

Growing Small Grains in Your Garden

by Bob Van Veldhuizen

AFES Circular 135

February 2010



With the recent release of 'Sunshine' hulless barley there has been an increase in interest about growing grains in a small-scale garden setting for use in soups and stews as well as for whole grain flour. Even though the scale is greatly reduced, a few square feet vs. many acres, the same principles apply to growing a high yielding crop successfully. Soil nutrition, seeding rates, weed and insect control, diseases, harvesting and cleaning methods are just as important for the home garden as for a large agronomic field. However, you don't need a tractor, grain drill, combine harvester, or grain elevator to grow small grains successfully in a garden setting. Typical garden hand tools will work just as well. The information that follows is a summation of many years of agronomic research into growing grains in Alaska scaled down to the typical home garden.

Heads of Sunshine hulless barley growing on the Fairbanks Experiment Farm at the University of Alaska Fairbanks campus.

Crop Selection

The first decision that must be made is—what kind of grain do you wish to grow? Small grains that can be grown in Alaska include barley, oats, wheat, rye, and triticale. There are many different types of each of these grains depending on the intended use for each variety—feed barley, malting barley, and hullless barley are examples. Furthermore, each of these can be divided into spring planting and winter planting varieties. Spring varieties are usually planted in early May and harvested in early September for a four-month growing season. These are the best-adapted varieties for Alaska's growing conditions. Winter varieties are usually planted in mid-August. They will then grow out to a rosette stage to build up winter root reserves before undergoing winter dormancy. The next spring the plant assumes an upright growth form with a seedhead similar in appearance to other spring grains. The grain is then harvested in mid-September for a 13-month growing season. Winter grains are better adapted to more southern climates and in Alaska they are susceptible to winter kill from desiccation, freezing of the rosette, and attacks of snowmold fungi including white snowmold (*Sclerotinia borealis*) and pink snowmold (*Gerlachia nivalis*). It is for these reasons that winter grains are not recommended.

Choosing a particular small grain variety is usually based on personal preference and what you intend to do with the grain after it has been harvested: whole grain, rolled and flaked, cracked, or ground into various grades of flour. These decisions should also include taste preferences and nutritional qualities. There is an abundance of information published on the nutritional qualities and recipes of various small grains that can be easily obtained through libraries, bookstores, or on line. If you are not familiar with the taste or cooking and baking qualities of a particular type of small grain, you should try a sample first. It would be a shame to plant a hundred square feet of your garden in a crop of hullless barley only to find out later that the flour quality isn't up to your baking standards. Many whole grains, rolled flakes, and flour grades of various small grains can be found at local health food stores or in the health food and baking aisles of larger grocery stores.

It is also important to know what a kernel of grain is and the various parts of a grain kernel. These parts of the grain kernel are important as some may be removed during the production of various types of grain products. All grain is living seed with a primary purpose of growing more grain plants. Each grain kernel is made up of four distinct parts. On the outside of the kernel is a fibrous hull (or husk) to which is attached an awn (or beard) on the top of the kernel. The hull provides a protective covering for the inner parts of the kernel. The awns are usually barbed in one direction and are a holdover genetic trait from wild grains that may have helped to ensure seed dispersal by animals. The outer fibrous hull on feed grains (feed barley and oats) is not digestible by non-ruminant animals or humans and must be removed in a de-hulling process. In hullless grains the hull is thin and papery, and detaches from the kernel during harvesting, exposing the

embryo and leaving a hullless or naked kernel. Because the hull is not attached to the kernels on hullless grains, dehulling is not needed. Inside of the hull there is the coarse bran layer. This bran layer helps to control the amount of water uptake by the seed during the germination process. Inside the bran layer the grain is made up of two main parts. The smaller part on the bottom of the kernel is called the germ. The germ is the embryonic plant, and contains a 'root,' called a radicle, and a 'shoot,' called an epicotyl, with leaves called cotyledons. It contains the highest amount of fats in the kernel. The larger part above the germ is called the endosperm. This is composed of starch, which is the food for the germ when the seed is going through the germination process. In whole grain products the bran, germ, and endosperm are all included. However, the bran and germ are usually made up of coarser particles with a higher ash content which in turn make a coarser, heavier flour. These are then removed in the milling process leaving only the endosperm as a finer, higher-quality flour.

The information that follows is for small grains that can be grown in Alaska. Descriptions start from the easiest to grow, best-adapted types with the highest yields and best quality grain to the most difficult to grow, poorly adapted types with lower yields and poorer quality grain. It is important to remember that just because a type of grain doesn't do well in large-scale agronomic fields doesn't mean that it also won't do well in small-scale setting like a garden. If you like a particular type of grain, try it. Start small and if it does well that year then you can expand next year. Information on well-adapted varieties for Alaska follows the description of each type of small grain.

More information on all agronomic varieties tested in Alaska can be found on line in the UAF SNRAS/AFES publication, Bulletin 111, *Performance of Agronomic Crop Varieties in Alaska 1978–2002* by Robert M. Van Veldhuizen and Charles W. Knight, available on line at www.uaf.edu/snras/afes/pubs/bul/B111.pdf.

Barley

Barley is the most important grain crop grown in Alaska. It is well adapted to the long day length and short growing season found here. There are many different types of barley: feed (or hulled) barley and hooded (or forage) barley that are used primarily for ruminant animal feed; malting barley that is used in the malt and brewing industries; and hullless (or naked) barley which is used for human consumption and swine and poultry diets. There are two common species of barley that are differentiated by the shape of the seed heads. Six-rowed barley (*Hordeum vulgare* L.) has a long, round-shaped seedhead, due to the kernels forming six rows evenly around all sides of the seedhead. Two-rowed barley (*Hordeum distichum* L.) has a flat-shaped seedhead due to the kernels forming two rows on opposite sides of the seedhead. Most barley varieties grown in Alaska have been the six-row types because they usually mature earlier and are more

