Bison Feedlot Production Information

Government of Saskatchewan

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Bison Feedlot: Production Information

1. Foreword

1.1. Why raise bison?

Bison are a native species to the North American plains. Through evolution, bison adapted to the existing weather conditions and the naturally available feeds. Bison are ruminants that have the ability to digest low-quality forages and, therefore, may be used to graze marginal cropland in Saskatchewan

Bison are better suited than cattle at utilizing lower quality feeds. Bison also seem to be better suited to range situations than cattle. If fed higher quality feeds, performance is improved, but not to the same level as beef cattle. A bison operation may realize more gains by utilizing lower cost feeds and requiring less labour input. However, the producer must carefully monitor both the cost and quality of the feed to ensure adequate performance and returns for inputs.

The promotion of bison meat as a niche market is accomplished using two very strong themes: as a heritage product and as a healthy and nutritious red meat product. The unique nutritional properties and distinctive flavour of bison is appealing to a growing number of health-conscious consumers looking for alternatives to traditional red meats. Bison meat has a rich and unique taste without a wild flavour. It has a dark red colour and is very lean, although it may show slight marbling. Table 1 compares the nutritional characteristics of several meats.

Table 1. ***Comparison of nutrient composition of various meats.*** (Source: Dr. M. Marchello, NDSU, 1997)

3 ounce. serving	Calories	Fat	Protein	Cholesterol
Bison Ribeye	148	2.4 %	22.1 %	61 mg/100g
Beef Ribeye	180	6.5 %	22.0 %	72 mg/100g
Pork Ribeye	165	4.9 %	22.3 %	71 mg/100g
Chicken Breast	167	0.7 %	23.6%	62 mg/100g

1.2. Why use feedlots?

If bison can be raised with lower-quality forages and less operator inputs, why are feedlots needed? The simple answer is related to market demand. The health conscious and educated consumer demands a consistent supply of a consistent product quality. By regulating the finishing diet of animals, the feedlot operator is better able to satisfy these demands. Therefore, the consumer can expect to purchase a consistent product year-round.

2. Marketing Considerations

Before starting a bison feedlot operation, a producer needs to understand the market for the end-product. Producers should make marketing plans at the same time they develop production plans. The following four "Ps" of marketing should be considered when developing a business plan: product, place, price and promotion.

2.1. What will you raise?

As the bison industry matures and grows, there are opportunities for producers and processors to specialize. Bison producers and marketers must be aware of several Canadian consumer trends. Consumers are becoming increasingly more health conscious and have an increased awareness of production practices and animal rights. A higher premium is paid for products that are natural, organic, environmentally sustainable, healthy and/or produced with the most humane practices possible.

Bison are being raised in the following types of operations:

1. cow/calf operations:
    a. selling weaned calves,
    b. selling bred two- year old heifers,
    c. or selling breeding stock (Wood and Plains bison bulls or bred heifers and cows).
2. backgrounding / feedlot / finishing operations:
    a. finishing your own animals,
    b. purchasing and finishing animals,
    c. custom feeding,
    d. backgrounding your own animals then moving them to a feedlot (either selling them or retaining ownership), or
    e. purchasing calves and backgrounding them.

The choice of a production unit depends upon the business goals of the operator. Prospective producers must be fully informed and consider all options carefully. Adequate supplies and availability of feeder animals and capital investment are among the factors that need to be considered prior to starting a bison finishing operation. Also producers must be aware that there production practices can affect which marketers are interested in their animals. For example, if the marketer wants natural animals, then, as a producer, you must only sell that marketer animals that meet the marketers specification for natural.

2.2. What will you sell?

The primary value of a bison carcass is in the meat.

Bison meat should be marketed visibly distinct from beef and promoted on the basis of both nutritional characteristics and production practices. The nostalgic image of the Wild West often plays a role in the promotion of bison products. However, this marketing strategy should not overshadow the unique nutritional properties of bison meat.

Many producers who finish bison only market the meat. The meat is either marketed privately by the producer, or the animals are sent to a processor or marketer who arranges processing.

There is potential for marketing byproducts such as hides and leather, robes, hair and skulls. When marketing bison byproducts, the level of processing becomes a significant factor in the potential value of the finished product.

2.3. Marketing the product

The producer should carefully evaluate how the animal/meat will be marketed before finishing any animals. Since the bison industry is small, there is relatively small number of buyers and marketers of bison meat. The industry has developed close alliances between producers, processors and marketers. There are several marketing options available for finished bison:

1. The producer markets the meat (often called Farmgate or Freezer-sales). The individual producer handles all promotion and marketing of the finished product. There is potentially more profit if successful. However, the producer assumes all the risk. Poor quality product will likely be unmarketable.
2. A local independent wholesale company or specialty shop such as a butcher shop or delicatessen. The independent company may either work on consignment or simply purchase meat wholesale. The risk is shared between several individuals or companies and the level of profit will vary according to agreements.
3. Through a producer-owned cooperative. All promotion and marketing is done by the cooperative. The producer is generally guaranteed a fixed price per pound for animals delivered to the processing plant.
4. Private, integrated producer marketing groups. Some producers have formed their own marketing groups to target specific markets, such as natural (i.e not growth hormones or antibiotics used in production) or grass-fed (i.e. not finished on grain). These group marketers develop their own product line and arrange custom kill and processing. The producers assume all the risk.
5. A combination of practices. Some feedlot operators ship the majority of their animals to a co-operative or to independent wholesalers, as well as market some animals privately. The number of animals being marketed privately is often kept to a minimum. Usually the animals that do not meet certain finishing requirements (either too light or heavy), are marketed privately rather than taking a grading penalty on the carcass. This spreads risk among various markets rather than solely relying on one marketer.

2.4. Negotiating the sale

For a list of current buyers and marketers of bison, the producer may want to contact the Saskatchewan Bison Association and/or the Canadian Bison Association. Producers should research the various markets and marketers to decide who will provide them with the best overall price for the type of the animals they raise. When comparing prices, the producers should consider the following:

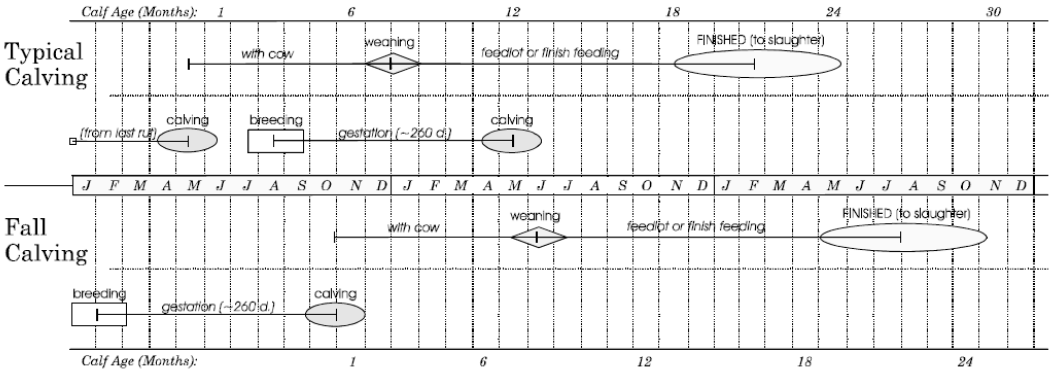
- What grade of bison (A1, maximum age, or ungraded)?
- The weight range acceptable to the buyer (usually finished bison are sold based on the hot carcass weight (HCW).
- What is the discount for animals whose carcasses do not meet either the grade, maximum age and/or the HCW range
- Is there and/or what is the price difference for young bulls versus heifers?
- Special attributes the buyer is looking for (e.g. grass finished, last 90 days on grain, no antibiotics, fully traceable)?

- Where are the animals being slaughtered?
- Who pays trucking costs?
- If being transported to the United States (U.S.) for slaughter, who is paying for the export testing, brokerage fees and U.S. government fees?
- Is there insurance to cover animals that are injured or killed during transport?
- When will the producer get paid?
- What are the deductions (e.g. marketing fees, killing fees, etc)?

2.5. Seasonality of bison

Bison are seasonally polyestrous, meaning there is a distinct breeding season and calving period during the year. Unlike cattle, the bison breeding season is relatively fixed. This implies that there may be a seasonal problem with the availability of bison meat. In practice however, there is year-round availability of bison meat. Differences in the method of finishing and the time of breeding ensure year-round availability of bison meat (Figure 1).

Figure 1. Bison Breeding Cycle



Two types of fat are found in bison meat. One type of fat, called marbling, is found in muscle tissue. Marbling is very low in bison meat and does not present much concern. The other type of fat is adipose or depot fat. This type of fat is of great concern to bison producers. It is this type of fat that is primarily used to grade carcasses. Depot fat is stored seasonally and is the type that is available for conversion into energy. This may pose a problem in that the carcass may be too fat or too lean depending upon the season.

The producer can take advantage of the fact that nutrient requirements are lower in winter and save money on feed during this period. The amount of food required by bison during the winter is comparatively lower than that required by cattle. As their metabolism slows, so does their feed intake.

An interesting point about the seasonal availability of bison meat is the global differences in consumer attitudes. North American consumers are accustomed to consistent product availability. An excellent example is the seasonal variation in the price of other fresh foods such as seafood, fruit, and vegetables. The customer is often willing to pay higher costs to import

when the product is out of season. This is contrasted to the European market, which is traditionally accustomed to seasonal availability of products.

3. Animals and Selection Criteria

3.1. Gender

3.1.1. Males

Males are more commonly finished than females. Bull calves and yearling bison bulls are more adaptable to the feedlot environment than older animals. Mixing genders in a pen is not recommended due to behaviour problems as the animals mature, differences in nutrient requirements and times to finish before market.

