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SUSTAINABLE MANAGEMENT OF NUTRIENTS ON THE LANDSCAPE FOR IN-FIELD LIVESTOCK WINTER FEEDING SYSTEMS

Canada

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INTRODUCTION

An increasing number of producers are feeding or grazing their livestock in a field setting rather than a confined corral during the winter season. In-field winter feeding systems include swath and bale grazing, and grazing standing corn, stockpiled perennial forages and annual crop residues. Mobile electric fencing, winterized watering systems, snow as a water source, portable windbreaks and calf shelters, and later calving periods help to maintain livestock health and productivity while utilizing these feeding systems.

Lower costs associated with reduced manure and feed handling is a primary reason for increased in-field livestock winter feeding. Other potential benefits include improved soil fertility and increased plant growth. However, in field feeding also involves risk of negative impacts, such as loss of nutrients by surface water runoff. Maximizing benefits and minimizing negative impacts related to nutrients can be challenging because achieving these outcomes requires a cost investment involving both additional infrastructure and ongoing management. At the same time uncontrollable factors such as harsh and variable weather can increase management costs. While this publication focuses primarily on sustainable management of nutrients on the landscape, producers should consider all aspects of their in-field winter feeding system before making any changes.

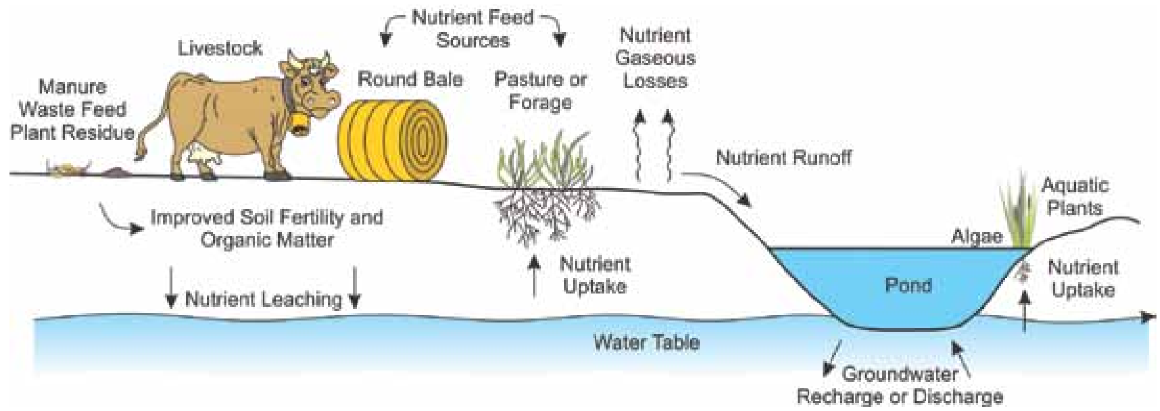
Livestock swath grazing

NUTRIENT ISSUES RELATED TO LIVESTOCK FEEDING SYSTEMS

For both confined and in-field livestock feeding systems, nutrients, such as nitrogen and phosphorus, are applied or deposited on the soil surface as part of manure and waste feed. Over time these materials enter and mix with the soil profile, helping to build good soil structure and fertility, and contributing to improved plant growth and yield. There is also a benefit in increasing soil organic matter and thereby reducing greenhouse gas emissions.

Livestock bale grazing

SIMPLE NUTRIENT CYCLE FOR IN-FIELD LIVESTOCK SYSTEM



Nutrients on the soil surface or within the soil profile are also at risk to being lost through various processes, including:

- transport via surface runoff, generated from snowmelt or rainfall, into surface water bodies. Nutrients in runoff occur in two forms: dissolved in water or bound to sediment particles. The latter form only occurs when runoff is also causing soil erosion.
- transport via leaching below the root zone, and potentially into groundwater aquifers
- gaseous losses of nitrogen (eg. ammonia volatilization and nitrous oxide emissions)

Nutrient losses not only reduce amounts available in the soil for plant growth, but may contribute to offsite environmental impacts. For example,

- increased phosphorus contributes to increased growth of harmful blue green algae in surface waters
- increased nitrates in drinking water poses health risks to human infants, as well as young or pregnant livestock
- nitrous oxide is a greenhouse gas which contributes to climate change, and
- ammonia gas can contribute to reduced air quality

CONFINED VERSUS IN-FIELD FEEDING SYSTEMS

With both confined and in-field feeding systems, nutrient losses vary considerably depending on the specific characteristics of the feeding site and how the site is managed.

