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Alternative Feeds for Ruminants

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General Concepts and Recommendations for Using Alternative Feeds

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Many feedstuffs are available to North Dakota livestock producers, including crop residues, processing coproducts, new or alternative grains and forages, as well as more traditional grains and forages. This publication is intended to familiarize livestock producers with the variety of feeds available and to provide feeding guidelines for various alternative feeds.

Feeds are listed alphabetically under the broad categories of:

1. Forages
2. Residues and fibrous coproducts
3. Weeds
4. Roots, tubers and associated coproducts
5. Grains, screenings and grain processing coproducts
6. Oilseeds and protein meals
7. Liquid coproducts

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General Concepts and Recommendations for Using Alternative Feeds

Many of the alternative feeds vary widely in nutrient content, making an analysis or some assessment of the feed value necessary. Producers must know the energy, protein and major mineral levels of these feeds to develop balanced, least-cost diets for livestock. With alternative feeds, wet chemistry analysis to determine nutrient content is strongly recommended, not near infrared spectroscopy (NIRS). New and alternative feeds require extensive calibration for proper NIRS estimation of nutrient content. Whatever feed products are used, the ration must be balanced to meet livestock needs and producer goals, which should include economical production.

Harvesting and Use of Residues

Grazing is one of the easiest ways to harvest crop aftermath. Grazing crop residues allows animals to select a higher-quality diet than would otherwise be obtained by harvesting and refeeding. This is an important consideration when developing diets based on crop residues.

Stocker cattle may have acceptable gains if they are allowed to selectively graze residues. When the grain and high-quality residue have been consumed, younger cattle should be removed from the field. Depending on the number of animals and the acreage, stocker cattle can feed on residues for about 30 to 40 days. Mud and snow can reduce access to forage, animal selectivity and forage availability. Water supply and lack of fencing are limitations that must be addressed prior to grazing crop residues. Electric fence can provide a low-cost temporary method of fencing large areas of crop aftermath.

Stack wagons and large round or square balers can be used to harvest crop aftermath material, but will increase the cost. Chopping residues adds more expense and is recommended only when crop residues will be included in a total mixed ration (TMR) or as a method to reduce feed waste.

When stacking or baling dry corn residue, wait until the moisture content has dropped below 20 to 25 percent or wait until temperatures have fallen late in the fall to avoid mold in the stored material. Corn stover can be packaged in large round bales; however, a flail harvester or rotary mower should be used to cut stalks prior to baling. Wait 7 to 10 days after combining to minimize spoilage.

Low-quality feeds (straw, corn stover and beet tops) can be fed when cow nutrient requirements are low such as the second trimester of gestation following weaning. Supplemental minerals and vitamin A are usually needed when rations are largely composed of crop aftermath. A number of low-quality forages can be fed to dry cows and replacement heifers, including small grain straw, corn stover, sunflower stover, slough grass and cattails. Feedlot diets can use low levels of residue in growing rations (maximum of 20 to 40 percent of diet) and finishing rations (maximum of 5 percent of diet).

Procuring Alternative Feeds

Increased grain processing in North Dakota has made large quantities of several different coproducts available for livestock producers. Economics dictate if, when and how much coproduct could be included in the ration. Shipping, storage, seasonal price variation, amount available, processing and nutrient variability need to be considered for each coproduct. Contracts or volume purchases may be negotiated at less than spot market prices. For information regarding current prices and contact information for specific suppliers, please refer to this Web site: *www.ag.ndsu.nodak.edu/aginfo/dairy/dairyext/coproduct.pdf* .

Forages and Fibrous Coproducts

Alfalfa Pellets
Alfalfa Regrowth
Bulrush
Canola Forage, Grazed
Canola Forage, Hayed
Canola Forage, Silage
Canola Straw
Cattails
Hollowstem
Lakereed
Millet Hay
Mustard Hay and Silage
Safflower Hay
Slough Hay
Small Grain Hay
Sorghum (Forage)
Sorghum-Sudan, Sudangrass
Soybean Hay
Sunflower Silage

ALFALFA PELLETS

Pelleted or finely ground forages can provide approximately one-half of forage needs for all dairy cattle. Since pelleted forage material is quite fine, another forage source will be needed to maintain fiber adequacy in rations. Five pounds of alfalfa pellets plus free choice straw can meet the nutrient requirements of beef cows in the second trimester of pregnancy. Dehydrated pellets are usually higher in quality than sun-cured pellets.

ALFALFA REGROWTH

Alfalfa regrowth can be grazed without injury to the plant after a killing frost has occurred. It is advisable to fill cattle with dry hay before allowing them access to alfalfa pasture. Alfalfa regrowth can be grazed in conjunction with low-quality aftermath to balance a growing diet. Grazing alfalfa regrowth immediately after a frost can result in potential bloat problems.

BULRUSH

Bulrush has little value for forage purposes.

CANOLA FORAGE, GRAZED

Little information is available regarding canola as a forage crop. Anecdotal evidence indicates that canola regrowth can be grazed following harvest. Goiter is not a problem with canola due to the low glucosinolate content. Canola is a close relative of rapeseed, which can cause bloat in some instances. Animals should be introduced to canola or rapeseed forage gradually. Canadian reports indicate that forage rapeseed is similar to alfalfa in nutrient content.

CANOLA FORAGE, HAYED

Winter canola's abundant fall and early spring growth makes excellent forage during these periods. Livestock should be adjusted to canola forage by mixing the feed rations over a 7- to 10-day period by blending with other forages to help prevent bloating.

In the spring, haying of winter canola should occur before it flowers (similar to alfalfa). Harvesting as silage has some advantages. Canola hay is difficult to put up due to the high moisture content of the forage. Experiments in Idaho and Montana have had recorded yields of 2 to13 tons per acre. This wide variation in yield may be due to differences in varieties, growing conditions and rainfall.

CANOLA FORAGE, SILAGE

Canola can also be harvested as a silage crop in emergency situations. However, the crop is difficult to dry, with moisture levels commonly averaging 75 to 80 percent. Consequently, seepage and effluent losses from the silage can be large. Allowing the crop to dry in the swath is usually necessary prior to ensiling. Other options can include adding dry feeds (hay, grain or straws) to the silage pile to reduce effluent (seepage) losses.

CANOLA STRAW

Canola straw is of little or no feeding value. It contains 3.5 percent protein and only 20 percent TDN.

CATTAILS

Cattails have little feed value but can be fed in an emergency. Cattails cut at a relatively young age may be equivalent to straw in feeding value. Mature cattails are a poor feedstuff, having energy values similar to or lower than straw.

HOLLOWSTEM

Hollowstem is used quite regularly and extensively as a coarse hay but is of less value than upland hay. Cut at flowering time or as soon as the area is dry enough.

LAKEREED

Lakereed can be used to supplement other hay or forage. It is rather unpalatable for livestock and can be somewhat laxative. Sometimes two cuttings are possible if the first crop is cut early. Cut before heading, if possible, to increase nutrient content.

MILLET HAY

Foxtail and proso millets are annual forages that produce respectable hay yields (2 to 4 tons per acre at various research centers in North Dakota), even when planted relatively late in the season. Nutritional quality is related to maturity, as with most other forages. Optimum harvest time is when seeds are in the milk to soft dough stage. Millet hay may sometimes cause scouring. Avoid feeding it to horses, as it can cause lameness and affect kidney function. Hairy and waxy varieties of millet can be difficult to cure as hay.

MUSTARD HAY and SILAGE

Mustard (brown, yellow and Oriental) can be used as a hay crop. Mustard hay typically averages 50 to 55 percent TDN and 10 to 12 percent CP. However, nutrient content can vary so a nutrient analysis is recommended. The crop should be cut from the early podding stage just after the flowers have dropped to the point where the lower leaves are starting to drop. Mustard can be difficult to bale at proper moisture levels. Crimping will ensure more uniform drying. Mustard can also be put up as silage. High moisture levels (75 to 80 percent) and difficulty drying mustard have been reported. Some producers have blended small grain and mustard together in the silage pile with good results. A silage innoculant may also be beneficial since mustard is low in soluble carbohydrate.

Mustard hay or silage should be limited to 60 percent or less of the diet dry matter. Scouring and hemolytic anemia have been reported when higher levels have been fed. In addition, producers should provide a trace mineral high in copper and selenium, since long-term feeding of mustard hays has been associated with inhibited absorption of these minerals. Mustard can also accumulate nitrate, so nitrate poisoning may be a potential problem.

SAFFLOWER HAY

Research conducted in Montana and Alberta indicates that safflower crops damaged by frost may be cut for hay. Naturally, the thorny nature of the plant causes concern, but in feeding trials conducted with ewes in Alberta, no aversions to the forage were noted and intakes were similar to a conventional alfalfa hay-based diet.

SLOUGH HAY

Slough hay is usually higher in nutritive value than cereal straw and may approach brome hay in quality. However, slough hay is more variable in quality. Slough hay harvested after a killing frost will have a nutritive value similar to straw.

SMALL GRAIN HAY

Wheat, oats, barley, triticale and rye hay can be used in beef, sheep and dairy rations. Harvesting should occur between heading and soft dough stages. Rye hay loses palatability and protein content rapidly after flowering. The nutritive value of these hays should be similar to brome hay when cut at heading to soft dough stage. Energy per acre is maximized by delaying harvest until the soft dough stage. However, protein content is maximized by harvest at late boot to early heading.

All these feeds should be checked for nitrate content if drought stressed and/or fertilized heavily with nitrogen. For more information on nitrate poisoning, please see NDSU Extension publication, ***V-839 Nitrate Poisoning of Livestock***.

SORGHUM (FORAGE), SORGHUMSUDAN and SUDANGRASS

Several commercial seed companies offer these warm season forages. Forage sorghum and sorghum-sudan yield well and are usually ensiled, as stems are thick and cure slowly when windrowed. Nutritional value varies greatly with maturity. Late-harvested sorghum and sorghum-sudan are similar in composition to corn stover. Vegetative sorghum-sudan and sudangrass are good protein and energy sources. Sudangrass hay cut in the vegetative state has nutritional values similar to good-quality grass hay. Prussic acid and nitrate poisoning are potential problems. Haying the crop will reduce prussic acid problems, and ensiling the crop will reduce prussic acid and nitrate risks.