3.1.2. Females

Heifer calves may be selected for finishing and slaughter when the market demand for meat is low in supply and high in demand. Based on research data (Rutley and Aalhus 2003), bison heifers can be fed for slaughter under similar conditions as bison bulls. However, heifers should be managed differently in the feedlot as body weight size, average daily gain and frequency of A2 and A3 carcasses (excess fat) can occur when fed under similar conditions to bison bulls.

While heifers may exhibit average daily gains less than that of bulls, they will arrive at a finished weight and begin fat deposition at an earlier time in the feeding period than bulls when fed similar finishing rations. Under proper management, bison bulls and heifers were observed to have similar marbling characteristics, meat colour, ossification scores and A1 carcass scores. Meat quality from heifers is similar to that of bulls.

3.2. Importance of genetics

Genetic selection cannot be over emphasized. Conversations with experienced bison feedlot operators have revealed a heavy emphasis on the importance of genetic selection. In particular, genetic selection should be for animals that reach finished slaughter weight after minimal days on feed.

Bison feedlot operators have reported bison that require 10 to 14 months on feed to reach slaughter weight while others require upwards of 20 months to reach slaughter weight under the same conditions. Since the most significant factor affecting the profitability of any livestock operation is the number of days on feed, it is extremely important that feedlot operations obtain bison feeders that will reach a slaughter weight after minimal days on feed.

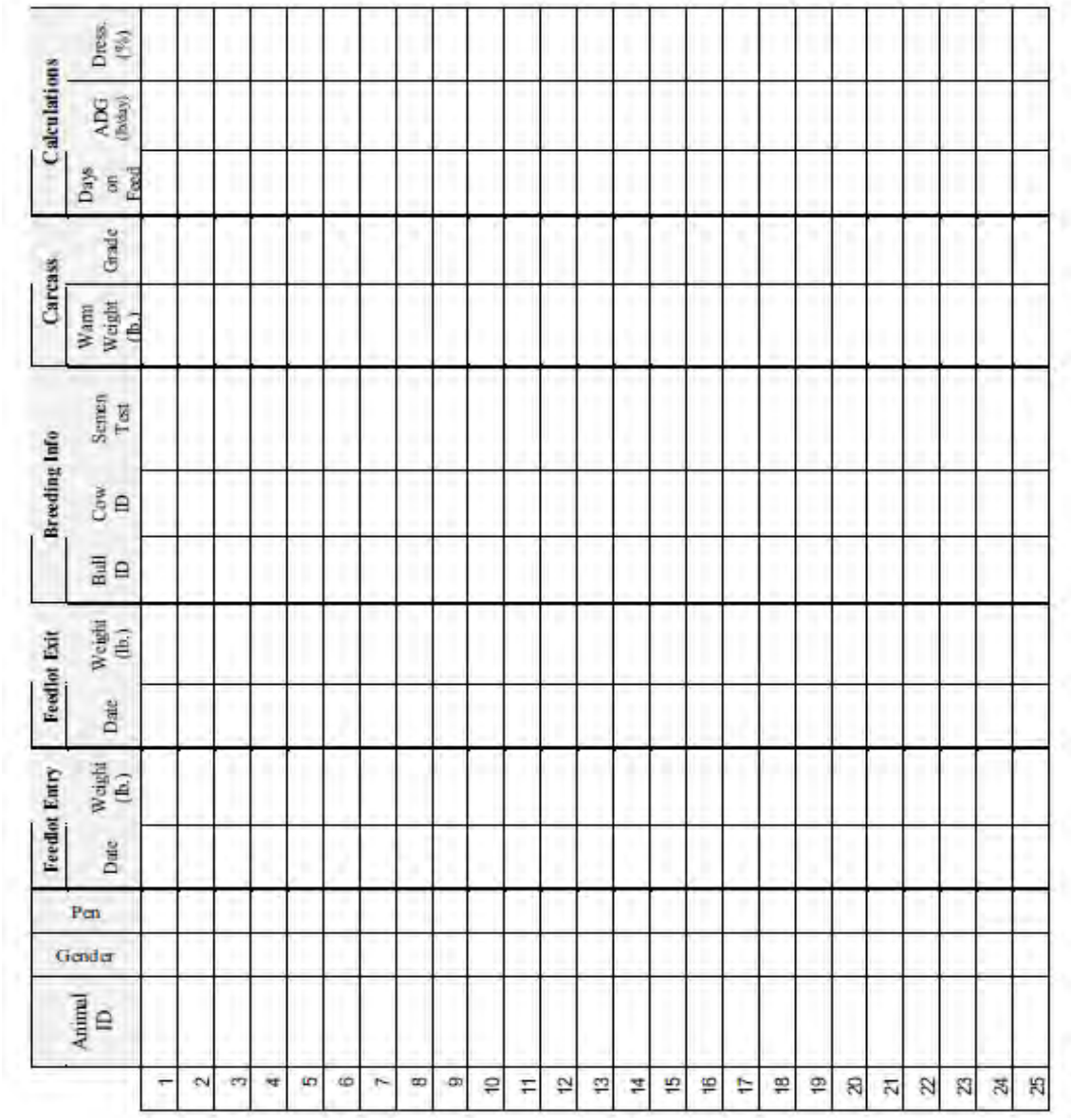
3.3. Importance of record keeping

The time when any bison was considered adequate breeding stock has passed. Careful record keeping and selective breeding are moving the bison industry away from the genetic bottleneck created by over-harvesting.

Record keeping abilities will differentiate a progressive enterprise from a non-progressive enterprise. It's necessary to keep accurate records on animal performance in order to determine the sources of future stock purchases and to constantly improve upon feed conversion efficiency through genetic selection.

To effectively cull, it is essential that accurate records are kept and critically analyzed. An example of proper record keeping is shown in Figure 2. Reports from the slaughter plant will allow the producer to judge the fleshing ability of the bulls and cows used in a breeding program. An index of the calf weaning weight to the body weight of the cow is another useful tool to evaluate the performance of a breeding herd.

Figure 2. Sample Record Form



	Animal ID	Gender	Pen	Feedlot Entry		Feedlot Exit		Breeding Info			Carcass		Calculations		
				Date	Weight (lb.)	Date	Weight (lb.)	Bull ID	Cow ID	Semen Test	Warm Weight (lb.)	Grade	Days on Feed	ADG (lb/day)	Dress. (%)
1															
2															
3															
4															
5															
6															
7															
8															
9															
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Identification of animals is the cornerstone for a reputable and accurate breeding-stock market. Single-sire breeding programs will allow paternity establishment of calves. Careful observation

of the calves and cows will allow the producer to identify the appropriate parentage. In this fashion, the record of performance can be used reliably.

3.4. Plains versus Wood bison

There is a controversy about which sub-species of bison may perform better in feedlot situations. To date, there have been no investigations to indicate better performance of Wood bison, Plains bison or a cross of the two types.

3.5. Health

Special attention to health must be taken with bison. It is often better to be preventative rather than reactive when dealing with the health of bison. The majority of feedlot health problems may be associated with over-crowding, freshly weaned calves, stress and poor pen conditions.

Typical processing prior to entry into a feedlot facility includes weighing, assigning unique identification and administration of a parasite control, eight-way vaccination (clostridia) and vitamins A, D and E.

It is important to recognize that there are very few drugs currently approved for use with bison. With the emphasis on food safety today, it is essential that bison feedlot operations consult with their local veterinarian about drug administration and residues.

4. Feeds and Feeding

During the finishing period, bison are offered a concentrated feed ration. There are a wide variety of quality feeds available. However, the feed ration must be both economical and balanced to meet the animal's nutritional requirements. Consequently, provide a mixed diet of high-energy feed grains and a roughage source.

Typical grains that are used include barley, wheat and oats. Common fibre sources include brome grass, alfalfa, timothy, cereal straw and grain cereal silage. In addition, food manufacturing by-products such as cull potatoes may be used where available.

Currently there are several different diet regimes producers follow when finishing bison. The most traditional method involves changing the ration several times during the finishing period. This allows the producer to carefully match the diet to the changing nutritional requirements of the growing bison. It may also incorporate a warm-up or adjustment period that allows the bison to become accustomed to the feed. The disadvantages of this method are the increased labour and feed storage cost. Other producers simply offer one ration throughout the finishing period. This method offers the advantages of often being cheaper and easier to implement; however, the performance of the animals may not be maximized.

Bison adapt readily to a diet that contains a grain concentrate. However, there is no consensus about how quickly the change may be done. Many producers have switched bison immediately from pastures to high grain diets without any problems. As a general recommendation, any changes in feed should be done gradually to avoid problems.

Although it has been documented that bison can survive on low-quality diets, it is unreasonable to expect the same performance that high-quality feeds may offer. Proper nutrition will yield top performance of bison.

Unfortunately, there is not a lot of information about feedlot diets for finishing bison. Most operations have adapted cattle knowledge and have learned by doing. All the books and tables in the world are not nearly as important as an attentive farm manager who carefully monitors the status and progress of his/her pastures and animals.

> *Note: Recently compiled data on finishing bison can be resourced from chapters located in the 2010 Bison Breeders Handbook obtained from the National Bison Association and the Canadian Bison Association.*

4.1. Parts of a balanced diet

4.1.1. Water

Water is essential for feed digestion. All animals should have free access to an adequate supply of fresh water. In a feedlot situation, bison require five to 10 gallons per day with peak consumption reaching 15 gallons. Note that feed consumption increases when there is free access to water, thereby resulting in increased gains.

The location of the water source is important. When water and feed sources are situated close together, an increase in competition may result in poor performance or animal injury. Conversely, placing the water too far from the feed may reduce intake. In many bison feedlot operations, the water is within 50 feet of the feeders.

4.1.2. Forages

A growing ration can predominately be forage based and augmented by a limited amount of grain or supplement. Finishing rations are predominately concentrate-based. Types of hay typically offered to bison vary considerably. Bison have shown a preference for grass hay over legumes. This practice can be cost-effective provided that the forage is tested and the complete diet is balanced.