A properly designed and constructed outdoor confined livestock pen has sufficient slope and external drainage to allow excess rain and snowmelt to flow offsite. This surface runoff is channeled through a waterway that leads to a containment pond. Both the livestock pen and containment pond have an impermeable base which prevents any leaching of nutrients below the surface. If the containment pond is not able to contain all runoff, the effluent can be applied to agricultural land as an irrigation and nutrient source. While this scenario will minimize nutrient losses, there are still significant amounts of gaseous nitrogen losses, in the form of ammonia, from the manure pack in the livestock pen.

For confined systems additional nutrient losses may occur after manure has been removed from the pen and applied to land. These losses can be minimized by optimizing the rate, timing, and placement of application, but this is challenging for a variety of reasons such as:

1. variable nutrient content of manure
2. cost of transporting manure from the pen to land
3. inability of spreaders to apply manure uniformly
4. inability to incorporate manure on perennial forage fields
5. applying manure in late fall or winter may contribute to snowmelt runoff nutrient losses

With in-field feeding systems all manure is deposited directly on the landscape by livestock. The same principles regarding rate, timing and placement of manure and waste feed have a large impact on efficient nutrient management. Some of the same challenges mentioned in the previous paragraph (ie. 1, 4, 5) for confined systems are also true for in-field systems.

Sustainable application of nutrients to the landscape is particularly challenging for in-field systems, since this involves controlling where livestock spend their time. A major factor impacting the amount and distribution of nutrients is the density of feed and livestock per acre. This varies tremendously with each feeding system, as illustrated in Table I. Other factors include the management of shelter, bedding, and watering sites. Despite these extra challenges, in-field feeding systems have a distinct advantage in minimizing ammonia volatilization losses, which results in increased forage and crop productivity compared to land applied manure from confined feeding systems. Nevertheless, one cannot state that in-field feeding is inherently a better system to manage nutrients than confined feeding. Rather sustainable nutrient management is dependant on good site selection and on going practices.

TABLE I: Typical Densities and Nutrient Deposits for Various In-Field Feeding Systems

FEEDING SYSTEM	FEEDING DENSITY per acre	COW DAYS per acre	NITROGEN (lb/acre)	PHOSPHORUS (lb/acre)
Whole Round Bales	25 – 1300 lb bales	844	548	49
Processed or Unrolled Bales	5 – 1300 lb bales	169	110	10
Standing Corn	4.5 tons	200	130	12
Swath Grazing	2.25 tons	100	65	6
Stockpiled Perennial Forages	1.5 tons	67	43	4
Annual Crop Residues	1 ton	45	30	3

Note: All of the above examples assume a 1400 lb cow and feed with 11% protein and 0.15% phosphorus content. Actual densities and nutrient deposits may vary considerably depending on numerous factors.

In field winter feeding of cattle *(Source: Saskatchewan Ministry of Agriculture)*

Confined winter feeding of cattle

IN-FIELD FEEDING SITE SELECTION

An ideal feeding site is one that has good capability for crops or forage to utilize added nutrients, and where the risk of nutrient loss is minimal. It is usually located on:

- mid or upper slope positions of gently sloping or flatter landscapes
- soils with sandy loam to clay loam soil texture
- land with a recent history of low nutrient additions

Conversely, one should avoid locating feeding sites on:

- low lying depressions with high soil fertility or subject to flooding or leaching
- steeply sloping land subject to high surface runoff which exits the property or enters a water body
- riparian zones and land adjacent to runoff channels, waterways, streams, rivers, wetlands, lakes, and other water features, particularly where the site is close to a downstream water user
- sandy soils located above shallow groundwater aquifers
- areas adjacent to natural shelter, where livestock naturally congregate
- soils with severe productivity limitations, which cannot be overcome by nutrient additions. Some examples include high salinity, coarse textured soils, and solonetzic hard pans. If these types of limitations are only moderate, the site may be used but will be less than ideal, since it has reduced capacity to utilize added nutrients

Avoiding locations with the above soil and landscape features will also help to minimize other problems such as:

