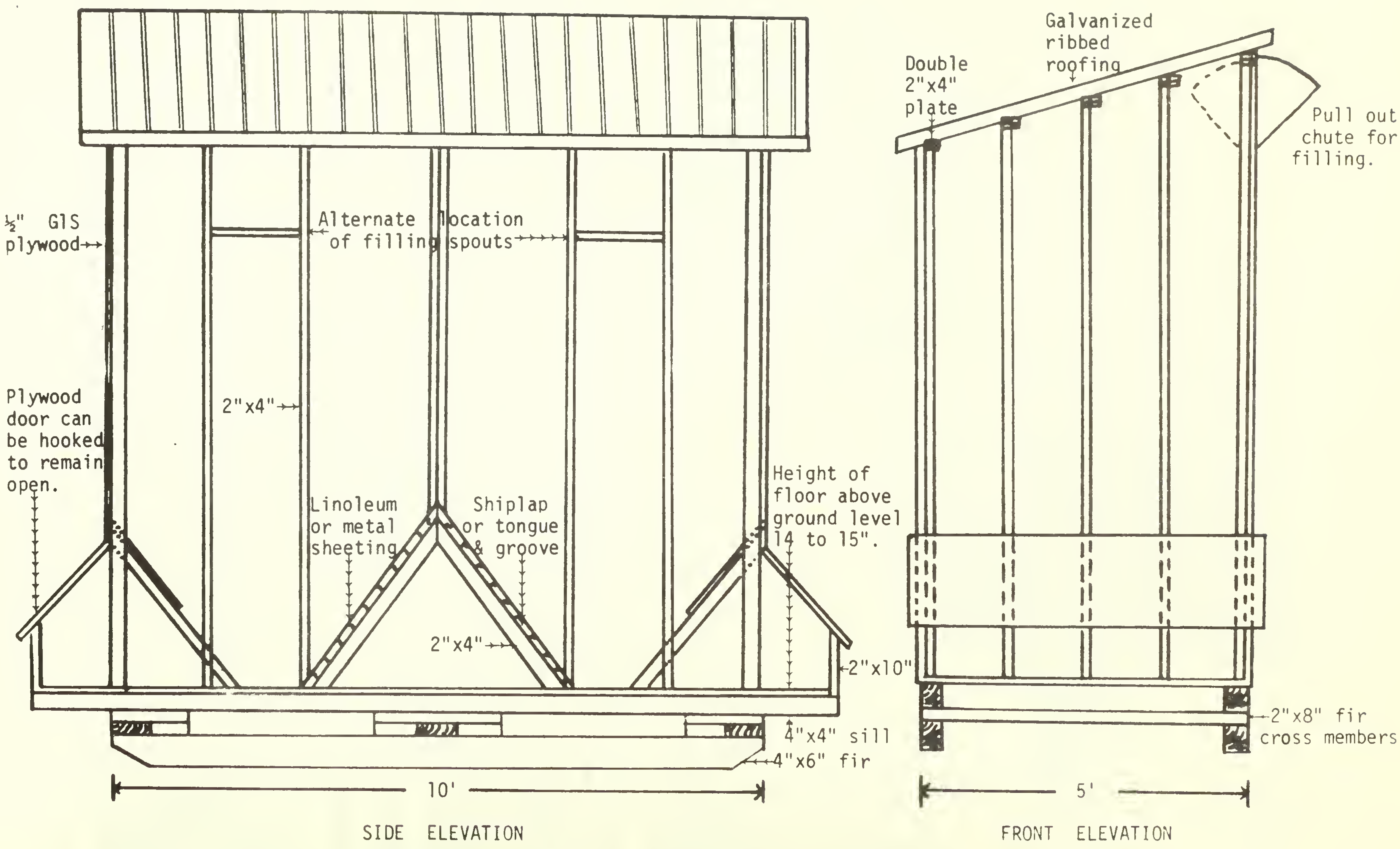

Figure 9 - Portable self-feeder for high-roughage rations.