4.1.3. Concentrates

Concentrates are high-energy feeds included in the diet to improve the rate of gain and reduce the cost of finishing. By adding grain concentrates to the diet, bison will reach finishing weight quicker. Consistently feeding concentrates also allows the production of consistent meat quality. Grain can be nutritionally variable depending upon the harvesting method and/or storage conditions. Low bushel weight grain will tend to be high in fibre and low in starch, thus have a lower energy content. As with forages, it is recommended that grains be tested prior to formulation of the finishing diet. A wide variety of grains have been used to finish bison without problems. The grain supplement offered varies considerably with geographic location and feed availability.

Concentrates comprise anywhere from 25 to 90 per cent of the complete ration. In bison feeding trials, it was shown that concentrates are best utilized when offered at a level between 70 and 90 per cent of the total diet. Through practice, producers have found that a minimum of 10 per cent fibre is required. The amount of concentrates fed per animal typically ranges between four to 16 pounds per day. This range varies with the nutrient value of the forage being offered.

4.1.4. Minerals

Bison in a feedlot-finishing situation are growing rapidly and their mineral requirements must be met. Therefore, operators should not underestimate the importance of providing additional minerals for bison. Unfortunately, specific mineral requirements for bison are largely unknown due to the relative newness of the industry. Bison specific mineral formulations are currently under investigation. At present, minerals are typically offered at the same rate as per cattle. Many producers ensure that they offer calcium and phosphorous with a 1:1 ratio. However, mineral content of feeds (forages and concentrates) will vary with the local soil and environmental conditions. Feeding minerals that contain calcium to phosphorus at ratios of 2:1 or 3:1 or the addition of limestone may be necessary to ensure proper calcium to phosphorus mineral balance. Feeding for calcium and phosphorus is essential, as is providing a mineral supplement that supplies the remaining macro (magnesium, sodium, sulfur, potassium) and micro (copper, zinc, cobalt, selenium, manganese, iodine, iron) minerals to meet requirements. It's recommended that your feed company nutritionist or the livestock specialist at the nearest regional office be consulted about any local mineral deficiencies.

4.1.5. Vitamins

As with mineral requirements, the vitamin requirements for bison are not well-known. At present, bison producers are following vitamin supplementation guidelines for cattle.

Vitamin A reserves may accumulate in the liver of animals grazing lush green pastures prior to entering the feedlot. Producers are therefore likely to be more concerned about marginal deficiencies when feeding a diet high in dried forages. Since there may be tremendous variation in the nutritional background of feedlot animals, it is recommended that a program of dietary supplementation be implemented upon their arrival at the feedlot. Zinc has been shown to influence the utilization of vitamin A in cattle and should be considered when supplementing minerals.

Previous data indicated that vitamin E supplementation can help reduce the occurrence of stress induced health and immune problems in cattle when fed at levels up to 400 to 500 IU/kg per day. When vitamin E is added to the final finishing ration of cattle, the meat quality is improved. The trace mineral selenium works in conjunction with vitamin E in an antioxidant defense system and needs to be considered when providing minerals and vitamins in the diet.

4.2. Quality of feeds

Feed quality is extremely important. Although it's been documented that bison can subsist on lower quality diets, it is unreasonable to expect the same performance level that high quality

feeds can bring. The performance of the animals is directly influenced by the quality of feeds utilized.

Feed quality can be greatly affected by a number of factors. These may include feeding practices, environmental factors (e.g. weather and soil conditions), harvesting practices, and storage length and method.

Moulds can develop in feeds that are improperly stored. The result of mould is that there may be a reduction of feed nutrient levels. Additionally, moulds may produce toxins. Feeds that contain mould should never be offered to feedlot animals, calves, pregnant cows or breeding bulls.

4.3. Processing of feeds

In general, feed processing improves utilization by the animal. The disadvantage is that processed feeds are more expensive, requiring specialized equipment and labour. Prior to utilizing ground feeds, animal digestive concerns and the associated cost of processing should be discussed with an animal nutritionist.

Prepared and processed feeds should not be fed on the ground. Use feed bunks or self-feeders to reduce wastage and possible feed contamination.

4.3.1. Forages

From the standpoint of feed management, grinding hay or straw results in better mixing capabilities and potentially can enhance consumption levels and feed-to-gain ratio as compared to feeding long hay. Processed forages allow for a more consistent blend when mixed with grain and minerals, as they hold together better in suspension. Significant levels of nutrient losses can occur, however, should processed forages be fed on the ground, due to the fact that smaller particulate matter will separate and remain on the ground. Dry matter and nutrient losses are higher when processing higher quality forage (e.g. alfalfa losses are higher than processed grass hay). Recent research indicates that these significant losses of up to 20 per cent in dry matter and 30 per cent losses in nutrients such as protein, energy and minerals can be avoided by feeding processed forages in feed bunks (Yaremcio 2009). Chopped or pit silage can lose up to 40 per cent of the dry matter and 60 per cent of some of the nutrients versus long-stem hay when fed on the ground/snow versus in a feed bunk (Yaremcio 2009).

4.3.2. Grains

Whole grains may have the tendency to pass through the animal undigested. Processing the grain kernel, such as cracking the outer shell, increases the total available surface area allowing for optimal ruminal digestion. Studies show that rolled grains are utilized by ruminants approximately 10 to 25 per cent better than unrolled grains (although this has not been documented for bison).

Mineral and vitamin supplements can be easily incorporated into the diet during processing. There is less wastage of supplements when they are supplied as part of a processed feed than when offered by other methods.

Feeding finely ground grains can cause problems in cattle and more than likely in bison. To date, bison producers have offered self-fed concentrates without reporting any complications or concerns.

4.4. Method of feeding

The method of feeding is often determined by the size of the feedlot operation. Facilities that are small (less than 200 head) can be fed by hand or cart, while in large operations (more than 500 head) it is more practical to utilize a total mixed ration delivered to fence line feedbunks with a mixing wagon.

Initial results of studies have indicated that the method of feed delivery appears to have little effect on the feed intake of bison, although some data supports that bison performance is slightly better when self-feeding concentrates and providing free choice hay versus daily total mixed ration) TMR or bunk feeding methods. While it remains unproven, some believe that lower feed intakes may result from frequent disruption caused by human presence while feeding.

4.4.1. Free-choice using self-feeders

Using this system, the feed is always available in self-feeders allowing the animal to eat at anytime. Typically, separate mobile feeders are used to supply forages and supplements. There are several commercial designs available along with countless custom designs. Each design must be carefully investigated to ensure that there is minimal wastage, contamination by manure, weather spoilage and bridging or lodging of feed within the feeder storage.

Feeders must be constructed rugged enough to withstand tractor towing and rough use by the bison. The design must also resist overturning by the animals.

The self-feeder design should facilitate the easy maintenance of the distinct herd hierarchy. This means that there must be adequate feeding space and that the bison are able to see other animals approaching. The early visual recognition of dominant or subordinate animals will greatly reduce fighting frequency within the pen. Typical self-feeder designs are shown in Figure 3.

Figures 1, 2 and 3. Typical Self Feeders

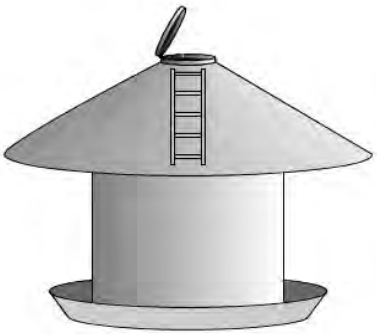


Figure 1

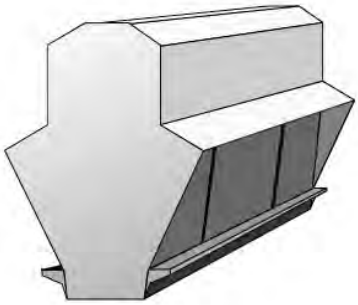


Figure 2

Grain / concentrate self-feeders

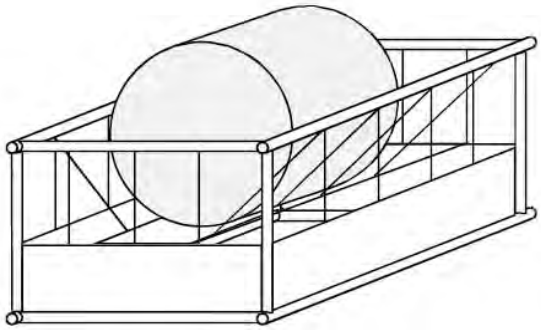


Figure 3

Hay self-feeders

Round bale feeders must be kept reasonably full. Nearly empty "tomb-stone" style feeders may become a hazard if animals are forced to reach for the hay remaining near the bottom. There have been cases reported where bison have become trapped in hay feeders.

There is less than five per cent wastage of hay when using a well-designed round bale feeder. There is also less wastage when a shorter supply of hay is offered (one-day's supply rather than a four-day supply).

The use of self-feeders may reduce the labour required to feed the animals. The mobility of the feeders provides benefits. The buildup of manure associated with a stationary feeder can be reduced or avoided when using a mobile feeder.

The producer must carefully consider the design and location of the feedlot when choosing a livestock feeder. Self-feeders may be inconvenient to refill if pens are muddy or filled with

snow. Refilling requires that machinery must enter the pen, which necessitates disturbing the animals.

4.4.2. Mixed ration using bunk feeding

Using a mixed ration system, the feed is delivered once or twice daily to fence-line bunk feeders. The ration may be a total mixed ration (TMR) that offers the complete diet or the ration may be provided to supplement self-fed forage. Typically this system is utilized by large feedlots.