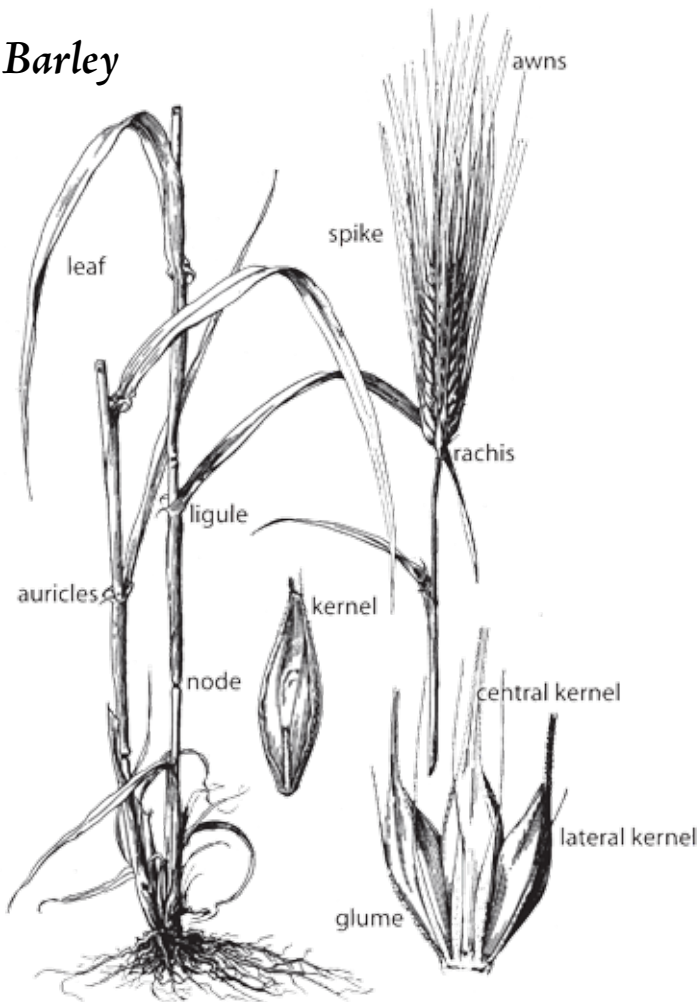
uniform at harvest than the two-rowed types. Early-maturing six-row barley varieties usually produce three to four tillers per plant. Each tiller is an additional stem with its own seedhead. For those early-maturing six-row barley varieties these tillers often reach maturity and ripen, increasing yields at harvest. Two-row varieties, which mature later, often produce a large amount of tillers even late into the growing season (late July to early August). These late tillers may never ripen by the time of harvest when compared with the main head. They also tie up plant nutrients important in filling and ripening seed and produce wet plant material in with the ripe seed at harvest.

Most barley varieties have a long awn attached to the hull surrounding the kernel. The awns of some varieties can be smooth, but most are rough or bearded. Unfortunately, the rough awns can work into the soft tissues around animals' mouths, nostrils, and eyes, causing potentially serious infections. These rough awns, if left on grain or found in straw, make it undesirable for use as food or bedding. When most varieties of barley are ripe (the kernel cannot be dented with a thumbnail), and harvested at the proper moisture conditions, these awns break off during harvesting. In hooded barley, the awn develops a winged, hollow structure in place of the rough, spiked awn. Because it does not have the rough, spiked awns, hooded barley was developed primarily for use as a forage crop.



Feed barley.

Barley



The fibrous hull on all feed and forage barley remains on the kernel. For animal feed, the grain is usually ground or rolled and fed with the hull attached. However, before hulled barley can be consumed by humans the outer hull must be first removed. This dehulling process consists of sanding off the outer fibrous hull using an abrasion wheel inside a large spinning closed container. The lighter hulls are then blown off and the dehulled kernels are collected. The bran and germ are still part of the kernel so dehulled barley is considered whole grain. The bran can be removed in an additional process called "pearling." This takes dehulled barley and removes the outer bran (and portions of the germ) through a steam and polishing process. Loss of the bran and germ also reduces the amount of nutrients in pearled barley. Because the hull is not attached to the kernels on hullless barley, dehulling is not needed. Dehulled and hullless barley grains can also be turned into flakes (or rolled barley). This process uses two large smooth or corrugated steel rollers spinning at the same speed in opposite directions. In commercial operations there are three sizes of flakes depending on the size of the kernels going through the rollers: regular, medium, and thick. Last, all whole grain (dehulled and hullless barley) can be ground into various grades of flour. If you decide to turn this grain into whole grain flour (or rolled flakes) then the yield will be 95 to 100 percent. The small amount of loss is usually due to transfer and clean out between the milling or flaking equipment and the storage container. If you want a higher quality flour, there are a number of screenings and re-milling steps to remove portions of the bran and the germ that are higher in ash content. Also, higher test weight grain produces higher percentages of flour than lower test weight grain. The average flour return using this milling process for standard test weight grain is 72 percent. The remaining 28 percent consists of coarse particles of bran and germ that are removed in the milling

process called shorts (or standard middlings). These byproducts can be used as dairy, swine, and poultry feeds.

In recent years there has been an increased interest in producing hullless barley not only for diets of nonruminant animals, which cannot digest the fibrous hulls of hulled barley, but also for human consumption in items such as breakfast cereals, food thickeners, and health foods. There are two types of hullless barley, normal and waxy. In normal hullless barley the ratio of amylose to amylopectin starch fractions is the same as that found in regular hulled barley (about 25 percent amylose and 75 percent amylopectin). In waxy barley there is a higher percentage of amylopectin starch and beta-glucans, (95 to 100 percent amylopectin). Because of their higher beta-glucan content, waxy barley varieties are more difficult to digest, making them better suited for industrial uses such as thickening agents. Regular hullless barley has higher beta-glucan content than hulled barley. The beta-glucan helps to lower LDL cholesterol levels. All barley contains eight essential amino acids and has available energy that is close to that of wheat. However, hullless barley has a slightly higher level of nutrients and crude protein by one to two percent over that of hulled barley. Whole-grain barley (not pearled) can help regulate blood sugar levels for up to ten hours after consumption compared to white or even whole-grain wheat, which has a similar glycemic index. This improves digestibility and helps weight loss by increasing satiety (feeling full). Hullless barley is very low in gluten, making it a suitable substitute for wheat in human diets.