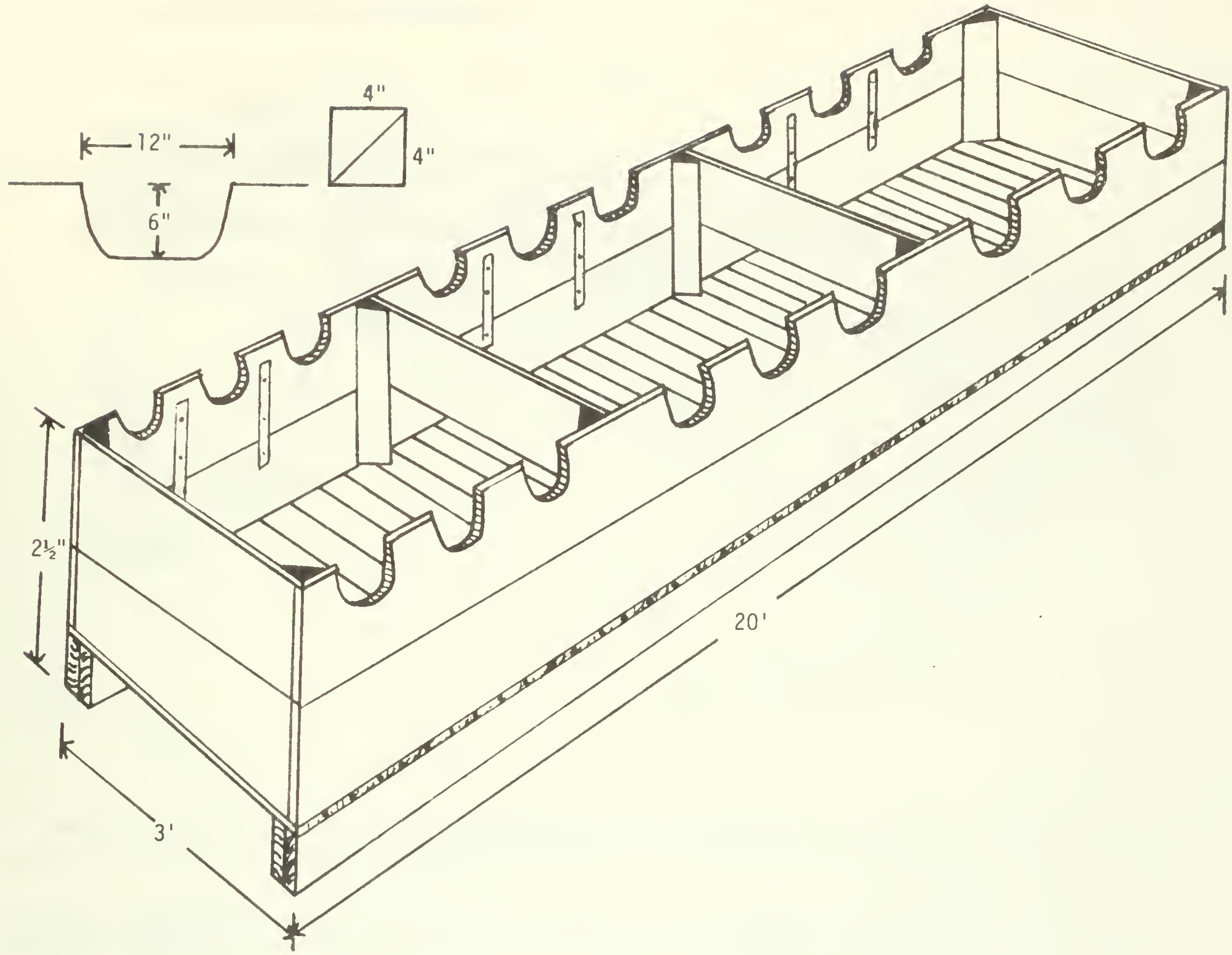

Figure 10 - Portable bunk feeder for silage, green chop and hay.

Materials Required

1. 2 - 4" x 6" x 22' (or equivalent) pressure-treated skids

2. 150 lineal ft 2" x 6" tongue and groove planking (for floor)

3. 98 lineal ft 2" x 12" planking treated with preservative (for sides and partitions)

4. 12 lineal ft 4" x 4" cut diagonally to form triangular sections to fit inside corners, as illustrated

GRAIN AND MINERAL TABLE

A feeder for grain and minerals is illustrated in Figure 11.