It is very important that there is enough bunk feeding space so that all the animals can eat at the same time (upon delivery). If there is insufficient space, subordinate animals may never have the opportunity to reach the bunk. It's been estimated that, for cattle, limited or regulated feeding requires approximately three times the feed space per animal than self-feeding systems. Bison feedlot operators report that about two feet of bunk space is typically required per animal. This amount increases to about three feet to accommodate bison with horns.

To capitalize on economies of scale, feeding a TMR may require specialized equipment for mixing and delivering the ration. This system is most practical in large feedlots. Feed can be delivered efficiently to the fenceline feed bunks by a single operator. There is less hay wastage when feeding ground forages as part of a TMR than when utilizing round bales. It is also easier to incorporate minerals and vitamin in a TMR.

Typically, TMR's are dry and therefore the animals may develop associated health problems. For example, dust from feeds may irritate the eyes and lungs of animals.

4.4.3. Water

Unlimited access to fresh water for all animals must be ensured. There are two basic types of water systems that may be used in a feedlot: conventional and constant flow.

The conventional system is familiar to most producers. Water is kept pressurized throughout the system by a pump and pressure tank. A float valve that reacts to the animals' water consumption regulates flow at the hydrant. The advantages of this system include low initial cost and that it only operates on demand. The disadvantages include possible mechanical problems with the float valve system and the need to heat and insulate the bowls.

A constant flow system operates by constantly recirculating the water throughout the system. The advantages include that there are no valve problems and no requirement for heating. Disadvantages include a high initial cost, a pump that runs continuously and higher maintenance to ensure that the waterers are clean.

It is recommended that waterers be shared between no more than two pens. This will reduce the number of pens affected by failures and reduce the possibility of disease transmission. To further reduce the risk of disease transmission, treatment or isolation pens should have separate and individual water sources.

4.4.4. Minerals

Minerals are most effectively delivered as part of a feed supplement. However, many producers have reported success offering minerals free choice. Offering minerals in a separate station increases the chances of wastage and spoilage. Competition and fighting frequency can be reduced if the station design allows bison to see other animals approaching.

5. Growing versus Finishing

In the beef cattle industry, growing and finishing are two distinct practices. The growing phase (also known as the backgrounding or stocker phase) is used to grow calves at a controlled rate of growth to reach a target weight within a certain period of time (McKinnon 1993).

Backgrounding calves in a dry-lot system tend to be based on dry forages (e.g. grass hay, cereal green feed, etc.) with or without grain concentrates (Ensminger et al. 1990). These diets contain lower energy levels relative to finishing rations. Average daily gains are typically lower in the backgrounding phase compared to the finishing phase (McKinnon 1993). The growing/backgrounding phase is mainly used to deposit muscle on the frame of the animal while the animal is still growing (Ensminger et al. 1990). One example of backgrounding in the bison industry has been to grow bull calves to weigh 700 to 750 pounds prior to entering a finishing phase.

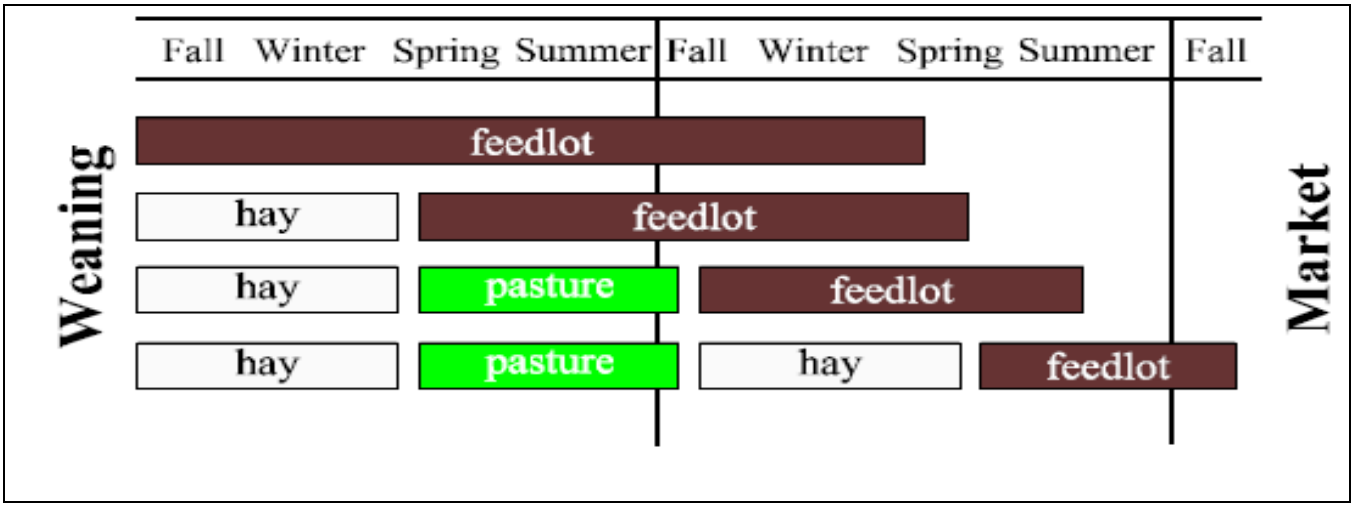
The finishing phase utilizes high energy rations to increase muscle mass, ensure fat deposition, and in the case of grass-fed animals change the colour of the fat from yellow to white (Ensminger et al. 1990). Finishing bison feeders can be completed in dry lots or pasture lots. Diets in a dry lot situation can utilize dry forages (hay) or wet forages (silage) with high levels of grain concentrates. It is desirable to feed the animals to a targeted weight with targeted fat levels as soon as possible.

5.1. Ways of finishing bison

Currently, the bison industry uses two methods in finishing bison. Grass finishing involves the feeding of bison on forages from weaning to target weight with the last 100 days feeding a high level of grain in the diet, while grain finishing involves the feeding of high levels of grains from weaning to target weight. There also are several combinations of grain and grass finishing being utilized. Given the different methods of growing bison for the meat market, finishing on high grain diets, at the present time, is desirable (in some markets) for at least the last 90 days prior to slaughter for the purpose of ensuring a white fat colour at slaughter. This practice is particularly important for grass fed bison as their fat will have a distinct yellow colour if no grain concentrates have been fed prior to slaughter.

Fieldlots, or field-lots (a term many producers are not choosing), utilize rotational grazing in large pens or paddocks with feed supplements and hay being offered free choice. These operations are more extensive rather than intensive. Figure 4 illustrates typical methods currently in use to finish bison.

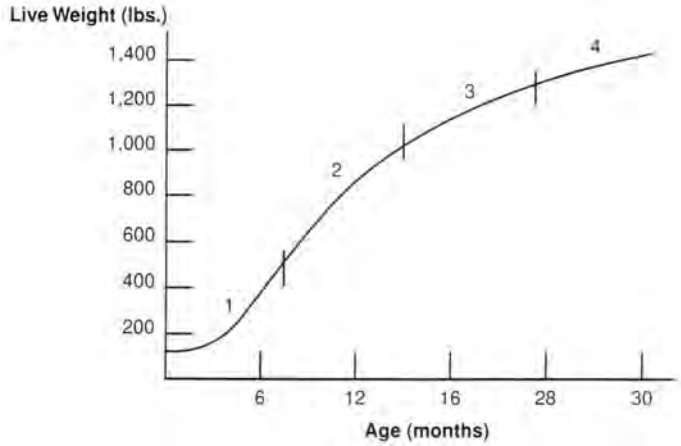
Figure 4. Typical methods of finishing bison.



5.2. Growth curves

Traditional livestock, such as beef cattle, exhibit a live-weight growth curve called the sigmoid growth curve (Western Canada Feedlot Management School Manual, 1997). This curve indicates that body weight is consistently increasing from birth to 30 months of age, with rapid growth during puberty as juveniles, followed by slowed growth as the animal approaches mature body weight (Figure 5). In Section 1, the young animal is rapidly growing. This rapid increase in body weight is due to the development of bone structure and the deposition of muscle, organs and nervous tissue with little body fat. In Section 2, skeletal, organ and nervous tissue growth is slowing with body weight gains attributed to the deposition of muscle mass. During Section 3, the majority of the growth is due to fat deposition with some muscle mass deposition. In Section 4, nearly all increases in body weight are attributed to fat deposition only. Feed conversion is reduced as feed energy is converted into fat and is not being used to drive muscle deposition. Sections 1 to 3 are considered the growing phase, and Section 4 is considered the finishing phase (Western Canada Feedlot Management School Manual, 1997).

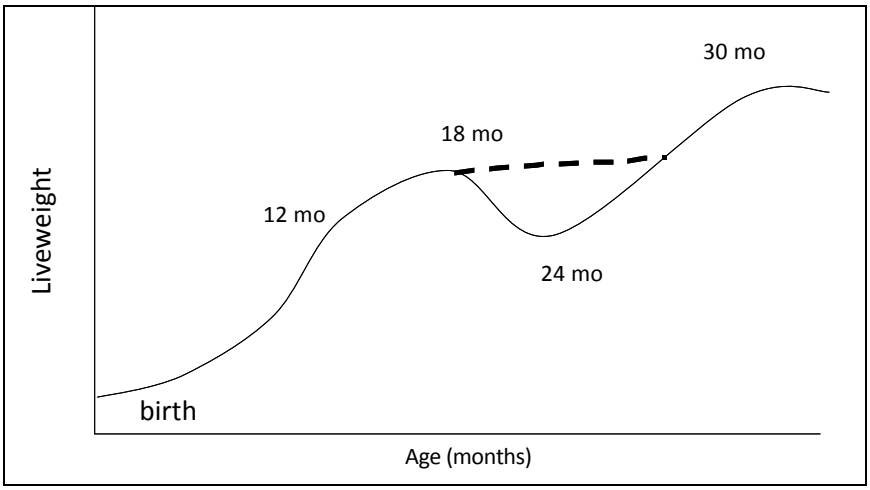
Figure 5. Live-weight growth curve for beef cattle (Adapted from Western Canada Feedlot School Manual, 1997).