Feed (hulled) barley varieties suitable for dehulling, pearling, and flaking

OTAL

'Otal' is an early maturing, mid-tall, stiff-strawed, rough-awned, six-row, high-yielding spring feed (hulled) barley released in 1981 by the USDA plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It is a cross between a six-rowed Finnish cultivar, 'Otra,' and an unnamed early maturing two-rowed selection from Sweden. Inquiries about seed sources should be directed to the Alaska Seed Growers Association, the Alaska Plant Materials Center, or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).

FINASKA

'Finaska' is another early maturing, short, stiff-strawed, rough-awned, six-row, high-yielding spring feed (hulled) barley, released in 2000 by the plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It is a cross between two six-rowed Finnish cultivars, 'Jo 1632' and



Finaska barley.

'Jo 1599.' Finaska has an improved lodging resistance compared with Otal but it does have lower test weights. Inquiries about seed sources should be directed to the Alaska Seed Growers Association, the Alaska Plant Materials Center, or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).

WOODING

'Wooding' is also an early maturing, short, stiff-strawed, rough-awned, six-row, high-yielding spring feed (hulled) barley, released in 2006 by the plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It is a cross between the six-rowed Finnish cultivar, Jo 1632, and the Alaska six-row cultivar, Otal. Wooding has an improved lodging resistance, higher yields, and comparable test weights with Otal. Inquiries about seed sources should be directed to the Alaska Seed Growers Association, the Alaska Plant Materials Center, or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).



Hulless barley grains.

Hulless (naked) barley varieties suitable for whole grain, flakes, or flour

THUAL

'Thual' is an early maturing, mid-tall, moderately stiff-strawed, rough-awned, six-row, hulless (naked)kerneled spring barley released in 1981 by the USDA plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It is a cross between the Finnish cultivar Otra, and an unnamed hulless line from Ireland. Thual is one of the first released hulless varieties to mature and produce yields comparable with hulled varieties such as Otal. Its moderate straw strength causes a higher percentage of lodging when compared with Otal in most years. Inquiries about seed sources should be directed to the Alaska Seed Growers Association, the Alaska Plant Materials Center or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).

SUNSHINE

'Sunshine' is an early maturing, mid-tall, stiff-strawed, rough-awned, six-row, hulless (naked)kerneled spring barley released in 2009 by the plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It is a cross between the Finnish cultivar Jo 1632 and the Alaska hulless variety, Thual. Sunshine is earlier in maturity, produces higher yields, and has stronger straw strength compared with Thual. Inquiries about seed sources should be directed to the Alaska

Seed Growers Association, the Alaska Plant Materials Center or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).

Oats

Oats (*Avena sativa*) are the second-most important grain crop for Alaska, after barley. They are also well adapted to the long day length and short growing season found here. Oats are 7 to 10 days later in maturing than the early season barley varieties. Oats can be planted early in the season in areas that are poorly drained, as oat seed germinates well in cold and wet soils. Oats are also more tolerant of acidic soils than barley or wheat and can produce high yields when soil pH values range between 5.0 and 5.5. There are many different types of oats; feed oats which include common (or white) oat (*Avena sativa* L.), black oat (*Avena stri-gosa* L.) and red oat (*Avena byzantina* C. Koch), and hulless oat (*Avena nuda* L.). Oat straw lacks the rough awns of barley straw so there is a high demand for use as animal bedding, especially with the local dog mushers. Seeds from feed oats have the hulls still attached but the hull from hulless varieties detaches from the kernel when harvested, exposing the embryo and leaving a hulless or naked kernel.



Close-up of ripe oat heads.

—photo by Veli Holopainen, found at Wikimedia



Yellow feed oats.

To be consumed by humans, hulled oat varieties must be dehulled first. The dehulling process differs slightly from dehulling barley because oats are higher in lipids (fats) than all other grains. This can cause the abrasion wheel to plug up and not be completely effective. An oat dehuller functions by dropping the hulled oats inside a large spinning closed container that encloses another spinning stone. On contact with this stone, the hulls are separated from the groats (the inside portion of the oat kernel). The lighter hulls are then blown off and the dehulled groats are collected. As with dehulled barley, oats can be pearled.



Black feed oats (Avena strigosa L.).

This takes dehulled oats and removes the outer bran through a steam and polishing process. Loss of the bran and germ in pearled oats also reduces the amount of nutrients.

Because of the high fat content in oat grain, both dehulled and pearled oats can become rancid in about four days if the fat isn't first stabilized. When the hull is removed and the groat is exposed to the air, enzymes in the groat start turning the lipids into free fatty acids. It is these free fatty acids that cause rancidity. To stabilize this, all dehulled and pearled oats need to be heated (kilning) in an oven at 240° F for 30 to 60 minutes. The length of time depends on the moisture content of the kernels after harvest. The drier the kernels, the less time that is necessary.

As with hullless barley, in hullless oat varieties the hull is thin and papery and detaches from the kernel when harvested. Dehulling and kilning are not necessary as the groat is not exposed. Dehulled and hullless oats can also be turned into flakes (or rolled oats) in a process exactly like that for barley. Oat flakes are made from dehulled oats, cleaned, sized, and dried to 6 percent moisture, steamed, and pressed between two large smooth or corrugated steel rollers spinning at the same speed in opposite directions. This produces three sizes of rolled oats: regular, medium, and thick, depending on the size of the groat or kernel. Quick oats are small, thin flakes cut from the groats and then rolled. All whole grain (dehulled and hullless oats) can be ground into various grades of flour with the same yields as for barley flour. Whole grain oat flour includes the bran, the germ, and the endosperm, and can be slightly coarser than debranned flour.

Oats used for animal feed are either whole, ground, or rolled. As with hullless barley, there has been an increased interest in producing hullless oats for human consumption in items such as breakfast cereals and health foods. Oats are the only grain



Hullless oats.

Toral oats



Wheat

containing a soy-like (legume) globulin protein called avenalin as the main protein in the kernel. Globulin proteins are water soluble, which helps to retard rancidity in fats, and are used as antioxidants and stabilizers for dairy products. When included in human diets, this protein may lower LDL blood cholesterol levels. Globulin is nearly equal in quality to meat, milk, and egg protein. By contrast, the main protein in wheat is a prolamin called gluten. The protein content of the hullless oat kernel (or groat) ranges from 12 to 24 percent, the highest of all the small grains.