- soil compaction, pugging (deep hoof prints) and hummocking (soil mounds)
- shoreline degradation and bank erosion
- tree bark damage from livestock rubbing
- harmful pathogens in surface water

There are a number of scenarios where a site has some inherent economic advantage while at the same time may not meet the preferred site characteristics previously discussed or may have limitations for long term use. These scenarios involve fields that are adjacent or close to the following:

- **A previously used confined livestock site**. These sites often have a history of land applied manure with limited nutrient deficiency, but livestock are able to access existing water and shelter infrastructure developed for the confined system. There are also fewer costs in moving livestock from a confined to an in-field system or vice-versa.
- **The farm residence.** Close proximity to the farm residence results in reduced travel costs to manage and monitor the in-field system. However, if the field drains to a farm dugout or other domestic water source there may be increased risk of reduced water quality.
- **Natural shelter and surface water bodies.** The advantage of these sites is lower cost in not having to provide additional infrastructure for water and shelter. Often trees are only found in low lying areas close to water, especially in semi arid regions where moisture is limiting in most other parts of the landscape. The closer proximity to a water body may increase environmental risk since nutrients don't have as far to travel to impact the water. However,

different landscapes have different natural shelter and surface water features, resulting in varying risk. For example, a very vulnerable scenario could be a river or stream with multiple downstream water users. A much less vulnerable scenario could be a field with sloughs or potholes that rarely contribute to groundwater or overflow to runoff leaving the field.

Less than ideal sites may still be acceptable for in-field feeding if one employs one or more of the following practices:

- lower density feeding systems with smaller nutrient additions
- increasing the time lag between repeat feeding on the same site
- export nutrients offsite by growing and removing crops, such as hay or grain, on land that has been recently used for high density winter feeding
- frequently moving shelter, bedding, and watering sites

Cattle winter feeding close to natural shelter and surface water may increase environmental risk

PREVENTING EXCESSIVE NUTRIENT ACCUMULATION

Once a site has been selected, a key ongoing requirement is that manure and waste feed deposits are not excessive. Excessive deposits can occur from a single feeding session or from using the same site too often over a longer period. Even on ideal sites there is a risk of nutrient loss to the environment if the amount deposited exceeds what can be utilized by subsequent crops. Furthermore, heavy manure and waste feed deposits can:

- choke out perennial forage species and lead to proliferation of undesirable weed species on perennial pastures and hayfields
- necessitate extra tillage on annual cropland
- create short term nitrogen deficiencies for subsequent crops due to nitrogen immobilization

Heavy deposits are most common under high density feeding systems such as bale grazing. However, they can also occur under lower density feeding systems where minimal livestock management results in non uniform deposition patterns. Nutrient hot spots can also occur around shelter and watering sites.

Excessive use of in-field feeding site *(Source: Saskatchewan Ministry of Agriculture)*

Proliferation of weeds including foxtail barley on same site as previous photo *(Source: Saskatchewan Ministry of Agriculture)*

MANAGING WASTE FEED AND HEAVY MANURE DEPOSITS

The amount of waste feed varies depending on feed quality, how the feed is provided, and how livestock access to feed is managed. While some waste feed is beneficial for building soil organic matter, for reasons explained in the previous section, the thickness of waste feed and manure should normally not exceed three to four inches.

If the field is not too rough for farm equipment, harrows can be used to spread excessive waste feed and solid manure more uniformly across the landscape. This will also help to reduce nutrient load in the high deposition areas and increase nutrients in gap areas. Some producers have been able to achieve a similar effect with livestock hoof action during subsequent summer grazing at a high stocking density. While high density grazing may be somewhat less effective than harrowing, it is also less costly. Bale feeders and feeding troughs can also help to reduce waste, however, purchasing and regularly moving these feeders is often cost prohibitive and not feasible in harsh winter conditions.

The remainder of this publication focuses on nutrient management for specific in-field feeding systems, shelter, and watering sites.

