

Information used to create this seed manual has come from Penn State University, Purdue University, University of Manitoba, Oregon State University, Ohio State University, University of Minnesota, University of North Dakota, Cornell University, Ampac Seed Company, CISCO Seed Company, Pickseed West, Wild Rose Seeds, USDA, and many others.

Farm Seeds

Legumes

The plant family Leguminosae contains just under a twelfth of the world's flowering plants. Many species are important as crop plants and as sources of pharmaceutical products. They are responsible for much of the world's soil fertility through nitrogen fixation.

Grasses

A plant in the Gramineae family. No less important than legumes in the overall scheme of feeding livestock are the grasses. Versatile and grown on every continent in almost every temperate zone. Grasses outnumber legumes in total species recommended for the Midwest.

Establishing Forage Stands

Plan ahead to encourage success!

Select Forage Species. Decide which forage species or mixture will be seeded. Some species are better suited to certain soil types than others. For example, alfalfa does not tolerate poorly drained or low pH soils. Red clover or reed canarygrass perform very well under these conditions. In many cases, it is difficult and expensive to change soil characteristics, however, species can be changed easily with little or no expense. Proper matching of forage species to soil characteristics not only makes establishment easier but also improves production over the life of the stand.

Select Varieties. Select a variety or the varieties of the forage species you expect to plant and order seed early to insure that you can obtain the best variety for your situation.

Do not attempt to seed alfalfa back into an alfalfa field within 1 year from when the old alfalfa was killed. Established alfalfa plants produce a chemical which is toxic to alfalfa seedlings. Rotating out of alfalfa for a minimum of one year will allow the chemical to decompose. In addition, rotating to another crop will help reduce alfalfa disease and insect pests.

Soil Test. A soil test should be completed and lime added to correct low pH conditions at least six months prior to forage seeding. Planning a year in advance will also allow several opportunities to apply any nutrients that the soil test recommends in large quantities.

Control Weeds. If the crop rotation permits, this is a final opportunity to control those perennial weeds that will be difficult or impossible to control once the forage is seeded. The cost of controlling weeds now should be considered an investment that will return over the life of the forage stand. Weed control in previous crops can significantly reduce weed infestations during forage seedling establishment. However, herbicide use during the year preceding a forage seeding should be monitored closely. Carryover in the soil of triazine herbicides used on the previous corn crop will cause yellowing and potential death of young legume seedlings. Avoid

using triazine herbicides in the last year of corn. If triazine is used in the year preceding forage seeding, rates should be less than one pound per acre.

Adjust Soil pH and Fertility. This is also the last chance to adjust soil pH prior to seeding. Most agriculture grade limestone requires about six-months from the time of application until it effectively changes the soil pH. Consequently, adding lime to raise the soil pH within less than six months of seeding will generally result in forages being seeded into soil with a pH lower than desired.

Apply fertilizer, as recommended by the soil test, to bring soil nutrient levels to optimum or high. Many fields will have received manure applications during the previous crop so that fertilizers may not be needed. However, a \$10.00 soil test can accurately measure soil nutrient levels and prevent poor forage establishment as a result of improper soil fertility.

Following Sound Seeding Practices: Selecting a Seeding Date

Late Summer. Late-summer seedings of forages are generally most successful in the Midwest. An early maturing grain crop can be grown and harvested, the seedbed prepared, and the forage crop seeded before late August. Fall rains and cool temperatures provide an ideal environment for forage seedling growth and establishment.

Spring. Spring forage seedings are popular throughout the Midwest and can be equally successful as late-summer seedings. However, wet soil conditions make preparing a good seedbed difficult, weed competition is generally greater, and the possibility of summer droughts all increase the risks of spring forage seedings.

Winter. Winter seedings or frost seedings are generally not as successful as late-summer or spring seedings, but they are not as costly. Winter seeding involves spinning forage seeds onto the frozen ground (generally to thicken an existing forage stand or to establish a forage crop into a fall-seeded small grain). It is more successful if completed during a time period when the soil is not snow covered and is freezing at night and thawing during the day. Traditionally, clovers are the easiest and grasses are the most difficult forages to establish with this seeding method.

Understanding Basic Establishment Principles

Regardless of the seeding date or seeding method, there are a few key agronomic principles that should be kept in mind when attempting to establish forage crops.

1. Seeding depth and seed-to-soil contact are critical. A general rule-of thumb is that seeds should not be seeded deeper than five times their diameter. For most forage crops this means that seeding depth should not exceed 3/8". Seeding deeper will reduce drastically the number of seedlings that will establish.

After planting, seeds must absorb water from the soil before they germinate. Poor seed-to-soil contact will delay water absorption, allow seeds to dry after absorbing water, and in general cause poor germination and forage establishment.

2. Recommended seeding rates are designed to compensate for normal forage seed and seedling losses during establishment. Seeding at lower rates than recommended can jeopardize the success of the seeding.

3. Legumes have the ability to convert atmospheric nitrogen into plant nitrogen, through a symbiotic relationship with rhizobia bacteria. In many soils, sufficient numbers of rhizobia bacteria are already present to adequately infect legume roots, particularly if the same legume species has been grown in the field within the past few years. **Inoculation (adding rhizobia bacteria to the seed prior to planting) is recommended when the legume being planted has not been grown in the field for the past three years. Inoculation is inexpensive insurance that sufficient bacteria will be in the soil for proper nitrogen nutrition of the legume plant.**

4. Use of a nurse crop with spring forage seedings is popular. Nurse crops can reduce soil erosion potential and weed infestations, but they can also compete with the forage seedlings for light, moisture, and soil nutrients. In addition, herbicides for weed control in a small grain/forage seedling mixture are limited. If a nurse crop is used then remember to: 1) seed nurse crop at reduced rate [e.g. one bushel of oats per acre]; 2) avoid nitrogen application because it will increase nurse crop growth and competition with forage seedlings; 3) mow the nurse crop off when it is in the vegetative stage or harvest it early, during the milk or early dough stage, to minimize competition with forage seedlings.

Tillage Options for Successful Forage Establishment

On some fields tillage is not practical because of the potential for soil erosion. In these fields no-till seeding is recommended. However, in fields that will be tilled prior to forage seeding, a few guidelines should be followed.

Conventional Tillage. Tillage of the soil when it is too wet will make establishing a forage crop difficult. Tilling wet soil causes soil compaction which reduces water movement through the soil and hinders root development. In addition, it is difficult to achieve a fine seedbed or good seed-to-soil contact if the soil was wet at the time of tillage.

A firm and fine seedbed helps regulate seeding depth and improves seed-to-soil contact. However, excessive tillage will destroy desirable soil structure, reduce soil porosity, decrease water infiltration, and increase the probability of soil crusting.

A level seedbed will greatly reduce the wear on equipment and the machinery operator during harvesting. A few minutes to properly adjust the tillage implement to achieve a level seedbed or one extra tillage pass to level the seedbed pays dividends over the life of the forage stand.

No-Till. No-till forage seeding is ideal for many soils and the topography in the Midwest. It can be very successful if a few precautions are taken.

1. A no-till drill is necessary for successful no-till establishment of forages. No-till drills are designed and equipped to seed in soil that has not been tilled. Conventional grain drills should not be used to no-till forages.
2. Weed suppression is essential to successful no-till forage establishment. Any green plants present in the field at seeding should be controlled with a total kill contact killing herbicide.
3. Successful no-till seedings require that seeding be done at the proper soil moisture. The no-till drill opens a slit in the soil by a disc or narrow shovel. The seed is dropped into the slit. If the ground is too wet, the slit will not close resulting in poor seed-to-soil contact. On the other hand, when the soil is too dry it is difficult to get the no-till drill to penetrate the soil and place the seed at the proper depth. Successful forage seedings have been made with many type of seeders. The method of seeding is not as important as achieving proper seeding depth and good seed-to-soil contact.

Properly Manage Young Forage Seedling

From the time the seedlings emerge until they are established is frequently the period when lots of money and energy are expended attempting to correct problems that should have been corrected months before the forage crop was seeded. Do it right the first time to avoid doing it later at a big cost.

Fertilization. If soil nutrient levels are optimum to high at the time of seeding, then fertilization generally should not be a concern during forage establishment. An exception would be the application of 30 to 50 lb/acre nitrogen fertilizer to spring seeded, pure grass forage crops in late summer of the seeding year if production warrants. Contact your local farm center for recommendations that fit your area.

Control Weeds. Weed control prior to forage seeding will greatly reduce the need for weed control during forage establishment. However, if weeds are a problem during establishment then cultural practices (such as harvesting) or herbicides are available to help control them. The best weed control in forages is achieved by maintaining a dense healthy forage stand through proper fertilization, cutting management, and insect control.

Harvest. The goal of harvest management during forage establishment should be to facilitate the production of a healthy vigorous crop and suppress annual weeds that may be in the new seeding. Delaying the initial harvest until the forage plant has flowered will allow adequate root reserves to develop for rapid re-growth and optimum establishment. Harvesting earlier to control weeds will reduce the amount of root reserves and result in weaker plants. Slightly weaker plants must be considered against the harmful effect of weed competition on forage establishment. Once the crop is mature the goal of harvest management should be forage quality and nutritive value for livestock.

Pest Control. Insect damage to grass forages during establishment is generally not a concern. However, legume forages, especially alfalfa, can be devastated by insect feeding. The primary insect of concern is the potato leafhopper which can reduce the vigor and later performance of alfalfa seedlings. Proper monitoring and control, when the economic threshold has been reached, is extremely important during alfalfa establishment. This is discussed further in the description of Alfalfa

Fertilization of Forages

Band placement of fertilizer, particularly phosphorus, 1 inch below the seed results in rapid seedling growth and often gives better stands of alfalfa, birdsfoot trefoil, and other perennial legumes such as clovers and crownvetch.

Alfalfa requires continuous fertilizer management for maximum economic production. Potassium fertilization is a major component of effective alfalfa management. Fertilizers for establishment are usually higher in phosphorus and lower in potassium than for topdressing. This reduces the likelihood of fertilizer injury to the seedlings and provides higher phosphorus for establishment.

Nitrogen is not required for the establishment of legumes, but it is needed for the establishment of grasses. Nitrogen fertilizer favors the establishment and growth of the grass at the expense of the legume in a legume-grass mixture. Therefore, nitrogen is not recommended for the establishment of either a legume or a legume-grass mixture.

Nitrogen is recommended when the legume content of a legume-grass stand is less than 50 percent. When the legume content is between 25 and 50 percent, 20 to 40 pounds per acre of nitrogen is recommended as a topdressing in early spring. The response to nitrogen may not be economical, however, especially considering the loss of legume from the stand. The nitrogen rate suggested for topdressing a legume-grass stand containing 25 percent or less legume is 30 to 50 pounds per acre. It is not economical to topdress nitrogen on stands containing 25 percent or more legumes on low-yield potential sites such as droughty, wet, or acidic soils or where the soil fertility is low.

Improved pastures and grasses respond to nitrogen, phosphorus, and potash. The fertilizer, especially most of the nitrogen, should be applied in early spring to get maximum growth of the grass. Unimproved grass pastures do not respond as well as improved pastures with timothy, orchardgrass, and brome grass because unimproved pastures have a lower yield capacity. As a rule of thumb, if no soil tests are available fertilize at a rate consistent with a medium ranking for the soil type.

Alfalfa ~ *medicago sativa* L.



Key Information on Alfalfa

Annual or Perennial	Perennial
Best Use	A top quality forage legume for use where nutritional quality is valued.
Bushel Size	60 lb
Planting Depth	¼” to 3/8”
Seeding Dates	March 10 th to April 20 th -or- August 10 th to September 15 th
Seeding Rate	14-25 pounds per acre alone 8-10 pounds per acre in a mix
Seeds Per Pound	Approximately 225,000 seeds per pound in alfalfa
Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Deep Top soil, well drained, firm seed bed with high fertility levels

History

Alfalfa was introduced into the United States in the mid 1700’s. It did not really take off as a popular crop until it was re-introduced on the west coast in the mid 1800’s. In many European countries where it has been a forage of choice since the early part of the millenium it is called Lucerne. The crop itself has its origins in Asia about 2500 years ago. It has long been known as one of the best legumes. It has been used alone or with grasses and other legumes since its introduction into this country. Alfalfas popularity is increasing, partially due to the fact that it has the highest yield potential of any forage legume. Alfalfa also can be a primary source for the delay of soil erosion.

Length of Life

Perennial, some well managed fields can be profitable for over 10 years. Most producers do not allow Alfalfa to live this long without replacing it or rotating it with other crops. A more typical stand would be up to 5 years old

Description of Crop

A Deep rooted Perennial legume, leafy, with a high protein content. Very palatable. Profitable as a hay crop. Grows best on well drained, pH balanced, fertile soils. The growth occurs from the crown of the plant. Mature plants will reach three feet or more with root systems reaching as much as 20 feet deep. Flowers range in color from purple to a yellowish white. Usually three leaflets with terminal leaflet on small stem. The last 1/3 of the leaf is toothed or serrated. Seeds are small with an average of 200,000 seeds per pound. Germination will occur in 7-10 days in optimum conditions.

Use

Alfalfa can be used as pasture, dry hay, haylage, alfalfa meal, pellets or cubes. Also, erosion control, soil improvement and as a good source for honey production. With better management and newer grazing practices, Alfalfa has increased in overall popularity. It is readily eaten by all kinds of live stock, it is high in protein and minerals, and when cut and cured properly, is equal or superior to other legumes and grass crops. Alfalfa can produce as much as 195 pounds per acre of Nitrogen. This compares to soybeans at nearly 60 pounds of Nitrogen per acre. It is no wonder why Alfalfa is garnering more attention. Alfalfa is most often used by dairymen for its high protein, high quality aspects. Alfalfa has potentially the highest forage quality of any forage crop. Alfalfa is considered to be higher in feed value than any other forage. **For Dairy and Beef cattle**, grazing is an opportunity lost for most producers. Summer grazing is an excellent way to fully utilize the plant in potentially slower growth or stressful situations. Be sure not to over graze as this will cause more stress than it can handle. However, less stress will be put on the plant if grazed during moisture stress than when it is a wet situation. **Horses** are more popular than ever, and a balanced nutritional feeding program is very important. Many horse owners are not from a farming or livestock background and have relatively little experience with animal nutrition. Many myths are the result of this lack of experience. Suffice it to say that Alfalfa as a part of the horse ration is now accepted in most circles.

Adaptation

Alfalfa is best suited to well drained to moderately well drained soils. pH levels should be in the 6.5 to 7.0 range and general fertility should be in the moderate to high levels on soil tests. Alfalfa is a good crop for soils that are droughty. Good seed bed preparation is a must, and proper management of the stand is critical.

Potential Problems

Disease and Insects are the primary problems that Alfalfa faces once established and general management is implemented. Several diseases and insects occur in Alfalfa stands that can kill seedlings, limit yields, and shorten stand life. It is better to buy seed that controls or limits these potential pests than to rely solely on management skills. Profitability increases with each trip over the field that is not needed. The DRI or Disease Resistance Index is a summarization of varietal disease resistance scores used to compare the pest resistance of several varieties. The major insects and diseases of Alfalfa and a short description of each are listed below:

Diseases

Antracnose Occurs most often under warm, moist conditions and causes yield losses up to 20% or more. It can range in appearance from a few small blackened areas on the stems to large, sunken oval shaped areas. It is important to realize that no economic control is available once Anthracnose is present in the field.

Aphanomces Root Rot Is a disease of wet soils. It stunts and kills seedlings and can cause lateral roots to disappear in established plants. It appears as yellow cotyledons followed by yellowing chlorosis of other leaves. Seedlings remain upright. Roots and stems

appear to be waterlogged with a gray to light brown appearance in established plants. Nitrogen producing nodules are often absent and cause a slow growth habit coming out of winter dormancy. This disease has symptoms similar to nitrogen deficiency. Again no economic control of Alfalfa diseases is available, buy seed with moderate resistance or better. And remember to plant alfalfa on well drained soils.

Bacterial Wilt Occurs only in second or third year stands and is economic in 3 to 5 year old stands. Plants effected by Bacterial Wilt will turn yellowish green and will be scattered throughout the field. The time in which the disease is most easily recognized in regrowth from cutting. The tap root shows a ring of yellowish brown near the outer edge. Current varieties available are typically bred with moderate resistance to this disease.

Fusarium Wilt Is a disease that will gradually make the stand not profitable. The potato leafhopper has been linked to this disease. The beginning stages will look similar to Bacterial Wilt, however recovery will seem to be immediate and total. Within a short period of time the disease will reappear as chlorosis and then bleaching of the leaves. One side of the plant typically takes on a reddish tint. The way to diagnose Fusarium Wilt is to take a angled cross cut of the tap root, a reddish brown in the outer ring of the root is the tell tale sign.

Phytophthora Root Rot Can kill seedlings and established plants in wet soils. The most common time for the disease in in new seedlings in cool wet soils. New seedlings appear wet and waterlogged and then collapse and wither. Remember, with Aphanomyces the plants remain upright. Plants die within one week of infection, if they do not die they continue on with very little growth or root mass development. Established plants typically get this disease after and heavy rain leaves water standing on a field for more than 3 days. In this case the lower leaves wilt and turn yellow to brown. The stem can rot in two at the point of water saturation. This disease is discovered until the soil dries. If standing water is a problem, trench or pump to lessen the chances of Phytophthora Root Rot. It is even better to not plant Alfalfa in those areas.

Sclerotinia A seedling disease, that effects the stands planted in late summer more than spring plantings. The symptoms appear in the fall after planting as small brown spots on the leaves and stems. In the cool wet spring weather the symptoms appear as a softening of the crown or lower stems. They often discolor and disintegrate. Spring plantings and deep plowing are two cultural practices that reduce the diseases ability to infect new seedings.

Stem Nematodes Not really a disease, however, it doesn't fit into the insect category either. Plants appear unhealthy and stunted. Nematodes reduce the plants ability to take up and fix Nitrogen. The nematodes are microscopic in size and attach to root hairs. They feed on them and on the feeder roots. Rotate to row crops, the best rotation is with corn. Let the soil remain fallow for 60 days or more following another forage crop.

Insects

Alfalfa Weevil Alfalfa Weevil larvae chew and defoliate leaf tissue, leaving the leave skeleton intact. A large population may totally defoliate the plant giving the field a gray tint. With low populations the damage will occur up to the first harvest. With higher populations the damage may occur after that and result in yield loss and stand loss. The larvae are gray colored when small but turn to a brilliant green when fully grown. They range in size from very small up to 3/8" when grown. A distinctive white strip on the back and a black head make identification quick and easy. They are typically an early season problem with the main problem in May to mid June. The adult weevil beetles find homes outside of the field to grow

and rest. By fall they are back in the field to lay their eggs. Control measures should be implemented when 40% of the plants have damage to the plant tips. If it is within a week of normal harvest, it is not economic to chemically control weevil and early harvest should be considered. If the population is heavy, scout the field closely for signs of damage to the new leaves after the 1st cutting.

Potato Leafhopper Potato Leafhopper takes over where the Alfalfa Weevil leaves off. Potato leafhopper rarely effects a first cutting of Alfalfa. The leafhopper is distinctive in its tight “v” shape or wedge shape. It is yellowish green and only about 1/8” in length. The Leafhopper is in a family of sucking insects that remove sap from the Alfalfa and inject a toxin causing them to turn yellow. Severe infestations will show up as the entire plant turning yellow or stunted. Damage and yield loss have already occurred by the time you see the yellowing. A sweep net is recommended to control this insect. Consult your local extension agent, IPM Scout or Farm Center Agronomist or use the following as a rule of thumb to control thresholds. Sweep 25 times at a steady walking rate, sweeping back and forth like with a broom. At 3” of height economic control is valid with 0.2 adults leafhoppers per sweep, or 5 per test area. On the same test area, at 6” tall Alfalfa .5 per sweep or 12 per test area. At 8”-11” tall Alfalfa 1.0 per sweep or 25 per test area. When Alfalfa is nearly ready to cut, 50 per test area are the economic threshold.

Aphids Aphids cause stunting and chlorosis of Alfalfa resulting in yield loss. Heavily infested plants wilt in the hot weather. This is not typically an economic problem in the Midwest, however it is worth watching for. Economic Sweep levels are reached when 100 per sweep are found.

Spittlebug Spittlebugs appear in the early season and are rarely if ever economic. They do suck the juices from the Alfalfa, however they do not yellow the plant. The spittlebug is normally found near the new growth at the tips of the stems.

Plant Bugs Plant Bugs suck the sap from the Alfalfa and crinkle the ends of the leaves. They do this as adults through a straw or tube like mouth. They range in length and color from green to brown and from 3/8” to 1/4”. Economic Sweep levels are reached when 5 or more Plant Bugs per sweep in more mature alfalfa.