Feeding animals according to the phases of growth requires that for the first two sections, diets need to be high in protein, energy and minerals to support the bone, muscle, organ and nervous tissue growth. In Section 3, bone, organ muscle and nervous tissue deposition are nearly completed, with fat deposition becoming the main contributor to body weight gain. At this time, beef cattle feeders are providing diets high in energy necessary to drive the laying down of fat and the finishing of the animal. High protein diets are not required during Section 3 as the protein will not by be converted into muscle and will not contribute to increased body weight. Rather, nearly all of the excess protein will be excreted in the feces and urine, with a very small percentage of the protein converted into energy. At this time, diets high in energy are required to further fat deposition. If feeding was to continue into Section 4 of the growth curve, too much fat will be deposited, resulting in down-graded carcasses (Western Canada Feedlot Management School Manual, 1997).

With bison, the growth curve does not show a continual increase in live-weight mass as it does for ruminant livestock such as beef (figure 2). Bison tend to grow from birth to 18 months of age. Upon reaching that age, the metabolism of the bison slows to a maintenance state, where the impetus to grow is drastically reduced or eliminated (Rutley 1998; Stanton and Schutz 1995). Much like other native ruminants from North America, mature bison experience a winter weight loss of up to 10 to 15 per cent of pre-winter weight (Christopherson et al. 1979; Hudson et al. 1985). This period of static/ negative growth occurs during the majority of the wintering period. In spring, the metabolism of the bison increases nearly two- fold, enhancing appetite and driving a growth in body weight (Rutley 1998). This growth in body weight mass continues until the animal reaches 30 months of age, upon when it enters its third winter. The metabolism again is reduced to a maintenance state where the bison may maintain or lose weight.

Figure 6. Live weight growth curve of bison.



At the present time, there are choices to make as to whether or not bison calves weaned at six to seven months of age should enter a finishing feed yard immediately, or start them in the feed yard as long yearlings at 15 to 18 months of age. The decision can affect how long the animals will be fed, how old and how heavy the feeder will be when marketed. Variable entry weights and mixing of animals from different herds may depress calf performance in a feed yard due to stress and the necessity to renew the order of dominance between animals. Performance may not be affected if the bull calves from one source are all kept together (Rutley 1992). Feed yard feeding and finishing of bull calves from weaning to finish requires a longer period of time in the feed yard, while the finishing program for long yearlings is usually shorter in duration (Figure 6).

This means that feeding long yearlings can be cheaper if the yearling bulls were fed forages prior to the finishing period; as forage based diets tend to be cheaper than grain based diets. One option that bison producers have been utilizing is feeding yearlings forages to maintain the animals during the wintering period. While this may result in slower daily gains, this practice does allow the feed yard manager to take advantage of compensatory gains in the spring and increase the marketing options available.

5.3. Creep feeding

Creep feeding is the practice where supplemental feed is provided to calves while nursing, to compensate for poor forages and/or declining pasture quality and declining milk production by the cow. The benefits of creep feeding include optimized growth of the calf when younger, resulting in increased weaning weights, cheaper gains due to better feed to gain ratios, more uniform bull calves and feed bunk or self-feeder recognition (Ensminger et al. 1990).

Some of the detractions to creep feeding include; increased cost to the producer, possible elimination of compensatory gains in the spring and over compensation for a poor milking cow that would make culling based on milk production more difficult (Ensminger et al. 1990). A common observation in trying to finish creep fed calves is that they don't seem to gain as much muscle mass as non-creep fed calves. Creep feeding calves may result in better calf gains prior

to weaning, but upon entering the feed yard, one of two things may happen. The calf may be put onto a lower energy, forage-based receiving ration, reducing gains. The object in growing and finishing calves is to step the energy content of the diet from low to high, not from a high to low to high energy level. This fluctuation in the energy level of the ration will affect the gain and most often reduce potential performance.

Smaller-framed calves that have been creep fed may actually stop depositing muscle mass earlier than the rest of the calves when placed in a feed yard, resulting in feed energy being converted into fat and a higher feed to gain ratio. These animals tend not to grade as well, due to excessive fat content as they become overfinished. Finally, if producers are looking at selecting breeding stock from backgrounded/ stocker bull calves, creep fed bull calves may have problems with foot/breeding soundness and decreased breeding lifespan (Ensminger et al. 1990).

5.4. Expected finishing performance

Several studies have been conducted measuring the finishing performance of weaned bull calves and yearling bulls in a feed yard environment (Anderson and Miller 2000; Stanton and Schutz 1992). Table 2 is an adaptation from Anderson and Miller (2000) and show some selected seasonal data for weaned bull calves and yearling bulls.

Table 2. Performance data for weaned bull calves and yearling bulls in a feed yard (adapted from Anderson and Miller, 2000)

	Spring	Summer	Fall	Winter
Weaned Calves				
Dry Matter Intake, lb.	17.67	18.50	25.13	24.75
Average Daily Gain, lb./	1.73	1.38	1.76	0.38
day Feed to Gain	10.24	13.51	14.41	66.00
Yearling Bulls				
Dry Matter Intake, lb.	19.71	22.72	17.40	18.36
Average Daily Gain, lb./	1.85	1.95	0.99	1.33
day Feed to Gain	10.80	11.99	18.71	14.05

This data shows that one can expect approximately 1.38 to 1.95 lb. per day average gain by both weaned bull calves and yearling bulls on finishing diets in a feed yard environment. In the winter, feed intake did not change that dramatically. However, expected gains and the calculated feed to gain ratio is drastically affected. When feeding bison, it is important for the feed yard manager to be aware of these changes in daily gain and feed-to-gain ratio, as it will dramatically affect the cost of finishing those animals. It is also important to consider whether or not to finish weaned calves versus yearlings, as feeding the weaned calf may result in having to feed that calf through two winters of poor feed conversion, whereas feeding yearlings only results in feeding through one winter.

5.5. Feed yard management tools

For existing producers or individual producers thinking of initiating a backgrounding/finishing operation, the operation has to be economically viable. Two equations that analyze for the break-even sale value and the break-even purchasing price can be used as tools for risk analysis. These two formulae only work if costs of production and animal performance can accurately be established (McKinnon 1993).

Break-Even Sale Value

For the producer interested in starting a feeding operation, the break-even sale value should be evaluated.

$$\text{Break-Even Sale Value} = \frac{\text{(Initial Value) + (Total Cost of Gain)}}{\text{Sale Weight}}$$

Initial value = (purchase weight x purchase price)
Total cost of gain = (total gain x the cost of gain)

The break-even sale price provides a value that shows what each animal has to sell for if there is accurate assessment of purchase weight, price and the cost of putting weight on the animal. When purchasing individual animals or a pen of animals, the initial value plus the cost equals the break-even-sale price. Any number above the break-even sale value can be considered a profit to the operation.

The following is an example of how to use this equation. Suppose a producer purchases 450 lb. bison bull calves at $1.50 per lb. live-weight and the calves will gain 2.0 lb. per day to a final sale weight of 1,050 lb. — a total weight gain of 600 lb.. If it costs $2.20 per head per day to raise the bulls, it would cost the producer $1.10 per lb. of gain ($2.20 per head per day divided by 2.0 lb. per day gain). Therefore, the break-even sale value would be purchase price plus the total cost per pound of gain divided by the sale weight. In this example, the break-even sale value would be $1.27 per pound live weight, or $1,335 per head.

$$\text{Break-Even Sale Value} = \frac{\text{(450 lb. x \$1.50/lb.) + (600 lb. gain x \$1.10/lb. gain)}}{\text{1,050 lb. Final Weight}}$$

$$= \frac{\$675 + \$660}{1{,}050}$$

= $1.27 per pound live-weight
= $1,335 per head

This producer would have to return $1,335 per 1,050 lb. bull to break-even in that feeding operation. Any returns over that value would return a profit to the operation.

Break-Even Purchase Price

By using the Break-Even Purchase Price, a manager is attempting to make decisions on what the operation can afford to pay for animals, based on a determined cost to grow that animal to finish and an anticipated return from selling those animals.

$$\text{Break-Even Purchase Price} = \frac{\text{(Sale Value) - (Total Cost of Gain)}}{\text{Purchase Weight}}$$

Sale Value = (sale weight x sale price)
Total Cost of Gain = (total gain x the cost of gain)

An example of how to use this equation follows. Suppose a producer knows that it will cost $2.20 per head per day to feed a bison bull and that the bull will gain 2.0 lb. gain per day costing $1.10 per pound of gain ($2.20 per head per day ÷ 2.0 lb. per day gain equals $1.10 cost per pound of gain). Also, if the producer expects that each 1,050 lb. bull finished bull will return $1.35 per pound live-weight, and is purchasing 450 lb. bull calves, those bulls would need to gain 600 lb. during the feeding period. Therefore, the break-even purchase price would be calculated by subtracting the cost of gain during the feeding period from the final sale value of the 1,050 pound bull, and dividing that value by the weight of the bull calves at time of purchase. In this example, the break-even purchase price would be $1.68 per pound live-weight or $758 per 450 pound bull calf.

$$\text{Break-Even Purchase Price} = \frac{\text{(1,050 lb. x \$1.35/lb.) - (600 lb. gain x \$1.10/lb. gain)}}{\text{450 lb. purchase weight}}$$

$$= \frac{\$1{,}418 - \$660}{450}$$
= $1.68 per pound live-weight
= $758 per head

This producer would have to purchase 450 lb. for $758 in order to break-even. Purchasing 450 pound bull calves for less than $758 will result in profit for the operation.