Feed (hulled) oat varieties suitable for dehulling, pearling, or flaking

TORAL

'Toral' is a midseason, tall, stiff-strawed, high-yielding, yellow-glumed, spring feed (hulled) oat released in 1972 by the USDA plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It was selected from a cross between an early maturing black-glumed oat from Sweden, 'Orion III' and a later maturing, high-yielding, yellow-glumed Polish oat, 'Tatranski.' Toral is a good general-purpose oat with consistently high yields for both seed and forage. A glume is the outside covering of the hull on all grains (specifically the basal, membranous, outer sterile husk or bract in the flowers—eventually the seed of grasses). In oats it is used as an identifier because it comes in three different colors, yellow, black, or red. Inquiries about seed sources should be directed to the Alaska Seed Growers Association, the Alaska Plant Materials Center, or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).

Hullless (naked) oat varieties suitable for whole grain, flakes, or flour

BELMONT

'Belmont' is a late maturing, mid-tall, stiff-strawed, mid-yielding, hullless (naked) kernal spring oat released in 1992 by Agriculture Canada in Winnipeg, Manitoba. It is much later in maturity and lower yielding than Toral. It does have good resistance to lodging and oat loose smut. Up to 12 percent non-hullless kernels are common. This variety is protected by Canadian plant breeders' rights. Producers may save seed for their own use on their own farms but sale or transfer of seed is prohibited without written permission and a payment of royalties to the breeder. Inquiries about seed sources should be directed to the SeCan Association (see appendix for address).

Wheat is of limited importance as a grain crop for Alaska due to its long growing season requirement. Wheat is much later maturing than barley or oats and its maturity is highly dependent on the climate. If the weather is warm and dry for a month after pollination then it matures on average 10 days later than barley. If the weather for that same period is cool and wet then an additional 10 to 15 days are required to reach maturity. Light frosts during heading can cause sterility, while light frosts before the plant reaches full maturity stops any further grain development.

There are many types of spring wheat. The bread wheat varieties (*Triticum aestivum* subspecies *vulgare* L.) are made up of the hard red spring wheats (true bread flour wheat) and the soft white wheats (pastry flour wheat). The other spring wheat type is the macaroni or durum wheat (*Triticum durum* Desf.). These are also divided into two types: white or amber (most common pasta flour wheat), and red durum wheats (rarely grown). Early maturing hard red spring wheat varieties are the best adapted for Alaska's growing conditions but are considered somewhat marginal. White and durum wheats require a longer frost-free growing season to reach maturity than the hard red spring wheats and thus are not recommended for Alaska. Spelt wheat (*Triticum spelta* L.) is considered to be a genetic parent of common wheat. It is a primitive form of wheat that more closely resembles the wheatgrass (*Agropyron* sp.) family than true bread wheat. The seedhead is long, slender, and awnless. Most of the hulls remain on the kernel after threshing. It is very late maturing but continues to ripen even under cool wet conditions when most bread wheats do not. Its primary use is as livestock feed although there is some limited traditional use for human consumption. The hull must be removed through an abrasion process (dehulling) prior to incorporating spelt wheat into a human diet for ease in digestibility. Spelt wheat is not accepted as a class of bread wheat, although a low-gluten bread may be made from it.

The seedheads of hard red spring wheat can be awnless, tip awned, or fully awned depending on the variety. Durum wheat has long stiff awns and compact seedheads. All other things being equal, kernels of awned varieties photosynthesize more than varieties without awns, resulting in higher levels of carbohydrates, higher test weights, and quicker drying during ripening.

The main uses of wheat for human consumption are as flour for baked products (because of the high gluten protein content in wheat), breakfast foods, pasta, and health foods. As with barley and oats, wheat can be ground into various grades of flour with the same yields as for other flour types. Whole grain wheat flour includes the bran, germ, and the endosperm and can be slightly coarser than any of the finer grades of flour. Because the bran and germ have a higher ash content than the endosperm, they have poorer baking qualities. Therefore, the finer flour (mostly



Spelt wheat.



Spelt wheat, debulled.



Durum wheat.



Hard red spring wheat.

endosperm) is preferred for baking confectionary products. Secondary uses for wheat are for non-ruminant animal feed (cracked or rolled), or for poultry diets (whole grain).

Ingal wheat



Rye & Triticale

Hard red spring wheat varieties suitable for whole grain, flakes, or flour

INGAL

'Ingal' is an early maturing, semi-dwarf, stiff-strawed, red-glumed, red-kerneled, awned, hard red spring wheat released in 1981 by the USDA plant breeding program at the Palmer Research and Extension Center of the University of Alaska Fairbanks Agricultural and Forestry Experiment Station. It was selected from a cross between a variety developed in Alaska, 'Gasser,' and 'Morin No. 16' from the USDA World Wheat Collection. Seed kernels of Ingal are smaller than average, requiring care in planting and harvest. Ingal is prone to head shatter if adverse weather conditions such as heavy rains or high winds persist at harvest. Ingal is satisfactory for milling and baking. Inquiries about seed sources should be directed to the Alaska Seed Growers Association, the Alaska Plant Materials Center, or the UAF Agricultural and Forestry Experiment Station (see appendix for addresses).

AC INTREPID

'AC Intrepid' (AC = Ag Canada) is an early maturing, mid-tall, stiff-strawed, red-glumed, red-kerneled, awned, hard red spring wheat released in 1997 by the plant breeding program of Agriculture Canada in Swift Current, Alberta. Yields are higher than Ingal but with lighter test weights. AC Intrepid is more susceptible to loose smut fungal attacks compared with Ingal. AC Intrepid is satisfactory for milling and baking. Inquiries about seed sources should be directed to Canterra Seeds (see appendix for address).