Grasshoppers Typically only a problem in hot dry years in the Midwest. Economic populations are reached when there are 20 per square yard along the edge of a field or 8 per square yard within the field. Spot treat areas rather than spraying entire fields.

Other problems

Autotoxicity Autotoxicity is also known as Alfalfa Toxicity by some. It is a result of a toxin that Alfalfa produces that reduces germination and seedling vigor. The amount of reduction is a result of the previous stand of alfalfa, the length between the two alfalfa crops, and the amount of residue disked or plowed in prior to the seeding. The toxin is medicarpin, a water soluble compound. By waiting at least 1 year the toxicity factor is nearly eliminated.

Establishment & Management

Alfalfa requires a well drained soil for optimum production. The soil should have a deep topsoil if at all possible. On sloping fields where erosion is a problem, plant alfalfa with a companion crop or use reduced tillage. Take soil samples to insure yourself of proper nutrition. Seedbed preparation should be to a point of a moist, fertile and firm bed. Firmness should only allow an adult to sink 3/8” or less when walking across the field. Plowing or disk harrowing is a

key to seedbed preparation. Seeding into an existing bed from a soybean field or other crop can also work as long as the stubble is thin enough to not cause competition. You must take into account the previous crop and the weed competition from the previous year.

Alfalfa needs adequate amounts of phosphorus, potassium and sulfur during establishment. Timing of the seeding should be in March or Early April for the lower great lakes area. Or in Mid August in the fall. This is also called summer seeding. **Inoculating the alfalfa seed with a commercial alfalfa rhizobia species of bacteria is considered to be a good insurance policy.** Most crop soils do not contain sufficient bacteria to fix enough atmospheric nitrogen to benefit the Alfalfa crop.

The depth of seeding the goal should be ¼ to ½ inch deep. On sandy soils in dry conditions a deeper seeding may be effective.

Using a companion crop such as oats is a traditional practice. A companion crop provides quick ground cover and helps reduce soil erosion. The negatives are that the same companion crop acts as a competitor for the nutrients and moisture the alfalfa needs. The companion crop may be harvested for its grain at the expense of one or two first year cuttings of alfalfa. **The seeding rate of any companion crop should be 40% of its regular rate seeded alone.**

Pure stands of alfalfa are now the norm. In some situations there is a need for additional crops to be seeded with alfalfa. In the case of a premium pasture seed mix the benefits are strong. The competition from weeds is reduced by the cool season grasses that occupy the bare ground between the alfalfa plants. The overall forage quality of the mix will not be as great as a pure stand, however, it does create a nice total forage with many options.

Overseeding thin stands of more than one year old is difficult to successfully do. Thin stands of less than one year old may be improved with a no till drill and herbicide applications to reduce competition.

Variety Selection

Variety choice should be made using several criteria. A listing of varieties and their benefits is in the Variety Characteristics section of this manual. A few general things to consider are the fall dormancy desired and the winter hardiness required. A history of the field should be reviewed with primary information being soil type and drainage characteristics. The last and maybe most important issue to consider is what your needs are. Is it for a pasture or for hay? Is it for Dairy or Beef or Horses? Is your major consideration pest resistance or yield? Define a clear set of desires and then find a variety that best fits your plan.

Barley ~ Poaceae

Key Information on Barley

Annual or Perennial	Annual
Best Use	A cereal grain, that can be pastured, or harvested for seed
Bushel Size	48 lb
Planting Depth	1" to 1 ½"
Seeding Dates	March 10 th to May 15 th - or - September 15 th to October 10 th
Seeding Rate	1 ½ to 2 bushels per acre
Seeds Per Pound	

Time to Germinate	Approximately 7 Days
Type of Plant	Cereal Grain
Type of Soil required	Well drained soils, no flooding, prefers cool, moist climate, balanced pH

History

Barley is a very old crop with the first knowledge from nearly 8,000 years ago. The origin is uncertain, however, Modern day Iran, Egypt, Tibet, or Northern Africa are the most likely spots. Now barley is grown from the arctic circle to the tropics. Barley is the 4th most important cereal grain grown in the United States with nearly 50% used for livestock feeding.

Length of Life

Barley is an annual cereal grain

Description of Crop

Barley can either be winter planted or a spring planted crop. The most common in the Midwest is a winter planting. Winter Barley is planted in the winter and Spring Barley is planted in the Spring. The crop looks similar to wheat and has either 2 rows of seed per head or 6 rows of seed per head.

Use

The feed value of Barley is less than corn and is less palatable than wheat or oats, but does compare favorably in these areas. Much of the feeding is done after processing, such as rolled barley.

Adaptation

Barley is well adapted to just about anywhere in the world. Take care to not put Barley in a field with flooding potential.

Potential Problems

Barley is susceptible to several diseases and fewer chemical controls are labeled for Barley than the better known cereal grains of wheat and oats. Acid soils are also a problem and can kill this crop.

Establishment & Management

Barley should be sown in an environment similar to wheat or oats. A seeding rate of 1 ½ to 2 bushels per acre is recommended. A firm, finely tilled seed bed is best. Use a grain drill and plant to a depth of 1 to 1 ½ inches deep. For a broadcast planting increase the rate of seed to 2 ½ to 3 bushels per acre. Excessive nitrogen or only quickly available nitrogen sources can cause the plant to put its energy into straw growth and lodge. This not only lowers the yield, but, makes harvest more difficult. Phosphorus is the primary nutrient for top Barley crops. Harvest can be done with a regular combine or Barley can be cut and windrowed similar to grass seed crops in the western United States. Take care to allow Barley to dry to below 14% moisture to ensure proper storage.

Variety Selection

Barley is typically sold as a common seed in the Great Lakes area. In other areas of the country where it is grown for the use in Alcohol production varieties are more common.

Big Bluestem ~ *Andropogon gerardii*

Key Information on Big Bluestem

Annual or Perennial	Perennial
Best Use	A native grass for hay or set aside fields requires 18" of rainfall per year.
Bushel Size	n/a
Planting Depth	¼" to ½"
Seeding Dates	Late Summer
Seeding Rate	7 -10 lbs per acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 150,000
Time to Germinate	Approximately 28 days
Type of Plant	Sod forming Native Grass
Type of Soil required	Thrives on moist, well drained soils of good quality. Can survive low moisture conditions.

This is a vigorous, rather coarse bunchgrass, native over most of the United States; but of major importance in the Central States and the eastern edge of the Great Plains. The stems, which may reach to 6 feet, are solid between nodes. The leaves reach 12 inches or more in length, and are 0.5 inch or less in width and hairy near the base. Growth starts late in the spring and continues throughout the summer, providing good grazing for all kinds of livestock. Good quality hay is produced if mowed before seed heads have formed. Roots penetrate deeply; but the grass thrives best on moist, well drained soils of good quality. Propagation is by seeds. Big Bluestem should not be harvested on the year it was planted. Established plants should be cut or grazed in the late bloom stage (18") to 6" of height. Allow at least 12" of growth before the first heavy frost. Removal of dead stubble in winter will allow increased yields the following spring.

Birdsfoot Trefoil ~ *Lotus corniculatus*



Key Information on Birdsfoot Trefoil

Annual or Perennial	Perennial
Best Use	A legume that does not cause bloat in cattle, palatable and nutritious. Excellent pasture in late summer
Bushel Size	60 lb
Planting Depth	¼" to ½"
Seeding Dates	March 10 th to April 20 th - or - August 1 st to September 10 th
Seeding Rate	6 - 12 pounds alone 3 - 5 pounds in mixes
Seeds Per Pound	Approximately 400,000
Time to Germinate	Approximately 14 Days
Type of Plant	Legume
Type of Soil required	Deep rooted, tolerates wet and dry conditions on poor soils w/ low pH

History

Introduced by chance from Europe, strains selected in this country are now of major importance as pasture and hay crops. It is hardy and adapted to areas of ample moisture supply from the Ohio and Potomac Rivers north into Canada and west to the edge of the Great Plains.

Length of Life

Birdsfoot trefoil is a perennial legume that is adapted to production on poorly drained, low pH soils.

Description of Crop

Birdsfoot trefoil is a perennial legume that is adapted to production on poorly drained, low pH soils. The leaf sets include; 5 leaflets, 3 at the end and 2 on the stem. Yellow to deep orange or red flowers occur at the end of stems. Several one inch long seed pods hang in a pattern similar to a bird's foot. It can re-seed itself, is resistant to Phytophthora root rot and numerous alfalfa insects, responds well to fertilization and does not cause bloat in animals. These characteristics have resulted in its expanded use in the northern United States and southern Canada where production of other forage legumes is limited. Trefoil has traditionally been used in forage grazing systems. Varieties are now available that are suitable for hay production.

Trefoil stems are smaller in diameter and less rigid than alfalfa stems and may grow to a height of 18 to 20 inches. Each yellow flower (4 to 8 per stem) produces one seed pod. Its root system consists of a tap root with numerous lateral branches predominantly located in the upper 15 inches of the soil profile.

The plant has a deep, branched root system and tolerates both wet and moderately dry conditions. It is unusual among legumes in that it does not cause bloat in cattle. Both as pasture and as hay it is highly palatable and nutritious. Trefoil will produce better than alfalfa on poor soils, but its fertility requirement for high yields are similar to those for alfalfa.

Use

As with other forage legumes, trefoil is most productive on fertile, well-drained soils with near neutral pH. However, it has the ability to produce relatively high yields and quality on land that is marginal for alfalfa production. Trefoil can be grown on low pH (5.5) soils and will tolerate short periods of flooding with less yield reduction than alfalfa. It can also tolerate periods of drought, which makes it suited for production on both sandy and clay soils.

Adaptation

In soils that are well drained and have good fertility, birdsfoot trefoil will not yield as well as alfalfa. Yields usually are 50 to 80% that of alfalfa in these soils. Therefore, the site in which trefoil is to be grown should have limitations which make alfalfa production difficult. Birdsfoot trefoil is adapted to production on poorly drained, low pH soils.

Potential Problems

The small seed size and low seedling vigor are potential problems with Birdsfoot Trefoil. A companion crop may be used, however, it should be used at 2-3' row spacing and removed quickly due to the lowly competitive nature of Birdsfoot Trefoil seedlings. It is not as resistant to fusarium type diseases as the newer varieties of Alfalfa, and for that reason entire plants may die. A management system that allows Birdsfoot Trefoil to re-seed itself is a must for a prolonged stand. Do this by not harvesting it during the last half of summer and grazing it after the first killing frost.

Establishment & Management

Birdsfoot trefoil requires careful management for successful establishment because of its small seed size and poor seedling vigor. Before seeding, trefoil seed should be inoculated with

Rhizobium lupini bacteria, which are specific for birdsfoot trefoil. This will ensure sufficient nodulation of the root system and adequate atmospheric nitrogen fixation.

The small seed of trefoil necessitates that the seed be placed no deeper than 1/4 inch in the soil to achieve maximum stand and yield. A smooth, firm seedbed will greatly facilitate accurate depth placement of the seed. Early spring seedings are generally more successful than late summer seedings.

Firming the soil before and after planting will improve the seeding depth and seed-to-soil contact, which improves moisture uptake by the seed and ultimately enhances germination and emergence. Seeding rates of 8 to 12 pounds per acre are considered adequate under normal conditions.

Trefoil establishment on soils that have a pH less than 5.6 may result in molybdenum (Mo) deficiencies. Molybdenum is an essential nutrient for nitrogen fixation. When needed, Mo can be applied as a seed coating. This method of application should provide sufficient Mo levels for the life of the trefoil stand.

Heavy grazing pressure may be needed in the spring to reduce lush growth and allow trefoil to better compete in a grass mixture. Trefoil will compete under continuous grazing better than alfalfa. However, close, continuous grazing is not recommended because trefoil regrowth depends on energy supplied by top growth. Unlike alfalfa, trefoil does not maintain high levels of root reserves during the summer.

Harvesting or grazing between September 1 and the first killing frost is not recommended. This period is needed to allow root reserves to accumulate to improve winter survival and growth the following spring.

Birdsfoot trefoil quality is greater than that of alfalfa because of increased "bypass" protein and smaller stems. Loss of quality with maturity is less pronounced with trefoil than alfalfa. However, leaf loss during hay making may be greater than alfalfa. When grazed, trefoil is more palatable than alfalfa and produces greater average daily gains and meat yield per acre for heifers and sheep. Unlike alfalfa, grazed trefoil does not cause animals to bloat.

The practice of not harvesting birdsfoot trefoil during the second half of the summer and grazing it in the fall after the first killing frost is known as stockpiling. Trefoil is well suited for stockpiling since it holds its leaves at maturity and after frosts, thus maintaining a relatively high level of quality. Stockpiling also allows root reserves to accumulate during the fall, which improves plant survival and spring growth.

Variety Selection

About 25 varieties of birdsfoot trefoil are currently available in the United States and Canada. Birdsfoot trefoil varieties are generally characterized by growth habit into two types, Empire and European. Both types are referred to as "broadleaf" trefoils.

Empire-type birdsfoot trefoils are better adapted for use in grazing situations since they have fine stems, prostrate growth and indeterminate growth habit. The Empire types are also slower growing during establishment and regrow more slowly following harvest than the European types. Dawn and Empire are high-yielding Empire types that have performed well in the Midwest.

European-type birdsfoot trefoils are better adapted to hay production practices since they are more erect, establish faster and regrow faster after harvest. For detailed information on current varieties see the Variety Characteristics section of this manual.

Blue Grama ~ *Bouteloua gracilis*

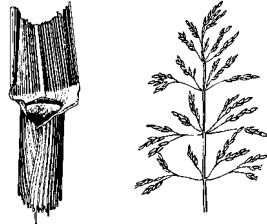


Key Information on Blue Grama

Annual or Perennial	Perennial
Best Use	A native grass for hay or set aside fields requires 13" of rainfall per year.
Bushel Size	n/a
Planting Depth	¼" to ½"
Seeding Dates	Spring or Late Summer
Seeding Rate	2 - 3 lbs per acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 750,000
Time to Germinate	
Type of Plant	Sod forming Native Grass with Bunch characteristics
Type of Soil required	Light to Loamy soils, dry land is fine.

Blue grama is a long-lived native perennial grass that grows throughout the Great Plains. It is low growing, up to 18 inches, with small leaves, not over 6 inches long and 0.125 inch or less in width. It is found on all soil types, but thrives best on upland soils. It is drought resistant. Growth is late starting in spring. It is relished as pasture by all classes of livestock. It is one of the more important range grass species, standing heavy grazing well. It is readily established by seeding.

Bluegrass as a forage ~ *poa pratensis*



Key Information on Bluegrass

Annual or Perennial	Perennial
Best Use	As a horse pasture, also effective with beef and sheep
Bushel Size	14 lb
Planting Depth	¼"
Seeding Dates	March 10 th to April 20 th - or - August 1 st to September 10 th
Seeding Rate	20 -30 pounds alone 4 - 6 pounds in mixes
Seeds Per Pound	Approximately 2,200,000
Time to Germinate	Approximately 21-26 Days
Type of Plant	Grass
Type of Soil required	Well drained, fertile soils with a pH of 6.0 or better. Cool, moist climate.

History

Kentucky bluegrass occurs over much of Europe and Asia, where it is believed native. It probably was brought to this country in early Colonial days. It is now so widely distributed throughout the Northern and Central States that its origin is questionable.

Length of Life

Kentucky bluegrass is a short- to medium height, cool-season, long-lived, highly palatable, perennial grass.

Description of Crop

The grass is long-lived, with underground rhizomes, resulting in dense sods. It becomes semi-dormant during hot, dry periods. The seed stems reach up to 24 inches high. Leaves are abundant, long, medium in width, and blunt at the terminal. It is a highly palatable pasture grass. It has a wide adaptation for soils, but is best suited to well-drained soils of limestone origin. Kentucky bluegrass is apomictic in nature. That is, seed may be produced without fertilization. For this reason a wide range of variability is present in this grass species. "Common" Kentucky bluegrass is a general-purpose grass for pasture or lawn use. Low-growing types have been selected for turf suitability. Of these, Kenblue, Park, and Troy were selected for reduced management requirements and are suitable for pastures. Superior cultivars have not been developed specifically for pasture or forage purposes. This may explain why greater forage production is often obtained with other forage grasses.

Use

Kentucky bluegrass is used primarily in irrigated pastures in combination with white clover. This combination typically has been associated with horse pastures, but it can be used effectively with beef or sheep as well. Kentucky bluegrass is a long-lived perennial that produces a dense sod from rhizomes. Although Kentucky bluegrass is relatively low in production in midsummer, yields can be increased by adequate irrigation and an ample supply of nutrients. In many cases, however, other grass forage species will be superior to bluegrass for forage production.

Adaptation

It has a wide adaptation for soils, but is best suited to well-drained soils of limestone origin. Kentucky bluegrass requires a high level of fertility for maximum production. It does best on soils of near neutral pH. Adequate liming and fertility should be provided for companion legumes in order to produce a good stand and reduce competition from weeds.

Potential Problems

It becomes semi-dormant during hot, dry periods. Overgrazing of bluegrass pastures will result in poor root and rhizome development, while under grazing will result in excess grass competition. Warm summer temperatures are the most limiting environmental factor to Kentucky bluegrass forage production. Kentucky bluegrass pasture is not shade tolerant and is slower to establish than timothy or orchardgrass.

Establishment & Management

Kentucky bluegrass can be "frost seeded" (in early spring when the soil is still honeycombed with frost) into existing pastures to thicken the stand. Successful seeding requires good seed-to-soil contact. This can be accomplished with frost seeding by seeding into a field with a thin stand of existing plants or where the pasture was grazed "into the ground" the previous fall. Greatest success is generally achieved when frost seeding is completed while the soil contains frost. Delaying seeding until mid-morning when the soil has become slippery on the surface will result in poorer stand establishment.

Seeding Kentucky bluegrass alone or in a mixture into a conventionally prepared seedbed or no-till seeding can also be an excellent method of establishment. Do not plant deeper than 1/4 inch

when seeding. Press wheels or cultipacking used in conjunction with or after band seeding will improve the seed-soil contact and the chances of obtaining a good stand. To obtain a proper seeding depth, the seedbed should be firm.

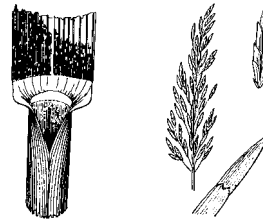
Under normal environmental conditions in the upper Midwest, Kentucky bluegrass produces nearly 70% of its annual forage production by early June. Consequently, proper management during the early growing season is essential to maximize Kentucky bluegrass's production potential. Since Kentucky bluegrass is a short growing plant, compared to many other cool-season forage grasses, it is ideally suited for grazing.

Kentucky bluegrass pastures are often under grazed in the spring, which results in an accumulation of mature, low-quality forage. Use high stocking densities early in the growing season when Kentucky bluegrass is most productive or harvest excess growth as hay or silage. Reduce the stocking density later in the grazing season as grass growth slows. In hilly areas, grazing of Kentucky bluegrass should begin on south-facing slopes which warm first and begin growth early in the spring. Maintaining a stubble height of 2 to 4 inches in spring promotes tiller (new shoot) formation, which helps keep a dense sod. Excessive defoliation often results in shallow rooting, an open sod, and weed invasion. These effects are particularly damaging to Kentucky bluegrass in a dry summer when it is less able to recover. Kentucky bluegrass productivity is increased substantially with proper pasture rotation and rest.

Variety Selection

No improved varieties of bluegrass have been produced specifically for forage production or pasturing. For detailed descriptions of Kentucky Bluegrass varieties see the Variety Characteristics section of this manual.

Bromegrass ~ *Bromus inermis*



Key Information on Bromegrass

Annual or Perennial	Perennial
Best Use	As a horse pasture, also effective with beef and sheep
Bushel Size	14 lb
Planting Depth	¼" to ½"
Seeding Dates	February to May - or - August 1 st to October 10 th
Seeding Rate	20 -30 pounds alone 4 - 6 pounds in mixes
Seeds Per Pound	Approximately 140,000
Time to Germinate	Approximately 14 Days
Type of Plant	Grass
Type of Soil required	Grows best on well drained silt loam or clay loam soil, can withstand periods of drought and extremes in temperature. pH of 6.0 to 7.0

History

Smooth brome is native to northern Europe and Asia. It was introduced into the United States in 1884 and is now widely distributed. Two types of smooth brome are recognized. "Southern" type came originally from Europe and is best suited to the corn belt and adjacent plains areas "Northern" type, originally from Siberia, is adapted to the Northern Plains and adjacent Canada areas.

Length of Life

Smooth brome grass is a leafy, sod-forming perennial grass that is best suited for hay or early spring pasture. It is deep-rooted and spreads by underground rhizomes. Forage quality of smooth brome grass compares well with other cool-season grasses, being affected primarily by stage of maturity.