Generally, when the green plant is hit with a killing frost it is advisable to remove grazing cattle until the plant has dried, during which time the prussic acid in the plant volatilizes. Dried plants normally contain very little prussic acid, but monitor cattle closely the first few days after turning them back into the field. The problem develops when the plant is not completely killed by the frost. If the weather turns warm and the plants start to regrow, pull the cattle out until another killing frost dries the plants. Prussic acid (cyanide) poisoning is very rapid and clinical signs last only minutes before the animal dies. Signs of poisoning are nervousness, abnormal breathing, generalized muscle tremors, gasping for breath and convulsions. Distinguishing characteristics are bright and cherry red color of the blood. There is no known treatment. See NDSU Extension Service publication ***V-1150 Prussic Acid Poisoning***, for more information.

SOYBEAN HAY

Soybeans can be harvested as a hay crop. Crude protein content can be similar to alfalfa or clover, with moderate TDN. In some areas of the U.S., soybean hay is used as a substitute for alfalfa or sweet clover. When allowed free access to soybean hay, cattle will generally not eat the stems, since they are quite coarse. Chopping or tub grinding can be used as a way to improve consumption. Soybean hay stems are quite low in energy and protein. When stored in round bales, water penetration and spoilage is more of a problem than with grass hay because of the coarse stems. Hay quality does not change drastically with increasing maturity, since more mature soybean hays have a higher proportion of the bale weight as whole soybeans. High levels of soybean seeds in the hay can cause digestive problems due to the high fat content. Soybeans can also accumulate nitrate.

SUNFLOWER SILAGE

Sunflower silage is 80 to 85 percent as valuable as corn silage under normal conditions. Intake may be a problem, especially with high oil varieties. Use of another forage along with sunflower silage is advisable for lactating cow rations. Dry cows and heifers may be fed sunflower silage as their only source of forage. Damaged sunflowers can be most easily ensiled by chopping and incorporating into other forage(s) being ensiled at the same time, such as corn, small grains or sorghum-sudans. Moisture levels are generally too high when sunflowers are ensiled alone, so ensiling with dry

forages or other feeds to prevent excessive nutrient loss is recommended. Waiting until after one or two killing frosts or incorporating ground dry roughage are methods to get ensiling moisture down to 70 percent or less.

Straws, Residues and Fibrous Coproducts

Ammoniated Straw
Buckwheat Hay
Buckwheat Hulls
Buckwheat Straw
Cereal Straw
Chaff, Small Grain
Chaff, Ammoniated
Chickpea Stubble
Chickpea Straw
Corn Cobs
Corn Residue, Grazed
Corn Stover
Dry Edible Bean Residue
Field Pea Straw
Grain Sorghum (Milo) Stover
Lentil Straw
Millet Straw
Oat Hulls
Soybean Stubble or Residue
Soybean Stover
Sunflower Residue
Sunflower Hulls

AMMONIATED STRAW

Straw is sometimes ammoniated to improve the feeding value by increasing protein content and fiber digestibility. When limited amounts of hay or other roughages are available, ammoniation may be a cost-effective way to increase the value of straw. Ammoniated feeds should be analyzed prior to feeding to determine actual nutrient content. Energy supplementation may still be necessary after ammoniation, depending on the nutrient requirements of each particular set of livestock. Ammoniated straw has a feeding value similar to average-quality grass hay. Refer to this Web site for more information regarding ammoniation: *www.ag.ndsu.nodak.edu/drought/ds-9-97.htm* .

BUCKWHEAT HAY

In emergency situations, buckwheat can be used as a forage crop. For optimum forage quality, buckwheat should be harvested prior to maturity. Mature buckwheat is relatively low in crude protein and digestibility. Anecdotal reports indicate that buckwheat hay is palatable.

BUCKWHEAT HULLS

Buckwheat hulls have very little feeding value. They are high in fiber, low in protein, and essentially indigestible.

BUCKWHEAT STRAW

Buckwheat straw can be used as part of the diet. Reports indicate that buckwheat straw is quite palatable. If the straw is used as a bedding source, cattle tend to consume buckwheat straw due to its palatability. Some reports indicate that buckwheat straw can cause digestive upsets if fed in large quantities. Therefore, buckwheat straw should be limited to 25 percent or less of the diet.

CEREAL STRAW

Straw, the most common crop aftermath in North Dakota, is a good alternative in wintering rations for cows and sheep if properly supplemented with energy, protein, minerals and vitamins. Satisfactory supplements include cereal grains such as barley, crop processing coproducts such as wheat midds, or high-quality hays.

Oat straw is the most palatable and nutritious, followed by barley straw and wheat straw. Rye straw has little feed value. Straw can constitute up to about 60 percent of the brood cow ration but has only about half the value of hay in growing rations. Straw can be used in combination with other feeds as the major roughage for beef cows. Rations based on wheat straw and wheat midds have given similar performance to rations based on corn silage and alfalfa hay when fed to lactating first calf heifers at the Carrington Research Extension Center.

Grinding straw can increase intake 10 to 15 percent, according to research done at the Dickinson Research Extension Center. However, compaction can be a problem in diets with high levels of straw. Straw a year or more old is usually more palatable and digestible than fresh straw.

Late-planted oats is often susceptible to rust. The resulting straw will be dusty and act as a respiratory irritant but is not toxic.

CHAFF, SMALL GRAIN

Chaff collected in bunch wagons behind combines is usually of high quality. It contains grain which passes through the combine, weed seeds and hulls, as well as some leaves. Bunch wagons, however, can be an inconvenience when harvesting grain. Other attachments that connect directly to the combine and leave small piles in the field for later collection or for fall grazing cows to consume are available. Other producers have chosen to utilize silage dump wagons to collect chaff. These dump wagons can deposit chaff directly into farm trucks or semis for transport to storage areas at the farm or ranch. This system requires additional trucks and drivers. Chaff can also be collected with stack wagons and transported to the feeding facility. Chaff can be collected from a number of different crops, including wheat, barley, oats, peas, lentils and flax. Approximately 300 to 500 pounds of chaff can be collected per acre. The feeding recommendations for chaff are similar to those

for good-quality straw. Chaff from some of the very rough-awned bearded wheats may cause palatability problems.

CHAFF, AMMONIATED

Chaff may be ammoniated to improve its feeding value. Ammoniation improves the energy availability and protein content of chaff. Procedures are the same as those used to ammoniate straw or other low-quality forages. Dry cows can be successfully wintered on ammoniated chaff. Lactating cows may require a source of supplemental energy (grains or grain coproducts) for optimum performance on ammoniated chaff rations.

CHICKPEA STUBBLE

Little useful stubble material remains after harvest of chickpeas.

CHICKPEA STRAW

Chickpea straw is slightly higher in nutritive value than wheat straw (44 to 46 percent TDN; 4.5 to 6.5 percent CP). Chickpea straw can be more palatable than wheat straw but livestock should be allowed to acclimate to the taste before offering large quantities.

CORN COBS

Corn cobs can be used as a ration ingredient in cow wintering diets. Corn cobs are low in protein (2.8 percent) but higher in TDN (48 percent) than other crop residues such as wheat straw.

CORN RESIDUE, GRAZED

Grazed corn residue (cornstalk fields following harvest) can effectively winter beef cows or "rough winter" beef calves. The amount of downed ears in a particular field will vary with the weather conditions prior to harvest, variety, degree of insect infestation and other factors. High amounts of downed ears can result in a high incidence of digestive disturbances (acidosis, founder). Corn residue is made up of grain, husk, leaf, stalk and cob. Grain and husk are usually highest in protein and energy, while stalk and cob are the lowest. Protein supplements should be provided once the grain has been consumed. Supplemental phosphorus and vitamin A should be provided for cattle grazing corn stalks. Do not force cattle to eat stalks and cobs. These products are of low quality.

As one might expect, irrigated corn has more residue per acre than dryland corn. However, dryland corn residue is typically higher in energy and protein content than is irrigated corn residue. Grazing is typically the most cost-effective harvest method. However, many producers in North Dakota will bale or mechanically harvest corn residue due to the possibility of snow cover limiting grazing *(see Corn Stover)*.

CORN STOVER

Corn stover is corn residue which has been mechanically harvested. Nutrient content is similar to other crop residues such as straw. As with other residues, corn stover can be used as a portion of the diet for wintering beef cows. Nutrient content is low, so energy and protein supplementation is necessary. Phosphorus and vitamin A supplementation is also needed.

DRY EDIBLE BEAN RESIDUE

Dry bean residue may be baled or stacked, but yield is modest and often there is substantial dirt. Grazing is the cheapest and most efficient method of utilizing this coproduct. As a legume, bean residue generally contains more protein than cereal grain residue and is quite palatable, although cattle will not consume the coarser stalks.

FIELD PEA STRAW

The residual vines, leaves and stems from field peas are a palatable and nutritious residue often resembling medium-quality grass hay in nutritional content. However, field pea straw appears to be quite variable (6 to 12 percent CP; 40 to 60 percent TDN). Consequently, a nutrient analysis is recommended prior to feeding. Peas are harvested in the early fall so grazing or baling are options for utilizing pea straw. Windrows may blow around or the straw may wrap on rotating equipment such as stack wagons or balers. Field pea residue decomposes more rapidly than cereal crop residues. Therefore, it should be baled or collected shortly after combining to minimize loss of leaves and retain nutrient quality.

GRAIN SORGHUM STOVER (MILO)

Residue from this crop remains upright in the field and retains nutritional value similar to grass hay late into the fall and winter. Cows can graze the plants down through snow up to two-feet deep.

LENTIL STRAW

Lentil straw is higher in digestibility, protein, calcium and phosphorus compared to wheat straw. In addition, lentil straw also tends to be more palatable than cereal straws. Lentil crops tend to have little harvestable residue following combining.

MILLET STRAW

Millet straw is more palatable and higher in energy and protein than small grain straws. Several millet varieties are available and residue may vary in nutrient content, so nutrient analysis is recommended prior to feeding.

OAT HULLS

Oat hulls are a coproduct resulting from oat processing. They are high in fiber, low in protein and have low digestibility. Research conducted at South Dakota State University indicates that oat hulls are similar in energy to alfalfa hay when used in diets for growing calves. However, Canadian research indicates that oat hulls are inferior to barley silage as a source of roughage. Ammoniating oat hulls can increase digestibility, increase protein levels and improve animal performance. Oat hulls are bulky and difficult to ship due to their low density. Oat hulls are generally ground prior to shipment to lower the transportation cost per ton. This may make the product dusty and relatively unpalatable. Due to low nutrient content, oat hulls should be used as a way to stretch tight forage supplies by blending with other higher-quality feeds, or be ammoniated prior to feeding to increase nutrient content. In most cases, oat hulls should be limited to 25 percent or less of the diet.

SOYBEAN STUBBLE

Soybean stubble can be grazed following soybean harvest. However, soybean stems, leaves, and pods are generally low in nutritive value. Non-lactating cows early in gestation may subsist on soybean stubble. However, lactating cows, growing calves and other livestock with higher nutrient requirements will not perform adequately if only given soybean stubble.