Recognizably, there are several elements that will vary when calculating break-even values of sale or purchase. Animal daily gain (varies with season and age and gender of the animal), cost per pound of gain (varies from season-to -season and year- to -year), sale weight, sale value and purchase weight can all vary, affecting the break even status of the operation.

Since finished bison are often priced based on their hot carcass weight (HCW), another calculation that should be known is how to estimate a live animal price when quoted the price per pound on HCW basis. To calculate this, the average dressing percentage for the grade and gender of animal being marketed needs to be known. Dressing percentages do vary based on gender, age, finished condition of the animal and slaughtering plants. Generally, a youthful bison bull will grade between 55 per cent and 58 per cent.

To estimate the approximate price per lb. of the live animal:

(Price/lb. HCW) X (average dressing percentage for class of bison)

For example, price quote of $2.50 per lb. HCW, and average dressing percentage of 55 per cent:

$$\frac{(\$2.50/\text{lb. HCW}) \times (55)}{100} = \$1.38 \text{ live weight}$$

Also buyers pay the higher price for animals that fall into a specific HCW range.

$$\frac{\text{HCW} \times 100}{\text{Dressing percentage}} = \text{finished live animal weight}$$

For example, a buyer may want carcasses between 575 to 625 pounds. To calculate the approximate corresponding live weight:

$$\frac{575 \text{ lb.} \times 100}{55} = 1{,}045 \qquad \frac{625 \text{ lb.} \times 100}{55} = 1{,}136$$

In the above example, 55 per cent dressing percentage was used to provide an estimate live animal weight range of 990 lb. to 1,136 lb. in order to meet the buyer's specifications. If the producer's animals generally dressed higher, e.g. 58 per cent, then the live animal weight range would be 991 lb. to 1,077 lb.

6. Facilities

Although the following gives an outline of what to consider in feedlot design, all systems must be specifically tailored for each site and the management intentions of the operator.

6.1. Location

A good site has many positive social and economic benefits. However, it is difficult to find a site with all the desired features. Evaluate potential sites from both a producer's and community perspective.

Site selection involves practical, technical and environmental factors. Even small-scale operations should observe or consider the following points when selecting a site for a livestock operation.

6.1.1. Practical

- Select a site that lends itself naturally to the operation. Make use of naturally occurring windbreaks, shelterbelts and other landscape features that provide protection and visual screening.

- Select a site that has good drainage away from buildings and facilities. Proper contouring of the ground provides for drier pens and better animal performance. Select a site with soil that will maintain its contour.
- Ensure there is adequate area for holding ponds or other environmental control structures.
- Since successful livestock operations tend to expand over time, allow extra space for future expansion.

6.1.2. Technical

- Evaluate present and future land-use in the surrounding area (e.g. proximity to neighbours and residential development). Recreational areas may be more sensitive to new livestock development than traditional farming communities. Local support in the community will help avoid ongoing problems in the future.
- Avoid areas with resort and recreational facilities (e.g. motels, parks, campgrounds, resort villages or golf courses) that may result in conflict. Avoid locating a livestock facility at an elevation higher than the surrounding area to minimize the effects of an atmospheric inversion. An inversion usually occurs under calm conditions, often on a cool summer evening after a warm day, and can carry odour a considerable distance with minimal dispersion.
- Ensure the availability of utilities such as power, water and telephone.
- Consider the availability of inputs such as livestock, feed supplies, labour and support services (e.g. veterinary services).
- Develop a traffic management plan for the delivery and removal of products and by-products to reduce dust and noise.
- Select a site with an all-weather road for moving livestock, feed, manure and other by-products. Municipalities may require specific road maintenance agreements for activities not located on a provincial highway.
- Evaluate the potential effect that poor weather such as heavy rain or snow may have on the selected site (e.g. pen and road conditions).
- Evaluate herd health restrictions, such as isolation to other livestock facilities that your operation may require, or that existing operations in the community may have.

6.1.3. Environmental

- Develop a plan to store and utilize manure and manage waste in a way that will minimize the impact on the environment and neighbours. Manure is a valuable by-product of any livestock operation.
- An engineering study may be necessary to evaluate soil and groundwater conditions and to determine the environmental constraints or opportunities for development of a site. Obtain access to enough land suitable for spreading manure.

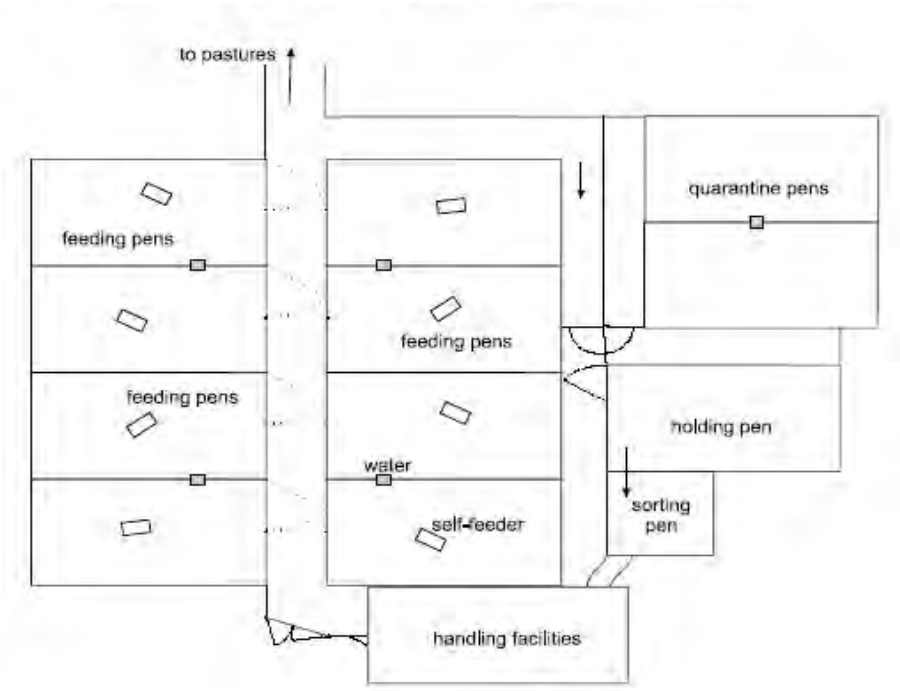
6.2. Design and construction

A producer starting a bison finishing operation should carefully consider potential public relations issues of the industry. Will the operation be patterned after a traditional beef feedlot and be intensive? Conversely, will the operation be an extensive “field-lot” and utilize supplemental feeding in large grazing pastures?

Keep the design simple and organize the layout for efficient operation. Extra pens should be easy to add simply by extending a few alleys and constructing new pens. The feed processing or storage area, handling facilities and existing gates should not need relocation when expansion occurs. The layout of the facility should utilize the natural topography to reduce the costs of earth shaping.

It is important that feedlot operators construct and utilize quarantine or isolation pens. This practice will reduce the likelihood of disease transmission from new arrivals to resident animals. Examples of typical facilities layouts are shown in Figure 7.

Figure 7. Typical Bison Feedlot Layout



Example feedlot that uses self-feeders

6.2.1. Pen Design

An informal survey of current bison finishing operations has shown that bison require approximately twice as much pen area compared to cattle. Daily gain performance declines when bison are crowded. Overcrowding causes problems with the established herd hierarchy by interfering with the natural spacing between dominant and subordinate animals. The bison will spend considerable amounts of time and effort to re-establish their hierarchical status, thereby increasing potential for injury and reducing gains. Likewise, groups of bison that are too small also have shown poor feedlot performance. Bison are distinctly social animals and will seek to re-establish a herd group. Although this implies that there is an optimal group size, there has been no formal research conducted to confirm this suggestion.

Typical pens are rectangular with the length being twice the width. If fenceline feed-bunks are used, the pens are typically twice as wide as their depth. See Figure 7 for typical bison feedlot layouts.

Pens should be large enough to hold about 40 animals. It has been shown that performance is better when the entire pen is always handled as a group. An additional advantage is that this number of animals represents one semi-trailer load (40,000 to 50,000 lb.). Groups larger than 40 animals are typically difficult to efficiently process through handling facilities. There is speculation that a square pen may simulate natural mingling of bison; however, it is very difficult to remove and handle bison in a square pen. Avoid the temptation to construct pens that are too large.

Group pens such that the system is modular. Extra pens should be easy to add simply by extending a few alleys and constructing the pens themselves.

Where possible, place feed bunks in a north-south direction. This allows winter sunlight to warm both sides of the bunks, thereby reducing snow and ice buildup. Feed wastage and animal injuries may be reduced.

Adequate drainage is necessary to prevent the formation of wallows around waterers. Following cattle recommendations, pens should have a minimum slope of 1:25 (one foot of slope for twenty-five feet of horizontal distance) to a maximum of 1:15 away from waterers, feed bunks and rest areas.

6.2.2. Animal considerations

In cattle, it is understood that poor performance can be attributed to muddy conditions, harsh wind and wet resting areas rather than cold air temperature. A muddy feedlot can reduce feed intake up to 30 per cent and reduce daily gains up to twenty-five per cent. While this data has not been calculated for bison, it is assumed that, harsh, muddy and wet living conditions will also have negative effects on bison performance.

All animals must have adequate wind protection. Natural bush offers the best protection and should be utilized where present. Properly designed windbreak fences supply adequate protection, but involve increased labour and material costs.

A dry resting-place is required to promote animal comfort and cleanliness. Cleanliness is even more important if the producer intends to market the robe. Most existing bison feeding operations utilize large pens that are well drained and require little effort to ensure a dry and clean resting location. Some producers provide bedding when weather conditions dictate. Others utilize a bedded mound during the winter. It is important that the resting area should be located so as not to interfere will pen drainage.

Providing rub or scratch locations can greatly reduce the abuse of pen fence lines. The comfort of the bison is thereby increased along with cleanliness.