Description of Crop

Smooth brome grass is a leafy, sod-forming perennial grass that is best suited for hay or early spring pasture. It is deep-rooted and spreads by underground rhizomes. Forage quality of smooth brome grass compares well with other cool-season grasses, being affected primarily by stage of maturity. The plant is a long-lived perennial with creeping rhizomes. It forms a dense sod. Leaf blades are smooth, up to 12 inches long and 0.5 inch wide. The flower head is a panicle, 6 to 8 inches long. The root system is strong and interlaced, making the plant excellent for erosion control. Smooth brome is among the best of the pasture and hay grasses, being both highly palatable and nutritious.

Use

Some 43 species of *Bromus* are native in the United States. Some of these are important forage sources, others are troublesome weeds. Most bromes are highly palatable during succulent growth, even the ones classed as weeds. Smooth brome grass is a leafy, sod-forming perennial grass that is best suited for hay or early spring pasture. It is deep-rooted and spreads by underground rhizomes. Forage quality of smooth brome grass compares well with other cool-season grasses, being affected primarily by stage of maturity.

Adaptation

Smooth brome grass is the most widely used cool-season grass in North America. It is grown extensively in Canada and the north-central United States. Smooth brome grass survives periods of drought and extremes in temperature. It can be grown on a variety of soil types, but it grows best on well-drained silt-loam or clay-loam soils. It is fairly tolerant of alkalinity and somewhat tolerant of salinity and acidity but will perform best at a soil pH between 6.0 and 7.0

Potential Problems

Brome grass is slow to establish, produces over a short period of time. It does not tolerate poorly drained soils and can crowd out some legumes. At the point of the first flush of growth and after each clipping the point of growth is above the ground and can be damaged or killed. Grazing management must be used to eliminate over grazing during this critical time. Smooth Brome grass cannot tolerate frequent cutting. If mechanical harvesting or clipping is used it should never be set below 5". Brome grass with Alfalfa is not productive since the maturity of the two crops aren't at similar times. Brome grass loves nitrogen with as many as 3 applications needed for top yields.

Establishment & Management

A moist, fertile, firm seedbed is required for smooth brome grass or brome grass- legume mixtures. Most often planted in spring when weather conditions usually are more favorable, smooth brome grass may be planted in the fall in warmer areas. Seed may be either drilled or broadcast. Drilling is preferred because it provides a more uniform depth of planting.

Plant seed 1/4 to 1/2 inch deep. Long, narrow seeds, however, often bridge in conventional seed drills and make planting difficult. Most hopper-type fertilizer spreaders can be calibrated to

broadcast seed. If seed is broadcast, however, be sure to cover the seed. This can be done by light disking or by following with a drag or harrow.

Spring harvest should be made before jointing or after the early-flower stage of development to ensure maximum smooth brome grass persistence. This restriction on harvesting makes brome grass unsuitable in mixture with alfalfa that will be harvested at the bud stage. However, mixtures with legumes that will not be harvested before 1/10 bloom are excellent.

Variety Selection

Some improved varieties are produced. These varieties start growing earlier in the spring and stay green longer than "common" brome grass. Common brome grass is not a variety but a brome grass of uncertain genetic makeup. For a complete description of Smooth Brome grass varieties please see the Variety Characteristics section of this manual.

Buckwheat ~ Fagopyrum

Key Information on Buckwheat

Annual or Perennial	Annual
Best Use	As a soil improvement, short season crop, germinates best at higher temperatures, also used for honey production and flour milling.
Bushel Size	60 lb
Planting Depth	1" to 1½"
Seeding Dates	July 1 st to July 20 th
Seeding Rate	35 -50 pounds alone
Seeds Per Pound	
Time to Germinate	Approximately 7-10 Days
Type of Plant	Summer Annual Grain
Type of Soil required	Grows best on well drained silt loam or clay loam soil, can withstand periods of drought and extremes in temperature

History

Buckwheat is believed to have originated in Central and Western China. It is now a relatively minor crop in the United States. Since the early 1900's the number of acres grown has dramatically decreased. Present production is probably under one million bushels, though exact data are lacking.

Length of Life

A Summer Annual, this crop lasts only a few months. Within 40 days of seeding, plants will begin blooming with harvest of mature seeds within a month of that.

Description of Crop

The buckwheat plant is entirely different from other grains and is not a grass. It is a summer annual with rather coarse, branched stems and large, broadly arrow-shaped leaves. Flower panicles and leaves rise from the nodes, both on the main stem and branches. Growth habit is indeterminate with flowers opening throughout a long season, so the seed crop does not mature at one time. The seed is partially but not entirely enclosed by adhering flower parts

during development. Seeds are pointed, broad at the base, and triangular to nearly round in cross section. There are over 200 wild buckwheat species in North America.

Use

Most of the buckwheat grown in the United States is milled into flour which is used largely in pancakes. For pancakes the flour is usually blended with that from other grains. Whole buckwheat grain may be used in poultry scratch feed mixtures. The middlings from milling make good livestock feed as they are high in protein. The straw is higher in protein but lower in digestible carbohydrates than grass grain straw. The buckwheat plant is an excellent honey source as the blossoms are rich in nectar, and blooming continues into the fall months. Some beekeepers plant buckwheat primarily for such use.

Adaptation

Buckwheat is usually seeded only after the ground is thoroughly warm in early summer.

Potential Problems

Few exist other than a somewhat common shortage of the seed to plant.

Establishment & Management

Buckwheat is usually seeded only after the ground is thoroughly warm in early summer. Plants will begin blooming in about 40 days from seeding and first seeds mature about 35 days later. Harvesting is done when a substantial part of the seed is ripe. Fields are then mowed and plants are stacked to dry before they can be threshed.

Variety Selection

No known varieties are available of Buckwheat. The common Japanese Buckwheat is the primary seed available to the Midwest grower.

Buffalograss ~ *Buchloe dactyloides*

Key Information on Buffalograss

Annual or Perennial	Perennial
Best Use	Erosion control or as a pasture in the plains states.
Bushel Size	
Planting Depth	1"
Seeding Dates	Spring
Seeding Rate	6 - 8 pounds alone
Seeds Per Pound	Approximately 50,000
Time to Germinate	
Type of Plant	Sod forming native grass
Type of Soil required	Adaptable

Buffalograss, a native species, is the dominant grass in parts of the Great Plains. It is a fine-leaved, sod-forming perennial, generally only 6 to 8 inches high, with leaves 3 to 6 inches long and less than 0.125 inch wide. It spreads by surface runners to form a dense sod. Growth starts in late spring and continues through the summer. It is very palatable and stands grazing well. It is readily established either by seeding or by sod pieces, and is valuable both as pasture and for erosion control. The species is unisexual, about half the plants being female and producing seed; and half male, the flowers of which produce only pollen.

Clovers ~ trifolium.

The clover family is famous even with urban people because of the elusive 4 leaf clover. Interstate exits are name for it and the Irish have embraced clover as a icon for their mysterious heritage. The Shamrock leaf made famous by the Irish came from an Irish folklore story that St. Patrick picked a clover leaf to describe as the Holy Trinity. Clover benefits us in many ways, from pasture for domestic and wild animals, to honey production, and as a cover crop. The first origin of the Clover family is clouded, but many believe it to be native to North America. It spread from Western North America into the Asian peninsula and then into Europe and Africa. The native American or hunters, trappers, and missionaries brought it east until now Clover in its many forms is vital in every state in America.

Alsike Clover ~ trifolium hybridum



Key Information on Alsike Clover

Annual or Perennial	Perennial - short lived 3 years
Best Use	In areas too cold, wet and acid for red clover. Used with Timothy as hay
Bushel Size	60 lb
Planting Depth	¼” to ½”
Seeding Dates	January to April 20 th - or - August to September
Seeding Rate	6 - 8 pounds alone 2 - 4 pounds in a mix
Seeds Per Pound	Approximately 700,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Adapted to wet, heavy soils, tolerant of flooding. pH of 6.0 to 7.0 Medium fertility levels

History

Alsike Clover was introduced into the United States in the 1830’s from England. The crop was first used in Northern Europe in Sweden. It was named in Sweden.

Length of Life

Alsike is a short lived perennial legume. It typically is treated as a biennial. The average stand will last 2-4 years.

Description of Crop

Alsike Clover branches from the crown with slender somewhat prostrate, stems that can grow up to 4 feet long. The normal height of the plant is about 24”. The stems and flowers are smooth with pink to white flowers. The plant has sets of three leaves. The three leaflets are all equal distance from the stem, no marks or different colorings occur on the Alsike leaf. The leaf is not shiny underneath. There are also no hairs on vegetative parts. Alsike will reseed itself and may continue on for several years in an unmanaged area. This accounts for heavy stands of volunteer Alsike clover when there is adequate moisture. Alsike clover is a legume and should be inoculated with the proper inoculant bacteria before planting. Alsike is an excellent pasture crop and can stand a lot of traffic.

Use

Alsike clover is a short-lived legume (3 years average) that is most useful in short-rotation pastures or in hay mixtures on wetlands. It can be used in combination with grasses for pasture or hay in areas that have high precipitation or are poorly drained.

Adaptation

Alsike clover is grown in the Pacific Northwest and the Great Lakes region of the upper Midwest. It has become an important forage legume in areas suited to clover-timothy production. Alsike clover is well adapted to wet, heavy soils and is tolerant of flooded conditions. It produces well on soils that are either too cold and wet or too acid or alkaline for red clover.

Potential Problems

Alsike clover is a short lived perennial only living 2 - 3 years. It normally only produces 1 hay crop per year. Alsike has spindly stems and must be supported with another crop, typically Red Clover and Timothy. Alsike Clover attracts more bees than most of the other clovers and caution should be taken for those allergic to bee stings. Alsike clover is susceptible to the same diseases and insects as red clover. It is resistant to anthracnose. Livestock bloating can be a problem with Alsike Clover also.

Establishment & Management

Alsike clover is most often established in the early spring when soil moisture conditions are most favorable. In areas where irrigation is available, late summer seedings are also successful. Seed may be broadcast and covered by a harrow or drilled ¼ inch deep into a well-prepared seedbed. When alsike is used in renovating pastures, the existing sod should be clipped or closely grazed, disked, fertilized, and seeded in early spring or late fall. As with all legumes, alsike clover should be inoculated with the proper inoculum immediately before seeding.

Including timothy with plantings of alsike for a hay crop is recommended because the clover has a tendency to lodge. Alsike clover produces only one crop of hay each season. Alsike clover is quite tolerant of grazing. A rotational system where alsike is grazed to height of 2 to 4 inches following a regrowth period of 4 weeks will result in a persistent stand of good quality forage.

Variety Selection

Common Alsike Clover is the seed sold in the Midwest. A tetraploid variety has been developed in Sweden for greater persistence and yield, however, it is not available in any quantity in the United States.

Crimson Clover ~ *trifolium incarnatum*

Key Information on Crimson Clover

Annual or Perennial	Annual
Best Use	As a winter annual, if mild winters are forecasted, better for the Mid South
Bushel Size	60 lb
Planting Depth	¼" to ½"
Seeding Dates	September
Seeding Rate	8 - 10 pounds alone
Seeds Per Pound	Approximately 500,000

Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Adapted to a wide variety of soils, likes cool soils.

History

Crimson clover, native to the eastern Mediterranean area, was brought to the United States from Italy in 1819. It was near the turn of this century that it became recognized as a useful crop, especially in the Southeastern States and in the western parts of the Pacific States.

Length of Life

It is grown mainly as an over wintering annual.

Description of Crop

Seeded in late summer it forms a dense rosette of leaves. Look for crimson flowers in a dense conical head. The plant has sets of three leaves. The leaves are large and dark green. In mild winter climates growth continues in winter, followed in early spring by the development of leafy flower stalks. Leaves are trifoliate with leaflets narrow at the base and broad at the terminals. Both leaves and stems are hairy. The flower heads are elongated and pointed, bright crimson in color, and contain up to more than 100 florets.

Use

Crimson clover is excellent for winter and spring grazing in mild winter areas. It also yields good red clover. When planted with Red clover Crimson flourishes in the cooler parts of the first year while Red clover flourishes in the warm months. Both as pasture and hay it is highly nutritious and palatable.

Adaptation

Crimson is better suited to the Pacific Western states and the Southeastern states where the climate is more temperate.

Potential Problems

If the weather turns too cold, the usefulness of Crimson clover is very low. It is a winter annual that best fits warmer climates. For this reason, seed is hard to find in the Midwest.

Establishment & Management

To establish Crimson clover a firm, fine seed bed should be prepared in late summer. The pH level should be from 6.2 to 7.0. Drill at the rate of 8-10 pounds or broadcast and drag at the rate of 12-14 pounds.

Variety Selection

Although improved varieties of Crimson clover do exist they do not fit the needs of the Midwest.

Ladino Clover ~ trifolium repens latum

Key Information on Ladino Clover

Annual or Perennial Perennial

Best Use	As a component of pastures with grass, a very productive white clover
Bushel Size	60 lb
Planting Depth	¼” to ½”
Seeding Dates	February 1 st to April 20 th - or - August to September
Seeding Rate	2 - 4 pounds alone 1 - 2 pounds in a mix
Seeds Per Pound	Approximately 800,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Prefers well drained, fertile loam soils. High fertility levels pH of 6 to 7

History

The Giant White Clover. Ladino white clover is found throughout the temperate regions of the world and is limited only by extreme cold or heat or by drought.

Length of Life

Ladino clover is a perennial plant that its life span is limited by the extreme temperatures in the upper Midwest. For this reason it sometimes performs like an annual or biennial.

Description of Crop

Ladino is also known as giant or Italian white clover, as it usually grows to a height of 8 to 12 inches compared to 4 to 6 inches for common white clover. New leaf and flower buds are continually developing on the running stems. The plant has sets of three leaves. The leaf varies from the typical “shamrock” to heart shaped. Light colored V marks are present on the upper leaf. No hairs are present on the vegetative parts of the plant. The crop recovers quickly from grazing or clipping.

Use

Ladino White clover is the most important pasture legume in temperate region pastures. It is almost always planted in combination with grasses for beef, sheep, or horse pastures. Like other legumes, white clover improves the feeding value of a grass pasture. This is the result of its high voluntary intake, digestibility, and crude protein levels. Ladino White clover is used widely in renovation of permanent pastures lacking legumes. Ladino White clover-grass mixtures also may be used for high-quality hay or silage. Ladino is infrequently planted for swine or poultry.

Adaptation

Ladino White clover is found throughout the temperate regions of the world and is limited only by extreme cold or heat or by drought. Optimum performance of white clover as a pasture plant occurs in mild, humid climates. In the United States, white clover is found in the humid eastern half of the country and in the Pacific Northwest. It is also utilized in irrigated pastures throughout the region between the Rockies and the Sierra Nevada ranges.

Potential Problems

Ladino clover causes bloating in livestock. Ladino White clover will not thrive on wet and low land susceptible to flooding or saturated soils. It is not well suited to sandy or light textured soils, due to their lack of moisture retention. It will not perform well in shaded areas and can be susceptible to winterkill. Ladino white clover is shallow rooted and is susceptible to drought or any mechanical harvest that is too close to the soil.

Establishment & Management

Soil preparation should provide a fine, firm, weed-free seedbed. Fall plowing followed by light working of the surface soil in the spring will produce an excellent seedbed. Spring seeding should be done early to allow 4 to 6 weeks of growth before the dry season arrives. A similar time should be allowed before the first freeze if seed is sown in late summer. Under irrigated conditions, timing is not as critical. Seed should be planted no deeper than ½ inch immediately following inoculation with the proper Rhizobium. Firming the soil following planting will aid in rapid establishment of the seedlings.

Liming to achieve a pH of 6.0 or using lime-pelleted seed is recommended. Adequate levels of potassium, phosphorus, and sulfur should be available, as white clover requires a high level of fertility for high production. Properly inoculated and nodulated white clover-grass pastures will not require the addition of nitrogen. Early spring application of small amounts of nitrogen (30-40 lbs.) will stimulate early growth of grass but will favor the grass over the legume.

The most difficult problem in managing white clover-grass pastures is maintaining the clover. Frequent defoliation during the period of maximum grass growth (early spring) encourages white clover by minimizing grass competition. Mixed pastures should be used before the grass reaches its maximum competition. Clipping or harvesting surplus forage in under stocked pastures will help maintain the clover and control the grass and weeds.

If pastures are grazed continuously, the height of forage should be maintained at 2 to 6 inches, depending on the grass species. Fall management should allow adequate re growth for rooting new stolons before the first freeze. Disappearance of white clover from pastures can be remedied by pasture renovation.

Bloat is often a problem for animals on pastures that contain a large proportion of white clover. Methods of controlling bloat in mixed clover-grass pastures include supplementing pastures with grass hay and intensive strip grazing. Bloat-preventative materials, which prevent rumen foam production, may be added to drinking water, applied as a top dressing on grain supplements, or added to salt-molasses blocks. The effectiveness of these methods depends upon animals obtaining a regular supply of bloat preventative.

Variety Selection

Common Ladino Clover is the seed sold in the Midwest.

Mammoth Red Clover ~ trifolium pratense perenne

Key Information on Mammoth Red Clover

Annual or Perennial	Perennial, treated as a biennial
Best Use	Primarily for soil improvement.
Bushel Size	60 lb
Planting Depth	¼" to ½"
Seeding Dates	January to April 20 th - or - August
Seeding Rate	10 - 12 pounds alone 2 - 8 pounds in a mix
Seeds Per Pound	Approximately 800,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Adapted to many soils, primarily used on poorer soils w low pH. It is

also adapted fairly well to light soils.

History

Called Big English or Sapling Clover due to its propensity to get woody stems. This crop has two main sources of seed, Domestic (usually grown in the Great Lakes states) and Canadian. The Canadian also goes by the name Alta Swede Red Clover.

Length of Life

Mammoth Red Clover is a perennial crop. It usually is not given the chance to prove it as it only produces one cutting per year and is harvested and plowed under as a green manure.

Description of Crop

Mammoth matures two weeks later than Red Clover, it also does not recover from cutting as quickly and for these reasons only produces one crop of hay or seed per year. Two cuttings per year are uncommon. It is a perennial, late flowering crop. Usually the first year the crop will not flower. The plant has sets of three leaves. It grows taller and coarser than Red Clover and will turn woody if not harvested at the proper time.

Use

On low fertility soils it is a good seed producing crop and an excellent legume to use for crop rotation and soil improvement. Not considered an excellent hay variety.

Adaptation

Adapted to all soils, however, typically used on lower fertility soils and light soils. The domestic grown seed is more expensive than its Canadian counterpart.

Potential Problems

Seed availability is the biggest problem with Mammoth clover. Aside from availability is the fact that it has lost popularity and is normally passed over for Red Clover.

Establishment & Management

Establishment is similar to other clover crops. It is key to remember that Mammoth will not normally produce flowers the first year. The harvest of Mammoth clover should come at the early bloom stage if used for hay. After harvest do not graze the field as there is little regrowth.

Variety Selection

Domestic and Canadian are the choices for Mammoth Clover. Domestic being the superior Midwestern choice if available.

Medium Red Clover ~ trifolium pratense

Key Information on Medium Red Clover

Annual or Perennial	Perennial - short lived 2 years
Best Use	Widely used in permanent pastures with grasses.
Bushel Size	60 lb
Planting Depth	¼" to ½"
Seeding Dates	January to April 20 th - or - August

Seeding Rate	10 - 12 pounds alone 2 - 6 pounds in mixes
Seeds Per Pound	Approximately 275,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Productive well drained soil with good fertility and soil make up.

History

Originally from southwest Asia, it was introduced to Europe where it was used as a hay crop. Early leaders of the United States had journal entry's describing their Red Clover fields. It is believed that in the 1500's clover became the dominant legume.

Length of Life

Red Clover or Medium Red Clover as it is called is a short lived perennial treated as a biennial. It is added into new hay plantings for the generous crop it produces while the grasses are establishing. By the time the grasses are established Red Clover is in its second and possibly final year. (Some newer varieties described in the Variety Characteristics section are noteworthy for their length of life)

Description of Crop

Medium Red Clover will produce flowers the first year. Medium Red Clover will reach heights of 25" or more. The growth comes from the crown, with a tufted appearance. The plant has sets of three leaves. The three leaves are equal distance from the petiole, light colored V marks are present on the surface. The bottom of the leaf is not shiny. The flowers are a brilliant red color similar to roses. The vegetative parts of the plant are covered with small hairs. Small round to oval, pinkish, nitrogen fixing nodules can be found on the lateral roots if it is actively incorporating atmospheric nitrogen into protein nitrogen.

Use

Widely used in crop rotations and permanent pastures. Hay, pasture, cover crop, soil improvement, plowdown green manure. Red clover also can be used as a hay crop in combination with orchardgrass, timothy, or small grains. The hay crop produced is very palatable. In the second year if the weather conditions are proper the crop can be left for seed production. Medium Red clover can be a cause of bloating and grazing and free choice hay feeding should be managed.