SOYBEAN STOVER

Soybean stover can be collected following harvest with either a baler or stack wagon. However, soybean stover is generally low in protein and energy and should only be used at 20 percent or less of the diet (DM basis) provided the diet includes other feedstuffs which are higher in protein and energy. Many livestock producers use soybean stover as a bedding source. It appears to keep the cattle very clean when used as bedding in confinement buildings. Cattle will sort through soybean stover looking for pods and seeds, but stems generally make up the largest fraction of this material.

SUNFLOWER RESIDUE

The head contains the most feed value, followed by the top, middle and bottom thirds of the stalk. If residue cannot be collected behind the combine, grazing will afford some use, although the time before snow cover is usually limited. Sunflower seeds are high in energy (due to the high oil content) and a good source of protein. Consequently, downed heads in the field result in a residue which can be highly nutritious.

SUNFLOWER HULLS

Sunflower hulls are a very poor roughage. They may be used to increase the total fiber level of dairy rations or to provide roughage in high grain growing or finishing rations at not over 20 percent of ration. Hulls are low in protein and digestibility.

Weeds

AWNED GRASSES AND WEEDS

Little wild barley and cheat grass awns stick to clothing, hair or wool. Awns may work into nostrils, mouths and eyes of livestock causing soreness and infection. Use forages containing these weeds cautiously. Viable weed seeds may be passed through the digestive system. Composting manure will help control weed infestations.

KOCHIA

Kochia can be used as an alternative feed source for cattle. Harvesting kochia at 20 to 26 inches in height, before flowering, will ensure a palatable and nutritious feed. Kochia cut at later stages is less desirable but can still be used if there is no other alternative. Kochia can yield approximately 1.8 tons per acre. A second cutting may be obtained if the first cutting leaves live branches on the stubble. Hairy leaves give hay a gray appearance. The nutrient analysis of kochia can resemble alfalfa hay, although second cutting kochia alone may not be adequate for growing heifers. Reports indicate kochia hays vary from 6 to 22 percent protein, suggesting wide variation in quality, which can be explained by variation in plant maturity at harvest. Palatability seems very good. Unfortunately, the laxative nature of kochia means much of its potential nutrient value will likely be lost in feces due to a rapid rate

of passage. Cattle have been reported to become sensitive to light from eating kochia. Some cattle that have been on kochia for 45 days or more may develop impaired liver and kidney function. Kochia is high in oxalates, which may cause the problem. Kochia is less laxative than Russian thistle. Do not graze kochia heavily, and only maintain cattle on kochia for about 60 days. Provide calcium supplementation to counteract the effect of the oxalates. Provide clean, fresh water when feeding kochia.

LEAFY SPURGE

Leafy spurge can be very palatable and nutritious for sheep and goats. However, cattle appear to develop an aversion to the milky latex found in the plant. Leafy spurge can be hayed or grazed as a feed for sheep and goats. Grazing leafy spurge with sheep or goats can be an effective control measure. Leafy spurge hay cannot be hauled to other farms due to noxious weed laws. Seeds are not digested well, so manure from animals fed or grazing leafy spurge may contain viable seeds, resulting in further spread of this weed. Ensiling does not improve palatability of leafy spurge for cattle.

PIGEON GRASS

This grass is often present in small grain straws. It is a medium-quality grass hay if harvested in the vegetative state, but as maturity approaches the plant lignifies and decreases in value. The presence of pigeon grass in small grain straw increases the nutrient content of the straw. Pigeon grass can be grazed following small grain harvest.

PIGEON GRASS HAY

Pigeon grass can be used as an alternative forage in drought and other emergency situations. It has a forage value similar to millet when harvested before maturity. When mature, it is relatively low in energy and protein. Pigeon grass can be difficult to windrow and harvest due to its relatively short growing height.

PIGEON GRASS STRAW

Pigeon grass straw has relatively little feeding value. Pigeon grass growing in small grain fields often ends up mixed with the cereal grain straw which can be used as feed or bedding. Composting manure is advised to minimize weed seed viability.

QUACKGRASS

Quackgrass can be harvested and fed to beef cattle and sheep. Quackgrass hay is of moderate quality (8 percent CP; 52 percent TDN).

RUSSIAN THISTLE HAY

The crude protein of young Russian thistle is similar to alfalfa, and the TDN or energy is about 10 to 15 percent less. Russian thistle should be hayed at blossom stage before spines form. Russian thistle makes good silage when mixed with other crops. It is somewhat laxative and should not make up over half of the ration.

Roots, Tubers and Associated Coproducts

- Beets, Sugar
- Beet Pulp
- Beet Tops
- Beet Top Silage
- Beet Tailings
- Carrots
- Potatoes
- Potato Waste
- Onions
- Turnips

BEETS, SUGAR

Occasionally, regional sugar processors must dispose of whole sugar beets due to spoilage. Whole beets can be fed successfully to cattle. Whole beets are low in crude protein (6.8 percent) but high in energy (75 percent TDN). If possible, whole beets should be broken up prior to feeding. Producers can utilize extended mixing times with a conventional mixer wagon to break up whole beets. In addition, some producers report success using manure spreaders to spread whole beets on stubble or stalk fields and allowing cows access to the beets on the field. Choking may be a potential problem when feeding whole beets.

BEET PULP

Beet pulp can be used effectively as an energy supplement for gestating or lactating cows, as an ingredient in backgrounding diets or as a roughage source in finishing diets. Beet pulp is relatively low in protein (8 percent), but relatively high in TDN (72 percent). Research conducted at NDSU indicates that beet pulp has an energy value slightly less than corn in backgrounding diets. In finishing diets, it can be used as the roughage source, having an energy value greater than corn silage. Beet pulp is available wet (pressed shreds) or dry (shreds or pellets). Wet pulp contains approximately 75 percent moisture, which limits the distance it can be transported economically. Wet pulp can be stored effectively in silage bags or in trench or bunker silos. Dry pelleted pulp can be stored in bins or quonsets.

BEET TOPS

Beet tops can be grazed directly or windrowed and grazed. Windrowing aids in preservation. The tops may be put into small piles and allowed to dry, then hauled to the feedyard. When gathered, the tops will weigh about half as much per acre as the marketed beets. Beet tops are laxative and should therefore be fed in moderation. Feeding a high calcium mineral with them will reduce scouring. Cattle should be watched closely when grazing beet tops, since the smaller beets left

behind by the harvesting equipment can cause choking problems. No more than 20 to 30 percent (dry basis) of a growing ration should be beet tops. Limit beet tops to 10 percent of the ration (dry basis) for finishing cattle. Beet tops should not be the only source of roughage in finishing rations. Most cattle feeders remove all the beet tops from the ration 20 to 30 days before marketing. Recent advancements in defoliator technology have limited the usefulness of beet tops, since the beet tops are essentially mulched as they are removed. This makes it difficult to gather the remaining residue into a windrow or for cattle to graze the material.

BEET TOP SILAGE

Sugar beet top silage will be approximately half of the per acre root yield. Tops should be ensiled at approximately 60 percent moisture, so allow the tops to partially dry in the field. Mixing with other feeds or forages at ensiling will reduce the sticky, gummy consistency of this coproduct. Field harvesting may be a problem and considerable soil contamination usually results. Beet tops are accumulators of nitrate, but the ensiling process should reduce this problem. Beet silage should be used as an extender of another forage source and not used as the principle forage crop. The silage is less laxative than the fresh tops, but it is best not to feed more than 30 pounds per head daily to cattle and 3 pounds to sheep (as fed basis). If feeding the maximum amount of tops is desired, add 1 pound of finely ground limestone to each 50 pounds of tops (wet basis) and allow to ensile.

BEET TAILINGS

Beet tailings consist of small beets, broken or damaged beets, soil and other foreign material not suitable for sugar production. Tailings are high in moisture (approximately 80 percent) and can be quite variable. Depending on soil contamination, beet tailings have a feeding value similar to or higher than corn silage on a dry matter basis. Choking may be a problem with beet tailings. Due to the high moisture content, transportation is a major expense with beet tailings.

CARROTS

Cull carrots from the vegetable industry are sometimes available as a livestock feed. Carrots are high in moisture (85 to 90 percent) and about 10 percent crude protein on a dry matter basis. Carrots are highly digestible. High levels of carrots in the diet can result in off-colored fat in finishing lambs and calves. Therefore, levels should be limited to 20 percent or less of the diet (DM basis). The leaf material of the carrot plant can accumulate nitrate. Consequently, care should be taken when grazing residues resulting from carrot production.

POTATOES

Potatoes have a feeding value equal to cereal grain (barley) on a dry matter basis. Potatoes are high in energy and low in protein and vitamin A. Chopping potatoes will prevent choking in cattle, but they can be fed whole if necessary. This risk is minimized if they are fed from low troughs. Acclimate cattle to potatoes gradually or they may cause digestive disturbances. Sprouted potatoes contain toxic alkaloids. The long sprouts should be removed before feeding. Frozen potatoes should never be fed because of the danger of choking. Satisfactory results can be obtained in finishing rations by feeding potatoes free choice with a protein supplement and low-quality dry roughage. Fifty percent of the ration (as fed basis) as potatoes is probably the maximum for finishing cattle. Do not remove potatoes from finishing rations once the cattle are adapted to them.

Ensiling can be used as a method of preserving potatoes. Potatoes should not be ensiled alone because of their high (80 percent) water content, as effluent losses will be excessive. Adding either 20 to 25 pounds of dry forage or 400 pounds of corn or sorghum-sudan silage per 100 pounds of potatoes will reduce moisture to an acceptable level. Other products such as wheat midds, sugar beet pulp or grains can be added to potatoes to reduce the moisture content. Moisture levels for optimum ensiling should be 60 to 65 percent (35 to 40 percent dry matter). Potato waste plus small grain chaff (1:1 mix) and potato waste plus chopped alfalfa is a viable alternative. One ton of potato haylage was found to be equal in nutrient content to one ton of corn silage on an equal dry matter basis.

Potatoes can also be spread on fields or pastures and freezedried over the winter. The following spring, cattle are allowed to graze the pasture or field and consume the potatoes. Danger of choking is reduced or eliminated as the potatoes freeze dry.

POTATO WASTE

Potato waste is the product remaining after potatoes have been processed to produce frozen potato products for human consumption. The product can include peelings, cull potatoes, reject French fries and other potato products. Due to differences in processing plants, moisture levels can vary considerably from plant to plant (75 to 85 percent moisture). The high water content limits transportation distances to local areas surrounding the processing plants. Potato waste is equal in energy to grains on a dry matter basis. However, it is low in protein and vitamin A. Research conducted at NDSU indicates optimal levels in finishing diets are less than 20 percent of the diet on a dry matter basis. Due to the wet nature of the product, spoilage can be a concern, especially during the summer.