CDC BOUNTY

'CDC Bounty' (CDC, Crop Development Centre, Lacombe, Alberta, Canada) is an early maturing, mid-tall, stiff-strawed, red-glumed, red-kerneled, awned, hard red spring wheat released in 1999 by the plant breeding program at the University of Saskatchewan in Saskatoon. Yields and test weights are higher than Ingal. CDC Bounty is more resistant to loose smut fungal attacks compared with Ingal. CDC Bounty is satisfactory for milling and baking. Inquiries about seed sources should be directed to Canterra Seeds (see appendix for address).

Rye

Rye (*Secale cereale* L.) has been shown to be even less adapted for Alaska than wheat. Similar to wheat, rye has a long growing season requirement but yields less than many wheat varieties. Rye is susceptible to head shatter making it difficult to harvest and results in many volunteer plants emerging in the field next season.

The primary use of rye is as bread flour. It can be ground into various grades of flour with the same yields as for other flour types. Whole grain rye flour includes the bran, germ and the endosperm and will be slightly coarser and darker than the finer grades of flour. The protein concentration of rye is less than that of wheat. Rye flour does not have true gluten proteins but it does contain proteins that make a nutritious, dark, heavy leavened bread. Rye flour also has a higher content of soluble fiber. Secondary uses are in the distillation of rye whisky and as a livestock feed. Rye is also used as an annual forage crop either by itself or with legumes. In addition, it is used as a green manure crop to help smother annual weeds and increase soil organic matter content.

Triticale

Triticale (x *Triticosecale* Whittmack) is a manmade crop resulting from a cross between wheat (*Triticum*) and rye (*Secale*). Most of these crosses have been with durum wheat varieties. The crop was developed with the hopes of combining the winter hardiness characteristics of rye into the bread making characteristics of wheat. Even though this crop has been around



Spring rye.

for more than 100 years it is still in the experimental stages of development. Like the rye varieties, triticale is very late maturing and highly susceptible to ergot. Triticale kernels are larger than those of wheat and have a higher lysine (sulfur containing amino acid) content for improved nutrition. Triticale has higher seed yields and better drought resistance when compared with wheat. It is highly resistant to head shatter and lodging.

The primary use of triticale is for bread flour, where it has similar properties as rye flour. Secondary uses are as a livestock feed. Triticale can be used as the only grain in poultry diets and has a similar value to hullless barley and wheat mixture. Triticale is also used as an annual forage crop either by itself or interseeded with legumes. It has about a 10 percent higher forage yield than either barley or oats. The quality of the forage ranks between that of barley and oats.



Triticale heads.

—photo by Markus Hagenlocher, Wikimedia, GNU Free Documentation License

Bebral winter rye.



Triticale.



Rye and triticale varieties suitable for whole grain, flakes, or flour

GAZELLE

'Gazelle' is a late maturing, tall, stiff-strawed, moderately high-yielding, spring rye released in 1974 from the plant breeding program of the University of Saskatchewan in Saskatoon. It was a selection out of a German strain. It is two to three weeks later in maturity than Ingal wheat but on favorable years has out-yielded Ingal. In Alaska, it is highly susceptible to ergot with average levels of contamination between 0.01 and 5.10 percent. This is an older variety and seed stocks may be difficult to find. Inquiries about seed sources should be directed to the Canadian Seed Growers Association, Stock Seed Distribution Committee (see appendix for address).

CARMAN

'Carman' is a late maturing, mid-tall, stiff-strawed, moderately high-yielding, spring triticale released in 1980 from the Department of Plant Science of the University of Manitoba. It was a selection from a cross between a Canadian triticale line and a Mexican line. It is two to three weeks later in maturity than Ingal wheat but under favorable conditions can outyield Ingal. In Alaska, it is susceptible to ergot with average levels of contamination between 0.01 and 0.91 percent. This variety has been deregistered and is now in the public domain. This is an older variety and seed stocks may be difficult to find. Inquiries about seed sources should be directed to the SeCan Association (see appendix for address).

Seedbed Preparation

The second decision that must be made is, how much of an area do you need? This all depends on how much grain you want to produce. Typical yields for hullless barley, hullless oats, hard red spring wheat, rye, and triticale run from 2,000–3,000 pounds per acre. Higher yields and test weights can be achieved from hullless barley and hullless oats, medium yields and test weights from wheat, and lower yields and test weights from rye and triticale. The standard test weight of grain types is the density or weight of a standard unit volume for that type of grain (56 pounds/bushel for hullless barley, 44 pounds/bushel for hullless oats and 60 pounds/bushel for wheat, rye, and triticale). It is a measure of the quality of the grain related to the maturity and ripeness of that grain variety. Generally, the later maturing the crop, the lower the yield and test weight due to the amount of green and unripe seed at harvest. This translates to yields of approximately 5 to 7 pounds of clean ripe seed/100 sq. ft. (10 feet by 10 feet). This is a seed volume of about one gallon. If you save aside enough seed to plant another 100 sq. ft. garden plot next year you'll need about a quarter of a pound. This will still give you about 4¾ to 6¾ pounds of grain for food. As was mentioned previously, if you decide to turn this grain into rolled flakes or whole grain flour then the yield will be 95 to 100 percent. A higher quality flour will have a number of screenings and re-milling steps to remove portions of the bran that are higher in ash content. The average flour return using this milling process for standard test weight grain is 72 percent. The remaining 28 percent consists of bran and shorts that are removed and discarded in the milling process.

