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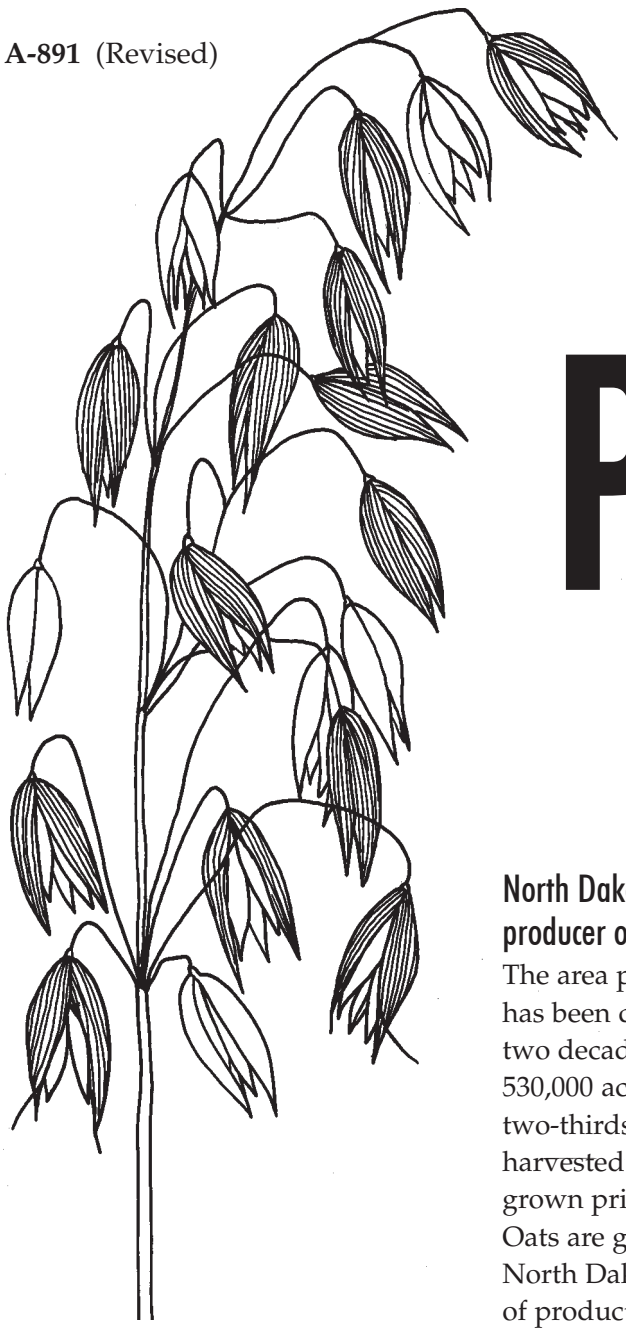

Oat Production in North Dakota

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North Dakota is the leading producer of oats for grain in the U.S.

The area planted to oats, however, has been declining during the last two decades. Oats were grown on 530,000 acres in 2007. Typically, two-thirds of the oats planted are harvested for grain, the rest being grown primarily for forage/hay. Oats are grown in every county in North Dakota, with the major area of production in the southwestern quarter of the state.

Oats produced in North Dakota are generally of high quality with good test weight and protein levels. Oats can be grown for the human food industry (milling), as an animal feed and for forage/hay. Each market demands differing quality. Knowing the market and using appropriate production practices and varieties are key to meeting the quality demanded by these diverse markets.

Quality requirements of milling oats

Oats are used in a wide range of food products, with a growing application in specialty foods due to the health benefits of oat bran. The milling market maintains high quality standards and prefers the following characteristics:

- High test weight (38 pounds/bushel or greater).
- Bright color.
- High groat percent – Groat refers to the kernel after the hulls have been removed. Groat percentage is calculated by dividing the weight of the groat by the weight of the kernel before dehulling.
- Low oil content – Oil increases the caloric value of the product. High levels of oil cause caking in the milled product, which creates handling challenges.
- High protein – All varieties recommended for North Dakota under most production environments meet the minimum requirement for protein content.

- High beta glucan – Extensive research indicates oat soluble fiber comprised of beta glucan (β-glucan) in human diets is effective in lowering serum cholesterol level, improving the ratio of HDL (good cholesterol) to LDL (bad cholesterol) and maintaining functions to moderate glucose metabolism in individuals with type 2 diabetes.
- Available varieties that are well-suited for the milling market include Jerry, Youngs, Morton, HiFi, Souris, Stallion, Hytest, Trucker, Maida and CDC Dancer.