ONIONS

Cull onions can be used as a feed for ruminant livestock. Onions are high in moisture (approximately 90 percent). On a dry matter basis, onions are 9 to 13 percent crude protein, 83 to 90 percent TDN, 0.35 percent calcium and 0.40 percent phosphorus. When fed at high levels, onions can cause anemia due to the presence of sulfur compounds which cause hemolysis of red blood cells. To maintain adequate performance in cattle fed onions, the level of onions in the diet should be limited to 25 percent or less (DM basis). The ruminal microorganisms in sheep appear to adapt to higher levels of onions readily. Consequently, higher levels of onions have been fed to sheep and sheep tend to be less prone to anemia when fed onions.

TURNIPS

Turnips can be planted to use in grazing programs. Grazed turnips are highly digestible and a good source of protein. Grazed turnips can be used as high-quality forage for yearling cattle or grazing lambs, a means to improve cow nutrition or to flush ewes prior to breeding. Turnips can be grazed as early as 70 days following planting. Livestock should be introduced to lush turnip pasture gradually over three to five days and be sure the animals are full when turned into the turnip field. Allow animals access to dry hay or other pasture while grazing turnips and other Brassica species. After the tops are consumed, animals will consume the tubers. In loose soils, tubers are easily pulled from the ground by grazing animals. However in heavy soils or soils which are compacted, some light tillage or spiking may be used to loosen the tubers. There have been some reports of choking by cattle eating tubers.

Grains, Grain Coproducts and Screenings

BARLEY MALTING COPRODUCTS

Barley malting coproducts consist of screenings, dried malt sprouts, and in some cases, thin or feed grade barley. Malting plants market these components together or separately, depending on the plant. Barley malt pellets are palatable and can be used effectively in creep or backgrounding rations. Barley malt pellets contain moderate levels of crude protein (14 percent) and are moderate in energy (74 percent TDN).

BREAD AND BAKERY COPRODUCTS

Stale and discarded bread and bakery products can be used in cattle and sheep rations as a source of energy and protein. These products vary greatly, depending on the particular product which was discarded. They are generally high in energy, and may contain relatively high levels of fat. These products also tend to ferment rapidly in the rumen. Therefore, levels should be limited to 20 percent or less of the diet to prevent digestive disturbances.

BUCKWHEAT

Buckwheat is not a cereal but has the same general nutritive characteristics as cereal grains. It contains energy and protein levels slightly lower than oats. Buckwheat is used for livestock when it is low in price compared to other feeds. Normally a bushel of buckwheat weighs 45 to 48 pounds. Buckwheat should be ground for all classes of livestock. Buckwheat grain contains a compound called fagopyrin which can cause photosensitivity, eruptions on the skin and itching behavior. Only white or light-colored areas of the hide are affected. The animals apparently become photosensitive after consuming large amounts of buckwheat for an extended period of time. Buckwheat should be limited to 20 to 25 percent of the concentrate mixture.

BUCKWHEAT MIDDLINGS

Buckwheat middlings are high in protein and energy. They should not be used as the sole source of concentrate or fed at more than 25 percent of the diet, since a skin rash can develop if fed at high levels.

CHICKPEAS (Garbonzo beans)

Chickpeas are an annual legume that are high in energy and protein. Peas should be used at less than 30 percent of the concentrate in calf diets. Rolling or coarse grinding may improve digestion and will allow for better mixing in TMRs. Whole seeds may be picked up by cows grazing winter pastures. The benefits from processing have not been evaluated.

CORN GLUTEN FEED

Corn gluten feed is a coproduct of the corn sweetener industry. It consists of various combinations of corn bran, corn germ and corn steep liquor, depending on the plant which manufactures it. Corn gluten feed is sold either as a wet product (40 percent dry matter) or as a dry pellet (88 percent dry matter). Wet corn gluten feed is equal in energy to corn (DM basis), with dry corn gluten feed being slightly lower in energy due to heat drying driving off volatile fatty acids. Corn gluten feed contains 22 percent CP. Corn gluten feed is low in calcium and high in phosphorus and sulfur. Corn gluten feed is useful in many different types of rations. The wet coproduct has a short shelf life during warm weather. Signs of spoilage include off colors and odors and mold development. However, it may be stored in bunker or trench silos as well as plastic silage bags for extended periods. Please see NDSU Extension publication, ***AS-1127 Corn Gluten Feed: Composition, Storage, Handling, Feeding and Value***.

CORN GLUTEN MEAL

Corn gluten meal is a very high protein product also produced by the sweetener industry. This meal is high in escape protein and finds limited use in livestock rations because of the high cost.

CORN, OLD

Shelled corn stored for more than a year will be similar in value to newer corn. Switch from new corn to old corn or old corn to new corn gradually (over several days). The reason for the gradual change is that old grains are somewhat less palatable and new grains may be higher in moisture and more rapidly digested. Old grains are practically devoid of vitamin A. Old grains should be inspected for evidence of mold and insect damage prior to feeding.

DRY EDIBLE BEANS (Culls and splits)

Cull beans contain moderate levels of energy (68 to 78 percent TDN) and protein (22 percent). Raw cull beans should be used as only a small portion of cattle diets (less than 10 percent of the diet) with severe diarrhea resulting from higher intakes. Roasting increases usefulness to more than 25 percent of the diet because the enzyme inhibitors are rendered ineffective with heating. Colorado and Nebraska research indicated depressed performance in growing steers at levels greater than 10 percent of the ration. Care must be exercised in adapting the cattle to rations containing cull beans. Cull beans should be ground if possible.

DISTILLERS GRAINS

Distillers grains are a coproduct of the ethanol industry. In most cases, ethanol production is corn-based, but other grains (barley, wheat) can be used. The product can be sold as a wet mash (60 to 65 percent water) or as a dried pellet (8 to 10 percent water). The shelf life of the wet material is limited to a few days, especially in warm weather. Signs of spoilage include off colors and odors and mold development. Bunker or trench silos as well as plastic silage bags can be used to store the wet material for longer periods of time. Distillers grains are very palatable and mix well with other ration ingredients. The product can be used to condition or add moisture to dry rations to improve acceptability. Distillers grains contain approximately 26 percent CP with a relatively high proportion being bypass (escape) protein.

ERGOT CONTAMINATED FEEDS

Ergot bodies have the potential for constricting circulation to body extremities, causing lameness, abortion and gangrene. Assume a zero tolerance for ergot in rations for breeding animals due to the possibility of abortion. Ergot is more prevalent in grains and hays grown in wet years. Grain screenings may also contain ergot. Carryover hays and grains may contain ergot.
If the ergot content of contaminated feeds exceeds 0.1 percent, the contaminated feeds should be blended with other grain or forage to reduce the ergot concentration.

EMMER AND SPELT

Emmer (Triticum sativum, dicoccum) and spelt (Triticum sativum, spelta) are close relatives of wheat, but the grain resembles barley in appearance. The hulls are not usually removed from the kernels in threshing. Emmer is often incorrectly called “speltz” or “spelt.” Emmer and spelt resemble oats in nutritive value. They may be used in the same manner as oats in feeding the various classes of stock.

When a large proportion of the hulls are removed in threshing, emmer will resemble barley more than oats in composition and feeding value. Emmer and spelt should be rolled or cracked prior to feeding.

FABABEANS

Fababeans can be fed whole or processed. They do not need to be heated. Fababeans should comprise no more than 30 percent of the grain mixture.

FIELD PEAS

An annual legume, field peas are grown in combination with small grains as a high protein forage or in a pure stand and harvested for grain. Peas are high in protein (20 to 27 percent) and energy (88 to 90 percent TDN) and are very palatable. Optimum use may be in diets where nutrient density is important, such as creep rations, receiving diets or cow supplements. Trials feeding increasing levels of peas in creep rations resulted in a linear increase in intake. Gain data suggests the most economical use of peas may be at 30 to 50 percent of creep diets. Data from lambs fed field peas in finishing diets indicate that the TDN of field peas is similar to or slightly higher than corn. As a general recommendation, field peas should be rolled for beef cattle. Additional information can be found in NDSU Extension bulletin ***EB-76 Feeding Field Peas to Livestock***.

GRAIN MILLET

Millet (proso and pearl) ranks intermediate as an energy source among cereal grains. It has many of the nutritional characteristics, including deficiencies, common to other grains. Seed density and fiber content are issues to consider. Grind or dry roll millet to break all the kernels. It is more difficult to break all the small kernels by rolling. Do not powder proso during grinding, as powdering will not improve intake or utilization over rolling or moderate grinding. Hammer milling with a one-fourth-inch screen makes a very acceptable product. Because of its higher fat content, millet tends to have more "body" when ground than most other grains and does not powder so badly when hammer milled. Millet can be the sole grain source if maximum gains of 2.0 pounds a day are desired. Limit millet to approximately 50 percent of the ration if gains of 2.7 to 3.0 pounds are desired. Millet may cause some laxative problems when starting cattle on feed. Using oats to start cattle on proso may be of benefit. Proso will probably work best in grain rations when combined with other grains such as corn or barley.

GRAIN SORGHUM (Milo)

This warm season grain is very drought tolerant and provides grain nearly equal to corn in nutritional value. Short season milo varieties have been grown successfully in the southern half of North Dakota in all but the coolest summers. Milo grain ferments slowly in the rumen because of its dense starchy component. Dry rolling, steam rolling or steam flaking is recommended for ruminants and grinding for swine and poultry. Whole plant silage is equal to corn silage.

HULL-LESS OATS

This is a very nutrient dense grain, high in protein (18 percent) and energy (10 percent fat, 93 to 95 percent TDN). Controlling particle size is important in beef feedlot rations, as feed intake and gain may be severely depressed with high proportions of finely ground hull-less oats in finishing diets. Feed hull-less oats whole if particle size cannot be controlled in the mill. Mixing with corn or barley at less than half the grain component is recommended. Hull-less oats are useful in supplementing cows at only a few pounds per day.

LUPINES

Lupine is an annual legume that can be fed as ensiled forage or as a seed meal. Lupine meal is made by grinding or flaking lupine seeds (32 to 42 percent crude protein, 72 percent TDN, 5 percent fat) and is an excellent protein source for ruminants. It is used around the world as a protein feed. Sweet white lupines are the preferred variety as others contain bitter-flavored alkaloids and are unpalatable. Lupine silage contains 13 to 18 percent crude protein and 52 to 61 percent TDN, depending on maturity at harvest.