Adaptation

Red clover is best suited to well drained soils of good fertility. It does not do well in low spots or areas or poor drainage. Medium Red clover does not adapt to a drought situation very well. It is best suited to a moderate temperatures and moisture. Medium Red Clover should be inoculated with the proper strain before planting to encourage the development of the nitrogen gathering bacteria. Red clover is extensively grown alone or in combination with grasses for hay and pasture in the northeastern, north-central, and southeastern United States.

Potential Problems

Bloating is a key concern with many of the legumes and with the palatability of young Medium Red clover plants, it is a real concern. The spittle bug can cause problems with Medium Red, it is fairly easy to control, however, the chemical control may reduce the bee population

(pollinators) in the field if improperly timed. This can eliminate or reduce the amount of seed potentially harvested. Seed harvest is not typically a concern in the Midwest, however, you must manage the crop if you attempt to harvest seed.

Establishment & Management

Early spring seeding of red clover is preferred because the soil moisture conditions are more favorable. However, red clover may be seeded in late summer if moisture conditions are favorable. Broadcast seeding, for spring germination, may be made until the end of January.

To insure adequate nodulation, red clover seed should be inoculated just before seeding with *Rhizobium trifolii* bacteria and a sticking agent. Pre-inoculated seed should be kept in a cool, dark place to optimize survival of the nitrogen fixing bacteria.

When sown as a hay crop, direct seedings of red clover can be made either by broadcast, band seeding or fluid seeding. If red clover is sown with small grains for a grain/red clover hay crop, the seeding rate for small grains should be reduced 50 to 75 percent. If red clover seed is broadcast, it should be covered by using a harrow. Use of herbicides may be necessary when direct seeded red clover without a companion crop. The success of red clover establishment by the fluid seeding technique (planting in a carrier of water or fertilizer solution) is dependent on the preparation of firm and fine seed bed prior to seeding and cultipacking after seeding. Fluid seeding requires special equipment, therefore a custom applicator is recommended.

When used in pasture renovation, red clover is best established when the existing sod is closely grazed and disturbed by disking. Seed sown in early spring will result in a good stand of clover in permanent pastures.

If red clover is seeded in spring with a companion small grain, this crop should be removed as hay or silage to prevent serious competition. In pastures renovated in early spring, two hay crops may be harvested the first year.

During the second year of production, harvest should be made between the prebloom and early bloom stage of maturity for highest forage quality. The regrowth may be made into hay or used as pasture. The second regrowth also may be made into hay, but this may cause lower yields in the third year. However, grazing or cutting following a killing frost will not damage the stand or reduce the next year's crop.

If used for pasture, red clover-grass mixtures should be rotationally grazed to a height of 4 to 6 inches following a 4-week regrowth period.

Red clover contains a high concentration of oestrogen and can cause infertility in sheep. For this reason, red clover should not be used for sheep pasture during the breeding season.

Variety Selection

Look for good disease resistance and persistence in a red clover variety. Varieties which are resistant to both Northern and Southern Anthracnose and Powdery Mildew are recommended for use throughout the Midwest. There are several red clover varieties marketed in the Midwest that have been bred for better persistence. With proper management, you can expect these varieties to persist for two to three years after the establishment year. See the Variety Characteristics section for specific varietal information.

White Blossom Sweetclover - melilotus alba



Key Information on White Blossom Sweetclover

Annual or Perennial	Annual / Biennial
Best Use	As a soil improvement and for honey production, in small quantities in hay or pasture.
Bushel Size	60 lb
Planting Depth	¼" to ½"
Seeding Dates	January to April 20 th
Seeding Rate	10 - 15 pounds alone 2 - 6 pounds in mixes
Seeds Per Pound	Approximately 260,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume but not a true clover
Type of Soil required	Adapted to a wide range of soil and moisture conditions. Neutral pH

History

The sweet clovers are native to temperate Europe and Asia. Although reported as found in Virginia as early as 1739, it was not until the present century that their great value for soil improvement, pasture, hay and silage became recognized.

Length of Life

Annual or Biennial.

Description of Crop

Sweetclover is not really a clover at all. It was improperly named that and has not been changed. It is actually a closer relative of Alfalfa than of Clover. In general, the white-flowered forms of sweet clover are somewhat ranker growing, heavier yielding, and have coarser stems than the yellow-flowered. They are 10 - 20 days later maturing so are generally preferred for pastures in areas of ample moisture. The more vigorous growth and heavier yields make them somewhat superior for soil improvement. In growth habit and appearance the two are similar except for flower color. Usually three leaflets with terminal leaflet on the small stem; entire leaf is toothed or serrated. Growth occurs from the crown. Plant grows 2 to 5 feet tall with very deep, penetrating tap roots.

Use

All the biennial sweet clovers fix large amounts of atmospheric nitrogen. Approximately 1/3 of the nitrogen in the plant is contained in the green matter above ground. During the late spring and early summer White Blossom Sweetclover produces very heavily. Yellow Sweetclover may be better suited to pasturing. If cut as silage care must be taken to preserve the silage properly. (See Potential Problems) The deep-penetrating tap roots decompose after the second year, so the crops are very useful for opening up subsoil. They are therefore probably the best of the crops for soil improvement. For hay purposes the first year of growth makes a protein level hay similar to Alfalfa. The second year growth becomes woody and is lower quality. It should be cut in the bud stage and properly cured. For pasture purposes, the first years growth, while light, can be grazed up to the first killing frost. The second year a large flush of growth comes on early and must be managed properly. A higher density of animals should be put on the

pasture in order to keep the Sweetclover from becoming lanky and woody. Additionally feeding a dry roughage is recommended when pasturing or feeding hay from Sweetclover

Adaptation

White Blossom Sweetclover is adapted well to a wide range of soils from light to heavy, however it will not tolerate low pH acid conditions.

Potential Problems

The sweetclovers have a high content of coumarin which reduces palatability. More important, in hay spoiled due to excess moisture when stored or in improperly prepared silage, di-coumarol, which reduces the clotting of blood, is formed. Animals fed such hay or silage are subject to excessive external or internal bleeding. This is called "Bleeding Disease". In the spring of the second year if the growth is not managed the Sweetclover will outgrow the other components of the pasture and become woody, this reduces the overall value of the crop. Bloat is also a problem with Sweetclover

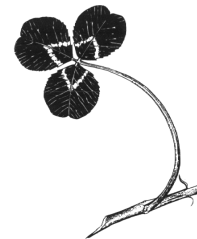
Establishment & Management

Seedbed preparation should be the same as for Alfalfa. Use seed that is inoculated properly. Cutting should leave a 10" to 12" stubble for re-growth. After the second year the crop should be plowed under to get the most use out of the nitrogen. The roots will decompose quickly and act as an aerator for the subsoil.

Variety Selection

Although varieties of White Blossom Sweetclover are available the common seed is the most widely used. Annual varieties such as Hubam and Isreal are grown in the southern states. Penta is a low-coumarin variety, bred in Wisconsin.

White Dutch Clover ~ trifolium repense



Key Information on White Dutch Clover

Annual or Perennial	Perennial - short lived 3 years, that re-seeds itself abundantly
Best Use	As an addition to grass pastures, or in non crop areas with little, maintenance desired. Also grows well in shaded areas.
Bushel Size	60 lb
Planting Depth	¼" to ½"
Seeding Dates	January to April 20 th - or - August to September
Seeding Rate	2 - 4 pounds alone 1 - 2 pounds in mixes
Seeds Per Pound	Approximately 850,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume
Type of Soil required	Moist fertile silt or clay loam soils

History

Once used extensively in lawn mixtures before the advent of commercially available lawn fertilizers.

Length of Life

Although White Dutch Clover is considered to be a short lived perennial, it rarely dies out of a pasture or non crop area. White Dutch re-seeds in years of adequate moisture and moderate temperatures. It will continue to appear as a volunteer crop for years to come.

Description of Crop

Without regard for the size of the plant, White Dutch Clover and Ladino are similar. White Dutch typically produces more flowers and has less stolons - surface running roots. The plant height normally only reaches 6" to 12". The three leaves are all equal distance from the stem, light colored V marks are present on the upper leaf surface. White to pinkish white flowers are abundant. No hairs are seen on vegetative parts of the plant. White clovers are the most shade tolerant of the clover family.

Use

Roadsides, non-crop areas, and pastures are the primary uses. Like other legumes, white clover improves the feeding value of a grass pasture. This is the result of its high voluntary intake, digestibility, and crude protein levels. Ladino is the better choice in a pasture situation, however, White Dutch is essentially the same as far as nutrition is concerned. The drawback of White Dutch is its size. White clover is used widely in renovation of permanent pastures lacking legumes. White clover-grass mixtures also may be used for high-quality hay or silage.

Adaptation

White clover can be used on wet areas of soils with low pH, but does best in well-drained silt loam and clay soils of pH 6.0 to 7.0. It does not tolerate saline or highly alkaline soils.

Potential Problems

White Dutch Clover can cause bloating in livestock. It can continue on as a volunteer plant for years or decades to come. Low phosphorus levels can severely diminish the yield and the longevity of White Dutch Clover.

Establishment & Management

Soil preparation should provide a fine, firm, weed-free seedbed. Fall plowing followed by light working of the surface soil in the spring will produce an excellent seedbed. Spring seeding should be done early to allow 4 to 6 weeks of growth before the dry season arrives. A similar time should be allowed before the first freeze if seed is sown in late summer. Under irrigated conditions, timing is not as critical. Seed should be planted no deeper than ½ inch immediately following inoculation with the proper Rhizobium. Firming the soil following planting will aid in rapid establishment of the seedlings.

Liming to achieve a pH of 6.0 is recommended. Adequate levels of potassium, phosphorus, and sulfur should be available, as white clover requires a high level of fertility for high production. Properly inoculated and nodulated white clover-grass pastures will not require the addition of nitrogen. Early spring application of small amounts of nitrogen (30-40 lbs.) will stimulate early growth of grass but will favor the grass over the legume.

The most difficult problem in managing white clover-grass pastures is maintaining the clover. Frequent defoliation during the period of maximum grass growth (early spring) encourages white clover by minimizing grass competition. Mixed pastures should be used before the grass reaches

its maximum competition. Clipping or harvesting surplus forage in under stocked pastures will help maintain the clover and control the grass and weeds.

If pastures are grazed continuously, the height of forage should be maintained at 2 to 6 inches, depending on the grass species. Fall management should allow adequate regrowth for rooting new stolons before the first freeze. Disappearance of white clover from pastures can be remedied by pasture renovation.

Bloat is often a problem for animals on pastures that contain a large proportion of white clover. Methods of controlling bloat in mixed clover-grass pastures include supplementing pastures with grass hay and intensive strip grazing. Bloat-preventative materials, which prevent rumen foam production, may be added to drinking water, applied as a top dressing on grain supplements, or added to salt-molasses blocks. The effectiveness of these methods depends upon animals obtaining a regular supply of bloat preventative.

Variety Selection

White Dutch is a type of White Clover and is considered to be a common type. There are no varieties of common seed. It is essentially the same plant as Ladino Clover and New Zealand Clover

Yellow Blossom Sweetclover ~ *melilotus officinalis*



Key Information on Yellow Blossom Sweetclover

Annual or Perennial	Annual / Biennial
Best Use	As a soil improvement and for honey production, in small quantities in hay or pasture.
Bushel Size	60 lb
Planting Depth	¼” to ½”
Seeding Dates	January to April 20 th
Seeding Rate	10 - 15 pounds alone 2 - 6 pounds in mixes
Seeds Per Pound	Approximately 260,000
Time to Germinate	Approximately 7 Days
Type of Plant	Legume but not a true clover
Type of Soil required	Adapted to a wide range of soil and moisture conditions. Neutral pH

History

The sweet clovers are native to temperate Europe and Asia. Although reported as found in Virginia as early as 1739, it was not until the present century that their great value for soil improvement, pasture, hay and silage became recognized.

Length of Life

Annual or Biennial.

Description of Crop

Sweetclover is not really a clover at all. It was improperly named that and has not been changed. It is actually a closer relative of Alfalfa than of Clover. The yellow-flowered is finer stemmed, matures 10-20 days earlier in summer, is more tolerant to drought and competition with companion crops, and gives a better quality but lower yield of hay. In growth habit and appearance the two are similar except for flower color. Usually three leaflets with terminal leaflet on the small stem; entire leaf is toothed or serrated. Growth occurs from the crown. Plant grows 2 to 5 feet tall with very deep, penetrating tap roots.

Use

All the biennial sweet clovers fix large amounts of atmospheric nitrogen. Approximately 1/3 of the nitrogen in the plant is contained in the green matter above ground. Yellow Sweetclover may be better suited to pasturing. If cut as silage care must be taken to preserve the silage properly. (See Potential Problems) The deep-penetrating tap roots decompose after the second year, so the crops are very useful for opening up subsoil. The Sweetclovers are therefore probably the best of the crops for soil improvement. The first season, a central much-branched stem is produced with a deep tap root which becomes fleshy in the fall. The second year, crown buds start growth early with vigorous, rather coarse stems.

Adaptation

Yellow Blossom Sweetclover is adapted well to a wide range of soils from light to heavy, however it will not tolerate low pH acid conditions.

Potential Problems

The sweetclovers have a high content of coumarin which reduces palatability. More important, in hay spoiled due to excess moisture when stored or in improperly prepared silage, di-coumarol, which reduces the clotting of blood, is formed. Animals fed such hay or silage are subject to excessive external or internal bleeding. This is called "Bleeding Disease". In the spring of the second year if the growth is not managed the Sweetclover will outgrow the other components of the pasture and become woody, this reduces the overall value of the crop. Bloat is also a problem with Sweetclover

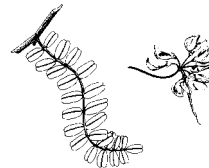
Establishment & Management

Seedbed preparation should be the same as for Alfalfa. Use seed that is inoculated properly. Cutting should leave a 10" to 12" stubble for re-growth. For hay, the second season crop should be cut early. After the second year the crop should be plowed under to get the most use out of the nitrogen. The roots will decompose quickly and act as an aerator for the subsoil.

Variety Selection

Although varieties of Yellow Blossom Sweetclover are available the common seed is the most widely used.

Crown Vetch ~ *coronilla varia*



Key Information on Crown Vetch

Annual or Perennial	Perennial
Best Use	As a soil improvement, and for soil stabilization
Bushel Size	55 lb

Planting Depth	½”
Seeding Dates	March to November
Seeding Rate	15 - 25 pounds alone
Seeds Per Pound	Approximately 110,000
Time to Germinate	Approximately 14 - 21 Days
Type of Plant	Legume but not a true vetch
Type of Soil required	Adapted to well drained, fertile soils

History

Crown Vetch is native to the Mediterranean area but now widely distributed in local areas throughout the Central and Northern States. It was originally only used as an ornamental in the United States, but now is a primary soil stabilizer. Tares as mentioned in the Bible are believed to have been common vetch.

Length of Life

Crown Vetch is a perennial plant.

Description of Crop

Crown Vetch will perform better and even thrive in a drought situation or in low fertility soils. Stems are weak and hollow, up to 5 feet, prone unless supported. The plant spreads by creeping underground roots and is excellent for erosion control. The leaf is made up of 12-14 pairs of leaflets arranged along the stem, opposite one another. The flower is variegated with color ranging from purple to white. Crown Vetch will form a dense cover.

Use

The primary use of Crown Vetch is as a soil stabilizer on hillsides, roadsides, and non-crop areas. In the Midwest, the purple flowers seen along side interstate highways are usually Crown Vetch. Overall Crown Vetch is not important as a hay or pasture crop with palatability being low.

Adaptation

Crown Vetch is adapted to fertile soils with good drainage. It will not perform well in a wet situation. It is not susceptible to disease or insect damage.

Potential Problems

Some have jokingly said that Crown Vetch will germinate between 2 weeks and 2 years! Inoculation is critical with Crown Vetch. The problem of establishing a good stand is normally in an acidic or low pH situation. Once established it will perform better in the low pH soils than most other legumes. Crown Vetch can have a higher percentage of “hard seed” than many other legumes also, making it slower to establish.

Establishment & Management

Seedbed preparation should be the same as for Alfalfa. Use seed that is inoculated properly. It is advantageous to put a nurse crop in with Crown Vetch. If perennials are desired a low rate of Fescue or orchardgrass should be used. For areas that will be solely Vetch, plant with annual ryegrass. An established stand will have one to two plants per square foot.

Variety Selection

Although varieties are available, such as Penngift and Emerald, the varieties are developed for a pasture situation. No specific variety is needed for use as an erosion control

Field Peas ~ *pisum arvense* L.

Key Information on Field Peas

Annual or Perennial	Summer Annual
Best Use	As a green manure for plowdown or primarily used with oats for hay, pasture, or silage.
Bushel Size	60 lb
Planting Depth	1" to 2"
Seeding Dates	Early Spring - similar to garden peas
Seeding Rate	90 - 120 pounds alone 60 - 90 pounds of peas with 30 - 50 pounds of oats
Seeds Per Pound	Approximately 4,000
Time to Germinate	Approximately 8 Days
Type of Plant	Legume - similar to garden peas
Type of Soil required	Adapted to well drained, fertile soils

History

Peas probably originated as a winter annual in southwestern Asia, possibly northwestern India, Pakistan or adjacent areas of former USSR and Afghanistan and spread to the temperate zones of Europe. Non-pigmented peas to be used as a vegetable were grown in United Kingdom in the middle Ages. Peas were introduced into the Americas soon after Columbus and a winter type pea was introduced from Austria in 1922. Pea was taken to China in the first century.

Length of Life

Annual

Description of Crop

A poor weed competitor, the field peas can get up to several feet tall. Field Peas do not taste as good to humans as garden peas. The plant looks very similar to a garden peas except the larger size. When grown for seed they sometimes are grown on a matrix of string or rope. The average pea crop will fix nearly 75 pounds of nitrogen per acre.

Use

Peas to livestock, primarily cattle, they are a real treat. The primary use is for a pastured forage with oats.

Adaptation

Peas are adapted to cold early spring weather and flourish in weather that other legumes have trouble in. They are similar to Alfalfa hay in feed value.

Potential Problems

Very few, as with garden peas, if planted too late the yield will be much lower.

Establishment & Management

For pasture purposes the oats and hay can be grazed at any time, however, for best quality wait until the peas are nearly at maturity. This mix can be grazed earlier if emergency

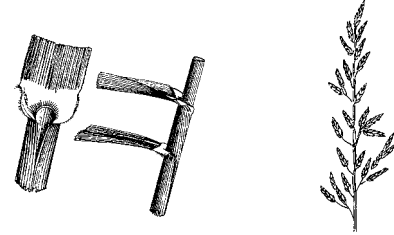
pasture is needed. The seed bed should be worked up similar to one for oats or wheat. Seeding can be done either drilled or broadcast. This mix is not as popular as it should be due to a lack of knowledge. The Field Peas and Oats mix is excellent when used before Wheat. The pasture can be grazed and then plowed under as a green manure before planting the wheat.

Variety Selection

Few varieties are available, please see the Variety Characteristics section for details.

Fescue ~ *festuca arundinacea* ~ Tall Fescue

Key Information on Fescue for forage use



Annual or Perennial	Perennial
Best Use	As a drought tolerant forage grass and in poor conditions, also for pond banks, ditch banks, sod waterways, and roadsides.
Bushel Size	22 lb
Planting Depth	¼” to ½”
Seeding Dates	March - May - or - August to Mid October
Seeding Rate	15 - 20 pounds alone 2 - 6 pounds in a mix
Seeds Per Pound	Approximately 225,000
Time to Germinate	Approximately 14 - 21 Days
Type of Plant	Grass
Type of Soil required	Adapted to drought situations, as well as wet soils, and low to high pH

History

Introduced from Europe, Tall Fescue is the only cool season grass to flourish even in the southeastern United States. Tall Fescue rapidly increased since the 1950’s and has now leveled in acreage devoted to Tall Fescue pasture.

Length of Life

Perennial bunchgrass.

Description of Crop

Tall Fescue is a deep-rooted sod forming grass which is best adapted to cool season production. The mature Tall Fescue plant can reach heights of 48”. Leaves at the base of the plant are numerous, broad and flat. Plants are vigorous and grow well on both wet and dry sites. They thrive best on heavy soils. Palatability for livestock is lower than that of some other grasses, and pastures should be grazed close for best acceptance and nutritive value.

Use

Animals will readily graze Tall Fescue during April, May and early June and again in the fall, but show reluctance to graze it during the summer months of July and August.

Tall Fescue is the best adapted cool-season grass for stockpiling (accumulating growth) for use in the fall and winter. In addition, Tall Fescue generally has greater quality in the fall because of greater leaf retention than other cool-season grasses in the fall. Thus it can provide much of the spring, fall and winter feed for a beef cow herd.