Quality requirements for feed uses

Oats are an excellent feed for sheep, hogs, dairy and beef, and horses. With the exception of the racehorse market, the specifications for oats used for feed are less strict than those used for milling, so yield becomes a dominant factor when selecting varieties for this market. Nevertheless, the following are the preferred quality characteristics of feed oats:

- High test weight.
- High oil content because this provides extra energy to the animal.
- High protein content.
- Kernel quality characteristics of primary concern for the premium racehorse market include uniformly large kernels with bright, white hull color and very high test weight. Protein standards usually are met by all varieties even though higher protein content is desirable.
- Current varieties that are well-suited for the race horse market include Beach, Morton, Trucker, Hytest, Stallion, Otana, CDC Dancer, AC Pinnacle and AC Ronald.

Quality factors for forage uses

Forage quality is largely determined by its digestibility and its crude protein content. Oat varieties can vary for these factors. Total energy also is influenced by the yield. Late-season varieties generally are grown for forage because they tend to produce more biomass.

Usually varieties that produce the highest grain yield will produce the greatest forage yield. Nevertheless, varieties that have been identified as having good forage yield and quality in a range of environments in North Dakota include Paul and Stark.

Fitting Oats in the Crop Rotation

Oats can be a good crop to include in a rotation. Oats do best when they are grown following a noncereal crop, such as soybean, dry bean, potatoes, flax and canola. Oats also can be grown after corn as they are not as susceptible to Fusarium head blight (scab) as other small grains. Oat stubble fields are excellent for establishing winter wheat no-till since they do not carry diseases that affect wheat. Oats also can be grown after barley or wheat with limited risk of diseases affecting barley and wheat carrying over to the oat crop; few diseases that are common to wheat and barley infect oats. The best yields, however, will be obtained when following a noncereal crop.

Variety Selection

The first consideration when selecting an oat variety is its intended use. Table 1 identifies a number of available varieties and their suitability for milling, feed or forage. For the most up-to-date information on the relative yield of available varieties, use the "North Dakota Barley, Oat, Rye and Flax Variety Trial and Selection Guide" that is published each year. These data can be viewed on the Internet at *www.ag.ndsu.nodak.edu/aginfo/variety/index.htm*. Additionally, data from off-station trials can be viewed at the same site.

When available, use data from multiple years and locations that are representative of the soil and weather on your farm when selecting a variety. Varieties that perform well in a range of environments have a higher probability of being more productive than those that do well in only a single year or environment. When selecting a variety for forage/hay, refer to *www.ag.ndsu.nodak.edu/plantsci/forage/research.htm* for quality and yield information.

When comparing the yield of hull-less oat varieties with regular hulled types, add 35 percent to the weight of the hull-less types because the hulls make up that additional weight.

In addition to yield, consider quality characteristics, such as test weight, protein, oil and grain color. β-glucan concentration may be a consideration if producers are targeting markets that will return value to producers for increased nutritional quality. Disease resistance, especially crown rust resistant, also should be considered. As new virulence

Table 1. Descriptions for oat varieties adapted to North Dakota, updated 2006.