6.2.3. Cleanout considerations

Pen cleaning will become an eventual chore for all feedlot situations. Placement of bunks and water sources must be done with cleaning in mind. Alleyway and gate access to the pens is critical. Having easy access to the pens and having a spreading or disposal plan will improve cleaning efficiency.

6.2.4. Electrical considerations

Bison feeding operations that utilize field-lots should consume less electricity per month than an equivalent sized cattle operation. By using the information presented in Figure 8, the producer should be able to begin to estimate the monthly electrical consumption of the feedlot operation.

It is important to note that in Saskatchewan only SaskPower can install three-phase power at a cost that will be project specific per individual application (Note: current projections target installation costs at $20,000 to $25,000 per mile).

Figure 8. Calculating Electrical Consumption

SaskPower agricultural electrical rates, 1998 (net rates not including taxes or surcharges)		
Basic monthly charge:		$15.99
Monthly reconstruction charge:		$4.95
Demand charge:	First 50kV.A/mo	$0
	Balance ($/kV.A)	$3.57
Energy charge:	First 10,000 kW.hr. /mo.	6.47¢
	Balance (¢/kW.hr.)	4.76¢
Calculating cost of kilowatt (kW) usage		
Cost = kilowatts (kW) × hours used (hr) × cost (kW/hr)		
Useful estimates of kilowatt (kW) usage		
Electric motors: 40 hp	30 kW	
60 hp	45 kW	
250 watt yardlight	0.25 kW	
1500 watt water heater	1.5 kW	
Office - 100 square feet (avg. 6 watts/square foot)	0.6 kW	

6.2.5. Waste management

Waste management must be properly addressed by all agricultural enterprises. The public is becoming more educated and sensitive to environmental issues including waste management. The consumer is already starting to make purchasing choices based upon production practices of animals. This global trend will directly impact the producer, through the adoption and enforcement of more strict regulations if this sensitive issue is not handled properly.

The Agriculture Operations Act, (1995,) provides a legislative framework that balances environmental and social responsibilities with the realities of agricultural production. The main provisions of the Act involve nuisance and intensive livestock and include protection for farmers from unwarranted nuisance lawsuits, a mechanism for resolving nuisance disputes between agricultural producers and their immediate neighbours and protection of ground and surface water by proper management of manure and animal waste.

6.3. Approvals

The Agricultural Operations Act, (1995,) requires that certain classes of intensive livestock operations obtain approval of manure management plans prior to the erection, construction or alteration of facilities. In addition to traditional livestock species, the Act also includes elk, mule deer, white-tailed deer, fallow deer and bison. Approval is required for any intensive livestock operation that:

- contains an earthen manure storage area,
- involves the rearing, confining or feeding of 300 or more animal units, or
- confines more than 20 animal units for more than 10 days in any 30-day period, and is within 300 metres of a domestic water well not controlled by the operator. (It is assumed that one animal unit equals one adult bison cow, bull or four calves.

The Act works in conjunction with other planning, environmental and health laws, as well as municipal bylaws. It does not supersede or negate the need for any other approvals. This means that you may need to obtain additional approval from your local Rural Municipal office. Check also with the Saskatchewan Watershed Authority if a water use licence is required.

Since the approval review process involves other agencies, approximately 50 days are required to complete the project review and to provide a decision.

For further information about the Act and guidelines for establishing and managing livestock operations, contact the Saskatchewan Ministry of Agriculture's Livestock Branch
at (306) 787-2150.

6.4. Economies of scale

Small feedlot operations may find hand or cart feeding adequate and effective. Close animal observation and control of feeding may prove invaluable for a small-scale operation.

Larger operations tend to utilize processed feeds, which may offer the added benefit of improved feed utilization. Although processing takes more time and power, the producer may gain additional economic benefits by purchasing bulk feed.

Although economies of scale can be realized by larger feeding operations, it may not be currently practical to develop such a facility. The bison industry is still expanding and stocking a large facility may be difficult and costly. Even a modest sized operation may experience difficulties if stocking primarily from its own breeding herd. Custom feeding arrangements may need to be investigated, as well as partnerships and cooperatives in order to stock a feeding facility.

6.5. Loan Guarantee Program

Saskatchewan Agriculture's Livestock Loan Guarantee Program does have a Bison Feeder and Breeder Option, as well as a Feedlot Construction Option that includes bison. Under the program, a Provincial Government guarantee is provided to lenders that extend loans to Producer Feeder Association (a group of producers) on behalf of the Association's members or to individual construction or expanding a feedlot. For further information contact the Financial Programs Branch at (306) 787-5275

6.6. Factors Affecting Gain

Figure 9. Summary of Factors That Affect Average Daily Gain

A summary of factors or practices reported to affect the finishing performance of bison in feedlots is presented in Table 2. Information presented in this table was derived from a review of current studies.

Activity or Factor	Effect on ADG
De-horning early (a long time before entering the feedlot)	Positive
Uniformity of animals within pen (with respect to both age, size and gender)	Positive
Warm-up period on feedlot diet (several weeks is sometimes needed)	Positive
Younger animals grouped together into pens early (early establishment of pens)	Positive
Remove the whole pen of animals for shipping (it is difficult to get efficient gains on those that are kept back)	Positive
Method of delivering concentrate (self feeder vs. bunk feeding)	No effect
Extra handling of animals	Negative
Small source group (when herded into new group) (minimum of four animals)	Negative
Mixing established groups of animals	Negative
Winter season feeding (although this is most common practice!)	Negative
Over crowding of animals in pens	Negative
Small number of animals in a pen	Negative
Muddy conditions in feedlot pens	Negative

(Source – Summary compiled from various studies.)

6.7. Feedlot practices

Production costing is a requirement in today's atmosphere of slim profit margins, especially with the high initial cost of animals. Reducing the cost of production and alternate practices should be explored without sacrificing animal welfare.

6.8. Code of Practice

There is growing public concern about humane husbandry and production practices. Increasingly, consumers are consciously selecting products that have a high level of quality assurance. In recognition of these concerns, the Canadian Bison Association (CBA) and the National farm Animal Care Council has a Code of Practice that can be resourced titled *Code of Practice for the Care and Handling of Bison*. This code is voluntary and intended to promote the highest standards of animal husbandry and handling. The recommendations of the code do not claim to be comprehensive, but cover a wide scope of production and husbandry issues. It is recommended that all bison producers obtain a copy of the code from the Canadian Bison Association or http://www.nfacc.ca/codes-of-practice/bison

6.9. HACCP

When developing quality control standards, the bison industry should be aware of quality control programs being developed for beef and other agricultural practices. Of note is the federal government's Hazard Analysis Critical Control Points (HACCP) program. The Canadian Bison Association (CBA) currently has a committee working with federal representatives to develop a bison related HACCP program.

7. Meat Grading System

In order to assure consistent quality products are available to the consumer, the bison carcasses are evaluated by a grading system. This third-party evaluation communicates the relative product quality and consistency level to both the producer and consumer.

7.1 Canadian system

The Canadian system is an internationally recognized system. The inspecting and grading system is universally applied by the federal Canadian Food Inspection Agency (CFIA). There are nine grades of bison carcasses with the following grade names: Canada A1, Canada A2, Canada A3, Canada A4, Canada B1, Canada B2, Canada B3, Canada D1, Canada D2 and Canada D3. The grades are determined by evaluating the carcass on the following criteria: muscling, fat colour, muscle colour, fat cover (thickness) and maturity (age and bone development).

It is important to note that carcasses are not automatically graded lower due to age of the animal. It is possible for younger animals to be graded lower than older animals and vice- versa. Bison mature slowly and production practices can greatly affect the quality of the carcass.

8. References

Alberta Agriculture, Food and Rural Development and Feeder Associations of Alberta, 1996. *Alberta Feedlot Management Guide*.

Anderson, V., Metzger, S. and D. Sexhus. 1997. *Commercial Bison Production in the Northern Plains*. NDSU, Carrington Research Extension Centre Livestock Field Day Proceedings, Vol. 20:34-38.

Beef Backgrounding Facilities, Saskatchewan Agriculture, 1996. FarmFacts LDB0396R

Beef Cattle Feeding Systems, Saskatchewan Agriculture, 1995. FarmFacts EXB0195

Beef Cattle Housing and Feedlot Facilities, Saskatchewan Agriculture, 1995. FarmFacts OAB1195

Bison Production: Economic and Production Information for Saskatchewan Producers, Saskatchewan Agriculture, 1998. FMB398

Curran, J. & M. Feist. 1998. *Bison Feedlot Do's and Don'ts*. (unpublished personal observations)

Guidelines for Establishing and Managing Livestock Operations, Saskatchewan Agriculture 1997. LOG0797R

McHugh, T. 1958. Social Behavior of the American Buffalo (Bison bison bison), Zoologica: New York Zoological Society, 43:1, p. 1-40

Miller, B. and V. Anderson. 1996. Effects of season and diet, including costs, on feedlot performance of bison. NDSU, Carrington Research Extension Center Livestock Field Day Proceedings, Vol. 19:16-20.

Miller, B. and V. Anderson. 1996. *Comparison of energy level, corn type, and corn processing for bison bulls in feedlot during four seasons of the year*. NDSU, Carrington Research Extension Center Livestock Field Day Proceedings, Vol. 19:21-24.

Miller, B. and V. Anderson. 1997. *Effect of feed delivery systems on the performance of bison in the feedlot*. NDSU, Carrington Research Extension Center Livestock Field Day Proceedings, Vol. 20:39-42.

Rutley, B.D. 1992a. *Average daily gains of feedlot finished plains bison*. Centre for Agricultural Diversification Bison Bulletin, BB92.3. June 1992.

Rutley, B.D. 1995. *Reproductive function of bison (Bison bison) females*. Report to the Peace Country Bison Association, November 1995.