Adaptation

It is extremely well suited for use as a stockpile forage because it retains its quality and improves in palatability in the fall. It is well adapted to soils of low pH such as strip mine reclamation. Low endophyte varieties improve animal acceptance of and performance on Tall Fescue. Tall Fescue can be part of a forage program but should not be the only species in the program. Tall Fescue is drought resistant and will maintain itself under rather limited fertility conditions. Tall Fescue is also ideal for waterways, ditch and pond banks, and farm lots and lanes. It is the best grass in areas of heavy livestock and machinery traffic.

Potential Problems

Dairy or finishing animals should not be pastured on Tall Fescue. Tall Fescue lacks palatability in mid-summer. Some of the reduced summer palatability and traditionally low-quality forage, which resulted in poor animal performance, is associated with the presence of a fungus in the plant (endophytic). The fungus grows between the plant cells and over winters in the base of the plant. The fungus produces alkaloids which are toxic to animals. These alkaloids are thought to cause the poor conception rates, low birth weights, and low daily gains of animals grazing fungus infected Tall Fescue. Low endophyte varieties are now available and are recommended for new seedings. Since Tall Fescue is rather slow to establish, new stands can be seriously damaged by overgrazing or grazing too soon. However, close grazing of well-established stands is a good management practice.

Establishment & Management

Tall Fescue and accompanying legumes can be seeded in the spring or late summer. Spring seedings should be made as early as possible to avoid hot dry weather when the seedlings are small. Late-summer seedings usually have less weed competition and more favorable moisture conditions than spring seedings. For best results, drill seed Tall Fescue 1/4 inch deep. Press wheels used in conjunction with band seeding will add additional stand insurance. If the seedbed is dry and not firm, culti-pack before seeding to make a firm seedbed.

Tall Fescue can be part of a forage program but should not be all of it. Legumes with Tall Fescue improves animal performance and increases forage production during the summer. Legumes are difficult to maintain in a Tall Fescue sod, but there are a number of management practices that will help keep legumes in the stand. Two of these practices are maintaining pH above 6.0 and annual applications of potash. Tall Fescue grown with either red or white clover should not be allowed to smother the legume in the spring. This can be avoided by grazing early and close to the soil surface. Red clover is a short-lived perennial and must be managed to produce seed if red clover is desired in the stand after 2-3 years.

Tall Fescue will withstand closer grazing and more abuse than most cool-season grasses. But it can be overgrazed to the point that vigor as well as production is reduced. Don't graze closer than 3 or 4 inches, and allow at least 30 days for the Tall Fescue to recover.

Improved animal performance has been reported for the new endophyte free varieties of Tall Fescue relative to endophyte infected varieties. Increased average daily gains of 0.5 lb per animal per day have been reported for 7-12 month old angus steers when grazing endophyte free compared to endophyte infected Tall Fescue. Other tests comparing orchardgrass and endophyte free Tall Fescue have shown similar animal performance. In a two-year study at Penn State University comparing endophyte free Tall Fescue varieties, animal performance was similar on all varieties. While orchardgrass is generally of higher quality during spring and summer, Tall Fescue is of higher quality in fall, especially after frost.

If Fescue is to be used during the summer, maintain a legume in the stand to improve animal performance. Otherwise, allow the late summer growth to accumulate for use in the fall or winter stockpiling. Tall Fescue that is used exclusively for stockpiling is usually maintained in a pure stand.

Although Tall Fescue can achieve adequate yields on low pH soils, maximum productivity is obtained when the pH is between 6.0 and 7.0. While small amounts of nitrogen and potash are beneficial at seeding, too high a concentration of these elements can interfere with germination. Do not apply nitrogen at seeding if Tall Fescue is seeded with a legume.

If pure Tall Fescue stands are used, high yields can be expected if fertilizer is applied during the winter or very early spring. This is especially true for the nitrogen portion of the fertilizer. Tall Fescue to be used for hay should receive 100 to 150 pounds of N during the winter period. The same fertilization practices apply for early grazing as well as for hay. If much fall pasture is desired, then fertilizer should be reapplied in July. Applying nitrogen fertilizer to mixed stands will cause the grass to dominate the mixture. Tall Fescue-legume mixtures should be topdressed annually with phosphorus and potassium.

Variety Selection

Numerous varieties are adapted for use in the Midwest. However, the endophyte free varieties have improved quality compared to those infected with the endophyte fungus. Endophyte infected varieties are well-suited for use on reclaimed strip mines and other conservation uses where the soil conditions are unusually adverse for plant growth. It is recommended that low endophyte seed be used if the Tall Fescue is to be used for animal feed. For specific variety information please see the Variety Characteristics section for details.

Hairy Vetch ~ *vicia villosa*



Key Information on Hairy Vetch

Annual or Perennial	Winter Annual or Biennial
Best Use	As a soil improvement, stabilization, and nitrofication.
Bushel Size	60 lb
Planting Depth	1" - 1½"
Seeding Dates	August to October
Seeding Rate	50 - 60 pounds alone
Seeds Per Pound	Approximately 20,000
Time to Germinate	Approximately 10 - 14 Days
Type of Plant	Legume
Type of Soil required	Adapted to well drained, fertile soils

History

Vetch plants are recorded in Bible times and are thought to have originated from the upper Middle East.

Length of Life

When planted in spring the crop is a biennial and will produce the most nitrogen the second year. When planted in fall, as is recommended for the Midwest, it will be an annual crop.

Description of Crop

Hairy vetch is the most winter hardy of the vetches, enduring below zero winter temperatures. It is generally grown as a winter annual.. Each leaf consists of about 10 pairs of elliptic-oblong leaflets. The leaf ends with a tendril that attaches itself to other plants. The weak stems reach to 4 feet and are prone unless supported. Stems and pods of common hairy vetch are covered with small hairs. The flowers are a brilliant blue violet color.

Use

Can be used as pasture or hay, although it is not recommended for the Midwest. The primary use is as a nitrogen producing legume and as a nutrient pump. Hairy Vetch will pull nutrients from the subsoil up through its emense root system and leaves them nearer the soil surface. When tilled under the plant also creates organic matter from the dense mat of foliage. Some experts claim as much as 200 pounds of nitrogen per acre can be “fixed” by a high yield of Hairy Vetch. Others claim less, however, it is a tremendous amount either way. The next most common use for Hairy Vetch is as an erosion control.

Adaptation

Adapted quite well to sandy soil. It is winter hardy and drought tolerant. As with most legumes it grows the best on soils of good fertility levels.

Potential Problems

Hairy Vetch is somewhat of a forgotten crop, and most do not inoculate it. Without inoculation it will be a spindly weak crop, with disappointing results.

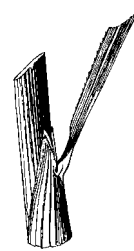
Establishment & Management

Soil preparation can range from a seed bed suitable for Alfalfa to none at all. Best results are when the soil is tilled and packed lightly. Aerial seeding into existing crops can also be successful, although with all aerial seeding timing is a key. Drilling or Broadcasting is the recommended way to plant.

Variety Selection

Smooth Vetch is a type of Hairy Vetch without hairs on the stems and pods. Varieties are available and primarily used in the southern United States. No descriptions of varieties will be listed in this manual.

Indiangrass ~ sorghastrum nutans



Key Information on Indiangrass

Annual or Perennial	Perennial
Best Use	A native grass for hay or set aside fields requires 14” of rainfall per year.
Bushel Size	n/a
Planting Depth	¼” to ½”
Seeding Dates	Spring
Seeding Rate	6 lbs per acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 170,000
Time to Germinate	Approximately 21 days
Type of Plant	Native Bunch Grass
Type of Soil required	Thrives on moist, well drained soils of good quality. Can survive low

moisture conditions.

This is a native bunchgrass with short rhizomes, widely distributed east of the Rocky Mountains from Canada south to the Gulf of Mexico and into Mexico. Under the best conditions stems may reach to 6 -10 feet. Leaves are smooth and flat, near a half inch wide, elongated, narrow at the base. Indiangrass thrives best on fertile bottom soils but also occurs on sandy soils and dry slopes. It is palatable while succulent but only fairly so when dry. It is most useful in the Central and Southern Great Plains.

Intermediate Wheatgrass ~ *elytrigia intermedia*

Key Information on Intermediate Wheatgrass

Annual or Perennial	Perennial
Best Use	A native grass for hay or set aside fields requires 14" of rainfall per year.
Bushel Size	n/a
Planting Depth	¼" to ½"
Seeding Dates	Spring
Seeding Rate	8 lbs per acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 90,000
Time to Germinate	Approximately 14 days on average
Type of Plant	Sod producing Introduced Grass
Type of Soil required	Thrives on moist, well drained soils of good quality. Can survive low moisture conditions.

This is a sod-forming wheatgrass, introduced from Russia. It has proved well adapted to the Northern and Central Great Plains, and in the Pacific Northwest. It is a little less hardy and drought resistant than crested wheatgrass. Plant growth is vigorous, and is relished by all classes of livestock. Stems reach a height of 3 to 4 feet. For both pasture and hay production, this is a valuable grass for its area of adaptation. It is readily established by seeding.

Herbage of intermediate wheatgrass is used extensively as an introduced cool-season forage in the USA and Canada and as a native forage in temperate regions of the Old World.

Intermediate wheatgrass is also used as a reclamation grass for mine sites and planted along roadways and airport landing strips for erosion control.

Intermediate wheatgrass, also called Wild Triga, is a perennial cool-season rhizomatous grass. As a member of the tribe Triticeae, intermediate wheatgrass is related to important annual grains such as wheat, rye and barley as well as 250 species of perennial grasses, many of which are important forage grasses.

Cultural techniques to produce intermediate wheatgrass seed have been developed by the forage seed industry. These techniques can be modified for the production of grain. Since intermediate wheatgrass is a perennial, it can be planted on hilly land that should not be planted to continuous annual crop production. It can be grown in contour strip alternating with annual crops and rotated with annuals on a five to seven year basis. The strips containing the perennial grain will build soil and catch any eroding soil coming from the areas planted to annuals.

The best stands are established when seeded into a weed free seed bed. With sufficient moisture, plants germinate quickly, within 3-4 days. The optimum planting date is late summer when warm-season weeds are not competitive. Seed should be drilled in rows spaced 7 to 10 inches

apart. Seeds within rows should be spaced 1-2 inches apart. Lighter rates should be used in drier climates and the heavier seeding rate in wetter environments.

Lespedeza Korean ~ lespedeza stipulaceae maxim

Key Information on Korean Lespedeza

Annual or Perennial	Annual
Best Use	Used as pasture, hay and soil conservation on poor soils where other legumes might not grow. Similar feed value to alfalfa or clover
Bushel Size	30 lb unhulled
Planting Depth	½"
Seeding Dates	February 15 to April 15
Seeding Rate	20 - 25 pounds alone 2 - 6 pounds in a mix
Seeds Per Pound	Approximately 240,000
Time to Germinate	Approximately 14 days
Type of Plant	Legume
Type of Soil required	Best suited to well drained, high fertility level, loam to silt loam soil. It will grow on low pH soils

History

Korean is an annual Lespedeza introduced into the United States in 1919. Many varieties of annual Lespedeza are known, however, almost all of them originated in the orient.

Length of Life

Korean Lespedeza is a reseeding annual. If it does not reseed the only crop dies at the first killing frost.

Description of Crop

The plants are long-lived, leafy, erect, with rather coarse stems reaching 2 to 4 feet high. Leaflets are long, narrow and blunt at the terminals. The leaflets have 3 leaves that are shaped somewhat like White Clover. Korean Lespedeza reaches full bloom in late summer when the growth rate rapidly declines.

Use

It is used for hay, in rotation and permanent pasture, as a cover crop and as a soil stabilizer. Korean Lespedeza is sometime cut for hay, and has been called the "poor man's alfalfa"

Adaptation

Korean Lespedeza is adapted to well drained, fertile soils, however, the reason it has the popularity it does is because of what it can do on poor soils. It grows well on acidic soils with low fertility. It can also survive both drought and flood

Potential Problems

Korean Lespedeza does not yield well enough for it to be as desirable as some of the other legumes.

Establishment & Management

Korean Lespedeza can be planted in late winter to early spring with harvest to come about 2 weeks before full flowering or in August. Be sure to inoculate the seed with the proper Rhizobium. It can be broadcast without any tillage into existing pastures, grains or onto set aside land. The germination will be adequate in each of these cases. After the beginning stages of establishment, mow the competing crops or weeds to allow the Lespedeza a chance to compete.

Variety Selection

Korean is considered to be a variety of Annual Lespedeza.

Lespedeza Sericia ~ *lespedeza cuneata*

Key Information on Sericia Lespedeza

Annual or Perennial	Perennial
Best Use	Used as pasture, hay and soil conservation on poor soils where other legumes might not grow. Also as a wildlife shelter.
Bushel Size	60 lb hulled
Planting Depth	½"
Seeding Dates	March 15 to April 15
Seeding Rate	25 - 30 pounds alone 4 - 6 pounds in a mix
Seeds Per Pound	Approximately 370,000
Time to Germinate	Approximately 21 - 28 days
Type of Plant	Legume
Type of Soil required	Best suited to well drained, high fertility level, loam to silt loam soil. It will grow on low pH soils

History

Sericea is the only perennial Lespedeza of importance agriculturally in the United States. Seed from Japan was first tested in North Carolina in 1896.

Length of Life

Perennial, it dies back each winter and grows from the crown each spring

Description of Crop

The plants are long-lived, leafy, erect, with rather coarse stems reaching 2 to 4 feet high. Leaflets are long, narrow and blunt at the terminals. The leaflets have 3 leaves that are shaped somewhat like White Clover. It becomes coarse and woody when mature.

Use

It is used for hay, in rotation and permanent pasture, as a cover crop and as a soil stabilizer. It is very valuable also as a wildlife shelter. Sericia Lespedeza is also used as a crop to bring back severely depleted soils.

Adaptation

Sericia Lespedeza is adapted to well drained, fertile soils, however, the reason it has the popularity it does is because of what it can do on poor soils. It grows well on acidic soils with low fertility. It can also survive both drought and flood

Potential Problems

Sericia Lespedeza does not yield well enough for it to be as desirable as some of the other legumes.

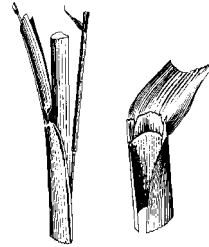
Establishment & Management

Be sure to inoculate the seed with the proper Rhizobium. It can be broadcast without any tillage into existing pastures, grains or onto set aside land. The germination will be adequate in each of these cases. After the beginning stages of establishment, mow the competing crops or weeds to allow the Lespedeza a chance to compete.

Variety Selection

Sericia is considered to be the only variety of perennial that is of economic value in the United States.

Little Bluestem ~ *schizachyrium scoparium*



Key Information on Little Bluestem

Annual or Perennial	Perennial
Best Use	Erosion Control where at least 14" of rain fall per year
Bushel Size	n/a
Planting Depth	½"
Seeding Dates	Spring or Fall
Seeding Rate	6 lbs per acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 240,000
Time to Germinate	Approximately 28 days
Type of Plant	Native Grass
Type of Soil required	Well drained soils of moderate fertility

This is a vigorous, long-lived native bunchgrass, widely distributed over the United States; but most prevalent in the Central and Southern Great Plains. It is usually found associated with big bluestem grass. It is more drought resistant than big bluestem, and a smaller plant - reaching not over 3 feet. Leaves are up to 8 inches long, and not over 0.25 inch wide. It furnishes dependable grazing and cured hay, but is not highly palatable. It is especially valuable for erosion control.

Millet ~ *Panicum* family

This grass was cultivated in China more than 4000 years ago. It was introduced into this country from Europe in 1849 and is now grown through the Plains and Central States north from Texas. It is used as hay, pasture and green fodder. The seed is used as bird feed.

Japanese, German, Hungarian, and Siberian and Pearl millets will all grow in the Midwest but are generally lower yielding than other grain crops and well below sudangrass and sorghum-sudans in forage production. Sudangrass and sorghum-sudans are better choices unless there is some special reason for growing millets. For best-quality hay, cut the plants at the boot stage. Curing is somewhat slow because of the thick stems. For grazing, it is usually best to begin about six to eight weeks after planting or when the plants are 6 to 12 inches tall. After this stage, the nutritive value for grazing decreases.

Millets are generally grown on less fertile soils. All millets respond to nitrogen and phosphorus fertilizers, but there are only broad guidelines on fertility practices for millets. Generally 40-100 lb of nitrogen and 30-60 lb of phosphorus per acre are adequate to produce hay or seed, but most forage crops for grazing should be fertilized more to enhance forage productivity and volume. The amount of forage needed and the number of livestock to be pastured will be the determining factors in planning nitrogen fertility practices. Nitrogen requirements for heavy forage production and heavy grazing will likely be double those required for hay or seed crops. Phosphorus requirements will also be higher than those for hay or seed crops. A soil test is recommended to evaluate nitrogen and phosphorus fertilizer requirements and to indicate the deficiency of any of the other required nutrient elements that might limit productivity. These nutrient elements include potassium, sulfur, calcium, magnesium, iron, copper, boron, manganese, zinc, molybdenum, and chlorine. One or more of these nutrients may be limiting in the less fertile soils used by millet producers.

German Foxtail Millet and Pearl Millet will be discussed in this manual

German Foxtail Millet - *setaria italica* - also called Italian Millet

Key Information on German Foxtail Millet

Annual or Perennial	Annual
Best Use	Hay or forage after other crops are to late
Bushel Size	50 lbs
Planting Depth	½"
Seeding Dates	Late Spring
Seeding Rate	20 - 30 pounds alone
Seeds Per Pound	Approximately 220,000
Time to Germinate	Approximately 10 days
Type of Plant	Millet Panicum type plant
Type of Soil required	Warm soils in late spring, used in dryer months.

Foxtail millet is an annual grass growing to 5 feet under the best conditions. It is a warm weather crop, usually seeded after the soil becomes warm in late spring. Flowering stems are leafy throughout their length, but the hay or fodder is less nutritious than a number of other grasses and legumes. For this reason it is now grown less than in the past. A number of varieties, differing slightly in characteristics, are available. A weed grass called foxtail is a close relative.

One of the oldest cultivated crops, foxtail millet has generally been displaced by sudan grasses as late-sown hay crops. Foxtail millet requires warm weather and matures quickly in the hot summer months. Generally grown in semi-arid regions, it has a low water requirement, though it does not recover well from drought conditions because it has a shallow root system. Successful

production is due almost entirely to its short growing season: millet hay crops will mature in 65-70 days; grain varieties mature in 75-90 days. Foxtail millet can be planted when it is too late to plant most other crops.

An annual grass, foxtail millet forms slender, erect, leafy stems varying in height from 1-5 ft. Seeds are borne in a spike-like, compressed panicle resembling yellow foxtail, green foxtail, or giant foxtail. Its small convex seeds are enclosed in colored hulls, with color depending on variety. Only about 10 or more varieties of foxtail millet are grown in the U.S.

Principal uses of foxtail millet include hay or forage. Although other hay crops are superior in quality, foxtail millet makes good hay for cattle and sheep. Foxtail millet is also used as a grain crop and for birdseed. Some diseases affecting foxtail millet including mildew, bacterial blight, and leaf spots. Kernel smut is also a problem in some cases; it can be controlled with seed treatments at planting. Wheat should not follow foxtail millet unless 6 weeks have passed due to the potential of a mosaic virus in the millet that could pass on to the wheat.

Pearl Millet ~ *setaria italica* - also called Cattail Millet, bullrush, and penicillaria

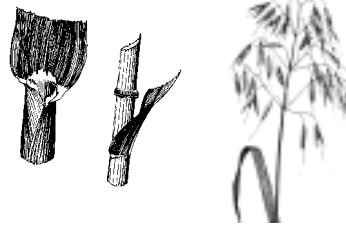
Key Information on Pearl Millet

Annual or Perennial	Annual
Best Use	Temporary summer pasture crop.
Bushel Size	35 lbs
Planting Depth	½"
Seeding Dates	Late Spring
Seeding Rate	16 - 20 pounds alone
Seeds Per Pound	Approximately 85,000
Time to Germinate	Approximately 10 days
Type of Plant	Millet Panicum type plant
Type of Soil required	Warm soils in late spring, used in dryer months.

Pearl millet is native to India but came to the United States via the West Indies. It is a tall upright annual grass, up to 10 feet, with coarse stems which grow in dense clumps. Leaves are coarse, 2 to 3 feet long and an inch wide and numerous. In fertile soil it produces great amounts of green fodder, which is palatable and nutritious, and can be cut repeatedly during a season. It is grown both for pasture and silage. it can be grown as far north as Maryland, but is better farther south. The seed is planted directly in the field, generally in rows about 4 feet apart.