Variety	Origin	Year Released	Grain Color	Height	Straw Strength	Maturity[1]	Reaction to Diseases				
							Stem Rust[2]	Crown Rust[2]	Barley Y.Dwf[3]	Bu/Wt	Protein[4]
AC Assiniboia	Can. Proven Seed	1997	red	med	strong	L	S	S	T	good	ML
AC Gwen	Can. SeCan	2000	hulless	tall	strong	L	S	S	R	good	L
AC Kaufman	Can.	2000	yellow	tall	strong	L	S	S	MT	v.good	ML
AC Morgan	Can. SeCan	1999	white	med.	strong	L	S	S	S	v.good	ML
AC Pinnacle	Can. QAS	1999	white	tall	med.	L	S	S	S	v.good	L
AC Ronald	Can. SeCan	2001	white	m. short	v. strong	L	S	S	T	v.good	M
Beach	NDSU	2004	white	tall	m.strg.	ML	S	MR/MS	MS	v.good	M
Buff	SD	2002	hulless	med.	m.strg.	L	S	MR/MS	MT	good	H
CDC Dancer	Can. Cargill	2000	white	tall	strong	L	S	MS	S	v.good	M
CDC Orrin	Can. QAS Cargill	2001	white	tall	strong	L	S	S	S	good	ML
CDC Pacer	Sask. Value Added	1996	white	tall	m.strg.	L	S	S	S	good	L
HiFi	ND	2001	white	tall	strong	L	MR/MS	R	T	good	M
Hytest	SD	1986	white	tall	m.strg.	E	S	MS	S	v.good	H
Jerry	ND	1994	white	tall	strong	M	S	MS	MT	v.good	M
Jud	ND	1997	ivory	tall	med.	L	R	MR/MS	T	good	MH
Killdeer	ND	2000	white	med.	strong	M	S	MS	MT	good	M
Leonard	MN	2001	yellow	tall	m.strong	L	S	S	T	fair	ML
Loyal	SD	2000	ivory	tall	m.strong	L	S	MS	T	good	MH
Maida	ND	2005	yellow	med.	strong	M	R	S	MS	v.good	MH
Monida	MT/ID	1985	white	m.tall	strong	L	S	S	NA	good	ML
Morton	ND	2001	white	tall	v.strong	L	S	R	MT	v.good	M
Otana	MT	1977	white	m.tall	m.weak	L	S	S	S	v.good	ML
Paul	ND	1994	naked	v.tall	strong	L	R	MR/MS	T	good	H
Reeves	SD	2002	white	m.tall	med.	E	S	MR	MT	good	H
Souris	NDSU	2006	white	med.	strong	M	MS	R	MS	v.good	M
Stallion	SD	2006	white	tall	med.	L	S	MR	NA	v.good	M
Stark	NDSU	2004	naked	tall	m.strg.	L	R	MR/MS	T	v.good	M
Vista	WI	2000	yellow	tall	strong	L	S	R	MT	good	M
Wabasha	MN	2001	white	tall	v.strong	M	S	S	T	good	M
Youngs	ND	1999	white	med.	strong	L	S	MS/S	MT	good	M

[1] E = early; M = medium; L = late.

[2] R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible.

[3] S = susceptible; MS = moderately susceptible; MT = moderately tolerant; T = tolerant.
Varieties rated MT or T have a relatively good degree of protection against barley yellow dwarf virus.

[4] H = high; M = medium; L = low; V = very; VL = very low.

develops in the crown rust population, genetic resistance to specific races in specific varieties may be ineffective in providing resistance to the new virulent races. Only the most recently released oat varieties have resistance to the prevalent races of crown rust in oats.

Certified seed is recommended when purchasing seed. Certified seed not only guarantees the levels of weed seed contaminates and germination, it also guarantees the genetic identity of the variety.

Planting

Date

Plant early. Oats respond positively to early planting and are adapted to cool seedbeds. Early planting enables more tiller production and larger panicles,

and avoids high-temperature stress later in the season that can reduce seed size. Diseases that develop late in the season may be avoided by early planting. The optimum period for planting is before May 15 in northern regions of the state and before the end of April in southern regions. In fields where wild oats are problematic, research has shown that wild oat severity can be reduced by planting after the first flush of wild oats have emerged and been controlled. This practice, however, likely will result in yield reductions due to the effects of late planting.

Seeding Rate

For grain production, the recommended seeding rate is 1 million pure live seeds per acre (approximately 60 to 90 pounds/acre). Use a slightly higher rate if seeding deep, late or into a rough seedbed. Higher seeding rates can offer improved competition with wild oats. However, excessive plant populations can reduce test weight and protein and increase lodging.

The percent of hull-less oat seeds that germinate can be low because the embryo can be damaged easily during harvest and handling. Be sure to adjust for germination when calculating your seeding rate of hull-less oats. Because of the heavier bushel weight of hull-less types, the recommended seeding rate equates to 48 to 62 pounds/acre.

When seeding oats for forage, use a seeding rate similar to that used for grain. However, when oats are grown as a companion crop when establishing a perennial forage, use two-thirds of a normal seeding rate if seeding early and a full seeding rate if seeding late since tillering is less with later seedings.

Seeding depth

Oats have the ability to emerge through elongation of the coleoptile and the first internode, resulting in the crown being closer to the surface of the soil than other small grains up to the three-leaf stage. The optimum seeding depth is 1.5 to 2.5 inches. When seeding depth approaches 3 inches, stand reduction can occur.