Soil Fertility

Proper fertilization is important in the production of a high-yielding and high quality grain crop. It is important to use a soil test to determine which plant nutrients are limiting and how to correct for those deficiencies. Soil testing should be done in the fall on the part of the garden in which next year's crop will be grown. Work with your local CES Agricultural Extension Agent to take soil samples for available nutrient analysis and interpretation of the results. In general, all soils should receive a complete mix of nitrogen, phosphorus, potassium, and sulfur. Complete fertilizer blends consisting of ammonium sulfate, urea, monoammonium phosphate, and potassium chloride work well. If ammonium sulfate is not available, a substitution of potassium sulfate for potassium chloride would work to provide the needed sulfur. Soils that have existing moderate to high levels of available nitrogen, phosphorus, and potassium (as residual soil nutrients from the previous year's crop) should have a complete fertilizer blend consisting approximately of the following: 15 to 20 percent N, 15 to 20 percent P₂O₅, 10 to 15 percent K₂O, and 5 to 8 percent S. (See explanations of each nutrient, below.) Actual percentages of each material as well as the rate of application vary with the

soil test results. This works out to an approximate rate (available soil nutrients plus added fertilizer) of about 60 – 80 lbs/acre (0.14 – 0.18 lbs/100 sq.ft.) of N, 60 – 80 lbs/acre (0.14 – 0.18 lbs/100 sq.ft.) of P_2O_5 , 50 – 60 lbs/acre (0.12 – 0.14 lbs/100 sq.ft.) of K_2O , and 10 – 20 lbs/acre (0.02 – 0.04 lbs/100 sq.ft.) of S. The plant nutrition sources can be either a commercial mineral fertilizer blend such as 20-20-20 or they can be organic sources such as fish meal or composted manures. Actual values of N- P_2O_5 - K_2O will vary depending on the source of the organic nutrients. Be sure to read the label or have your own compost tested through your local CES Agricultural Extension Agent. Either source should follow the recommended rate of application from the soil test results. All types of fertilizer sources (mineral and organic) can be broadcast and incorporated with the spring tillage but only portions of mineral blends can be banded next to or with the seed at planting.

Nitrogen, N

Pure mineral nitrogen fertilizers and fresh manure should be broadcast applied, especially at high rates, and should never be banded with the seed. Most mineral forms, like urea, and fresh manure (which contains ureic acids) are hygroscopic and draw soil water away from the seed. This hinders germination and “burns” the seedlings. A general rule is to not place any nitrogen source with the seed. Monoammonium phosphate fertilizer is only 11 percent N so it can be banded one inch below and one inch to the side of the seed row. Newly cleared soils are usually low in available nitrogen and application rates need to be increased to compensate for this. If there are a lot of plant residues to be tilled in with the fertilizer then an extra amount of nitrogen should be applied to compensate for the microbial decomposition that competes with the crop for the available nitrogen. An extra half ounce of nitrogen per square foot should be applied for each pound of dry crop residue incorporated during spring tillage. Summer fallow (leaving the soil unplanted for a year) practices do not need as much nitrogen as would planting grain following another crop from the previous year. This is especially true if the previous crop was a heavily fertilized one such as potatoes. It is easy to apply too high a nitrogen rate as many phosphorus carriers also contain nitrogen. Too high of a nitrogen application causes excessive plant heights which leads to lodging problems, late tillers, delayed maturity, and reduced total yields.

Phosphorus, P_2O_5

Phosphorus fertilizers should be banded with the seed where possible. Many soils in Alaska have a low pH and high levels of free iron or aluminum ions. These conditions tend to fix phosphorus and make it unavailable for plant use. Banding the phosphorus fertilizer, such as monoammonium phosphate, with the seed allows quick access for the plant and reduces overall soil fixation of phosphorus. Application rates for phosphorus should be 20 to 25 percent higher if the fertilizer material is broadcast.

Potassium, K_2O

Potassium fertilizers should be broadcast-applied with the nitrogen. Banding potassium, like potassium chloride, with the seed causes serious salt problems leading to poor germination and seedling damage. Proper potassium levels help in reducing the incidence of plant lodging by increasing straw strength. Most soils in Alaska have moderate levels of potassium and good crop yields may be obtained without addition of this nutrient. Therefore, cropping systems where straw and stubble are added back to the soil or utilizing summer fallow may be adequate to sustain yields over a long time. However, removal of the straw from the field also removes about three times more the amount of potassium than just removing the grain. Therefore, an increase in the potassium rate is needed when removal of all plant residues or continuous cropping has occurred.

Sulfur, S

Sulfur is deficient in many Alaska soils. Lack of sufficient sulfur causes a decrease in total yields and a reduction of overall grain quality. This is especially noticeable on older fields that have been in continuous production for five years or more. There is not as strong a crop response to sulfur on summer fallow land. Fertilizer blends containing ammonium sulfate or potassium sulfate should provide sufficient levels of sulfur when blended for nitrogen or potassium. Soils in the Tanana River flood plain are not deficient in sulfur due to the high concentration of calcium carbonate and calcium sulfate salts dissolved in the ground water. These salts are brought into the root zone by capillary rise because the evaporation rate is greater than precipitation.

Soil acidity, pH

All small grains do well in soils that are slightly acidic to slightly alkaline, with a pH from 5.5 to 7.5. However, there will be better nutrient uptake in soils that have a pH range of 6.0 to 7.0. Most soils in Alaska are on the acidic side of this pH range so applications of agricultural grade dolomite limestone are beneficial. To determine the amount of lime to add to your garden a soil pH buffer test is required. This can be done on the soil sample that was collected for available nutrient analysis. Again, work with your local CES Agricultural Extension Agent to take soil samples for analysis and interpretation of the results.

Tillage

Use tillage practices that conserve the most soil moisture. Broadcast fertilizer and lime should be applied to the soil surface before tilling and incorporated with any plant residues from the previous year. A typical garden rototiller or even a hand implement such as a garden fork works very well. A raking after tillage helps to smooth out the tillage marks and form a weak crust on the surface. This helps to slow the soil moisture

evaporation rate and keeps the moisture within the root zone. Tillage and raking when conditions are too wet causes the soil to develop a hard crust which impedes emergence and thus should be avoided. Excessive nitrogen fertilization should also be avoided as most hulless barley, hulless oat, and wheat varieties are late-maturing and weak-stemmed. Too much nitrogen can delay maturity and induce lodging. Because the hulls are loose on hulless varieties, any seedheads that lodge severely enough to touch the ground can quickly sprout while still in the head. When selecting an area to plant, check the cropping history and pick one that doesn't have the likelihood of any volunteer grain from another variety coming up in the crop. A year of summer fallow before planting or a planting history of another type of crop (rotation) helps to reduce volunteer grains and diseases transmitted by crop residues.