Pearl millet is generally used as a temporary summer pasture crop or in some areas as a food crop. It is a tall, erect, annual bunchgrass growing from 6-15 ft in height. It is particularly well adapted to nutrient-poor, sandy soils in low rainfall areas. Stems are pithy and leaves are long-pointed with finely serrated margins. The plant tillers freely and produces an inflorescence with a dense spike-like panicle 14" long and 1" or less in diameter. Pearl millets are generally cross-pollinated. Several varieties and hybrids have been developed. Uses of pearl millet include hay, pasture, silage, seed crops, and food. There appear to be few or no disease problems associated with pearl millet. Late summer drought can be devastating to crop yields in Indiana. Pearl millet, a cereal with good drought tolerance, could alleviate this problem. Furthermore, the short growing season required by pearl millet confers the potential of millet being double-cropped after winter wheat has been harvested in northern Indiana so that valuable soil is not idled after June.

Oats ~ *avena sativa* l. poaceae



Key Information on Oats

Annual or Perennial	Annual
Best Use	Cereal grain, but most commonly used as a nurse crop in the Midwest
Bushel Size	32 lbs
Planting Depth	½"
Seeding Dates	Late Spring
Seeding Rate	64 - 90 pounds alone
Seeds Per Pound	Approximately 14,000
Time to Germinate	Approximately 10 days
Type of Plant	Annual Grass, Cereal Grain
Type of Soil required	Moist Fertile Soils

History

Oats are believed to be mainly Asiatic in origin. Different kinds of oats probably came from different parts of that continent or Europe. As a cultivated crop oats appear to be substantially later in origin than wheat. Early use of oats appears to have been medicinal. Not until about the beginning of the Christian era are references to oats as a cultivated crop found in literature. Cultivation of oats was extensive in Europe prior to the discovery of America, and the earliest settlers brought seed to the new world. They are now an important crop in all temperate zone countries.

Length of Life

The oat plant, like wheat, is an annual grass with kinds and varieties adapted either to fall planting and midsummer harvest or spring planting and late summer harvest.

Description of Crop

Oats are an annual cereal grain that grows in the cooler seasons of the year. The plant will mature at 2' to 4'. The leaves are ¼" to ½" wide and ribbon like, curling. The seed head forms flag like clusters at the top of a stout stem. The hull, composed of lemma and palea, comprises on the average about 23 percent of the weight of the whole grain. Oats are high in mineral content and also in several vitamins. Oat straw is more nutritious and palatable than wheat straw

Use

When oats are planted in early spring and grazed or chopped early, they will re-grow sufficiently for an additional harvest. The primary use of oats today is as a nurse crop that can be harvested or grazed. Many oats are still grown in the Midwest for grain, to be used primarily as a livestock feed, however, oat flour and wheat flour mixed together as a multi-grain baking product are also popular.

Adaptation

Oats are well adapted to the Midwest. With the cool spring weather the growing oat flourishes. Oats can be grazed and still produce a grain crop.

Potential Problems

If grown for seed or the grain, the primary problems are disease related. Barley Yellow Dwarf virus, crown rust and smut are the major enemies. Lodging, or falling over prone, before harvest is also a concern with oats. Newer varieties are bred for better lodging resistance and for increased resistance to diseases. Always plant certified seed to minimize risks.

Establishment & Management

When Oats are planted in early spring and grazed or chopped early, they will re-grow sufficiently for an additional harvest. Normally, they can be pastured five to seven weeks after planting. For silage, harvest at the boot stage. Once the head is emerged, small grain forage will contain more than 55 percent neutral detergent fiber. Late summer planting can provide some grazing during September and October. Oats grow well during periods of cool temperatures, which restrict the growth of sorghum or sudangrass.

Variety Selection

Many varieties are available that were developed by Midwestern land grant universities. Specifics will be discussed in the Variety Characteristics section of this manual.

Orchardgrass ~ *dactylis glomerata* L



Key Information on Orchardgrass

Annual or Perennial	Perennial
Best Use	As a grazing or haying pasture grass.
Bushel Size	14 lbs
Planting Depth	½"
Seeding Dates	February 1 st to April 20 th - or - August 20 th to October 1 st
Seeding Rate	10 - 15 pounds alone 2 - 3 in mixes (no more than 2 with Alfalfa)
Seeds Per Pound	Approximately 590,000
Time to Germinate	Approximately 18 days
Type of Plant	Bunch Type Grass
Type of Soil required	Adapted well to moist soils with good drainage and fertility. Sandy or muck soils can be a problem and should be avoided.

History

Orchardgrass is native in Europe, but has been in cultivation in the United States for over 200 years. In the colonial times the value as a crop was not recognized. Not until the 1800's was Orchardgrass grown commercially for seed. Orchardgrass is known as "cocksfoot" in Europe, New Zealand, and Australia. This name was derived from the shape of its seed head (inflorescence). The genus name (*Dactylis*) also was derived from the shape of its seed head; from the Greek word *dactulos*, a finger, referring to the stiff branches of the panicle. The current name of Orchardgrass probably came from its ability to grow in shade or an orchard. Hence the name "Orchard Grass".

Length of Life

Orchardgrass is a perennial bunch type grass. It does not spread through the roots by stolons or rhizomes, however, it readily reproduces from seed if allowed to.

Description of Crop

Orchardgrass is a bunch grass which forms irregular sod from densely tillered plants. It has no rhizomes or stolons. The leaves are pale or bluish-green. Orchardgrass is folded in the bud and the sheath is distinctly flattened. Leaves are 1/8 to 1/2 inch wide, long, flat, sharply pointed, and V-shaped in cross section. The lower surface of the leaf is not shiny and has a distinct keel. Leaf margins and leaf sheaths are somewhat rough to the touch when mature. The seed head is one of the more distinctive with a full shape.

Use

Orchardgrass is grown for hay, green chop, silage, and pasture. It is compatible with many legumes (alfalfa, birdsfoot trefoil, and various clovers) and other grasses (perennial ryegrass, tall fescue, prairie grass, etc.). Pure stands or simple mixtures (one grass and one legume), however, are easiest to manage. With high levels of N fertility, orchardgrass is among the most productive cool-season grasses. It also has among the most even production distribution throughout the growing season when maintained under high fertility and adequate moisture levels.

With mechanical harvest, high yields of high quality forage are obtained if proper harvest and fertility management are used; six to seven tons of dry matter per acre are possible with irrigation or in deep soils without irrigation.

Growth characteristics of orchardgrass make it well suited to early spring pastures except when soils are very wet. Its tall growth habit makes it better suited to rotational grazing than to continuous grazing. Various legumes can be used in combination with orchardgrass for pasture. When grown in mixtures with other, less palatable grasses (like tall fescue), selective grazing may result in depletion of the orchardgrass portion of the pasture. Pasture yield is affected greatly by grazing frequency and intensity, but with sufficient rest periods, yields approaching mechanical harvesting may be possible.

Orchardgrass is able to use high rates of N (400-500 lbs N/acre/year). Thus, orchardgrass is valued in manure nutrient recycling systems to simultaneously produce high quality forage while protecting ground water from nitrate contamination.

In a 3-year study at Purdue University, animal performance was compared when grazing orchardgrass and tall fescue. Both cows and calves gained approximately 1/2 pound more per day on orchardgrass than on tall fescue. Conception rate of the cows was 18 percentage points higher on the orchardgrass pastures. Although some tests have shown orchardgrass and tall fescue to give similar animal performance, it is generally agreed that orchardgrass is of higher quality than fescue during spring and summer. This is probably associated with the endophyte problem in older varieties of tall fescue. However, fescue is of higher quality in fall, especially after frost.

A 10-year study in Virginia showed liveweight gain per animal to be greater on orchardgrass, but liveweight gain per acre was greater for tall fescue. Palatability, as measured by grazing preference, was higher for orchardgrass than either tall fescue, brome grass, or bluegrass.

Adaptation

In North America, orchardgrass is grown through much of the northeastern and north central United States and in the high rainfall and irrigated regions of the western mountains, the

Pacific Northwest, British Columbia, and southern Alberta. Orchardgrass is adapted to well-drained soils and is tolerant of shade; its ability to grow under trees undoubtedly led to its common name. Orchardgrass will not survive in flooded or wet soil conditions but will tolerate moderately poor drainage. It can be grown with irrigation or on dryland areas having at least 18 to 20 inches of precipitation.

Drought tolerance of orchardgrass probably is related to its extensive root system. Orchardgrass is more tolerant of heat and drought than perennial ryegrass, timothy, or Kentucky bluegrass but less so than tall fescue. Smooth brome grass is better adapted to low rainfall, high summer temperatures, and severe winters. In mild winter areas where forage growth occurs, orchardgrass cultivars with low levels of fall dormancy can be chosen. Winter production of these cultivars, however, usually is less than that of perennial ryegrass and they typically will have less winter hardiness than tall fescue. The most winter hardy cultivars, however, have excellent winter hardiness.

Potential Problems

Many diseases attack orchardgrass. Selecting resistant cultivars is the most economic means of control. In the case of leaf diseases, adequate fertility and water enables the plant to outpace the disease. Early harvest preserves the quality and reduces inoculation load for subsequent harvests. More than 30 insects have been identified in orchardgrass stands. Although insect damage sometimes results in losses of yield, quality, and stand longevity, little is known about the economic losses incurred.

Promoting plant health through maintaining soil fertility and using appropriate harvest management practices will reduce disease and insect damage. In addition, insect parasites, climate, and crop rotations are important factors in controlling orchardgrass pests.

Establishment & Management

Orchardgrass establishes more slowly than perennial ryegrass but faster than tall fescue. It may take orchardgrass 12 to 18 months to fully establish a "sod", but can be harvested much sooner. Grazing should be delayed until seedlings are anchored sufficiently to prevent uprooting.

Orchardgrass can be established in early spring or late summer, depending primarily on soil type. Fine textured soils may be too wet to cultivate and seed in early spring, while coarse textured soils may be planted in spring or fall. Slow establishment in cool fall temperatures makes spring planting preferred for many areas, especially where winter injury is a threat.

Seeding rates for conventional and no-till establishment methods and suggested combination species are shown in the table. When broadcast methods are used for seeding, rates should be increased 50% or more depending on seed bed condition. The seedbed should be loose on the surface but firm below the surface to assure proper planting depth. Seed should be planted no deeper than 1/2 inch. If a legume is mixed with orchardgrass, a planting depth of 1/4 inch is better.

The use of a presswheel, cultipacker, or other soil firming device, will improve establishment when orchardgrass is planted on a dry seedbed. "Cereal-type" double disc drills with depth bands work well on prepared seedbeds. Broadcast seeding success can be improved if followed by rolling. More seed is required for broadcasting. Shallow harrowing often is used following broadcasting to provide better seed/soil contact, but it is difficult to harrow lightly enough to avoid planting depths in excess of 1/4 to 1/2 inch.

Seedling growth may be retarded by inadequate levels of soil phosphorus or other nutrients. In addition, orchardgrass is less tolerant of low or high pH than many other grasses; best growth will occur between pH 5.8 and 7.0. Adjustment of soil pH values is most easily accomplished prior to planting.

Monitoring of soil nutrient levels is important for sustained high production levels and stand density. Orchardgrass is very responsive to N fertilization. More N is required for pure grass stands than grass-legume mixtures.

To obtain high quality forage, orchardgrass should be harvested at the boot stage. Delaying harvest until head emergence or early bloom will increase yield but reduce quality and regrowth. An additional delay of two weeks will decrease aftermath harvest by one-fourth and further reduce forage quality.

Orchardgrass stands become thin and clumpy when first growth is cut late, but stand longevity generally is not adversely affected. Re-growth of orchardgrass depends primarily on carbohydrate reserves. Leaves remaining after harvest will hasten regrowth. When root and crown reserves are high, close cutting or grazing has little impact on the stand. When reserves are low, continuous close grazing causes serious stand injury. Repeated grazing below two inches removes tissue that can store food, thus weakening the plant. Short, grazing tolerant grasses and weeds may then replace orchardgrass in the pasture. Appropriate resting period length varies with season and should be determined by plant re-growth rather than a fixed number of days. A resting period after cutting or grazing that allows re-growth to 8-12 inches will encourage long-lived stands and minimize the negative effects of shading on legumes in the mixture. If needed, the legume can be re-established in the stand by no-till seeding or by over seeding during the fall and winter following close grazing or herbicide application.

Variety Selection

Orchardgrass breeders have developed varieties that mature later, are more productive, more resistant to disease, and more widely adapted than common orchardgrass. The harvest date of late maturing varieties coincides with that of alfalfa.

Four different growth habit types have been developed in orchardgrass: 1) tall, stemmy, early, 2) tall, leafy, late, 3) medium tall, leafy, medium late, and 4) dwarf, leafy, medium-late. The tall types are intended for mechanical harvest. The medium and dwarf types are commonly listed as "pasture types" and recommended only for grazing systems. The tall or medium tall, leafy, "hay type" orchardgrasses, however, will work well for grazing if proper management is used. Varieties differ widely in resistance to leaf diseases, viruses, and winter hardiness. For information on specific orchardgrass varieties please see the Variety Characteristics section of this manual.

Rape Seed ~ brassica napus

Key Information on Rape Seed

Annual or Perennial	Annual or Biennial
Best Use	Emergency pasture for times of the year when perennial forages are weak.
	Excellent for hogs, and sheep.
Bushel Size	n/a
Planting Depth	½” to 1”

Seeding Dates	March 10 th to April 15 th - or - July 10 th to July 20 th
Seeding Rate	8 - 12 pounds alone 2 - 4 pounds in mixes
Seeds Per Pound	Approximately 160,000
Time to Germinate	Approximately 7 days
Type of Plant	Brassica (the same family as cabbage, mustard, and forage turnips)
Type of Soil required	Moist Fertile Soils with good soil drainage

The descriptions below are based on the brassica family in general.

History

A member of the brassica family, Mustard, was regularly mentioned in the Bible. More due to the size of its seed than for the production of it, but this shows that the brassica family has been known for nearly 2000 years. It has been grown as an agricultural crop since the 1700's. The original crop uses were in Europe and Northern Asia

Length of Life

Annual or biennial, when sown late and flowering the following spring, Requires fertile, well-drained soils. Can be grown to supplement perennial cool-season pastures in August and September or to extend the grazing season in November and December. In the first instance, brassicas would be planted in May or early June when spring rains will help assure production for August and September grazing

Description of Crop

Rape is an annual. Some biennial varieties are available including the most common variety, Dwarf Essex. Rape is a brassica plant that resembles Mustard. It can grow to a height of 18" to 36" and have several broad fleshy leaves. Rape is a multistemmed crop with fibrous roots. The stems vary in length, diameter, and in palatability to livestock. Forage yields of spring-planted rape increase until plants become physiologically mature. Growth slows or ceases at maturity and yields plateau until leaves senesce and die.

Use

Mature forage rape is one of the best crops available for fattening lambs and flushing ewes. Brassicas can be harvested for green chop or silage but are most frequently grazed. Brassica crops can produce high yields of highly digestible forage during periods when perennial forages have limited production. In addition, the digestibility of the forage remains high over a relatively longer period than perennial crops.

Adaptation

Sunny days and cool nights are favorable for growth; dry weather at harvest time is essential. All brassica crops require good soil drainage and a soil pH between 5.3 and 6.8 for optimum production.

Potential Problems

Brassica crops can cause health disorders in grazing animals if not managed properly. The main disorders are bloat, atypical pneumonia, nitrate poisoning, hemolytic anemia (mainly with kale), hypothyroidism, and polioencephalomalacia. Researchers have discovered that these disorders can be avoided by adhering to a couple management rules:

1. Introduce grazing animals to brassica pastures slowly. Avoid abrupt changes from dried-up summer pastures to lush brassica pastures. Don't turn hungry animals that are not adapted to brassicas into a brassica pasture.
2. Brassicas should not constitute more than 75 percent of the animal's diet. Supplement with dry hay if continually grazing brassicas or allow grazing animals access to grass pastures while grazing brassicas. No-till establishment into existing sod will reduce the risk of these disorders because of grass in the brassica pasture.

Once established, brassicas are very competitive with weeds. However, precautions should be made prior to planting to reduce weed competition during brassica establishment.

Insects, such as aphids, flea beetles, and imported cabbage worms, that feed on brassicas are not consistently a problem in the Midwest. However, appropriate use of insecticides may be warranted if insect populations become severe.

Establishment & Management

Responds favorably to nitrogen and phosphate fertilizers, but can be injured by contact with the fertilizer. Use only low rates of fertilizers in drills where both seed and fertilizer empty into same tubes.

Fall plowing and preparation of a good firm seedbed is desirable as rape seeds are small. Cultipacking before seeding make a firm even seedbed. Germination must be fast with uniform emergence for the crop to get ahead of the weeds.

Seedlings develop slowly and are easily destroyed by drifting soil. Spreading manure where drifting might start helps trap drifting soil. Early sowings give higher yields, but crop is more susceptible when emerging. Rape may be planted after grains, flax, corn, or fallow, but not after rape, mustards or sunflowers

The following recommendations will improve the chances of successful brassica establishment.

1. Attempt establishment only on well drained soils.
2. Do not seed deeper than one-half inch.
3. When seeding into a sod, suppress the sod long enough (2 to 3 weeks) to allow the brassicas to establish.
4. Apply 75 pounds of nitrogen at seeding to stimulate establishment and growth.

As previously mentioned, forage brassicas can be grown to supplement perennial cool-season pastures in August and September or to extend the grazing season in November and December. In the first instance, brassicas would be planted in May or early June when spring rains will help assure production for August and September grazing

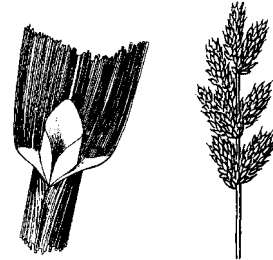
Brassicas can be harvested for greenchop or silage but are most frequently grazed. Grazing management is important to optimize the true potential of these crops. Strip grazing small areas of brassica at a time provides the most efficient utilization. Grazing large areas increases trampling and waste of the available forage. Rape is more easily managed for multiple grazings than are the other brassica species. Approximately 6 to 10 inches of stubble should remain after

grazing rape to promote rapid re-growth. Re-growth may be grazed in as few as 4 weeks after the first grazing. Graze rape close to ground level during the final grazing.

Variety Selection

Dwarf Essex is the only variety of Rape that is of economic concern in the Midwest. It is a biennial that is rarely grown any different than if it was a perennial. A complete description can be seen in the Variety Characteristics section of this manual.

Reed Canarygrass ~ phalaris arundinacea l.



Key Information on Reed Canarygrass

Annual or Perennial	Perennial
Best Use	Pasture for spring and early summer. Excellent in wet soils
Bushel Size	44 lbs
Planting Depth	½"
Seeding Dates	February 1 st to April 15 th - or - August to September
Seeding Rate	8 - 12 pounds alone 2 - 4 pounds in mixes
Seeds Per Pound	Approximately 550,000
Time to Germinate	Approximately 21 days
Type of Plant	Perennial grass
Type of Soil required	Moist Fertile Soils with or without good drainage. Adapted to wet soils.

History

Reed canarygrass is native in North America, Europe and Asia. Its seed has long been used as canary bird feed, hence the name. One of the earliest grasses to begin growth in spring. Considered a good forage plant in Sweden as early as 1749

Length of Life

Reed canarygrass is a tall-growing, perennial grass

Description of Crop

Perennial, tall, robust, rather coarse, spreading extensively by creeping rhizomes. Very tolerant to flooding. Leaves are killed by temperature not low enough to kill leaves of timothy or Kentucky bluegrass. It is particularly well adapted to wet soils and soils with a pH below 6.0. The leaves are up to ½" wide and flat. It is a cool- season grass which is greater in winter hardiness and more resistant to foliar diseases than other cool-season grasses. The plants spread and thicken from short rhizomes, creating a dense sod. If not grazed or clipped, plants will reach heights exceeding 6 feet under high fertility conditions.

Reed canarygrass does well on most Midwest soils except droughty sands. It is a "natural" for poorly drained soils because of its tolerance to flooding and standing water. In addition to its adaptation to wet sites, reed canarygrass is one of the most drought-tolerant of the cool season grasses. Thus, under proper management this species does well on upland sites.

It is hardy and grows rapidly during spring and early summer, persists well, and has a long grazing season. It produces heavy yields of nutritious, palatable forage, silage or hay.

Use

Reed Canarygrass is hardy and grows rapidly during spring and early summer, persists well, and has a long grazing season. It produces heavy yields of nutritious, palatable forage, silage or hay.

Reed Canarygrass produces nutritious, palatable, succulent herbage for pasture, silage, and hay. It is the most popular species for irrigation with pollution control sewage effluent from municipal and industrial sources as practice. Also used on stream beds, gully bottoms, on sloughs, pond banks, swamplands of muck or peat nature, but it makes an excellent growth on upland sites as well. One of the earliest grasses to begin growth in spring.