Excessive feed waste choking out subsequent forage growth

High stocking rate summer grazing helps to spread waste feed and manure through intensive hoof action

Round bales placed for bale grazing *(Source: Saskatchewan Ministry of Agriculture)*

Using electric fence to manage livestock access to bales helps maximize forage utilization and minimize feed waste *(Source: Saskatchewan Ministry of Agriculture)*

Cattle finishing up a bale grazing site *(Source: Saskatchewan Ministry of Agriculture)*

IN-FIELD FEEDING SYSTEMS

HIGH DENSITY WHOLE BALE GRAZING

BALE DENSITY

Grazing whole bales typically involves the highest livestock and feed density, and the largest nutrient load on the landscape, as shown in **Table 1**. When bales are harvested from one field and fed on another, this represents a net removal of nutrient from the harvested field and a net addition of nutrient into the field on which the bales are fed. Even if the bales originate from the same field, there is a nutrient loading impact by moving bales scattered over a large area into a smaller area to facilitate more efficient feeding management. The amount of nutrients added to the landscape can be easily calculated by multiplying the weight of the bales by the bale density and the nitrogen and phosphorus contents of the bale. The latter value can be obtained from a standard feed analysis. An example calculation using the **Table I** density is shown in **Table II**.

For the above example the amount of nutrients taken up as livestock weight gain is about 8.1 and 0.4 lb / acre, or about 1.5 and 0.8 % of the total load of nitrogen and phosphorus, respectively. **Therefore, the vast majority of nutrients added to the site in the form of the bales, simply cycle through the livestock and are deposited on the field in the form of manure or remain as feed waste.**

TABLE II: High Density Bale Grazing Nutrient Loading Example

FEED AND NUTRIENT CHARACTERISTICS AND DENSITY	
Bale Density	25 bales / acre
Distance between bale centers	42 feet
Bale Size	1,300 lb / bale
Feed Biomass Loading: 25 x 1,300 lb round bales	32,500 lb / acre
Nitrogen Load: 11% [1] protein / 6.25 [2] x 32,500	548 lb N / acre
Phosphorus Load: 0.15% [1] x 32,500	49 lb P / acre

LIVESTOCK MANAGEMENT AND DENSITY	
Livestock Size	1400 lb / cow
Daily Net Feed Requirement: 2.5% [3] of body weight x 1400	35 lb / cow
Daily Gross Feed Requirement: based on 10% feed waste	38.5 lb / cow
Cow Days per Acre (32,500 / 38.5)	844

[1] Typical protein and phosphorus content of grass/alfalfa hay as determined from feed analysis.
[2] Nitrogen content = protein / 6.25, as per numerous literature sources.
[3] Source: Alberta Agriculture and Rural Development, Beef Ration Rules of Thumb.

Research at the Western Beef Development Centre (WBDC), near Lanigan,Saskatchewan from 2003 to 2005, revealed that an average of 73 lb / acre of additional nitrogen became available for plant growth in the year after bale grazing compared to a control treatment.This was based on a feeding density of 25 –1300 lb bales per acre. A different treatment of corral manure did not increase available soil nitrogen levels, even though the rate of manure application was twice as high as the bale grazing treatment on a cow days per acre basis. The greater soil nitrogen from bale grazing resulted in a greater forage yield response, which continued for at least two years.

While the distribution of available nitrogen across the field varied considerably depending on where the manure and feed waste was deposited, the average amount of 113 lb/ac is considered appropriate for crop or forage utilization for the black soil zone of the Prairie region. Therefore, this is currently considered a maximum recommended density based on utilization of nutrients by the subsequent crop.

Significant forage growth response from nutrients added by bale grazing

TABLE III: Impact of Feeding System on Soil Nitrogen and Forage Yield at WBDC

TREATMENT	AVAILABLE SOIL NITROGEN (lb / acre)		FORAGE DRY MATTER YIELD (tons / acre)	
	Fall 2003[1]	Spring 2004	2004	2005
Bale Grazing Manure & Feed Waste (Winter 2004)	30.3	113.3	1.48	1.58
Corral Manure Spread on Land (Late Fall 2003) [1]	32.5	40.1	0.93	0.47
Control	36.6	44.3	0.63	0.43