RYE

Rye is a minor feed grain in North Dakota. However, there are times when it might be available for feeding. Rye can be relatively unpalatable and can also have problems associated with ergot contamination. Therefore, rye should be limited to 40 percent of the concentrate mixture. When limited to this amount and when ergot is not a problem, the feeding value is similar to barley. Rye should not be used as an ingredient in calf creep feeds or calf starters due to its low palatability. Rye should be rolled or cracked prior to feeding.

SCREENINGS, CORN

Except for being smaller particles, corn screenings are usually similar to corn grain in nutritive value unless substantial amounts of cob or weed seeds are present. Processing is usually not required.

SCREENINGS, GRAIN

Screenings are a combination of materials obtained in the grain cleaning process. Screenings may include light or broken grain seeds, weed seeds, hulls, chaff, joints, straw, elevator dust and floor sweepings. Understandably, there is substantial variation in the nutritive value of screenings. The best grades of screenings resemble oats in composition and may nearly equal oats or barley in feeding value. However, some of the poor quality screenings more nearly resemble straw in composition. A large proportion of dark seeds (usually mustard or pigweed) can reduce the palatability of screenings. When feeds contain large numbers of viable seed, the resulting manure is a possible weed menace. It is recommended to compost the manure for at least two to three months to reduce weed seed germination. Grinding the seeds will reduce germination. Spreading manure from screenings-fed animals onto sodded grazing land will reduce weed infestations. One might expect less viable seeds being voided from sheep than cattle since sheep chew their food more extensively. Screenings may be used as the only concentrate for dry cows and replacement heifers. Heifers can utilize up to 6 pounds of screenings per day while cows can use up to 10 pounds. Total screenings fed to milking cows should not exceed 6 to 8 pounds per day. Do not feed screenings within two hours of milking due to possible milk flavor effects. Ergot may also be a concern when feeding screenings.

SCREENINGS, PIGEON GRASS

Pigeon grass screenings are high in CP (14 percent) and low in energy (65 percent TDN) compared to grains such as corn. Pigeon grass should be ground prior to feeding, since the seed coat is relatively difficult to digest. Pigeon grass screenings should be limited to 20 to 40 percent of the grain portion of the ration, depending on desired level of performance. Pigeon grass screenings can be ensiled with corn silage or other silages by layering screenings into the silage pile. Intact pigeon grass seed found in the manure can germinate, resulting in the spread of this weed. Composting manure for two to three months can reduce or eliminate this problem.

SCREENINGS, SUNFLOWER

Sunflower screenings consist of a mixture of groat pieces, light weight seeds, pieces of the heads, sclerotinia bodies and hulls in variable proportions. Protein and fiber levels may be equivalent to good quality hays or higher, depending on the amount of whole seeds and groats in the screenings. Oil found in broken and/or lightweight seeds increase the energy and protein content. Nutritive value can be extremely low also, with the presence of substantial stalk material and hulls. High levels of sclerotia bodies in sunflower screenings do not appear to affect intake and performance of gestating beef cows, according to NDSU experiments.

SCREENINGS, WHEAT

The most common ingredients in wheat screenings are broken wheat kernels and pigeon grass (green and yellow foxtail) seed. This weed seed is an economical energy source for many livestock rations despite the fact that it is generally inferior to feed grains as an energy source. A general rule in ruminant rations is to use less wheat screenings as the proportion of grain in the ration increases. Cattle on a high grain diet may "back off" from maximum consumption if the screenings level exceeds 20 to 30 percent of the grain. With high roughage rations, up to 40 percent or more of the grain mixture may be wheat screenings.

Sheep require less processing of grains and can use pigeon grass whole rather efficiently. NDSU trials have shown fattening lambs can be fed up to 40 percent pigeon grass seed in their ration with no reduction in gain.

Other research at NDSU suggests pigeon grass has an energy value of approximately 62 percent TDN (dry matter basis). This means that adding pigeon grass to corn silage will not improve the energy value of the silage but will only increase the total tonnage of silage. Ensiling, however, is an excellent way to use wheat screenings with whole pigeon grass seed for cattle. The ensiling process will prevent the seed from germinating and will soften the hull.

Wheat screenings with immature pigeon grass seed contain substantially more moisture than the dry grain. Pigeon grass, therefore, causes problems in storage of the harvested grain or separated screenings. Incorporating pigeon grass into silage at ensiling time is one method of utilizing the weed seed for feed.

SMUT CONTAMINATED FEEDS

Smut contaminated feeds such as corn, corn silage and oats appear to be harmless to livestock. One report has detailed injury to livestock fed large amounts of smut separated from grain. This is not a common feeding practice. There is no need to remove smut from grain or silage corn prior to feeding.

SPELT

See Emmer.

TRITICALE

Triticale is a hybrid of wheat and rye. At times, triticale is available for feeding. Triticale is higher in protein than other cereal grains and similar in TDN to barley. For best results, triticale should be rolled or cracked prior to feeding. Ergot can develop in triticale, so producers should evaluate triticale for ergot content prior to feeding.

WHEAT

Wheat (hard red spring or winter) levels should not exceed 30 percent of the ration for beef or dairy cattle unless extreme care is taken in balancing the diet and mixing the ration. Wheat should be limited to 30 to 40 percent of the grain mix for dairy cows. The level of durum should be limited to about 75 percent of the level of spring wheat. Popping does not appear to improve utilization. Steam rolling can produce a ration which contains less fines, resulting in fewer incidences of digestive disturbances when high levels are fed. However, steam rolling is a relatively expensive method of processing. For cattle, wheat should be coarse rolled and fines should be kept to a minimum. Sheep, however, can utilize whole wheat. Less protein supplement is required where wheat is included in the ration. This is a particular advantage for wheat when protein is expensive.

Wheat is an excellent livestock feed but is not conducive to self-feeding programs because of its rapid fermentation rate. If self-feeding is the only option, then mixing salt (necessary salt level will vary depending on conditions) with wheat may be a viable option. For more detailed information regarding wheat feeding, please see NDSU Extension publication, ***AS-1184 Feeding Wheat to Beef Cattle***.

WHEAT MIDDS

This coproduct has moderate levels of protein (18 percent) and energy (80 percent TDN) and is a versatile and palatable feedstuff for a variety of livestock diets. This commodity feed is very useful in growing calf diets and as a supplement for gestating and lactating beef cows. Wheat midds are used as an ingredient in many different commercial supplements, creep feeds and cakes. Storage of wheat midds can be a problem. Storage in a bin with an aeration system or in flat storage (quonset) is recommended for best results. Pellet quality can also deteriorate as wheat midds are handled multiple times. The price of wheat midds varies seasonally with demand for feed products. Wheat co-roducts are lower in calcium and higher in phosphorus than most other grains and grain coproducts. Wheat midds can be fed as the only concentrate source to growing calves (up to 10 to 12 pounds per head per day) but should be limited to less than 40 percent of the concentrate in finishing diets. Refer to NDSU Extension Service publication, ***AS-1175 Feeding Wheat Midds***, for more detailed information.

WILD OATS

Wild oats have little value as a feed for livestock. They are often part of grain screenings. Hammer milling is recommended to break the germ and maximize nutrient availability. Fed whole, few nutrients are extracted and the physical form may irritate the mouth. Whole wild oat seed is also viable following the digestive process, requiring further processing to prevent weed infestation problems in areas fertilized with viable wild oat seed found in manure.

Oilseeds and Oilseed Coproducts

- Canola
- Canola Meal
- Crambe Meal
- Flaxseed
- Linseed Meal
- Safflower
- Safflower Meal
- Soybeans
- Soybean Hulls
- Sunflower Meal
- Sunflower Seeds

CANOLA

Whole canola seed can be used as a protein and energy supplement. It is a good source of energy because of its high oil content (40 percent ether extract). Canola should be rolled or cracked prior to feeding. Due to the high oil levels in canola, it should be limited to approximately 10 percent of the ration (dry matter basis).

CANOLA MEAL

Canola meal is a coproduct protein meal remaining after edible oil is extracted from canola. The meal contains 40 to 44 percent CP and makes a good source of supplemental protein for cattle fed low-protein forages or cows grazing dormant range. Expeller canola meal may contain up to 8 percent oil compared to 0.5 percent in solvent extracted meal, providing added energy from residual oil.

CRAMBE MEAL

Crambe meal has been proven to be a useful as a protein source for feedlot cattle and beef cows. Presently, FDA regulations limit the inclusion level to 4.2 percent of the diet for feedlot cattle. There are currently no other classes of beef or dairy cattle covered under this clearance.

The meal contains approximately 30 percent CP and 65 to 70 percent TDN. Residual oil levels may be as high as 8 percent in expeller crambe meal. Crambe meal is best used in totally mixed rations or at low-to-moderate levels in protein supplements.

FLAXSEED

Flaxseed can be used as a livestock feed but should be limited to use as a protein supplement because of its oil content. Flaxseed should be ground before feeding to livestock. In rare cases, flaxseed may contain prussic acid. Flaxseed should be limited to 10 percent of the grain in livestock diets.

LINSEED MEAL

The residual meal from flax processing, linseed meal, is in demand as high-quality protein for dairy cows, poultry and swine. Expeller processing leaves up to 8 percent residual oil in the meal compared to solvent processing which removes all but 0.5 percent. Linseed meal is very palatable, but demand from the dairy industry often limits economical inclusion levels in beef cattle diets.

SAFFLOWER

Safflower seed can be used as a protein and energy supplement for beef cattle and sheep. Safflower seed is high in oil and therefore high in energy. Research conducted in Montana indicates that feeding high linoleic whole safflower seed may improve survival of calves subjected to cold stress. In North Dakota research, feeding ewes supplemental safflower prior to lambing improved lamb survival.

SAFFLOWER MEAL

Safflower meal can be used as a protein supplement for low protein forages or in backgrounding diets where a source of natural protein is needed. Safflower meal is relatively low in energy (57 percent TDN) due to the inclusion of the hulls with the meal.

SOYBEANS

Soybeans can provide the total protein supplement for beef cattle and sheep, but growing and finishing cattle and lambs should not be fed more than necessary to balance the ration. Research is limited, but one trial involved feeding approximately 2 pounds of soybean seeds to growing beef cattle along with corn silage. The steers supplemented with soybean meal gained slightly faster and consumed more feed than calves supplemented with soybean seeds. Another study with dairy steers demonstrated similar gains on soybean seeds or soybean meal. Lactating dairy cattle may be fed 3 to 5 pounds of whole soybeans. Higher levels may have a laxative effect and reduce fat test. Raw soybean seeds will swell, and this is one of the limitations of this type of ration. Processing the beans for cattle may improve performance. Processed raw soybeans should not be stored longer than one week before feeding since they may become rancid.