Adaptation

Reed Canarygrass is often found in low-lying, mucky meadows and pastures liable to flooding. Still it is moderately drought-resistant. Also grows on fertile upland soils in humid areas. Grows best on moist sandy soils, rich in organic matter, but also on fertile loams and clays. Very tolerant to flooding.

Potential Problems

Problems have been associated with the high alkaloid content of native varieties and the practice of delaying harvest until reed canarygrass is mature. Both of these problems can be overcome by using newer low alkaloid varieties and by proper harvest management. The other problem that cannot be overcome is that Reed Canarygrass seed is relatively expensive.

Establishment & Management

Spring seedings are most common. However, late-summer seedings are often more successful because weeds are less of a problem. Reed canarygrass can be slow to establish and may fail when weed competition is severe during establishment. Grass weeds are especially harmful. Companion crops can be used for spring seedings, but should not be used for late-summer seedings. Oats are the most common companion crop, but early removal for silage or by grazing is necessary to reduce competition for light and moisture.

If a late-summer seeding is planned, prepare the seedbed 2 to 4 weeks ahead of seeding, if possible. This will allow the soil to become firm and provide an opportunity to accumulate moisture in the seedbed. Best stands of reed canarygrass are obtained when sown not deeper than 1/2 inch in a well-prepared, firm seedbed. This is best accomplished with band seeders equipped with press wheels. Other seeding methods can be used, but chances of obtaining thick stands and vigorous growth in the seeding year are reduced. Cultipacker seeders and grain drills work well if the seedbed is firm and the seed is covered to a depth not exceeding 1/2 inch. Roll or cultipack after seeding with grain drills not equipped with press wheels or after broadcast seeding. Caution must be used not to bury the seed after broadcast seeding.

Reed canarygrass should be seeded at 8 - 12 lb. per acre when seeded alone. This is a similar seeding rate compared to orchardgrass or timothy; however, reed canarygrass seed tends to have a low percentage of germination which necessitates considering a high seeding rate. Legume mixtures are recommended especially for hay or silage production. When seeding reed canarygrass in a mixture, decrease the seeding rate to 6-8 lb. per acre for reed canarygrass.

Reed canarygrass can be used for pasture, hay or silage. Recovery following defoliation is excellent in the spring and early summer and is fair to good in late summer and early fall. However, it is frost-sensitive and will turn brown quickly after early fall frosts.

Reed canarygrass is high yielding when cut for hay or silage. Highest yield is obtained when harvested at heading. In contrast, highest quality is obtained before seed heads begin to appear and declines rapidly thereafter. This change in quality is primarily due to increases in portions of the stem relative to the leaf. There is not a close relationship between time of first harvest and stand persistence. Re-growth after harvesting reed canarygrass will be leafy with stem elongation but no seed heads will be produced.

When using reed canarygrass for pasture, excessive forage growth must be avoided to maintain quality and palatability. Animals who have a choice will often choose grasses other than reed canarygrass. This is accentuated if the reed canarygrass is a high alkaloid variety or is allowed to become mature before grazing. Growth starts early in the spring with grazing generally available by the third or fourth week in April. Approximately 60% of the total yield of reed canarygrass is produced by July. Maintain the grass below 10 to 12 inches tall during the rapid spring growth of May and June. Short duration rotational grazing with a heavy grazing pressure will allow the best utilization and greatest animal gains per acre. In addition, rotational grazing is recommended to allow hay harvesting of the ungrazed fields during the spring. Reed canarygrass should not be grazed closer than 3 to 4 inches above the ground. A recovery period following grazing will also improve productivity.

Fertilization is important to take advantage of the high yielding characteristics of reed canarygrass. Determine the lime and fertilizer needs by soil testing before seeding. If pH is below 6.0, apply lime. In the absence of a soil test, assuming medium fertility. It is advantageous to use a starter amount of fertilizer with Reed Canarygrass. When seeding with a legume, apply none or less than 20 lb per acre of nitrogen at seeding. Nitrogen application in excess of 20 lb per acre will stimulate reed canarygrass development and inhibit legume establishment.

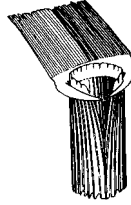
A soil test is the best guide for proper fertilization of established reed canarygrass. In pure reed canarygrass stands, apply nitrogen annually. Reed canarygrass responds more to nitrogen fertilization more than the other cool-season grasses. Annual rates of N application may range from 80 to 240 lb per acre depending on soil condition and type and consequently yield potential. Generally, about 40 lbs of nitrogen is required per ton of forage produced. Nitrogen rates in excess of 120 lb per acre should be applied in split applications. Fertilization systems which apply at least 1/2 of the annual N in August can be utilized to take advantage of the high-yielding characteristics of reed canarygrass in the fall.

A productive stand of reed canarygrass will require about 30 lb of phosphorus per acre annual for stand maintenance. Potassium fertilization of reed canarygrass for maintenance is more variable than phosphorus. Depending on the soil type and cropping history, rates may range from none to 160 lb potassium per acre per year. On higher organic matter soils, higher rates would be necessary.

Variety Selection

Older varieties (Common, Rise, Vantage) contain high levels of alkaloids which make these reed canarygrasses less palatable than other grasses. Newer varieties (developed since 1976) contain lower levels of alkaloids and are more palatable. Low-alkaloid varieties are Palaton and Venture. Both varieties are high yielding, have good winter hardiness and can be used for pasture or in mixture with a legume for hay and silage. Details on Palaton can be found in the Variety Characteristics section of this manual.

Rye Grain ~ secale cereale



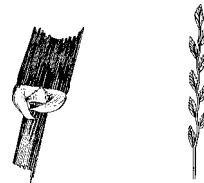
Key Information on Rye grain

Annual or Perennial	Annual
Best Use	Used mainly for grazing or green manure.
Bushel Size	56 lbs
Planting Depth	1" to 1½"
Seeding Dates	September to October
Seeding Rate	120 - 180 pounds (2-3 bushels)
Seeds Per Pound	Approximately 18,000
Time to Germinate	Approximately 7 -10 days
Type of Plant	Grain
Type of Soil required	Performs best on light sandy soils. Adapted to medium to low fertility.

The rye plant grows rapidly and vigorously from seed, resulting in a rapid cover valuable for erosion control or early pasture. Selected varieties are hardier to cold than other cereal grains, so rye as a winter crop can be grown in areas too cold for winter wheat. Also, rye will produce better on light, sandy soils and on soils of low fertility than other small grains. Because rye develops rapidly, especially in early spring, it can be plowed in early and still give a good volume of organic matter for soil improvement. Rye as pasture or hay is less palatable than other small grains or legumes but is readily grazed if other grazing is not available.

Rye as a grain crop is similar in most respects to wheat. Practically all the rye for grain is sown in the fall and harvested in early summer. It is earlier maturing than wheat. Stems reach 3 to 5 feet in height. The spikes are 3 to 5 inches long, slender and awned. Spikelets generally contain two fertile flowers. Seeds are enclosed in the palea and lemma, as in wheat, but tend to protrude when near ripe, so are less completely enclosed than in wheat. The seed threshes free of the palea and lemma. The seeds tend to shatter or fall out when ripe. For this reason, coupled with earlier ripening, rye may be a bad weed in wheat fields.

Uses of rye grain: Rye is second only to wheat for flour production. Milling of rye is essentially similar to wheat. Baked goods made with rye flour have a distinctive flavor. As feed, rye is not relished by livestock, so rye grain is usually fed in mixtures with other cereals. In nutritive value rye is a little lower than wheat. Substantial quantities of rye are also used for making distilled alcoholic beverages.



Ryegrass ~ lolium perenne

Key Information on Perennial Ryegrass as a forage

Annual or Perennial	Perennial
Best Use	As a pasture grass
Bushel Size	24 lbs
Planting Depth	½"

Seeding Dates	February 1 st to April 15 th - or - August 15 th to October 20 th
Seeding Rate	20 - 25 pounds alone 3 - 5 pounds in a mix
Seeds Per Pound	Approximately 240,000
Time to Germinate	Approximately 7 days
Type of Plant	Perennial grass
Type of Soil required	Adapted to moist soils of medium to high fertility. Light to heavy soils

History

Perennial ryegrass, also called English ryegrass is a cool season perennial grass that is native to Europe, temperate Asia, and North Africa. It has been widely distributed to other parts of the world, including North and South America, Europe, New Zealand, and Australia. In Europe, perennial Ryegrass has been grown as an important crop for over 300 years.

Length of Life

Perennial ryegrass is a cool-season bunchgrass that can behave as an annual, short-lived perennial, or perennial depending on environmental conditions

Description of Crop

Leaves of perennial ryegrass are folded in the bud, sharply taper-pointed, and keeled. Blades are bright green, prominently ridged. The edges of the leaves are rough to the touch with minute serrations. The blade width is 1/8". Perennial Ryegrass grows to be 2 to 3 feet tall. The comparatively shallow root system is highly branched and produces roots from tillering. Perennial ryegrass has no rhizomes or stolons. It will, however, produce a dense and closely knit sward or turf with high plant densities and proper management. The seeds stay tight to the stem and are opposite. Within the perennial ryegrass species there are two basic groups, the diploids and tetraploids. The distinction between the two groups is based on the number of chromosomes within each plant cell. In the diploid ryegrass cells, each chromosome is present twice; however, in the **tetraploid ryegrasses** cells each chromosome is doubled and is present four times. Tetraploid perennial ryegrasses have larger leaves, fewer but larger tillers, produce a more open (less ground cover) growth, and are more suited for production in a legume mixture than the diploid perennial ryegrasses. Tetraploids have a higher percentage of sugars in the forage than diploids, which explains their higher digestibility and grazing preference over diploids. Both the seed and seedlings of tetraploid varieties are larger, but the growth following emergence and persistence is often greater for diploid varieties.

Natural hybridization between the annual and perennial species has occurred frequently. Persistence of hybridized ryegrasses is intermediate between the parents. Therefore they are frequently referred to as "**Intermediate**" or "short rotation ryegrasses" in recognition of their lack of persistence compared to perennial ryegrass. In addition, flowering in the hybridized ryegrasses is similar to that of the Italian species in that there is no dormancy requirement for flowering and tillers will continue to flower sporadically throughout the growing season.

Use

This is an important cool-season bunchgrass, introduced from Europe, where it has been grown under culture for more than 3 centuries. The numerous leaves are long and slender. The major use is in permanent pastures where it is usually seeded in mixtures with other grasses. It thrives best over the long run in cool, moist regions with mild winters. It is, however, an excellent choice for large quantities of pasture for all types of livestock. It is nutritious and palatable both for pasturage and hay.

Adaptation

Optimum growth occurs between 68-77° F. Perennial ryegrass grows best on fertile, well-drained soils but has a wide range of soil adaptability. It is tolerant of poorly-drained soils and frequently is used in these environments. It tolerates both acid and alkaline soils, with a pH range of approximately 5.0 to 8.3. Similar to tall fescue, perennial ryegrass is adapted to shade in the warmer portions of a cool, humid climate where winter kill is not a problem.

Potential Problems

Perennial ryegrass is less persistent than other perennial cool season grass species such as orchardgrass, tall fescue, timothy, smooth brome grass, and Kentucky bluegrass. There is potential for winter kill in severe, open winters with no snow cover.

Establishment & Management

Normal winter temperatures in the Midwest are mild enough to allow ryegrass seeding in either the spring or late summer. Ryegrass may be seeded alone; however, to improve hay yields when growing ryegrass a mixture with a legume is recommended. Legumes, such as alfalfa or white clover in the mixture will also provide some nitrogen to the ryegrass and can also improve the quality of forage produced. Ryegrass seedings have been successful in both a clean, tilled seedbed and in existing grass sod. However, when no-till seeding, the existing grass sod should be mowed or grazed very short or desiccated with a chemical prior to seeding to reduce competition. Ryegrass should be band seeded 0.25 to 0.5 inch deep. If the seedbed is dry and press wheels are not used, cultipack before and after seeding for additional stand insurance.

Ryegrass seeding rates depend on its intended use and the condition of seedbed. When seeding into a well-prepared seedbed, 20 -25 lb per acre is recommended. When seeded with a compatible or adapted legume (alfalfa, birdsfoot trefoil, and white or red clover) 3-5 lbs per acre is recommended.

Seeding year harvest management of perennial ryegrass is dependent on time and method of seeding, fertility, growing conditions, and other factors which effect rate of establishment. However, with favorable establishment and growing conditions one or more harvests are possible in the seeding year. First time harvest or grazing on newly established ryegrass should be delayed until it is 10 to 12 inches tall.

As a hay crop, ryegrass yields may be relatively low unless considerable time is allowed for forage accumulation for fall harvest. Ryegrass plants contain less dry matter and therefore require longer curing time before baling relative to other cool season grasses. In addition, they are more difficult to mow with a sickle bar mower than other grasses.

Established ryegrass pastures can be initially grazed when spring growth reaches 2 to 3 inches in height and the pasture does not risk excessive damage due to wet soil conditions. It may be continually grazed but yield and plant persistence are compromised if it is continuously grazed below 1.5 inches in height. Greater yields are possible when ryegrass is rotationally grazed. A grazing system which allows 7 to 10 inches of regrowth between grazings will benefit grass yield as well as persistence. Animals should be removed from rotationally grazed pastures when the ryegrass stubble is from 1.5 to 2 inches in height. Under grazing, perennial ryegrass-alfalfa mixtures are superior to orchardgrass-alfalfa mixtures in production of crude protein, digestible dry matter, and alfalfa persistence.

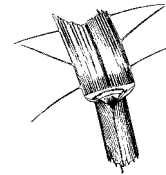
Soil pH for optimum ryegrass production is between 6.0 and 7.0; however, ryegrass has been grown at pH of 5.0. Determine fertility and lime needs by soil testing. Ryegrass responds very well to nitrogen fertilization which is very important for economical production. Profitable

economic returns over investment can usually be obtained with applications of 150 lbs of N per acre per year. It should be applied in split applications.

Variety Selection

The types of Perennial Ryegrass most often used in intensive or rotational grazing are Intermediate and Tetraploid. Descriptions of varieties that fit into these categories are available in the Variety Characteristics section of this manual.

Sideoats Grama ~ *bouteloua*



curtipendula

Key Information on Sideoats Grama

Annual or Perennial	Perennial
Best Use	A native grass for hay or set aside fields requires 8" of rainfall per year.
Bushel Size	n/a
Planting Depth	½"
Seeding Dates	Late Summer
Seeding Rate	3 - 4 pounds alone
Seeds Per Pound	Approximately 170,000
Time to Germinate	Approximately 28 days
Type of Plant	Native grass
Type of Soil required	Adapted to a wide range of soil conditions

This is a long-lived native grass, widely distributed, but most abundant in the Central and Southern Great Plains. In the days of massive herds of bison on the American Great Plains, Blue Grama and Sideoats Grama, were two of the primary sources of nutrition for these beautiful animals. It produces short rhizomes and tends to a bunch-type growth. The leaves are about 6 inches long and under ¼ inch wide. Flower stems may reach to 3 feet. It produces an abundance of leafy forage well liked by all classes of livestock. Hay of good quality is produced if mowed sufficiently early. It is adapted to wide ranges of soil and climate. Seedling vigor is good, and stands are readily established by seeding. Generally, side-oats grama is seeded in mixtures with other grasses. Sideoats grama is distinctive in that the seeds "fall" to one side of the stem looking like feathers from a staff. The leaves also have hairs coming off bumps on the edges, these hairs can look like catfish whiskers.

Sorghum Family ~ *sorghum*

Shortages of forage crops in the Midwest most often occur during the summer months when the productivity of pastures, hay crops, or silage corn fields have been reduced by dry conditions. Summer- annual grasses, which maintain relatively high levels of production during hot and dry conditions, can greatly reduce the risk of inadequate forage production during the summer. They can also be used as an emergency forage source when production from corn and hay crops is likely to be less than adequate.

Summer-annual grasses differ in growth and production potential but have several similar characteristics. They grow best at relatively high temperatures (80 degrees F) and can produce under conditions of limited moisture.

Sorghum is an upright growing grass which has been bred for both grain and forage production. This section is broken down into information on the different types and then general information

that applies to the sorghum family. Included in the general section is a discussion of prussic acid poisoning.

Key Information on Grain Sorghum ~ sorghum bicolor

Read the section on Prussic Acid Poisoning.

Annual or Perennial	Annual
Best Use	A grain producing crop, primarily in the southern Midwest and Midsouth and southwestern states
Bushel Size	56 lbs
Planting Depth	1" to 1½"
Seeding Dates	May 1 st to June 30 th
Seeding Rate	8 - 15 pounds
Seeds Per Pound	Approximately 40,000
Time to Germinate	Approximately 7 -10 days
Type of Plant	grass bred for grain production
Type of Soil required	Adapted to a wide range of soil conditions primarily the same type soil corn would be suited for.

The Grain Sorghum types are relatively short growing (less than 6 feet) and provide moderate yields when harvested as a forage. **Forage Sorghum**, on the other hand, grows tall (6 to 15 feet) and has the potential for high yields. Of the two types, forage sorghum is the preferred type for forage production. Like corn, sorghum hybrids are classified into maturity classes. Late-maturing sorghum types yield more than earlier- maturing types, but may not reach maturity before a killing frost. The forage sorghums are usually harvested only once and used for silage or green-chop production. In the United States most of the grain sorghum is used as livestock feed, but in the Orient and Africa most is used as food.

Sorghum culture goes back to antiquity with Egypt being an early area. Grain sorghums grown in this country mainly trace to African origins. Although they were brought here during early colonial days they did not become important crops until farming developed in drier sections of the United States. They generally out yielded other grains under conditions of limited moisture.

Grain sorghum varieties are classed in seven agronomic groups. Milo is the only economic one for the Midwest and then only in the southern Midwest. Milo sorghums, originally from East Africa, have stems that are less juicy than in Kafir. Leaf blades are wavy with a yellow midrib. Heads are bearded or awned, compact, oval in shape. Seeds are large, pale pink to cream in color. Plants tend to be more tolerant to heat and drought.

Key Information on Forage Sorghum ~ sorghum bicolor

Read the section on Prussic Acid Poisoning.

Annual or Perennial	Annual
Best Use	As an emergency forage only after the cut vegetation is cured.
Bushel Size	56 lbs
Planting Depth	1" to 1½"
Seeding Dates	May 1 st to July 1 st
Seeding Rate	8 - 12 pounds
Seeds Per Pound	Approximately 40,000
Time to Germinate	Approximately 7 -10 days
Type of Plant	grass bred for forage production
Type of Soil required	Adapted to a wide range of soil conditions primarily the same type soil corn would be suited for.

Forage Sorghum

Forage sorghums are similar to the grain sorghums but differ from the latter in having sweet or slightly sweet and juicy stems and are more leafy. The leaves are broad and coarse. The stems vary from 2 up to 15 feet in height depending on variety and growing conditions. They are mainly summer annuals, usually seeded in rows like corn. They have been grown since prehistoric times in Asia and Africa and a great many varieties have been obtained through natural selection. Forage sorghums were introduced into the United States about 1850, and numerous varieties have developed here. They tolerate heat and limited moisture and are valuable for hay or silage, especially in the Central and Southern Plains. Many of the forage sorghums are dangerous to livestock while green because of the prussic acid (hydrocyanic acid) content. This disappears as the fodder is cured.

Key Information on Sorghum - Sudan Hybrids ~

Read the section on Prussic Acid Poisoning.

Annual or Perennial	Annual
Best Use	Ideal for a green chop and for pasturing, hay or silage
Bushel Size	56 lb
Planting Depth	½" to ¾"
Seeding Dates	Late Spring to Mid Summer
Seeding Rate	30 - 40 pounds
Seeds Per Pound	Approximately 40,000
Time to Germinate	Approximately 7 days
Type of Plant	grass bred for forage production
Type of Soil required	Adaptable to soils similar to corn ground

Sorghum-Sudan Hybrids or Sudax resemble sudangrass but are taller, have larger stems and leaves, and give higher yields. They are a cross between Sudangrass and Hybrid Forage Sorghum. Hybrids tend to be coarser than sudangrass and vary in seed color and size, yield and growth characteristics depending on their parents. Like sudangrass, sorghum-sudangrass hybrids will regrow after each harvest unless environmental conditions are restrictive.

Key Information on Sudangrass - sorghum vulgare sudanense

Read the section on Prussic Acid Poisoning.