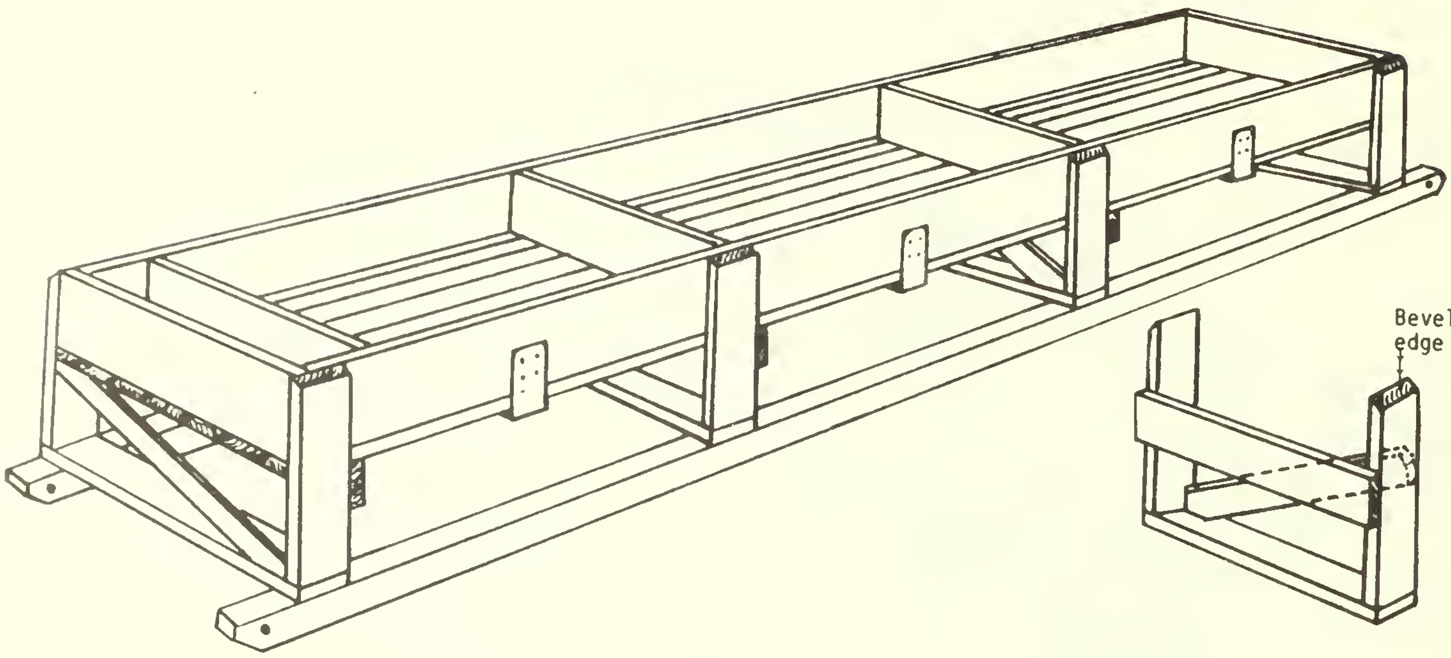

Figure 11 - Grain and mineral table.

Construction

1. Bevel and drill both ends of two 20-ft 4" x 4" or 4" x 6" pressure-treated skids and place 3 ft apart (outside measurement).

2. Construct four support units using one 2" x 8" x 3' as the base, two 2" x 8" x 2' as the side members, one 2" x 6" (or 2" x 8") x 3' as the cross support for the table (preferably notched into the uprights), and one 2" x 6" brace about 38 ft long.

3. Attach support units to the skids by spikes or lag bolts, leaving about 6 in. at each end and spacing evenly along the skids.

4. Nail floor of table in place. Use 2 - in. tongue and groove for best results. Shiplap will do but may break if cattle try to jump or walk over the table.

5. Attach two, 2 x 8's to side supports, leaving room for two end plank sections.

6. Hang 2" x 6" floor supports between main support units using galvanized metal strips nailed around ends of supports and sides of table.