Fertility Management

Nitrogen (N) and phosphorus (P) are the plant nutrients most often found deficient in this region. Fertilizer rates should be based on yield potential, a fall soil test and any expected N to be released from the previous crop. The basic recommendation for N is:

N recommendation (pounds N/acre) = 1.3 X YP – STN - PCC

YP = yield potential (bushels/acre) based on some historic average from the farm or area

STN = soil test nitrate-N (pounds N/acre) from a soil surface to 2-foot depth

PCC = previous crop credit (pounds N/acre) from annual/perennial legumes or sugar beet leaves

The previous crop credit (PCC) for annual legumes, including soybean, dry bean, pea and lentil, is 40 pounds N/acre. The PCC for sugar beet varies with canopy color at harvest. See NDSU Extension publication SF-882 (revised 2007) for more detailed information on suggested PCC values.

Selection of N source should be based on cost, convenience, practicality, safety and availability. Placement and timing of application also is critical to achieving the highest efficiency possible for each product. If applied correctly, no difference occurs in the efficiency of any source of N. Anhydrous ammonia should be applied 4 to 6 inches deep to reduce gaseous losses. If applied at seeding, the lateral distance between the center of the ammonia band and the seed furrow should be 3 inches.

Dry products broadcast on the soil surface should be incorporated shortly after their application. In no-till, subsurface applications of N are preferred to avoid large possible ammonia volatilization losses from urea. Fall applications of N are usually as efficient as spring applications, except on sandy soils or soils subject to flooding. Some fall conditions with exceptionally warm weather would make fall applications less efficient than spring applications.

Fertilizers should not be applied to frozen soils. Urea-based fertilizers are very soluble and spring runoff will carry the fertilizer off site if the soils are frozen. The amount of fertilizer placed with the seed should be limited (See NDSU Extension publication EB-62).

Sulfur deficiencies may occur on low organic matter sandy soils following higher than normal rainfall. No responses to micronutrients have been observed in North Dakota.

The following table shows selected values of fertilizer nutrient rates using current recommendation formulas for oats:

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/acre	lb/acre		lb P_2O_5/acre					lb K_2O/acre				
50	65		29	21	13	5	0	55	38	21	4	0
70	90		41	29	18	7	0	77	53	29	5	0
90	115		52	38	23	8	0	100	69	38	7	0
110	145		64	46	28	10	0	122	84	46	8	0

Nitrogen recommendation = 1.3 YP-STN-PCC
Bray-I P recommendation = (0.644-0.032 STP)YP
Olsen P recommendation = (0.644-0.041 STP)YP
Potassium recommendation = (1.2777-0.0086 STK)YP

STP = soil test P from the 0- to 6-inch depth

STK = soil test K from the 0- to 6-inch depth

Weed Control

Oats can be competitive with weeds when properly managed. Fields infested with wild oat should be avoided because no herbicides that are registered can control wild oats selectively in an oat crop. A number of herbicides are registered for use in controlling broadleaf weeds. Refer to the most recent edition of the "North Dakota Weed Control Guide" (W-253) available from the NDSU Extension Service for information on registered herbicides. Always refer to and follow the label of any product before applying.

Wild oats are controlled most effectively by rotating with crops where wild oat control is possible. When growing oats, higher seeding rates (> 1 million seeds per acre) can help reduce the production of wild oat seeds. Late seeding after the first flush of wild oats has emerged and been controlled by a preplant burn-down also can be used to limit wild oat competition in fields where wild oats are known to be problematic. Late planting can significantly reduce yield, however.

Disease Management

Oats are subject to a large number of diseases that can cause severe damage to quality and reduce yields. The most common diseases that effect yield are crown rust, stem rust and barley yellow dwarf virus.

Crown Rust

Crown rust generally is the most widespread and destructive disease of oats in North Dakota. Crown rust can reduce yields, lower test weights and groat percentage, and increase lodging. This disease is caused by the fungus *Puccinia coronata*, whose spores are blown in from oat-producing regions further south; late planting can exacerbate crown rust-related losses. Crown rust can be identified by the pustules producing yellow-orange spores that infect leaves primarily. The size of the rust pustule can be variable depending on the susceptibility of the variety and the weather. As the crop approaches maturity, a black spore stage also is found on the oat leaves, appearing as a black or dark brown ring around the yellow-orange pustules.

The most effective and economical method of crown rust control is achieved with resistant varieties. The crown rust fungus can quickly develop new races that are pathogenic to the genetic resistance that is available. Therefore, resistant varieties become susceptible to crown rust as new races develop. Refer to the latest select variety selection guide to determine the level of resistance to the prevalent races of crown rust.