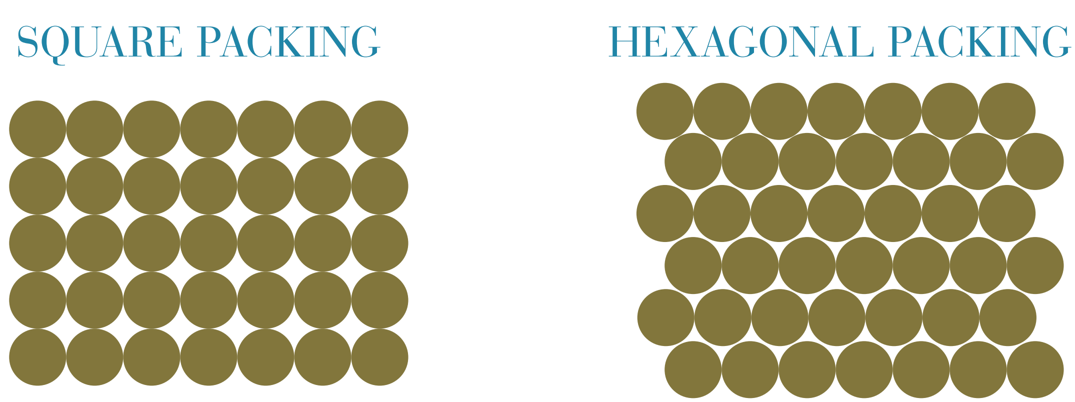
[1] soil sampled prior to any manure additions

Manure and minimal feed waste from uniformly placed round bales at a density of 25 bales/acre *(Source: Saskatchewan Ministry of Agriculture)*

BALE PLACEMENT PATTERN

Research and field observation has shown that most nutrients are deposited in a circle shaped area surrounding each bale. This suggests that most manure and urine is deposited while livestock are feeding. These circles also contain a certain amount of nutrients in the form of waste feed. The exact pattern of nutrient deposition is quite variable, and depends on many factors including fence control. For example, nutrient gaps are greater between adjacent rows of bales fed at different times, than adjacent bales fed at the same time. This is an indication of livestock moving from one bale to another while feeding. Nevertheless, the WBDC study suggested that at 25 bales / ac (ie. 42 feet between bale centers) nutrient deposition from one bale on average just touched deposition from adjacent bales, with minimal overlap. Therefore, this could be considered a recommended density as it strives to minimize both overlap and gaps.

The WBDC study involved placing bales in a square packing pattern, as shown in the diagram below. Assuming most manure and waste feed is deposited within these circles, this results in a maximum of 78% of the land area occupied by circles, leaving a gap area of 22%. The "hexagonal packing" pattern is more efficient in covering 91% of the surface leaving only 9% as gaps. Using the spacing recommended from the WBDC study, the distance between bale centers in each horizontal row is 42 feet for both packing patterns. However, for the hexagonal packing pattern the spacing between adjacent rows is reduced to 36 feet by shifting the bales in successive rows by 21 feet horizontally, and then sliding them six feet closer to the adjacent row. This results in an increase in bale density to 29 bales /acre. To maintain a density of 25 bales per acre for the hexagonal packing pattern, one would have to increase the within row spacing to 45 feet and the spacing between adjacent rows to 39 feet. While it is likely not possible to achieve 91% coverage with minimal overlap, the hexagonal pattern will still be a more efficient method to place bales to strive for this goal.



Square and hexagonal packing patterns of manure and waste feed deposits from high density feeding of whole round bales

TIME INTERVAL BETWEEN BALE GRAZING ON THE SAME SITE

In the previously mentioned WBDC study, about 20% of the total nitrogen load became available for uptake by perennial forage in the first year after bale grazing. While additional nitrogen becomes available in subsequent years, the specific amounts and ultimate fate of the other 80% is uncertain and variable. Even under optimal management and weather conditions, one could expect some nitrogen to be lost to the environment. **A general recommendation is to wait at least five years before considering a repeat bale grazing on the same site.** If the site is used for crop production where nutrients are exported offsite in the form of grain, hay, or silage, then it may be possible to shorten this waiting period.

It is common to have relatively large fields where only a portion is used each year for bale grazing. Under this scenario new areas within the same field can be bale grazed in consecutive years. In order to establish a permanent record of when and where specific areas are bale grazed, it may be necessary to use a global positioning system (GPS) linked to a simple geographic information system (GIS) mapping tool.