7. Nail in two end plank sections.

8. Insert three 2" x 8" partitions.

9. If table will be moved often, place diagonal bracing along top of skids between support units.

PORTABLE SELF-FEEDER FOR CHOPPED HAY

The portable self-feeder shown in Figure 12 will hold 3 tons of chopped hay.

Materials Required.

1. 2 - 4" x 6" fir stringers 18 ft long

2. 5 - 2" x 4" x 16' fir, angle-cut to give 10 cross members for A-frames

3. 20 - 2" x 4" x 8' fir for sides of A-frame

4. 34 - 2" x 4" x 8' studs for walls

5. 2 - 2" x 4" x 18' and 2 - 2" x 4" x 12' plates for walls

6. 4 - 2" x 4" x 8' for 8 braces (walls to A-frame)

7. 48 lineal ft 2" x 4" for brace supports for feed deflector

8. 12 sq ft 3/8 - in. plywood for gussets to attach brace supports to wall studding.

9. 6 sheets 4' x 8' x ¼" plywood for ends

10. 2 sheets 4' x 8' x 1" plywood and 2 sheets 4' x 10' x 1" plywood for lower wall sections and feed deflector

11. 2 sheets 4" x 8" x ½" plywood and 2 sheets 4" x 10" x ½" plywood for upper wall sections

12. 4 sheets 4" x 8" x ½" plywood and 4 sheets 4" x 10" x ½" plywood for floor (some material left over for completing 4 in. required on sides)

13. Carriage bolts, nails, and hinges and bolts for 6 access doors

STACK FEEDING CORRAL

Figure 13 shows a 27' x 11' corral for feeding hay from a stack. As the stack is consumed, larger animals will push the gate into the stack. For lighter animals, it may be necessary to hook a chain on one corner and pull with a tractor to keep feed within reach.

Materials Required

1. 188 ft 2 - in. (inside diameter) pipe and 152 ft 1½ - in. (outside diameter) pipe for horizontal side members and corner uprights

2. 14 pieces 1½ - in. (outside diameter) pipe, 9 in. long, for vertical members in top sections