High levels of fat can reduce ruminal fiber digestion. Therefore, levels of soybeans should be limited based on fat content. In dairy cattle rations, ground soybeans may make up to 15 to 20 percent of the concentrate mixture, but daily intake should be limited to 4 to 5 pounds. Whole soybeans, either raw, toasted or extruded, have been used successfully in lactating cow diets. Heated soybeans can give high producing cows the extra nutrients (CP, escape protein, energy) they need during the early part of lactation. Heated soybeans are better suited to cows with milk production peaks of at least 80 pounds and only during the early part of lactation. Heating soybeans decreases the amount of protein degraded in the rumen and increases the escape or bypass protein available for the animal. Raw beans degrade more rapidly in the rumen, increasing the amount of ammonia excreted in the urine. Heating also makes the beans more palatable and easier to store.

Green, immature or frost-damaged soybeans can be fed to ruminants without problems. Research conducted at South Dakota State University indicates the raw, frost-damaged soybeans should be limited to less than 14% of the diet dry matter, in order to avoid any negative effects due to the amount of oil or enzyme inhibitors present in the raw soybeans. Lambs fed higher levels of soybeans (in corn silage based diets) had lower fiber digestibility due to the high oil levels, which interfere with fiber digestion in the rumen.

SOYBEAN HULLS

Soybean hulls are relatively low in protein but high in energy. Even though soyhulls are high in fiber, they are similar in energy (TDN) to corn grain when fed as energy supplements for cattle consuming forage-based diets. The energy from soybean hulls is provided largely by digestible fiber (hemicellulose) rather than starch. Soybean hulls are very palatable and used in many commercial feeds.

SUNFLOWER MEAL

Sunflower meal is another coproduct protein meal which remains following oil extraction from sunflowers. The meal contains 32 to 35 percent CP and can be used effectively as a protein supplement in beef cattle rations.

Lower (28 percent CP) or higher (40 percent or more CP) protein levels are the result of adding or removing sunflower hulls from the meal product. Addition of hulls to the meal lowers the energy content of the meal as well, so a nutrient analysis of the meal is appropriate.

SUNFLOWER SEEDS

Whole sunflower seeds may be included as a protein and energy supplement. Whole seeds should be limited to 10 to 15 percent of the ration. Whole sunflower seeds do not need to be processed before feeding. Oil type sunflowers are higher in oil (ether extract) and consequently are higher in energy than confectionary type sunflowers.

Liquid Coproducts

- Condensed Distillers Solubles
- Corn Steep Liquor
- Desugared Molasses (Concentrated Separator Byproduct)
- Molasses
- Whey

CONDENSED DISTILLERS SOLUBLES OR 'SYRUP'

Condensed distillers solubles are a liquid coproduct of the ethanol industry. They are sometimes referred to 'syrup' or 'corn syrup.' Condensed distillers solubles are high in moisture and must be handled with pumps and tanks. Condensed distillers solubles are high in protein and energy and contain 9 to 15 percent fat on a dry matter basis. They are useful as a source of supplemental protein, phosphorus and trace minerals. They have been used successfully as a ration conditioner and are very palatable. The product works well in many different types of rations, but the high moisture level limits the distance it can be transported economically. Since it is a liquid, it also requires investment in liquid handling equipment. Please see NDSU Extension publication, ***AS-1242 Feeding Coproducts of the Ethanol Industry to Beef Cattle***, for more information.

CORN STEEP LIQUOR

Corn steep liquor (also referred to as "steep" or "steep liquor") is a liquid coproduct of the corn sweetener industry. Corn steep liquor contains 30 to 35 percent CP (on a dry matter basis) and is high in energy (88 percent TDN) as well. Nebraska research indicates corn steep liquor is an effective ingredient in growing and finishing rations for beef cattle. It also can be used as a protein supplement for cows grazing dormant winter range. Level of use will be dictated by economics.

DESUGARED MOLASSES (CONCENTRATED SEPARATOR BYPRODUCT)

Desugared molasses or condensed separator byproduct is molasses which has gone through further refinement to remove remaining sugar. It is slightly lower in energy (67 percent TDN) compared to molasses but is higher in protein (20 percent CP) and potassium. Research conducted at NDSU indicates that it increases intake in a wide variety of diets when fed at 5 to15 percent of the diet.

MOLASSES

Beet or cane molasses is used primarily as a source of energy (75 percent TDN) in animal feed, but it is also included as a palatability enhancing agent, an agent for reducing dust, a binder for pellets and a carrier for NPN, vitamins and minerals. When molasses is used in dry feeds, it should not be incorporated in an amount exceeding 15 percent for adult cattle, 8 percent for calves and 8 percent for sheep. Beet molasses may have a greater laxative effect than cane molasses, so lower inclusion rates are strongly recommended.

WHEY

Whey is the coproduct of cheese manufacturing. Whey may be available in liquid, condensed or dried forms, depending on the equipment at a particular plant. Due to the lower moisture content, dried and condensed whey can be economically transported longer distances than can liquid whey. Liquid whey contains about 93 percent water, condensed whey contains approximately 36 percent water and dried whey contains 7 to 10 percent water.

On a dry matter basis, whey is approximately equal to corn in energy and to barley in protein. Liquid whey can supply 20 to 30 percent of the ration dry matter in cattle diets. One-hundred pounds (12 gallons) of liquid whey can replace up to 7.5 pounds of grain in cattle diets. Cattle should be adapted to whey gradually by blending with water.

Liquid whey should be delivered on a daily basis and a continuous supply should be provided to prevent digestive upsets. Whey can become unpalatable after 36 hours. Whey that is not fresh is lower in palatability and can cause tooth decay and sore gums. Cows need time to become accustomed to liquid whey. It may be necessary to limit water during this period to force them to consume the liquid whey. Cows will consume about two-thirds of their liquid intake as whey and one third as water.

Nutrient Content of Conventional and Alternative Feeds

Feedstuff	DM	CP	UIP	TDN	100% Dry Matter Basis				
					NE_m	NE_g	ADF	Ca	P
	(%)	% DM	% CP	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(%)
Alfalfa Hay, Immature	90.0	21.5	10.0	63.0	0.63	0.36	NG	1.72	0.30
Alfalfa Hay, Early Bloom	90.0	18.4	15.0	60.0	0.60	0.34	NG	1.40	0.23
Alfalfa Hay, Mid Bloom	90.0	15.9	20.0	57.0	0.56	0.30	NG	1.35	0.22
Alfalfa Hay, Mature	90.0	13.5	30.0	51.0	0.50	0.24	NG	1.26	0.17
Alfalfa Haylage, Immature	50.0	21.5	10.0	63.0	0.63	0.36	NG	1.72	0.30
Alfalfa Haylage, Early Bloom	50.0	18.4	15.0	60.0	0.60	0.34	NG	1.40	0.23
Alfalfa Pellets, Dehydrated	90.0	19.7	55.0	61.0	0.61	0.35	35.0	1.43	0.26
Alfalfa Pellets, Suncured	90.0	16.3	30.0	59.0	0.58	0.32	41.0	1.32	0.24
Alfalfa Silage, Immature	35.0	21.5	10.0	63.0	0.63	0.36	NG	1.72	0.30
Alfalfa Silage, Early Bloom	35.0	18.4	15.0	60.0	0.60	0.34	NG	1.40	0.22
Alfalfa Silage, Mid Bloom	35.0	15.9	20.0	56.0	0.56	0.30	NG	1.35	0.20
Alfalfa Silage, Mature	35.0	13.5	30.0	50.0	0.50	0.24	NG	1.26	0.17
Alfalfa Stubble (regrowth)	27.2	19.3	NG	57.0	0.58	0.29	43.0	1.72	0.31
Alfalfa-Brome Hay, Early Bloom	90.0	16.2	15.0	56.0	0.52	0.27	NG	1.03	0.30
Alfalfa-Brome Hay, Mid Bloom	90.0	14.0	20.0	53.0	0.50	0.24	NG	1.14	0.15
Alfalfa-Brome Silage	35.0	16.2	20.0	56.0	0.52	0.27	NG	1.03	0.30
Barley Grain	88.0	13.5	27.0	84.0	0.94	0.64	7.0	0.05	0.47
Barley Grain, Lightweight	89.1	15.0	20.0	77.4	0.81	0.56	16.0	0.07	0.37
Barley Grain, Thick	89.0	11.0	20.0	86.0	0.96	0.66	NG	0.07	0.39
Barley Hulls	93.3	13.0	NG	73.0	0.78	0.51	18.7	0.20	0.56
Barley Hay, Forage Type, Boot	90.0	14.7	NG	61.0	0.61	0.35	NG	NG	NG
Barley Hay, Forage Type, Milk	90.0	11.7	NG	62.9	0.64	0.38	NG	NG	NG
Barley Hay, Forage Type, Soft Dough	90.0	9.9	NG	63.8	0.65	0.39	NG	NG	NG
Barley Hay, Forage Type, Firm Dough	90.0	9.8	NG	62.6	0.64	0.37	NG	NG	NG
Barley Malt Pellets	89.0	14.0	NG	74.0	0.77	0.52	15.0	0.14	0.56
Barley Screenings	89.0	11.6	NG	77.0	0.79	0.53	11.0	0.35	0.32
Barley Straw	90.0	4.1	25.0	43.0	0.38	0.00	52.0	0.37	0.11
Beans, Dry Edible	90.0	25.4	20.0	87.0	0.91	0.64	6.0	0.17	0.63
Beans, Dry Edible, Culls and Splits	90.0	24.4	20.0	78.0	0.81	0.56	16.0	0.15	0.59
Bean Straw, Dry Edible	90.0	6.8	NG	51.0	0.51	0.12	56.0	1.85	0.14
Beans, Garbanzo (Chickpeas)	89.0	21.9	NG	89.0	0.93	0.65	10.0	0.17	0.37
Beet Tops, Sugar	17.0	15.1	NG	58.0	0.59	0.27	14.0	1.01	0.22
Beet Top Silage, Sugar	21.0	12.7	NG	53.0	0.55	0.20	18.0	1.56	0.20
Beet Tailings, Sugar	18.4	8.9	NG	65.0	0.67	0.40	34.0	2.35	0.27
Beet Tailings Silage, Sugar	20.0	10.0	20.0	65.0	0.66	0.40	NG	2.50	0.20
Beet Top Silage, Sugar	32.0	11.9	20.0	51.0	0.45	0.20	NG	1.56	0.22