MINIMIZING ENVIRONMENTAL RISK FOR HIGH DENSITY FEEDING

High density bale grazing involves higher potential environmental risk than other feeding systems due to the high nutrient loading. There are many factors that may impact this risk including soil and landscape features, proximity to water bodies and aquifers, climate, and management. For example, the specific time that bale grazing takes place likely impacts if manure and waste feed is deposited before or after most of the snowfall occurs. This may have an impact on snowmelt runoff and nutrient movement. These factors are being investigated through a number of research projects. Therefore, current recommendations may change as new information becomes available.

Deposition of manure and feed waste over compacted snow late in the winter season.

In the meantime, it is recommended to target high density bale grazing to highly suitable sites. One should also delay repeat bale grazing as long as it is feasible to utilize sites that have never had bale grazing or other large nutrient loads such as a history of long term manure application.

LOW DENSITY WHOLE BALE GRAZING

Lower density whole bale grazing results in a similar circular pattern of high nutrient load, but the gaps between adjacent circles are greater. One would expect somewhat lower nutrient losses to the environment due to the ability of gap areas to absorb nutrients being transported via water runoff from the high nutrient load areas. However, this has not been confirmed through research. With this feeding system one has the option of placing whole bales in consecutive years within gap areas between previously bale grazed spots.

The lowest density scenario is likely where whole bales are fed in the spot they were dropped by the baler. In this case there are no costs associated with transporting feed. However, fence control will be more expensive due to managing larger areas of land. Producers may still need to move bales short distances within the field to adhere to the guidelines already discussed in the In-Field Feeding Site Selection section (eg. moving bales from low lying areas to mid and upper slope positions). Furthermore, bales that are dropped by the baler within an area that still contains nutrients from a previous bale grazing should be moved into an area not previously impacted.

UNROLLED OR PROCESSED BALE FEEDING

Another feeding option is to unroll bales or use a bale processor to create parallel feed windrows. This enables a producer to achieve a much lower nutrient loading per acre and still maintain a uniform nutrient deposition. This reduces environmental risk and at the same time maximizes nutrient benefits to subsequent crops. Compared to high density feeding of whole bales, this feeding system requires more land in a given year, but allows the same site to be used more often for in-field feeding. However, unrolling bales or using a bale processor involves a significant incremental equipment cost.

The spacing between windrows should ensure that both nutrient deposition gaps and overlap between adjacent windrows are minimized. If two adjacent windrows are being grazed at the same time, the spacing should be wide enough that it doesn't increase feed waste from trampling. Typical spacing between windrow centers should be 30 to 40 feet.

Snowfall cover after an initial feeding may allow for a second feed windrow on the same site in the same winter period. However, in order to maximize the nutrient benefits to the subsequent crop or forage stand, it is normally recommended to spread out the nutrient additions to as much land as possible by not feeding on one site more than once per year. The time interval for revisiting the same site will be considerably less than the five year interval recommended for high density bale grazing, but will depend on the density of feed within the windrow.

Corn Grazing

SWATH GRAZING AND GRAZING STANDING CORN

For practices such as swath grazing or grazing standing annual crops like corn, there is no nutrient loading since all feed is produced on site. Nevertheless, for these moderately dense feeding systems, other issues such as minimizing feed waste, distributing nutrients uniformly, and accounting for nutrients in subsequent crop production are still important.

As described in the previous section for feed windrows, appropriate spacing between swaths is important to minimize feed waste and achieve uniform nutrient deposition. Nutrient gaps can be mitigated somewhat by changing the direction or shifting the position of swaths in successive years.

With these feeding practices fields will have substantially lower nutrient requirements for a subsequent crop than if the crop had been harvested and removed as grain, hay or silage. That's because most nutrients produced on site simply recycle through the livestock back onto the field. It will also be more challenging to assess this nutrient requirement due to variability in manure and feed waste distribution. In many cases these fields can be used in consecutive years for swath grazing and/or grazing corn. However, issues such as increased crop disease arising from growing the same crop year after year should be considered.

Swath Grazing

GRAZING ANNUAL CROP RESIDUES, DORMANT VOLUNTEER GROWTH, AND STOCKPILED PERENNIAL FORAGES

Annual crop residues, dormant volunteer growth, and stockpiled perennial forages represent lower density feeding systems that generally have much lower nutrient impacts. Some local nutrient and waste feed accumulations can occur from larger feed point sources such as straw bales or straw and chaff piles.These accumulations can be managed as previously described in the *Managing Waste Feed and Heavy Manure Deposits* section.