A number of fungicides are registered for use on oats that can control crown rust and other foliar diseases. However, the use of fungicide is not common due to economic considerations. Consider applying fungicide only when the yield potential and value of the crop is high, the oat variety is susceptible to crown rust and other foliar diseases, leaf diseases developed early in the season and the long-range forecast is for continued moist weather. Fungicides should be applied to protect the flag leaf. The best time to apply fungicide is near flowering. Refer to the most recent "North Dakota Field Crop Fungicide Guide" for details of the registered products.

Stem Rust

Stem rust epidemics are infrequent in North Dakota, but they have the potential of being very serious if oats are planted late and spores from the south are abundant. Stem rust is caused by the fungus *Puccinia gaminis* f. sp. a*venae*. The major source of infection is from spores blown up in summer winds from southern-grown oats. The spores infect the stem, leaf sheaths and blades, and when the spores break through the surface of the tissue, a red-rust mass of spores is visible.

Stem rust and crown rust are distinguished fairly easily on the basis of spore color. Stem rust spores are more brick red, while crown rust spores are a bright yellow orange. The red-rust spores of stems rust also are carried from diseased plants to nearby plants via wind. These spores are replaced with a mass of black spores later in the season.

Control of stem rust, as with crown rust, is most economically accomplished by using resistant varieties. Refer to the latest selection guide to determine the level of resistance in available varieties to the prevalent races of stem rust. Stem rust resistance in oat varieties is generally more stable than crown rust resistance. Stem rust can be controlled with fungicides. The guidelines for the use of fungicides for crown rust also apply to their use to control stem rust.

Barley Yellow Dwarf

Barley yellow dwarf (BYD) is an aphid-vectored virus with the potential to be destructive in oats in North Dakota. It often is referred to as oat "red leaf" disease because of the reddish-brown discoloration seen on the infected leaves. The barley yellow dwarf virus also infects wheat and barley. It is transmitted from plant to plant by several species of grain aphids. These aphids acquire the virus when feeding on infected plants in the southern half of the U.S. and then those aphids are carried to northern oat fields in winds and by storm fronts. The disease potential greatly depends on the northward movement of these aphids from southern fields.

Barley yellow dwarf-infected plants normally are first seen along edges of fields. The leaves turn a yellow red to reddish brown. The entire leaf blade may die prematurely. The plants generally are stunted and heads of infected plants often are severely blasted and seed is low in test weight. Control is accomplished by growing tolerant or resistant varieties. Early planting also is helpful in reducing damage caused by BYD. Refer to the latest variety selection guide to identify varieties with tolerance or resistance.

Oat smuts

Smuts of oats have not been serious problems in North Dakota, but loose smut has reached economic levels in Wisconsin and Minnesota. As with loose smut of barley, this disease can be controlled with seed treatment. Refer to the most recent "North Dakota Field Crop Fungicide Guide" for details of the registered seed treatment products.

Oat Blue Dwarf

Oat blue dwarf is a virus disease that generally occurs in trace amounts in oats and it can occur in other grass hosts, including barley. Oats infected with blue dwarf are severely stunted and a dark bluish green, and spikelets are blasted. The disease is transmitted by the six spotted leaf hopper. No control measures are available.

Fungal leaf spots

Helminthosporium and *Septoria* species cause fungal leaf spots on oats. These leaf spots have not been a serious problem in North Dakota. They would be expected to be most serious where oats have been planted on oat stubble and if moist, rainy weather persists. These diseases can be controlled through rotation. A number of fungicides are registered for the control of leaf spots. Refer to the most recent "North Dakota Field Crop Fungicide Guide" for details of the registered products.

Blast

Blast of oats occurs when the spikelets do not develop completely and sterility results. Virus diseases, such as barley yellow dwarf and oat blue dwarf, may cause blast. More frequently, blast is due to excessively high temperatures and moisture stresses occurring at the time of panicle differentiation and pollination. Early planting reduces the likelihood of blast while late seeding and overplanting favor the occurrence of blast.

Harvesting and Storage of Oats for Grain

To avoid losses from shattering, oats usually are swathed and threshed by a combine with a pickup attachment. Swathing of oats should commence when the kernel moisture content is about 35 percent. This is usually when the panicle has turned yellow or brown, even as some stems still may show some green color and the least mature kernels have changed from green to cream. The swathed oats should be threshed as soon as they reach an appropriate moisture. Oats that are left too long in the field can weather and may not be acceptable for premium markets.