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					NE_m	NE_g	ADF	Ca	P
	(%)	% DM	% CP	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(%)
Beet Pulp, Dried Sugar	90.0	9.1	30.0	72.0	0.77	0.49	31.0	0.72	0.20
Beet Pulp, Wet Sugar	25.1	9.1	30.0	72.0	0.77	0.49	31.0	0.72	0.20
Beets, Whole Sugar	20.1	6.8	NG	81.0	0.90	0.60	NG	0.24	0.24
Bread Coproduct	70.2	15.9	NG	90.0	1.00	0.70	NG	NG	NG
Brome Hay, Immature	90.0	15.0	10.0	63.0	0.58	0.32	NG	0.59	0.32
Brome Hay, Early Bloom	90.0	10.5	15.0	55.0	0.52	0.26	NG	0.43	0.25
Brome Hay, Mid Bloom	90.0	8.0	20.0	53.0	0.50	0.25	NG	0.29	0.28
Brome Hay, Mature	90.0	6.0	30.0	50.0	0.46	0.21	NG	0.26	0.15
Buckwheat Grain	86.6	12.5	NG	77.0	0.79	0.53	17.0	0.11	0.36
Buckwheat Hulls	87.8	3.5	NG	16.6	0.00	0.00	NG	0.29	0.02
Buckwheat Middlings	88.7	33.5	NG	83.7	0.88	0.60	10.0	NG	1.15
Buckwheat Straw	88.0	4.9	NG	42.0	0.42	0.00	NG	1.41	0.12
Bulrush Hay	90.0	8.8	NG	NG	NG	NG	42.0	0.76	0.16
Canola Hay	88.0	16.3	NG	65.0	0.67	0.40	41.0	1.30	0.27
Canola Meal, Expeller	90.0	41.0	35.0	76.0	0.80	0.52	16.0	0.60	0.94
Canola Meal, Solvent	90.0	43.6	28.0	69.0	0.73	0.45	18.0	0.67	1.00
Canola Seed	92.0	21.0	20.0	115.0	1.34	0.97	12.0	0.35	0.68
Canola Seed, Frozen	85.0	21.1	NG	101.0	1.16	0.82	NG	0.39	0.69
Canola Silage	25.0	12.5	NG	55.0	0.52	0.27	40.0	1.03	0.30
Carrots	13.0	10.3	NG	82.0	0.86	0.59	11.0	0.37	0.32
Cattail, Narrowleaf	91.0	6.4	NG	45.0	0.45	0.11	50.0	NG	NG
Chaff, Small Grain	93.0	6.2	NG	37.0	0.39	0.00	45.0	0.21	0.07
Chaff, Small Grain, Ammoniated	85.0	10.0	NG	50.0	0.51	0.12	NG	0.21	0.07
Chickpeas (Garbanzo Beans)	89.9	21.7	NG	89.0	0.93	0.65	8.0	0.17	0.37
Chickpea Straw	89.0	5.5	NG	45.0	0.36	0.12	53.6	NG	NG
Concentrated Separator By-product	66.0	20.0	20.0	67.0	0.75	0.42	0.0	0.05	0.03
Condensed Distillers Solubles	30.0	25.0	20.0	97.5	1.08	0.87	NG	0.10	1.38
Corn Cobs, Ground	90.0	2.8	30.0	48.0	0.47	0.07	44.0	0.12	0.04
Corn Gluten Feed, Wet	43.0	21.5	20.0	88.0	0.99	0.68	14.0	0.10	1.20
Corn Gluten Feed, Dry	90.0	21.5	20.0	83.0	0.92	0.62	14.0	0.10	1.20
Corn Gluten Meal	91.0	65.9	60.0	89.0	1.00	0.69	5.0	0.08	0.51
Corn Grain, Dry Rolled	88.0	10.0	60.0	90.0	1.02	0.70	3.0	0.02	0.31
Corn Grain, Ear	87.0	9.0	60.0	83.0	0.92	0.62	NG	0.05	0.28
Corn Grain, High Moisture	75.0	10.0	40.0	90.0	1.02	0.70	NG	0.02	0.31
Corn Grain, High Moisture Ear	75.0	8.7	40.0	83.0	0.92	0.62	NG	0.05	0.28
Corn Grain, High Moisture snapped	74.0	8.8	40.0	81.0	0.90	0.59	NG	0.06	0.27
Corn Grain, Steam Flaked	82.0	10.0	45.0	94.0	1.06	0.73	NG	0.02	0.31
Corn Silage	35.0	8.0	25.0	70.0	0.74	0.47	NG	0.27	0.20

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	(%)	% DM	% CP	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(%)
Corn Silage, Drought Damaged	35.0	11.1	25.0	61.0	0.67	0.40	NG	0.34	0.20
Corn Steep Liquor	54.0	35.0	0.0	90.0	1.02	0.70	0.0	0.06	1.10
Corn Stover	90.0	4.8	30.0	45.0	0.44	0.19	46.0	0.49	0.09
Cottonseed Meal, Solvent	91.0	45.8	30.0	76.0	0.83	0.54	NG	0.17	1.21
Crambe Meal	91.0	29.8	20.0	70.0	0.77	0.50	30.0	1.10	0.90
Crested Wheat Hay, Mid Bloom	90.0	9.7	20.0	53.0	0.49	0.24	NG	0.33	0.21
Crested Wheat Hay, Full Bloom	90.0	8.7	25.0	50.0	0.46	0.21	NG	0.28	0.16
Crested Wheat Hay, Mature	90.0	6.0	30.0	44.0	0.33	0.09	NG	0.26	0.12
Distillers Dried Grains, Barley	92.0	30.1	NG	69.1	0.70	0.43	14.0	NG	NG
Distillers Dried Grains, Corn	92.0	29.5	60.0	86.0	0.96	0.66	17.0	0.10	0.40
Distillers Dried Grains, Milo	93.0	33.2	60.0	83.0	0.92	0.62	16.0	0.16	0.74
Distillers Dried Grains, Wheat	93.0	33.5	NG	78.9	0.85	0.56	NG	0.08	0.56
Distillers Wet Grains, Corn	30.0	29.5	60.0	126.0	1.43	0.98	NG	0.10	0.40
Emmer, Grain	91.0	13.5	NG	80.0	0.85	0.56	NG	0.06	0.40
Fababeans	85.0	30.6	NG	88.2	0.93	0.68	10.0	0.12	0.59
Fababean Silage	33.0	20.0	NG	53.9	0.54	0.25	39.0	0.91	0.24
Field Peas, Grain	88.0	23.6	30.0	90.0	1.02	0.70	8.0	0.15	0.44
Field Pea Hay	88.0	13.6	NG	58.0	0.56	0.27	38.0	1.39	0.28
Field Pea Hulls	92.1	9.0	NG	60.0	0.59	0.33	40.0	0.48	0.09
Field Pea Screenings	90.0	23.6	NG	80.0	0.88	0.59	8.0	0.14	0.48
Field Pea Silage	35.0	15.4	NG	58.0	0.57	0.31	37.0	1.32	0.22
Field Pea Straw	89.0	8.5	NG	46.0	0.38	0.13	38.0	1.62	0.11
Flaxseed	94.0	22.8	NG	110.0	1.28	0.89	8.0	0.26	0.56
Hollowstem Hay, Mature	90.0	5.3	NG	27.0	0.04	0.00	NG	NG	NG
Kochia Hay, Early	87.0	17.0	NG	57.0	0.58	0.29	43.0	NG	NG
Kochia Hay, Late	89.0	12.6	NG	NG	NG	NG	45.0	NG	NG
Lentil Grain	91.0	27.7	NG	83.0	0.92	0.62	7.0	0.08	0.61
Lentil Hay	89.0	14.1	NG	56.0	0.54	0.28	39.0	1.22	0.22
Lentil Silage	35.0	14.5	NG	56.0	0.54	0.28	38.0	1.22	0.22
Lentil Straw	90.0	6.9	NG	45.0	0.36	0.12	46.0	0.65	0.20
Linseed Meal, Solvent	90.0	38.3	48.0	78.0	0.85	0.56	19.0	0.43	0.89
Lupines	89.7	36.2	NG	82	0.87	0.59	14.0	NG	NG
Lupine Silage	37	15.4	NG	66	0.68	0.41	34.0	NG	NG
Millet Grain, Proso	90.0	12.9	30.0	84.0	0.93	0.64	17.0	0.15	0.42
Millet Hay, Foxtail	89.0	14.7	30.0	57.0	0.58	0.29	36.0	0.31	0.23
Millet Hay, Pearl	87.0	13.2	30.0	57.0	0.58	0.29	37.0	NG	NG
Millet Hay, Proso	90.0	10.4	30.0	56.0	0.55	0.23	NG	0.33	0.19
Millet Hulls	93.4	5.7	NG	65.0	0.67	0.41	32.0	0.06	0.24