Planting

Seeding rates for all small grains are around 90 to 100 pounds per acre of pure live seed. This is about a quarter of a pound for an area of 100 square feet (10 ft by 10 ft). This heavy rate is important to help reduce late tillering and ensure uniform ripening. Small grains should be planted to a depth of 1.5 to 2.5 inches so each grain is in contact with moist soil. Deeper seeding slows emergence, produces thin stands, and reduces yields. The seed can be broadcast over the seedbed and raked in but this will often result in an uneven stand that is difficult to maintain during the growing season. It is better to plant the grain in rows that are about 6 inches apart the length of the plot area. For a 10 feet x 10 feet plot, that will be 21 rows. At this point you can either use a hoe or garden trowel to make a furrow in the soil that is 1.5 inches deep and plant by hand or use a garden seeder like a Planet Jr. from the Cole Planter Company. Most garden seeders will have a seed hopper that sits on top of a seed distribution plate. This plate has a series of different sized holes or slots (usually round in shape) that meter the seed in a uniform way as the seeder is pushed down the row. The distribution hole size chosen is slightly larger than the seed. For small grains the proper distribution hole size is measured for the seed length and not the diameter. For wheat, the typical seed length is about three-eighths of an inch; for barley, rye, and triticale half of an inch; and for oats about five-eighths of an inch. Adjust for the proper sized hole when you purchase your seed. The seeder will also have a "shoe," a curved piece of metal that makes the furrow. This shoe is adjustable up and down so that the seeding depth can be set properly (1.5 inches). The seed is then dropped through the distribution hole behind the shoe as the seeder is pushed forward. There will usually be a stirring device inside the hopper that moves seed toward the distribution hole to ensure uniform seed distribution. There will some sort of metal or plastic bars or a small chain that follows behind the shoe to push soil over the seed, which is in turn followed by a press wheel to slightly compact the soil over the seed to help keep the soil moisture in next to the seeds. Until

you are familiar with how well a garden planter works for small grains it would be best to divide your seed into equal amounts for each row and plant each row separately. That way you'll get a more uniform stand.

Because the embryo is exposed on hulless grains it can be damaged in handling. This can reduce the germination ability of any seed lot. It is not uncommon to have hulless grain seed lots with less than 90 percent germination. With a lower percent of pure live seed in any seed lot, a greater volume of seed needs to be purchased prior to planting to achieve the same stand density. Improved germination comes from seed lots where the combine operator did not set the combine to thresh all the hulls from the seed at harvest. However, hulless grains have smaller kernels than hulled grains and higher test weights. Therefore, the seed flows faster through seeder metering systems. As a result, seeding rates must be adjusted accordingly. Use of certified or foundation seed is strongly recommended. This helps to ensure good germination and emergence and reduces weed and disease infestations. You can perform your own germination test on your seed by using the "Rag Doll" method. Take a couple of paper towels and distribute 100 seeds evenly on the first towel. Cover this with the second towel and lightly sprinkle water over the top (this helps to hold the seeds evenly between the towels). Then gently roll the towels in a cylindrical shape (the Rag Doll) and secure the top and bottom of the cylinder with rubber bands. Place this inside of a drinking glass half filled with clean water. Most small grains should germinate in three to seven days so start checking your Rag Dolls three days after you set them up. Remove any seeds that have germinated and continue checking every day for a maximum of 10 days. Be sure to maintain the water level in the glass for the entire 10 days. At the end of 10 days count the seeds that didn't germinate and subtract from 100. This will be the percent germination for your seed lot.

Pest Control

Pest control practices for high quality, high-yielding crop are very important. Assess plot for all pests (weeds, diseases, and insects) and plan control measures accordingly. Identification of potential pests before they become a serious problem is the first step in producing good crops. Consult with your CES Agricultural Extension Agent and Pest Scout for more information.

Weeds

Common annual broadleaf weeds that occur in Alaska gardens are **chickweed** (*Stellaria media* L.), **corn spurry** (*Spergula arvensis* L.), **hawksbeard** (*Crepis tectorum* L.), **lambsquarter** (*Chenopodium album* L.), **Pennsylvania smartweed** (*Polygonum pennsylvanicum* L.), **shepherd's purse** (*Capsella bursa-pastoris* (L.) Medic.), **tansy mustard** (*Descurainia sophioides* Fisch.), and **wild buckwheat** (*Polygonum convolvulus* L.). Weed control on a small



Shepherd's purse.



Chickweed.

plot the size of 100 square feet is best done “mechanically” using a sharp, narrow-bladed hoe. Scuffle hoes which work with a push-pull action are best suited for this type of weed control. This is especially true for crops planted in six-inch rows. As the seed germinates and emerges from the soil, weed control can be done easily by walking between the rows. After heading, the crop may get too tall for you to walk effectively between the rows. However, as the crop gets taller it also shades out the soil at the base of each row, which helps

to suppress weed growth. If you have the extra space and can leave a section of your garden fallow by keeping the weeds hoed out for a year before planting then this will reduce the number and species of weeds for the following year. Chemical weed control for broadleaf weeds can be obtained with an application of a post emergence herbicide. Good results for control of these broadleaf weeds can be obtained using a 2, 4-D amine type of weed killer. This herbicide must be applied after the grain has reached the three leaf stage but

before it reaches the boot stage and when the weeds are small and free from drought stress. If a choice of herbicides is available, it is best to use the one that causes the least stress to the crop.

Common grassy weeds that occur are **bluejoint reed grass** (*Calamagrostis canadensis* (Michx.) Beauv.), **foxtail barley** (*Hordeum jubatum* L.), and **quackgrass** (*Agropyron repens* (L.) Beauv.). There isn't a good chemical weed control to eliminate grassy weeds in small grains because the grains and the weeds are all in the grass family. Best control of grassy weeds is through mechanical means with your sharp hoe. However, like the broadleaf weeds, if you have the extra space and can leave a section of your garden fallow for a year before planting then this will reduce the number and species of weeds for the following year. To eliminate grassy weeds with chemical fallow, a broad-spectrum post-emergence herbicide such as glyphosphate (Roundup) can be used. Higher than recommended application rates of any herbicide can cause injury to the crop which can lead to increased tillering and a reduction in yields. Also, some herbicides can be persistent in cold soils and take many years to break down, resulting in potential detrimental effects on subsequent rotational crops. Always read the pesticide label and follow the directions on mixing, application, and disposal.