Combine settings should be slower and the concave wider from those used for other small grains to avoid dehulling kernels. Hull-less oat varieties are more susceptible to kernel damage, so cylinder speeds should be reduced to approximately 900 rpm to prevent damage.

Oats should be dried to at least 14 percent moisture before storage and to 12 percent moisture for long-term storage.

Growing Oats for Forage

Growing oats for forage requires many of the same management factors as growing oats for grain. Variety selection is one area to consider. The forage quality and yield of oat varieties are evaluated from time to time.

In a recent study, oat varieties and experimental lines were evaluated for three years at Fargo and one year at Williston and Minot for forage quality and yield. The entries were seeded at 1 million pure lives seeds/acre and harvested at the very early soft-dough maturity stage. Paul oats, a naked variety, was the highest forage yielding line at Fargo and nearly the highest at the other two locations. A few experimental lines also looked promising (data on the forage quality of new releases will be made available at the following site *www.ag.ndsu.nodak.edu/plantsci/forage/research.htm)*.

Early maturing oat varieties, such as Jerry and Killdeer, and two forage varieties, such as Ensiler and Forage Plus from Wisconsin, generally were lower yielding than Paul. In general, later maturing entries were higher yielding than early maturing entries.

Forage quality generally was greatest from the late-maturing cultivars (ForagePlus was an exception), which is opposite of that reported in Wisconsin. Paul oats had the greatest relative feed value due to a low neutral detergent fiber and acid detergent fiber. In vitro dry-matter digestibility of Paul was similar to Ebeltoft and the greatest of the released entries tested.

In other research conducted at Dickinson, the forage yield of Paul oat was typically lower than most other conventional oat cultivars tested, though forage quality was generally superior for Paul. This indicates varieties that are best suited for forage production in one environment may not be the best for other environments. Use data from as many sites and years as possible to help in selecting varieties that will perform well consistently.

If undecided as to whether the oats will be used for forage or grain, consider using a variety such as AC Ronald, AC Assiniboia or Beach. These varieties have a good grain yield and above-average forage quality. Unfortunately, not all oat varieties have been tested for forage quality.

The maturity stage at which oats should be harvested for forage varies with the type of livestock to be fed. Oats should be harvested at the soft-dough stage when fed to a cow-calf herd so nearly maximum nutrients per acre can be obtained. If oats are harvested too late, the palatability decreases and mature kernels will shatter during the baling operation. Oats should be harvested at the late-boot stage when the forage is to be used in a dairy ration to help meet the energy demands of the producing dairy cow.

Oats used as forage generally are put up as hay in North Dakota, but occasionally are harvested as a haylage. The maturity stage for haylage should be the same as for hay. The primary problem with obtaining good-quality haylage is controlling the moisture content when ensiling. Oats at the soft-dough stage will have from 25 percent to 35 percent dry matter, depending on the environment. Haylage should have 45 percent to 50 percent dry matter for good ensiling, so some wilting will be required. Be careful not to lay down too much at one time or it will be difficult to control the ensiling moisture content.

Field pea/oat mixtures sometimes are used to increase hay quality. If peas are included, the seeding rate of oats should be decreased about 20 percent to 30 percent to allow some space for the peas. Typically, 40 to 60 pounds per acre (lb/a) of peas are seeded. Pea/oat mixtures generally yield similar to or slightly less than pure oat stands. Including peas will increase the crude protein content about 1.5 percentage units, increase the digestibility and lower the fiber content of the hay.

Useful Internet Resources

Information on variety performance and characteristics

North Dakota
www.ag.ndsu.nodak.edu/aginfo/variety/oat.htm

Minnesota
www.maes.umn.edu/06VarietalTrials/index.asp

Montana
http://plantsciences.montana.edu/crops/

South Dakota
http://plantsci.sdstate.edu/smallgrains/index.cfm

General production information

South Dakota
http://agbiopubs.sdstate.edu/articles/FS384.pdf

Manitoba, Canada
www.gov.mb.ca/agriculture/crops/cereals/bfc01s01.html

Ontario, Canada
www.omafra.gov.on.ca/english/crops/facts/98-017.htm

Saskatchewan, Canada
www.agr.gov.sk.ca/document_level_4.asp?lev=4&cat=77&cat2=117

Certified Seed Catalog for North Dakota
www.nd.gov/seed/reports/Default.asp

Forage Production Information

www.ag.ndsu.nodak.edu/plantsci/forage/research.htm

For more information on this and other topics, see: www.ag.ndsu.edu

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