Annual or Perennial	Annual
Best Use	
Bushel Size	n/a
Planting Depth	½"
Seeding Dates	Late Summer
Seeding Rate	3 - 4 pounds alone
Seeds Per Pound	Approximately 170,000
Time to Germinate	Approximately 28 days
Type of Plant	Native grass
Type of Soil required	Adapted to a wide range of soil conditions

Sudangrass usually grows between 3 and 8 feet high and has stems about ¼ inch in diameter. Solid stands of sudangrass grow shorter than when seeded in rows. Sudangrass develops only

fibrous roots and does not have rhizomes. However, many stems may develop from a single seed if space is available. Sudangrass will regrow following each harvest until cool temperatures or lack of moisture inhibit growth. This grass was introduced into the United States in 1909 from Africa and is now one of the most valuable summer annual forage grasses. It is widely adapted, is drought resistant, and grows rapidly from late seeding. It is usually seeded alone in low-rainfall areas but is often combined with soybeans in more humid areas. Leaves are numerous, long and narrow. Sudangrass is valuable for hay, silage or pasture. If growth is short and stunted the prussic acid content may be high enough to make pasturing hazardous to livestock, but it is safe to use as hay. The prussic acid content is lower than in the forage sorghums.

Description of Crop, Use, Adaptation, Establishment & Management

Summer annuals should be planted from two weeks after corn until the end of June. Soil temperatures should be at least 60 degrees F. Seedings may be made as late as July 15 in emergency situations, but yields will be reduced because of limited moisture in the summer and cool temperatures during the fall. When utilizing any of the summer annual crops in a planned rotational grazing situation, two seedings should be made about three weeks apart. This will stagger the maturities and make grazing management easier.

Forage and grain sorghum planted for forage should be planted in rows to facilitate harvest and minimize lodging. Avoid planting the sorghums too deeply as emergence problems may occur when planted deeper than one inch in most Midwestern soils. Also, avoid seeding rates above 10-12 pounds per acre since they can increase the risk of lodging, particularly with the tall forage sorghum types. Corn planters work well for planting sorghum provided the appropriate plates or feed cups are used to achieve the desired seeding rates. Sorghum can be planted using any tillage system provided adequate weed control can be achieved.

Fewer herbicides are labeled for grain and forage sorghum than corn so select fields where weeds can be controlled with labelled herbicides. When using Lasso or Dual, be sure to use seed that has been treated with the appropriate safener. When planting after a failed corn crop, be sure that the herbicides used on the corn are labelled for sorghum.

The other summer-annual species can be broadcast seeded and cultipacked or seeded with a grain drill into a well-prepared seed bed. A firm, well-prepared seedbed is best, however, acceptable stands may be established without tillage using no-till drills. Solid seedings result in finer and shorter plants which are desirable for silage and grazing. Wider row spacings (20 to 36 inches) allow for cultivation and results in better regrowth and more uniform production throughout the season. Narrow rows provide intense competition and herbicides are rarely necessary when seeded in this fashion. Only a few herbicides are labelled for these summer-annual crops so weed control should be considered carefully in selecting a row spacing. Row spacing itself, however, has relatively little effect on total forage production. Seeding rates vary depending on seeding method and anticipated moisture conditions.

Plant sudangrass, sorghum-sudangrass hybrids, and millets 1 inch deep in medium to heavy soils and 1 1/2 inches deep on sandy soils. If the soil is dry and rain is not anticipated before seedling emergence, cultipack the seedbed to maximize seed-to-soil contact and moisture conservation.

Both the grain and forage sorghums are most frequently used for silage or green chop in a single cut system, although they can be grazed if desired. Silage should be cut when the grain is in the medium to hard dough stage. Generally, whole plant moisture should be near the desired level for ensiling at this time. In some cases, where maturity is delayed, a frost may be necessary to reduce whole plant moistures to an acceptable level. Under most conditions, corn silage will produce higher silage yields and quality. The sorghums will produce similar or higher yields than corn

silage on droughty soils or in fields with significant deer damage. Deer will not graze the sorghums to the extent they will corn. Digestibility of silage made from the sorghums will usually be about 90-95% of well preserved corn silage.

The other summer-annual grasses can be used for grazing, green chop, silage or hay. When used for grazing, these grasses must be grazed at the proper stage of growth to reduce herd health problems and optimize production. The best time to graze is when the plants are between 18 and 30 inches tall (6 to 8 weeks after planting). Grazing when the plants are less than 18 inches tall will delay regrowth and increase the chances of prussic acid poisoning in sorghum, sudangrass, and sorghum-sudangrass hybrids.

Sufficient animals should be placed on the pasture area to graze the grass down in less than 10 days. Six or more animals per acre may be necessary to accomplish this rapid grazing. After grazing, clip the residue at about 8 inches high to eliminate old stems and insure high quality for the next grazing period. Do not graze or clip these grasses too close (less than 8 inches) because it will weaken and may kill the plants. It will normally take three to four weeks for sufficient regrowth before grazing again.

Grazing can continue on these grasses until frost, or even after frost if the plants are allowed to turn brown (one week after a killing frost) before they are grazed. Do not graze frost damaged or stunted sorghum, sudangrass, or sorghum-sudangrass hybrids until they have been killed (turn brown) by the frost. If the plants begin to grow again after being frost damaged, they should not be grazed until the regrowth is 18 inches tall or the entire plant is killed by frost and turns brown.

Summer-annual grasses are ideal for green chop. Use the same harvest precautions when feeding as green chop as used when grazing to avoid prussic acid poisoning. Cut the plants down to about 8 inches. Green-chop harvesting should not begin until the plants are at least 18 inches tall, however, it should begin early enough to complete harvesting before the plants begin to head. Harvesting after the plants have headed will reduce dry matter intake and milk production in cows, and regrowth potential of the plants.

Sudangrass, sorghum-sudangrass hybrids, and millet should be harvested for silage when they are between 36 and 48 inches tall or in the boot to early-head stage, whichever comes first. At this maturity, they contain excessive moisture for proper ensiling and should be wilted (mowed and allowed to partially dry in the field) before ensiling.

Greatest hay yields are obtained if the annual grasses are harvested when the seed is in the soft-dough stage. However, proper drying is difficult at this stage. Therefore, harvest for hay is recommended during the vegetative stage before the heads emerge or the plant reaches a height of 4 feet. A hay conditioner should be used to mow and crush the stems for rapid, uniform drying. It is extremely difficult to field cure these grasses adequately for safe storage as hay.

For forage production, fertilize grain and forage sorghums using soil test recommendations. In lieu of a soil test, fertilize similar to corn silage. Starter fertilizers can be used and should be most beneficial on the earliest plantings.

Fertilization of the other summer-annuals grasses, should be similar to other annual grass crops. Apply sufficient nitrogen at planting to insure establishment and stimulate plant development. Use the low rate of N when manure has been applied and when planting after a failed corn crop which already received N. Crude protein content of these grasses is directly related to rate of nitrogen fertilization. However, caution must be exercised to avoid nitrate poisoning when high rates of nitrogen fertilizer or manure are applied especially if dry conditions persist. The amount

of phosphorus and potassium will depend on the soil test level and yield goal. At optimum soil test levels and a yield of about 4 tons dry matter per acre, 60 pounds of P₂O₅ and 120 pounds of K₂O would be removed.

Key Information on Prussic Acid Poisoning. *Potential Problems*

Potential Animal Health Hazards Associated with Sorghum & Sudangrass

Prussic Acid Poisoning is a major concern when feeding sorghum, sudangrass, or sorghum-sudangrass hybrids. These species contain varying amounts of cyanogenic glucosides. In the rumen, these compounds are converted into prussic acid which is readily absorbed into the blood stream where it interferes with respiration. If prussic acid is present in the rumen and absorbed rapidly enough, the animal will soon die from respiratory paralysis.

Forage species and varieties may be selected that contain low levels of cyanogenic glucosides. Piper sudangrass has low levels and millet is free of these compounds. The management practices described below can also reduce the risk of prussic acid poisoning from sorghum, sudangrass, and sorghum- sudangrass hybrids:

1. Graze or green chop only when they are greater than 18 inches tall.
2. Don't graze plants during or immediately after a drought when growth has been reduced.
3. Don't graze on nights when a frost is likely. High levels of the toxic compounds are produced within hours after a frost occurs.
4. Don't graze after a killing frost until the plant is dry (the cyanogenic glucosides usually dissipate within several days).
5. Don't graze after a non-killing frost until regrowth is greater than 18 inches.
6. Delay feeding silage for 6 to 8 weeks after ensiling.

Nitrate Poisoning can be a problem under conditions of high nitrogen fertilization, heavy manure applications, drought, or overcast weather, when the plants can accumulate high levels of nitrates. When plants containing high levels of nitrates are eaten, the nitrates are converted into nitrites faster than they can be properly utilized by the animal. These excessive nitrites are absorbed into the bloodstream and alter the blood so that it can not carry oxygen. This causes rapid breathing, fast and weak heartbeat, muscle tremors, staggering and ultimately death if corrective steps are not taken.

The same precautions for prussic acid poisoning will help prevent nitrate poisoning. Millet can cause nitrate poisoning but not prussic acid poisoning. High nitrate levels will persist in forages cut for hay but will be reduced by one-half or so if the crop is ensiled. If you suspect high nitrates in the forage, have it tested by a forage testing laboratory.

Poisoning of Horses fed sorghum, sudangrass, or sorghum-sudangrass hybrids has also been reported. The exact cause of this poisoning is not known. Affected horses exhibit a staggering gait, urine dribbling, and aborting in pregnant mares. There is currently no treatment for this poisoning and affected horses rarely recover. Don't feed horses any of these summer-annual species.

Spelt ~ triticum spelta

Key Information on Spelt also called Spelts or Speltz

Annual or Perennial	Annual
Best Use	As an emergency forage only after the cut vegetation is cured.
Bushel Size	40 lbs
Planting Depth	1" to 1½"
Seeding Dates	Fall, same dates as wheat
Seeding Rate	60 - 100 pounds
Seeds Per Pound	Approximately 14,000 (dehulled)
Time to Germinate	Approximately 7 days
Type of Plant	grass bred for grain production
Type of Soil required	Adapted to the same soils as Winter Wheat

The origin of spelt is controversial. Spelt was widely distributed from the Near East origin during the Bronze Age (4,000-1,000 BC), throughout the Balkans, Europe, and transcaucasia. Some of the earliest recordings of spelt appear in the Bible, the King James version calls it wheat or primary wheat (Exodus 9:32, Isaiah 28:25, and Ezekiel 4:9). Along with the free threshing wheats, spelt may have played a role in the first politically established welfare system in Rome, beginning in 59 BC when after food riots, grain was distributed free to the Roman citizens. The wide distribution of spelt was facilitated by the northern and southern route migrations of early civilizations westward. Spelt production continues to be a major cereal crop in isolated regions throughout southeastern Europe, primarily in Germany and Switzerland.

U.S. production of emmer, another subspecies of wheat, and spelt peaked in the early 1900s and declined steadily thereafter. The inconsistent yield potential and higher protein advantage of spelt could not compete with the progress of breeding programs which improved the yields and quality of barley, oats, and the free threshing wheats. Factors such as limited availability of adapted varieties, low test weight of 30 - 40 pounds, in addition to time and expense of dehulling (for grain use) also contributed to the loss of interest in the covered wheats.

The suggested attributes of spelt relative to wheat are ease of digestion, taste, and that individuals with certain allergies to common bread wheats can consume spelt. The flour is not as easily milled due to the bearded seed and it can grow on poorer soil than wheat. It has been called "poor mans wheat".

Speltz can be grazed or treated like oats, barley, or wheat in just about any way. The seeding typically must be done with a broadcast spreader and only on a narrow pattern. The bearded seed will not flow through a grain drill very well, and it also does not fly from the spreader fans very far.

Switchgrass ~ panicum virgatum

Key Information on Switchgrass



Annual or Perennial	Perennial
Best Use	A bunchgrass for set aside, pasture and hay requiring only 19” of rainfall
Bushel Size	n/a
Planting Depth	½”
Seeding Dates	Late Summer
Seeding Rate	5 -8 pounds/acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 730,000
Time to Germinate	Approximately 14 days
Type of Plant	Native Sod grass
Type of Soil required	Adapted to moist fertile soil, it will produce on droughthy soils of low fertility and highly eroded.

This is an important native sod-forming grass which occurs over much of the United States. It is especially valuable in the Central and Southern Plains. It grows up to 5 feet tall, with short rhizomes. Leaves are 6 to 18 inches long, 0.25 to 0.5 inch wide. While it grows on most soil types, it thrives best on low, moist areas of good fertility. Growth starts rather late but continues throughout the summer if moisture is available. Yield of forage is high, with quality fair while green; but poor as standing winter feed. Propagation is by seeds.

Switchgrass can be grazed earlier in the year than bluestem or indiagrass. It also is a good companion to bluegrass in a pasture.

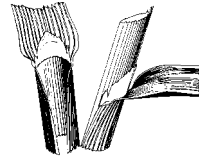
Tall Wheatgrass ~ *elytrigia pontica*

Key Information on Tall Wheatgrass

Annual or Perennial	Perennial
Best Use	A bunchgrass for set aside, pasture and hay requiring only 12” of rainfall
Bushel Size	n/a
Planting Depth	½”
Seeding Dates	Spring
Seeding Rate	8 -10 pounds/acre PLS (Pure Live Seed - See description in Glossory)
Seeds Per Pound	Approximately 77,000
Time to Germinate	Approximately 14 days
Type of Plant	Introduced bunch grass
Type of Soil required	Adapted to moist fertile soil, it will produce on droughthy soils of low fertility and highly eroded.

Tall wheatgrass is a tall-growing, coarse-textured bunchgrass native to the Eastern Mediterranean Region, introduced from Russia in 1932. It is adapted to growing on wet, alkaline soils and has been used extensively for seeding such sites in the Northern Plains and Intermountain Regions. Clumps reach up to 6 feet and yield heavily with sufficient available moisture. It is less drought resistant and less palatable than crested wheatgrass, but is useful for both hay and pasturage on soils not suitable for other wheatgrasses.

Timothy ~ *phleum pratense*



Key Information on Timothy

Annual or Perennial	Perennial
Best Use	A bunchgrass for pasture and hay
Bushel Size	n/a
Planting Depth	¼” to ½”
Seeding Dates	February 1 st to April 20 th - or - August 20 th to October 1 st
Seeding Rate	10 -12 pounds alone 2 - 6 pounds in mixes
Seeds Per Pound	Approximately 1,250,000
Time to Germinate	Approximately 10 days
Type of Plant	grass
Type of Soil required	Adapted to moist fertile soil, it will not tolerate droughthy soils.

History

Timothy is of European origin but was first cultivated in the United States. It became the most important hay-grass in this country by the start of the last century.

Length of Life

Timothy is a perennial, bunch-type, shallow-rooted, cool- season grass. However, timothy is intolerant of cutting during jointing or early- heading. Very hot temperatures, drought and close grazing will shorten the life of this long lived perennial.

Description of Crop

The plant is a bunchgrass, shallow rooted, long-lived and winter hardy in cool, moist areas. Stems are leafy, and reach to 40 inches under the best conditions. Timothy is palatable and nutritious both for hay and for grazing. Timothy proteins are rich in tryptophane, lysine, and valine. Reproduces by seeds and plants do not spread vegetatively or from a sod. Seed yields are large and establishment is rapid and easy. Its shallow root system, however, make it unadapted to droughty soils. Timothy is a hay-type forage grass, with relatively few basal leaves below the cutting height. It is easily weakened by frequent cutting or grazing. This is due to its limited storage of energy reserves in the corms, its production of few basal leaves to support regrowth after harvest and its upright growth habit which is generally dominated by a single stem. As in the case of orchardgrass, the Timothy seed head is one of the most distinguishable. The Seed head has reminded some of a large green pipe cleaner.

Use

Timothy is grown primarily for hay for horses but is frequently included in pasture mixtures. It is less competitive in a legume mixture than most sod-forming grasses and is frequently grown in a legume mixture for hay. However, special attention must be made to match the maturity of the timothy with the maturity of the legume to ensure timothy persistence and quality forage.

Adaptation

Timothy can be successfully established in either spring or late-summer seedings. However, fall seedings are more successful because the cooler weather during the fall is more suitable for timothy growth, and weeds are less of a problem. Timothy can be slow to establish and may fail when weed competition is severe during establishment. Grass weeds are especially harmful. Small grain companion crops can be used in spring seedings, but should not be used for late-summer seedings. Oats are the most common companion crop, but early removal for silage or by grazing is necessary to reduce competition for light and moisture. A small grain and field pea companion crop may provide too much competition when establishing an alfalfa-timothy mixture.

Potential Problems

Timothy is a hay-type forage grass, with relatively few basal leaves below the cutting height. It is easily weakened by frequent cutting or grazing. Timothy makes relatively little yield after the first harvest because of its intolerance to the hot and dry conditions that prevail during summers. Under grazing management, timothy should not be allowed to progress very far into jointing before grazing. Delaying grazing will reduce the stored energy reserves and ultimately reduce timothy stand.

Establishment & Management

If a late-summer seeding is planned, prepare the seedbed 2 to 4 weeks ahead of seeding, if possible. This will allow the soil to become firm and provide an opportunity to accumulate seedbed moisture.

The best stands of timothy are obtained when sown not deeper than 1/2 inch in a well-prepared, firm seedbed. A firm seedbed is essential to the successful establishment of small-seeded grasses such as timothy. A firm seedbed allows greater regulation in seeding depth, holds moisture better, and increases seed to soil contact. Proper seeding depth can be accomplished with band seeders equipped with press wheels. Other seeding methods can be used, but chances of obtaining thick stands and vigorous growth in the seeding year are reduced. Cultipacker seeders and grain drills work well if the seedbed is firm and the seed is covered to a depth not exceeding 1/2 inch. Roll or cultipack after seeding with grain drills not equipped with press wheels or after broadcast seeding. Caution must be used not to bury the seed after broadcast seeding.

Mixtures of cool-season grass species are generally not recommended for hay or silage production because of the difficulty of managing grass mixtures (e.g. proper harvest to obtain high quality and persistence when the grass maturities are different). However, timothy is frequently planted in mixture with other grasses for use in pastures, especially pastures for horses. A pasture mixture that has performed well in Pennsylvania is 8 lb. of Kentucky bluegrass plus 4 lb. each of smooth brome grass and timothy and 1 lb. of white clover. This mixture can serve as a good pasture for horses throughout much of the summer.

The spring growth of timothy passes through the typical stages of grass development, tillering, jointing (stem elongation), heading, flowering and seed formation. Flowering heads are commonly produced in the summer aftermath growth, in contrast to most perennial cool-season grasses which produce seed heads only during the spring growth.

Timothy is a hay-type forage grass, with relatively few basal leaves below the cutting height. It is easily weakened by frequent cutting or grazing. This is due to its limited storage of energy reserves in the culms, its production of few basal leaves to support regrowth after harvest and its upright growth habit which is generally dominated by a single stem.

Timothy is relatively tolerant of pre-joint harvest in early to mid-May but is adversely affected by harvesting during the jointing stage in mid May. In addition, harvesting at early heading reduced timothy yields and persistence, compared to harvesting at either early or late bloom (Table 3). Harvesting the spring growth of timothy at early heading reduced first harvest yield and there is generally no increase in yield of subsequent harvests to compensate for this loss. In Pennsylvania, timothy makes relatively little yield after the first harvest because of its intolerance to the hot and dry conditions that prevail during summers. More summer yield can be expected in New York, where moisture and temperature are more favorable for summer growth of timothy. Quality of timothy is among the highest of cool- season grasses when vegetative, but decreases very rapidly as reproductive growth is initiated.

Under grazing management, timothy should not be allowed to progress very far into jointing before grazing. Delaying grazing will reduce the stored energy reserves and ultimately reduce timothy persistence. Grazing in the spring can begin when the timothy is 3-4 inches tall. Timothy will tolerate moderate continuous grazing but rotational grazing with a minimum recovery period of 3 weeks will improve timothy production.

Timothy requires a high level of fertility for maximum production. Potassium fertilizer is important to maximize the legume yield in a timothy-legume mixed stand.

Variety Selection

Several varieties of Timothy are available, however, Clair and Climax are the most common in the Midwest. Specific information on varieties is listed in the Variety Characteristics section of this manual.

Triticale ~ triticale

Key Information on Triticale

Annual or Perennial	Annual
Best Use	As a drought tolerant grain
Bushel Size	42 lbs
Planting Depth	¼” to ½”
Seeding Dates	February 1 st to April 20 th - or - August 20 th to October 1 st
Seeding Rate	100 - 126 pounds alone
Seeds Per Pound	Approximately 20,000
Time to Germinate	Approximately 10 days
Type of Plant	hybrid grass
Type of Soil required	Similar soils to other small grain production

Triticale, the derivative of wheat and rye hybridization, provided the world with a glimpse of the future of agricultural technology in the 1950s. Triticale represented the first serious effort at synthesizing a new crop. This had been attempted through simple crossing in the late 1800’s but with little success.

Triticale can be used for an annual pasture, for the grain, for a cover crop or as a green chop silage. When using Triticale as a pasture, the same management technique should be used as with Wheat, Oats, or Rye. Triticale should be planted at a similar time to Winter Wheat.

Triticale has a higher protein content in the seed than wheat, and will mature nearly the same time as wheat