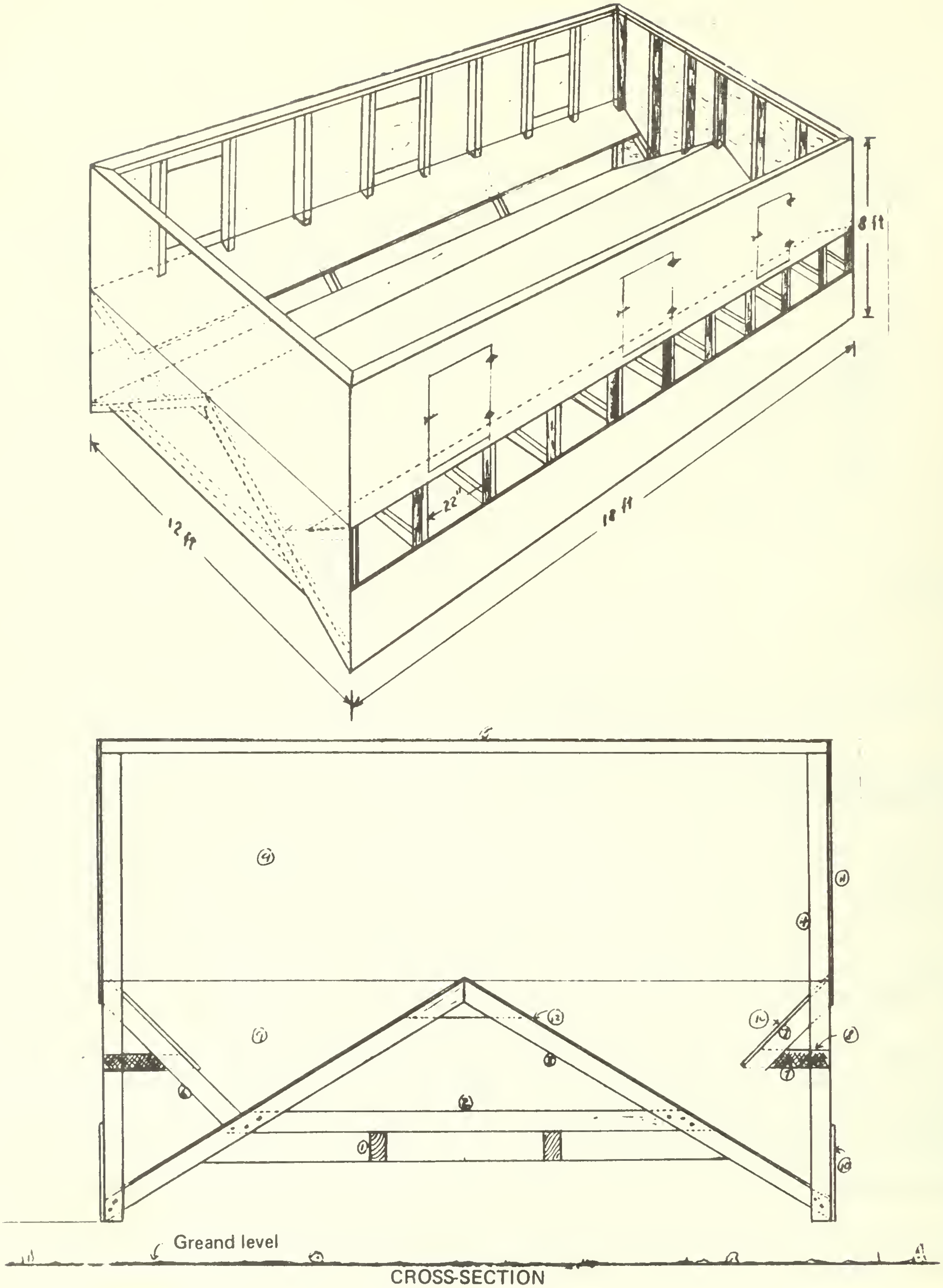

Figure 12 - Portable self-feeder for chopped hay (3 tons).