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	(%)	% DM	% CP	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(%)
Millet Straw	86.0	6.4	NG	51.0	0.47	0.15	45.0	0.44	0.12
Milo (Grain Sorghum)	88.0	10.0	60.0	84.0	0.93	0.64	5.0	0.03	0.33
Milo (Grain Sorghum) Stover	80.0	5.3	30.0	47.0	0.50	0.23	NG	0.48	0.11
Mint Hay	87.5	14.6	NG	57.4	0.56	0.30	NG	1.71	0.22
Molasses, Beet	77.0	10.0	20.0	75.0	0.77	0.50	0.0	0.12	0.03
Mustard Seed, Tame	94.2	35.1	NG	69.0	0.69	0.42	27.0	0.33	1.04
Mustard Seed, Wild	95.9	24.0	NG	93.7	1.07	0.75	NG	NG	NG
Mustard Hay, Tame	90.0	10.0	NG	52.5	0.48	0.23	NG	NG	NG
Oats, Grain	89.0	13.6	30.0	77.0	0.84	0.55	NG	0.07	0.36
Oats, Grain, Light	89.0	13.2	30.0	74.0	0.81	0.53	NG	0.10	0.41
Oats, Grain, Heavy	89.0	12.8	30.0	80.0	0.86	0.57	NG	0.06	0.41
Oats, Grain, Hull-less	89.3	17.8	30.0	93.0	0.97	0.67	4.0	0.11	0.44
Oats, Hay, Flower	90.0	9.2	30.0	59.0	0.58	0.31	NG	0.26	0.24
Oat Hay, Boot	90.0	14.7	NG	61.1	0.61	0.35	NG	NG	NG
Oat Hay, Milk	90.0	11.7	NG	59.8	0.59	0.33	NG	NG	NG
Oat Hay, Soft Dough	90.0	9.9	NG	61.9	0.63	0.36	NG	NG	NG
Oat Hay, Firm Dough	90.0	9.8	NG	61.8	0.66	0.39	NG	NG	NG
Oat Hulls	91.6	5.9	NG	55.0	0.57	0.30	36.0	0.15	0.18
Oat Straw	90.0	4.5	30.0	47.0	0.45	0.09	50.0	0.27	0.10
Oat-Field Pea Hay, Boot	90.0	14.8	NG	61.1	0.61	0.35	NG	NG	NG
Oat-Field Pea Hay, Milk	90.0	13.0	NG	62.9	0.64	0.38	NG	NG	NG
Oat-Field Pea Hay, Soft Dough	90.0	11.9	NG	64.1	0.66	0.39	NG	NG	NG
Oat-Field Pea Hay, Firm Dough	90.0	10.6	NG	62.8	0.64	0.37	NG	NG	NG
Onions	10.0	10.2	NG	86.0	0.97	0.66	NG	0.35	0.40
Pasta Waste	89.7	16.4	NG	91	1.02	0.71	1.0	0.06	0.02
Pigeon Grass Hay, Immature	85.7	9.4	NG	57.7	0.56	0.30	40.0	NG	NG
Pigeon Grass Hay, Mature	88.1	7.6	NG	50.0	0.44	0.19	44.0	NG	NG
Pigeon Grass Seed, green and yellow foxtail	84.0	14.0	NG	62.0	0.63	0.36	32.0	0.20	0.38
Pigweed, Seed	90.0	18.7	NG	65.7	0.65	0.39	NG	NG	NG
Potatoes	23.0	9.6	20.0	80.0	0.83	0.57	3.0	0.05	0.24
Potato Silage (Cull Potatoes)	25.0	8.2	20.0	79.0	0.82	0.55	5.0	0.04	0.23
Potato Processing Waste	13.0	9.9	20.0	82.0	0.91	0.61	9.0	0.11	0.26
Prairie Hay, Early Bloom	90.0	8.7	15.0	53.0	0.52	0.27	NG	0.49	0.19
Prairie Hay, Full Bloom	90.0	6.2	25.0	50.0	0.45	0.20	NG	0.38	0.14
Prairie Hay, Mature	90.0	4.9	30.0	46.0	0.38	0.13	NG	0.38	0.09
Quackgrass Hay	87.0	8.0	NG	52.0	0.48	0.20	48.0	0.34	0.28
Rapeseed, Forage (Pasture)	20.0	17.0	NG	65.0	0.67	0.40	30.0	NG	NG
Rapeseed Straw	80.0	3.5	NG	19.0	0.00	0.00	59.0	NG	NG

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	(%)	% DM	% CP	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(%)
Russian Thistle Hay	90.0	7.2	NG	44.0	0.33	0.00	45.0	NG	NG
Rye Grain	88.0	13.8	30.0	84.0	0.94	0.64	4.0	0.07	0.37
Rye Straw	88.0	3.6	NG	41.0	0.40	0.05	51.0	0.22	0.08
Safflower, Seeds	93.0	17.5	20.0	91.2	1.00	0.65	40.0	0.26	0.67
Safflower Hay, Immature	90.1	9.7	NG	58.0	0.56	0.31	23.0	NG	NG
Safflower Hay, Mature	90.9	13.1	NG	55.0	0.52	0.26	39.0	NG	NG
Safflower Meal, Solvent	92.0	25.4	20.0	57.0	0.55	0.29	41.0	0.37	0.81
Sagebrush, Fresh	50.5	12.9	NG	49.9	0.50	0.18	28.0	1.01	0.25
Screenings, Barley	93.0	12.6	NG	62.0	0.63	0.36	26.3	NG	NG
Screenings, Canola	89.8	15.4	NG	90.0	1.00	0.70	10.0	1.04	0.47
Screenings, Corn	90.0	9.0	60.0	83.0	0.90	0.62	7.0	0.04	0.41
Screenings, Field Pea	90.0	20.0	NG	75.5	0.82	0.54	NG	0.11	0.44
Screenings, Flax	94.0	23.1	NG	96.0	1.09	0.80	17.0	0.33	0.64
Screenings, Grain	90.0	14.2	NG	70.0	0.72	0.44	16.0	0.48	0.43
Screenings, Millet	89.3	13.1	NG	NG	NG	NG	13.1	0.08	0.28
Screenings, Pigeon Grass	89.0	15.8	NG	NG	NG	NG	25.0	0.08	0.44
Screenings, Refuse	90.0	11.5	NG	56.0	0.57	0.29	40.0	0.46	0.32
Screenings, Sunflower	87.0	11.1	NG	64.0	0.66	0.39	29.0	0.72	0.42
Screenings, Wheat	86.0	16.0	20.0	72.0	0.75	0.49	16.0	0.17	0.40
Slough Hay	94.6	5.0	NG	45.0	0.54	0.19	47.0	0.42	0.14
Sorghum Grain, Dry Rolled	88.0	10.0	60.0	84.0	0.93	0.64	NG	0.03	0.33
Sorghum Grain, High Moisture	75.0	10.0	40.0	90.0	1.02	0.70	NG	0.03	0.33
Sorghum-Sudan Hay	91.0	6.0	30.0	56.0	0.57	0.27	42.0	0.55	0.30
Sorghum-Sudan Silage	28.0	8.0	20.0	55.0	0.56	0.26	42.0	0.46	0.44
Soybeans, Whole	91.0	41.7	20.0	91.0	0.96	0.67	10.0	0.27	0.63
Soybean Hay	88.0	16.6	20.0	55.0	0.53	0.22	40.0	1.25	0.25
Soybean Hulls	92.0	12.4	30.0	80.0	0.83	0.57	45.0	0.59	0.17
Soybean Meal, Solvent	89.0	49.0	30.0	84.0	0.94	0.64	NG	0.33	0.71
Soybean Straw or Stover	88.0	5.2	20.0	40.0	0.31	0.06	55.0	1.59	0.06
Spelt, Grain	90.0	13.3	30.0	75.0	0.78	0.53	17.0	0.13	0.42
Sudan Grass Hay, Early Bloom	89.0	11.0	15.0	56.0	0.54	0.29	NG	0.56	0.19
Sudan Grass Hay, Mature	90.0	6.6	30.0	48.0	0.41	0.16	NG	0.26	0.14
Sudan Grass Silage, Immature	25.0	16.8	10.0	59.0	0.58	0.32	NG	0.43	0.19
Sudan Grass Silage, Early Bloom	28.0	11.3	15.0	55.0	0.55	0.28	NG	0.46	0.19
Sudan Grass Silage, Mature	30.0	6.0	20.0	48.0	0.52	0.24	NG	0.26	0.14
Sunflower Hulls	90.0	5.0	NG	40.0	0.41	0.00	63.0	0.00	0.114
Sunflower Meal, Solvent	90.0	38.9	20.0	64.0	0.65	0.35	28.0	0.39	1.06
Sunflower Seed, Confectionary	94.9	17.9	20.0	83.0	0.93	0.63	39.0	0.18	0.56

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	(%)	% DM	% CP	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(%)
Sunflower Seed, Oil Type	94.9	17.9	20.0	121.0	1.42	1.03	39.0	0.18	0.56
Sunflower Silage	25.0	12.2	NG	55.0	0.56	0.26	33.0	1.32	0.38
Sweetclover Hay, Early Bloom	90.0	17.8	15.0	60.0	0.60	0.34	NG	1.45	0.24
Sweetclover Hay, Mid Bloom	86.0	16.0	20.0	55.0	0.56	0.28	NG	1.40	0.21
Sweetclover Hay, Full Bloom	86.0	13.0	25.0	52.0	0.50	0.25	NG	1.35	0.18
Sweetclover Hay, Mature	88.0	11.0	30.0	47.0	0.42	0.17	NG	1.30	0.18
Sweetclover Silage, Early Bloom	27.0	17.8	15.0	60.0	0.60	0.34	NG	1.45	0.24
Sweetclover Silage, Mid Bloom	30.0	16.0	20.0	55.0	0.56	0.28	NG	1.40	0.21
Triticale, Grain	89.0	16.5	20.0	84.0	0.93	0.64	6.0	0.05	0.33
Triticale Hay, Boot	90.0	15.6	NG	60.9	0.61	0.35	NG	NG	NG
Triticale Hay, Milk	90.0	10.5	NG	59.5	0.59	0.33	NG	NG	NG
Triticale Hay, Soft Dough	90.0	9.4	NG	63.2	0.64	0.38	NG	NG	NG
Triticale Hay, Firm Dough	90.0	9.2	NG	62.7	0.64	0.37	NG	NG	NG
Turnip Roots	9.0	14.0	20.0	84.0	0.88	0.61	15.0	0.64	0.21
Turnip Tops	10.0	16.0	20.0	58.0	0.57	0.31	NG	2.90	0.58
Wheat Bran	89.0	18.0	20.0	70.0	0.72	0.44	14.0	0.12	1.32
Wheat Chaff	92.6	5.5	NG	39.8	0.39	0.00	40.0	0.20	0.15
Wheat, Hard Red Spring	89.0	15.1	20.0	88.0	0.99	0.68	4.0	0.04	0.44
Wheat, Durum	88.0	15.7	30.0	85.0	0.95	0.65	4.0	0.11	0.41
Wheat Middlings	90.0	19.1	20.0	83.0	0.87	0.59	11.0	0.16	1.01
Wheat Straw	90.0	3.6	30.0	43.0	0.40	0.02	52.0	0.19	0.09
Wheat Straw, Ammoniated	90.0	9.7	NG	48.0	0.47	0.07	NG	0.19	0.09
Whey, Condensed	63.6	13.7	0.0	82.3	0.87	0.59	0.0	0.60	0.91
Whey, Dried	90.0	14.2	0.0	84.0	0.88	0.61	0.0	0.95	0.80
Whey, Liquid	7.0	14.0	0.0	78.0	0.81	0.54	0.0	0.98	0.81
Wild Oats, Grain	89.0	9.1	NG	74.0	0.80	0.52	22.0	0.25	0.27

Abbreviations

DM = Dry Matter
CP = Crude Protein
UIP = Undegrable Intake Protein (Escape Protein)
TDN = Total Digestible Nutrients
NE_m = Net Energy for Maintenance
NE_g = Net Energy for Gain
ADF = Acid Detergent Fiber
Ca = Calcium
P = Phosphorus
NG = Not Given

Table adapted from:

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www.ag.ndsu.nodak.edu/drought/ds-9-97.htm
www.ag.ndsu.nodak.edu/aginfo/dairy/dairyext/coproduct.pdf

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