OTHER IMPORTED FEED SOURCES

Other feed sources such as silage, grain, and grain based products (eg. distillers grains, weed screenings, etc.) are often used, particularly as a feed supplement with poorer quality feed to meet livestock ration requirements. These feed sources are normally imported from offsite and involve a nutrient loading onto the landscape.

Therefore, care must be taken to prevent excessive nutrient accumulations in one area. If these feed sources are provided as windrows on the ground the same principles described in the section on unrolled or processed bale feeding should be followed. If the feed is provided in a trough or feed bunk, this should be regularly moved to new areas.

Assessing the impact of grazing annual crop residues in combination with imported feed supplements may be more complex than other feeding systems. For example, one needs to consider both the nutrient removed from the site in the form of grain as well as the nutrients brought onto the field in the form of feed supplement.

ASSESSING SOIL NUTRIENT LEVELS AND REQUIREMENTS

Assessing soil nutrient levels is important to determine fertilizer requirement for annual cropland. In-field feeding systems on annual cropland introduce an extra degree of complexity to this decision compared to land used exclusively for grain production. This is due to the non uniform distribution of manure across the landscape and the varying amounts of manure deposited depending on the density of feeding system. For high density feeding systems like bale grazing, assessing soil nutrient levels is also important to determine when it is acceptable to repeat the practice on the same site, regardless of whether the site is in annual cropland or perennial forage.

There are many useful tools and information sources to help manage soil nutrients sustainably, including:

- keeping a record of nutrient additions from bale grazing, feed supplements, and land applied manure or fertilizer
- keeping a record of yields and nutrient removals from grain, hay, and silage production
- assessing crop or forage growth visually
- managing in-field winter feeding systems to achieve as much as possible a uniform distribution of manure with minimal gaps, without exceeding maximum recommended loading rates
- assessing soil nutrients through a soil test

For annual cropland used for swath grazing, corn grazing, or grazing crop residues, soil testing should be done in the first spring after the in-field winter feeding. Subsequent samples can be taken every two to three years. **For high density bale grazed sites, where no additional nutrients are added for several years after, one only needs to soil test when one is considering another bale grazing treatment or fertilizer addition.** Some key recommendations for soil testing are to:

- increase the number soil cores taken to at least 20 per field in order to account for the increasing variability of nutrient distribution.
- assess gap areas separate from areas that received past manure additions. Unless one is willing to apply variable rate nutrients, one should base a subsequent nutrient addition on areas that received manure deposits.
- exclude feed waste and manure deposits at the soil surface in the soil sample.