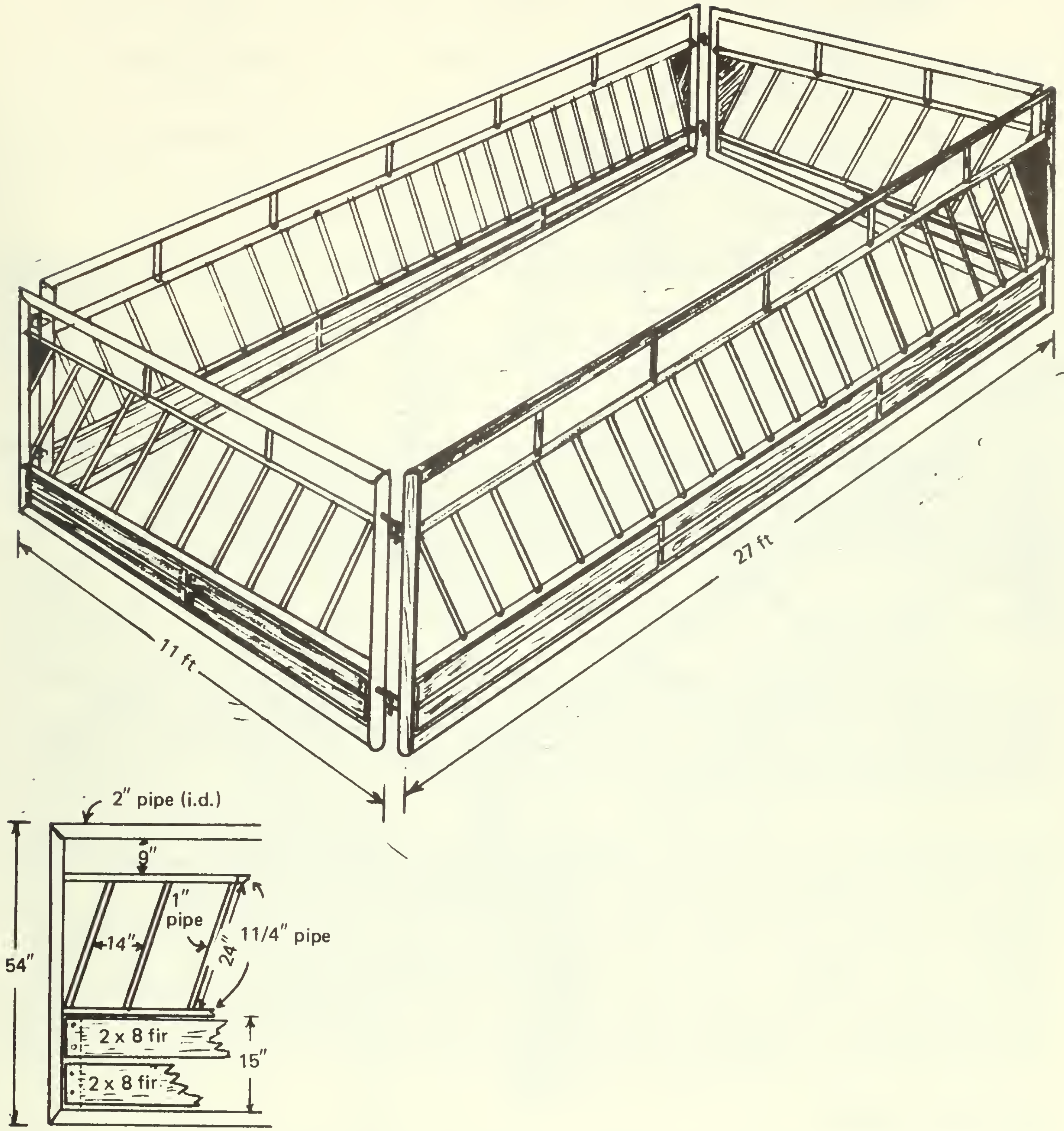

Figure 13 - Stack feeding corral.

3. 14 pieces 3/16 - in. flat iron, 15 in. long, drilled and welded between lower two horizontal members, for attaching planking

4. 58-60 pieces 1 - in. (outside diameter) pipe, 24 in. long, for sides

5. 8 pieces flat iron, $3\frac{1}{2}$" x $2\frac{1}{2}$" x $\frac{1}{4}$" with 1 - in. - diameter hole, for hinge members for long sides

6. 8 hooks, 7/8 in. diameter, $3\frac{1}{2}$ - in. upright, $2\frac{1}{2}$ - in. horizontal + $\frac{1}{2}$ in. into post, for hinge members for end sections

7. 152 lineal ft 2" x 8" fir planking for lower sides

8. 80 - 3/8 - in. carriage bolts, $2\frac{1}{2}$ in. long, for attaching planking

FEEDERS FOR HAND-FEEDING

Permanent Bunk Feeder

Where a permanent bunk-type feeder is to be placed along one side of a feeding paddock and filled by means of a mechanical unloader, the plan shown in Figure 14 may be useful, particularly if the buildup of manure behind the feeder can be eliminated. Where this is not possible, bunk feeding units that can be supported between two posts and raised or lowered as required may be the answer.

Raisable Bunk Feeder

This kind of feeder (Figure 15) has been in use in a pole-type barn at Melfort for several years. The feeders are lined up along the middle of the barn and are usually used for hand-feeding baled hay stored within the barn. With some minor adaptation (redesign of end sections) they could be filled by self-unloading wagons if required.

Two 2" x 2" x $\frac{1}{4}$" angle-iron sections (about 6 ft long) are attached to the poles at each end of the feeder to form a groove, which accommodates one side of a 2" x 2" x $\frac{1}{4}$" angle iron attached to each end of the feeder. One hole is drilled in each of the angle irons attached to the feeder (about 2 ft from the bottom) and holes are drilled through the angle irons attached to the poles at about 6 - in. centers. These 6-ft angle irons, running from 2 ft off the floor to 8 ft off the floor on the poles, allow the feed bunk to be raised by about 6 ft if the hole in the angle iron attached to the feeder is drilled at about 26 in. from the bottom. If shallower manure pack is anticipated, cut down on the length of the angle irons on the poles accordingly.