Rutley, B.D., C.M. Jahn and R.J. Hudson. 1997. *Management, gain and productivity of Peace Country bison* (Bison bison), Canadian Journal of Animal Science, 77, p.347-353

Rutley, B.D. and J.S. Church. 1995a. *Effect of time of year on average daily gain of feedlot finished bison (Bison bison)*. Report to the Peace Country Bison Association, November 1995.

Rutley, B.D. and J.S. Church. 1995b. *Feed-weigh station as a method of grain finishing bison (Bison bison) bulls.* Report to the Peace Country Bison Association, November 1995.

Stanton, T.L., D. Schutz, W. McFarlane, R. Seedig and D. Stewart. 1995. *A Study of Bison Finishing Rations at Four Energy of Concentrate Levels. Bison World*, January/February 1995, p. 20

Yaremcio, B. 2009. *Determining the nutritional and economic impact of feed waste when wintering beef cows in central Alberta*. Edmonton, Alberta (M.Sc. thesis). University of Alberta. 197 pp.

9. Selected Reading

Anderson, V.L. and Miller, B. 2000. *Practical lessons in feeding bison bulls for meat*. North Dakota State University, North Dakota Agricultural Experiment Station. pp 1-16 in Bison Research Report. July 2000, Volume 1.

Anderson, V., Burr, D. and T. Schroeder. Protein Requirements of Bison Bulls fed for Meat NDSU, Carrington Research Extension Center https://www.ag.ndsu.edu/archive/carringt/bison/Protein.htm

Christopherson, R. J. and Hudson, R. J. 1978. *Effects of temperature and wind on cattle and bison*. Feeder's Day Report. 57: 40-41.

Christopherson, R. J., Hudson, R. J. and Christophersen, M. K. 1979. *Seasonal energy expenditures and thermoregulatory responses of bison and cattle.* Can. J. Anim. Sci. 59: 611-617.

Christopherson, R. J., Hudson, R. J. and Richmond, R. J. 1978. *Comparative winter bioenergetics of American bison, yak, Scottish highland and Hereford calves*. Acta Theriologica. 23: 49-54.

Church, D. C. 1988. *The ruminant animal. Digestive physiology and nutrition*. Waveland Press, Inc. Prospect Heights, Illinois.

DelGuidice, G. D., Singer, F. J., Seal, U. S. and Bowser, G. 1994. *Physiological responses of Yellowstone bison to winter nutritional deprivation.* J. Wildl. Manage. 58: 24-34.

Ensminger, M.E., Oldfield, J. E. and Heinemann, W.W. 1990. *Feeds and Nutrition*. 2nd Edition. Ensminger Publishing Company. Clovis, California. 93612.

Feist, M.F. 1998. *Evaluation and development of specialized livestock diets in Saskatchewan*. Saskatoon, Saskatchewan (M.Sc. thesis). University of Saskatchewan. 154 pp.

Grazing and Pasture Technology Program (GAPT), 1998. Bison Pastures and Grazing Management.

Green, W. C. H. and Rothstein, A. 1991. Trade-offs between growth and reproduction in female bison. Oecologia. 86: 521-527.

Hawley, A. W. L., Peden, D. G. and Stricklin, W. R. 1981a. *Bison and Hereford steer digestion of sedge hay*. Can. J. Anim. Sci. 61: 165-174.

Hawley, A. W. L., Peden, D. G., Reynolds, H. W. and Keith, E. 1977. *Nylon bag digestibility's of five native plants in bison and cattle*. Can. J. Anim. Sci. 57: 825.

Hawley, A. W. L., Peden, D. G., Reynolds, H. W. and Stricklin, W. R. 1981b. *Bison and cattle digestion of forages from the Slave River Lowlands, Northwest Territories, Canada*. J. Range Manage. 34: 126-130.

Hofmann, R. 1988. Anatomy of the gastro-intestinal tract. Pages 14-43 in *The ruminant animal: digestive physiology and nutrition*. Church, D. C. ed. Waveland Press Inc. Prospect Heights, Illinois.

Hudson, R. J. and Frank, S. 1987. *Foraging ecology of bison in aspen boreal habitats*. J. Range Manage. 40: 71-75.

Hudson, R. J., Watkins, W. G. and Pauls, R. W. 1985. *Seasonal bioenergetics of wapiti in western Canada*. Pages 447-452 *in* P. F. Fennessy and K. R. Drew, eds. Biology of deer production. R. Soc. N.Z. Bull. Vol. 22.

Keith, E. O., Ellis, J. E., Phillips, R. W., Dyer, M. I. and Ward, G. M. 1981. *Some aspects of urea metabolism in North American bison*. Acta Theriologica. 26: 257-268.

Koch, R. M., Jung, H. G., Crouse, J. D., Varel, V. H. and Cundiff, L. V. 1995. *Growth, digestive capability, carcass, and meat characteristics of Bison bison, Bos taurus, and Bos x Bison.* J. Animal Science 73: 1271-1281.

MacNeil, J. D., Patterson, J. R., Salisbury, C. D. C. and Tessaro, S. V. 1990. *An investigation of the trace element status of bison in Wood Buffalo National Park and of ranch-raised bison in Saskatchewan, Canada*. Intern. J. Environ. Anal. Cham. 41: 99-104.

McKinnon, J.J. 1993. Backgrounding*: An option for Saskatchewan Calves?* Parts 1-3. Saskatchewan Beef Industry Chair, Department of Animal Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

National Research Council, 1984. Nutrient Requirements of Beef Cattle., Sixth Re. Ed. National Academy Press. Washington, D.C.

National Research Council, 1996. *Nutrient Requirements of Beef Cattle*., Seventh Re. Ed. National Academy Press. Washington, D.C.

Peden, D.G., Van Dyne, G. M., Rice, R. W. and Hanse, R. M. 1974. *The trophic ecology of Bison bison L. on the shortgrass plains*. J. Appl. Ecology. 489-497.

Richmond, R. J., Hudson, R. J. and Christopherson, R. J. 1977. Comparison of forage intake and digestibility by American bison, yak and cattle. Acta Theriologica. 22: 225-230.

Robbins, C. T. 1983. *Wildlife feeding and nutrition*. Acad. Press, Inc., New York, N.Y. 343 pp.

Rutley, B. D. 1998 . *Management, growth and performance of bison (Bison bison) on seasonal pastures (PhD dissertation)*. Edmonton, Alberta: University of Alberta. 155 p.

Rutley, B. D. and Rajamahendran, R. 1995. *Circannual reproductive function of female bison (Bison bison).* Pages 242-245 *in* Proc. West. Sect. Amer. Soc. Anim. Sci.

Rutley, B. D. 1992. *Average daily gains of feedlot finished plains bison*. January 1992. bison Evaluation Unit - Bison Bulletin, BB 92.1.

Saskatchewan Agriculture, 1998. *Bison feedlot; Economic and production information*. ISBN: 0-88656-700-9

Saskatchewan Feed Testing Laboratory, 1996. Saskatoon, Saskatchewan. University of Saskatchewan.

Schaefer, A. L., Young, B. A. and Chimwano, A. M. 1978. Ration digestion and retention times of digest in domestic cattle (*Bos taurus*), American bison (*Bison bison*) and Tibetan yak (*Bos grunniens*). Can. J. Zool. 56: 2355-2358.

Shaw, J. H. and Carter, T. S. 1989. *Calving patterns among American bison*. J. Wildl. Manage. 53: 896-898.

Sikarskie, J. G., Schillhorn Van Veen, T., Ullrey, D. E. and Koch, M. D. 1989. *Comparative serum selenium values for ranched and free-ranging American bison (Bison bison).* J. Zoo. Wildl. Med. 20: 34-38.

Stanton, T. L., Schutz, D., McFarlane, W., Seedig, R. and Stewart, D. 1995. *Effects of concentrate level in bison finishing rations on feed yard performance*. Colorado State University. Ft. Collins, Colorado.

Stelfox, J. B. and Stelfox, J. G. 1993. *Hooved mammals of Alberta*. Stelfox, J.B. ed. Lone Pine Publishing. Edmonton, Canada.

Western Canada Feedlot Management School Manual, 1997. University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Young, B. A., Schaefer, A. and Chimwano, A. 1977. *Digestive capacities of cattle, bison and yak*. Annual Feeders Day Report. 56: 31-34.

10. Information Sources

- Saskatchewan Ministry of Agriculture website: www.saskatchewan.ca/agriculture

- Agriculture Knowledge Centre 1-866-457-2377

- Livestock Branch
    - Room 202 - 3085 Albert Street
    - Regina, SK S4S 0B1
    - Phone: 306-787-4678

- Agricultural Operations Branch
    - Room 202 – 3085 Albert Street
    - Regina, SK S4S 0B1
    - Phone: 306-787-4680

- Program Design & Delivery Branch
    - Livestock Loan Guarantee Program
    - Room 329 – 3085 Albert Street
    - Regina, SK S4S 0B1
    - Phone: 306-787-4325

- Regional Services Branch – Regional Offices:
    - Kindersley: 306-463-5513
    - North Battleford: 306-446-7962
    - Outlook: 306-867-5575
    - Prince Albert: 306-953-2363
    - Swift Current: 306-778-8285
    - Tisdale: 306-878-8842
    - Watrous: 306-946-3320
    - Weyburn: 306-848-2857
    - Yorkton: 306-786-1531
    - Moose Jaw: 306-694-3619

Saskatchewan Bison Association. PO Box 31, Regina, SK S4P 2Z5 Phone: 306-585-6304

Canadian Bison Association.
Suite 200 - 1660 Pasqua Street,
PO Box 3116 Regina, SK S4P 3G7 Phone: 306-522-4766
Internet: http://www.canadianbison.ca

National Bison Association.
8690 Wolff Ct, #200,
Westminster, CO 80031
Phone: (303) 292-2833
Internet: http://www.bisoncentral.com/