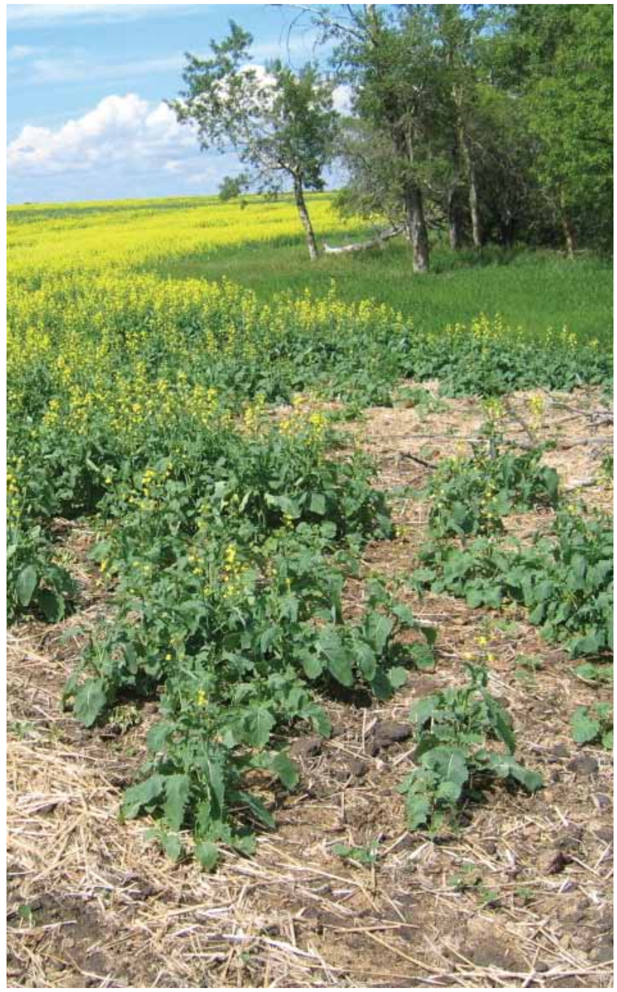
MANAGING OTHER MANURE DEPOSITION HOT SPOTS

In addition to the feeding area, livestock tend to spend considerable time near shelter and watering sites. Without proper siting and management these can become hot spots for manure accumulation and potential environmental risk. The same principles already discussed for feeding sites, also apply to these sites. Since shelter and water often occur naturally in lower parts of the landscape, which are inherently more susceptible to environmental risk, special management is often required to minimize problems.

Ideally, the amount of nutrient accumulation in shelter and watering sites should not exceed what can be used by subsequent crops. For sites that are used every year (eg. swath grazing) this amount will be considerably less than sites used less often for bale grazing. For sites that are used only during high density bale grazing, this accumulation could theoretically be as high as the amount that occurs with the maximum recommended density of bale grazing, as already discussed. If it is not feasible to limit manure or straw accumulation, it may be acceptable to scrape, pile, haul and spread excessive deposits on nearby untreated land. However, this should be done as soon as possible after deposits occur to minimize environmental impacts.

Livestock should be encouraged to spend most of their time in feeding areas, since feed is easier to move than shelter or watering sites. Therefore, one should locate other livestock related activities such as bedding during calm weather, salt blocks, mineral feeders, and oilers near the feeding area, and not near shelter or watering sites. One should also maintain a reasonable separation distance between feeding, shelter, and watering sites.

Following are some specific guidelines for both shelter areas and watering sites.



Excessive use of a natural tree bluff for livestock shelter, resulting in poor crop emergence and growth the following year

SHELTER AREAS

Shelter is a requirement for livestock survival and health. It is often challenging, during the harshness of winter, to limit or control the amount of time livestock spend in a sheltered area, without compromising their health. The amount of time livestock use a sheltered area during the winter depends on weather conditions, particularly wind chill, and accessibility of the sheltered area. There are numerous sources of shelter, including natural tree bluffs, planted shelterbelts, low lying depressions, and even permanent constructed wind breaks. A common feature of these shelters is that they are fixed and therefore can become a nutrient hot spot if used for a long period.

Portable windbreaks mounted on skids for easy movement

However, a field that has numerous tree bluffs scattered in various parts of the field enables the producer to strategically have livestock use different natural shelters over the same winter period by providing feed in different parts of the field.

Portable windbreaks, including calf shelters, have become a useful option where available fixed shelter is limited. **When mounted on skids or wheels these portable units can be easily moved on a regular basis throughout the feeding season, thereby preventing excessive nutrient deposits in one area.** Moving windbreaks may be challenging in deep snow, but this problem can be minimized by placing them in mid and upper slope positions where snow accumulation is less. This may also reduce the risk of nutrients impacting water quality, as these slope positions are farther removed from surface water bodies.

Using minimal or no straw bedding will help ensure these areas are only used during harsh weather. In some cases fence control may be required to prevent livestock from using a specific natural shelter, while at the same time providing access to another more suitable shelter. There may be other benefits to limit livestock access to natural shelters, for example, to prevent tree damage and maintain wildlife habitat and biodiversity.

Portable windbreaks provide effective shelter

Use of bedding near natural shelter and surface water encourages over use and increases environmental risk

WATERING SITES

For watering sites, the separation distance from the feeding site can be substantially further than shelter, since livestock do not need to water more than twice a day. As a result, fewer watering sites are required than shelter areas.

Watering sites that utilize surface water bodies are particularly susceptible to water quality deterioration from excessive nutrient accumulation. **A remote watering system is an important first step in ensuring that livestock do not water directly from a surface water body.** However, it may be necessary to pipe or transport water a certain distance away from surface water body to minimize the risk of accumulated nutrients being transported to the water body via snowmelt runoff.

In higher snowfall areas livestock can be trained to eat snow, thereby further reducing the need for specific watering facilities. However, snow conditions should be closely monitored to ensure livestock are obtaining adequate water from this source.

Winterized watering site located in exposed upland location minimizes loitering