Fenceline Feeding

Rather inexpensive fenceline feeding can be accomplished by feeding right on the ground where there is good drainage so that feed is not wasted or spoiled. Allow cattle access to the feed through two cables (min. 3/8 in.) threaded through eye bolts in posts set at about 8-ft centers. The bottom cable should be about 18-22 in. off the ground and the top cable about 20 in. higher. Cables can be held taut by means of heavy springs attached to braced post at one end of the line. In poorly drained areas, some type of wooden or concrete bunk is recommended to reduce feed wastage.

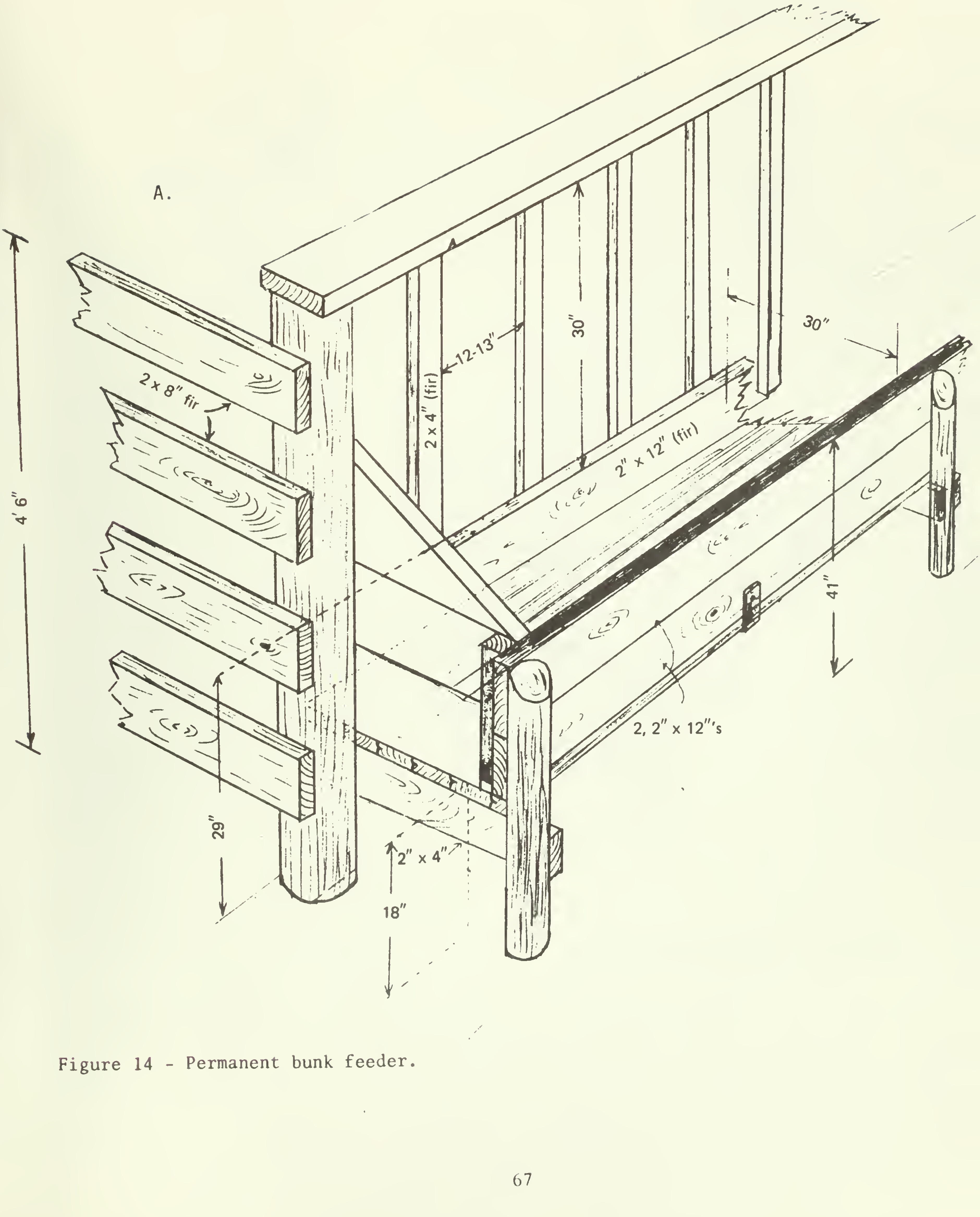

Figure 14 - Permanent bunk feeder.

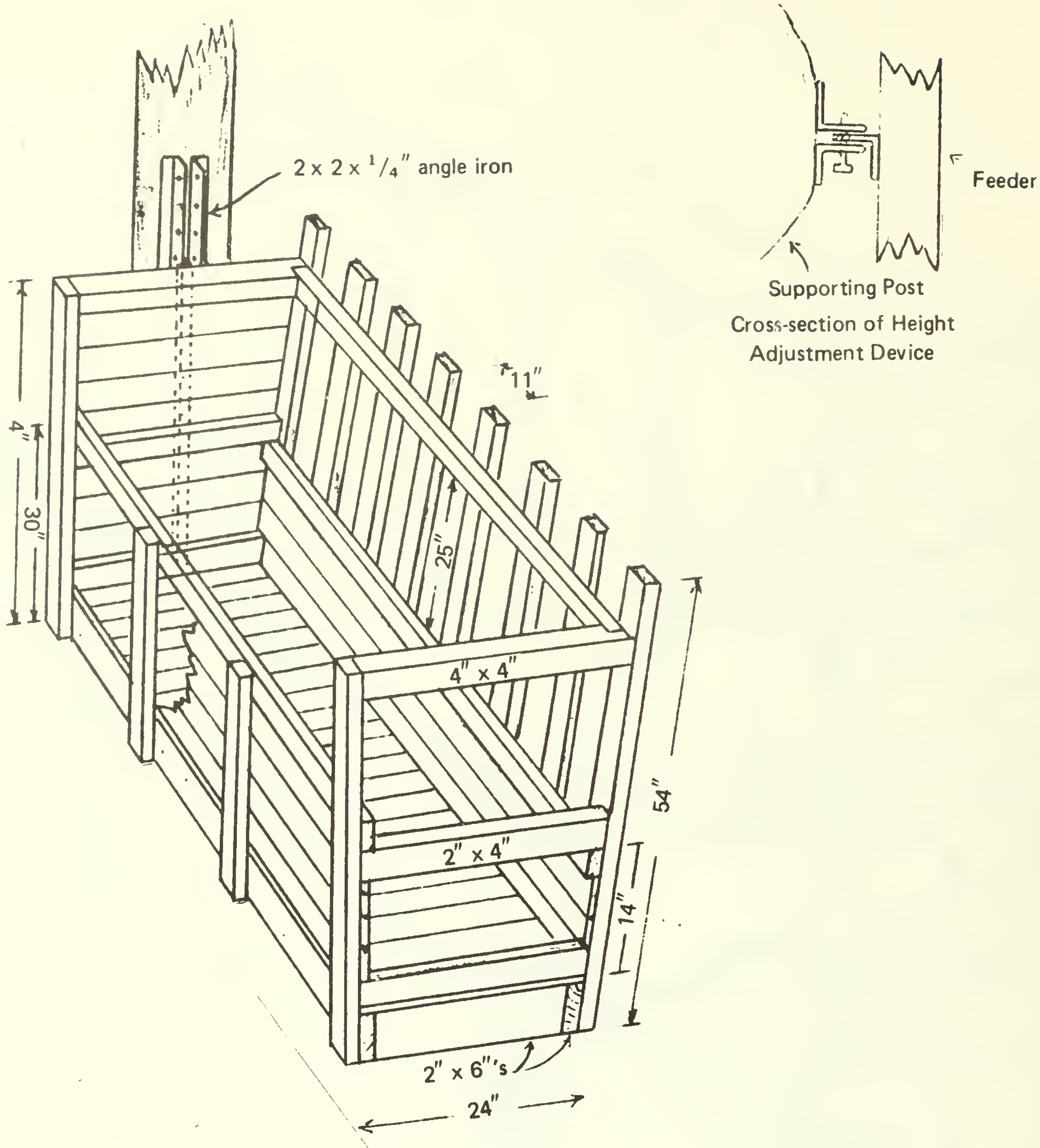

Figure 15 - Raisable bunk feeder.

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