Fungal diseases

Net blotch (*Pyrenophorea teres*), **spot blotch** (*Cochliobolus sativus*), and **barley scald** (*Rhynchosporium secalis*) are the most prevalent fungal diseases found on barley in Alaska. All of these diseases produce brown spots on the leaves. Net blotch has light brown, irregular sized and shaped blotches with dark brown net-like patterns within. Spot blotch has round or oblong spots that later combine to form irregular brown stripes. Barley scald has water-soaked lesions which later appear scalded. Photosynthetic ability of these spotted leaves are reduced and thus grain yields are also reduced. All of these dis-

eases develop in cool, moist environmental conditions that often exist in Alaska just before and during the 50 percent maturity growth stage. These diseases are most prevalent in barley after barley rotations as they overwinter on plant residues. If infection levels are high, yield and grain quality reductions can become significant. To reduce the levels of these diseases occurring in following seasons, a year of summer fallow or another crop in the rotation is recommended. **Barley stripe mosaic** (*Pyrenophora graminea*) has also been found in Alaska. Although not as prevalent as net blotch, spot blotch, and scald, a 1.0 percent infection of barley stripe can cause a 0.75 percent reduction in yield. Stripe causes long white or yellow stripes along the leaves that later run together and turn brown. The plants are stunted and the seed heads may not emerge.

Many different species of *Fusarium* fungi (*Fusarium graminearum* and others) have also been found on small grains, causing **Fusarium blight**. They can be easily identified by the pinkish color of the fungal mass on diseased kernels. They form on seed heads during seasons of high precipitation and can increase in storage if moisture and temperature levels are higher than optimum. In addition to potentially reducing yields, *Fusarium* molds can produce mycotoxins. If used for feed or food, this infected barley can cause unpalatability and even be toxic. This disease is most prevalent in rotations where the same type of grain is grown in the same place in successive years as it over-winters on plant residues. A year of summer fallow or another crop in the rotation is recommended to reduce the level of disease occurring in following years.

Other fungal diseases such as **barley loose smut** (*Ustilago nuda*), **oat loose smut** (*Ustilago avenae*) and **wheat loose smut** (*Ustilago tritici*) form loose, powdery brown masses in place of the seedhead, earlier than normal heads. They are especially prevalent on all hullless grains, wheat, rye, and triticale. These fungal spores are then blown around to infect the forming seed on the rest of the crop. **Leaf blotch** (*Scolecotrichum graminis*)



Smut on barley.

and **Alternaria blotch** (*Alternaria* sp.) are fungal diseases that have been found on oats in Alaska. **Barley yellow dwarf virus** (BYDV) has also been found on oats. Yield loss to these diseases has been minimal over the years. **Bacterial mosaic** (*Corynebacterium tessellaria*), and barley stripe mosaic (*Pyrenophora graminea*) are

diseases that have been found on wheat in Alaska. Rye's biggest problem is the susceptibility to **ergot disease** (*Claviceps purpurea*). Ergot is a fungal disease that can be toxic to livestock and humans. Rye seed lots containing 0.5 percent or more ergot are rejected for food grade quality for human consumption. Seed lots



Grasshoppers. From top to bottom: northern grasshopper, *Melanoplus borealis*; female migratory grasshopper, *Melanoplus sanguinipes*; male migratory grasshopper on barley head.

—photos by Linda Defoliart

containing between 0.3 and 0.5 percent are considered “ergoty” and must be cleaned prior to milling. The weather conditions best suited for producing ergot are warm, moist spring weather followed by warm dry conditions during the flowering growth stage. Ergot forms on the plant during the flowering growth stage, later producing sclerotia when the plant matures. The sclerotia can fall to the ground with regular rye seed when head shatter occurs or be in with the seed at harvest. It overwinters in the soil and can infect plants grown the following year. Ergot can also infect other small grains with the following order of susceptibility: rye, triticale, barley, durum wheat, common wheat, and oats. These diseases are seed-borne and can be controlled with a seed treatment. To prevent disease infections from seed-borne fungal attacks, the certified or foundation seed you purchase to plant should be clean or treated with a seed protectant such as carboxin (Vitavax). Loose smut and Fusarium blight are the biggest fungal disease problems on hullless grains. Food grade hullless grains cannot contain any diseased kernels. Remember always to read the pesticide label and follow the directions on mixing, application, and disposal.

There are two important virus diseases of barley, barley stripe mosaic virus (BSMV) and barley yellow dwarf virus (BYDV). Both cause stunted plants, with stripe mosaic causing light green or yellow leaves and yellow dwarf causing bright golden yellow leaves. Stripe mosaic differs from fungal barley stripe in that a barley plant with stripe mosaic remains light green or yellow whereas with fungal barley stripe the yellowing turns brown. These viruses are both seed-borne and the only control is to plant clean seed or resistant varieties. Yellow dwarf can be transmitted from plant to plant by several species of **aphids** (family Aphididae). This can become especially problematic during years of heavy aphid infestation. However, most aphid population booms occur late in the growing season for barley thus yellow dwarf is not a serious disease problem.

Insects

Other than the previously mentioned aphids, **grasshoppers** including the lesser **migratory grasshopper** (*Melanoplus sanguinipes* Fabricias), the **northern grasshopper** (*Melanoplus borealis* Fieber), and the **clear-winged grasshopper** (*Camnula pellucida* Scudder) are the most serious insect pests for small grains. Grasshoppers in Alaska usually have a two-year growth cycle, becoming pests every other year. This cycle is also dependent on weather, soil conditions, and previous cropping practices which can extend the time between infestations. Tillage practices such as summer fallow destroy the eggs in the soil; however, any eggs laid in fence rows, ditches, or nearby untilled areas of the garden may overwinter. These overwintered eggs hatch and emerge

as nymphs in June. Young grasshoppers start moving into grain when the plants are at the three to five leaf stages. Heavy infestations at this time can severely defoliate the crop. Grasshoppers can damage the crop at any growth stage of the plant by eating leaves or even the green awns after heading has occurred. This reduces the plants' ability to photosynthesize, thus reducing yields. Oats are less subject to insect predation than barley, wheat, rye, or triticale. Carbaryl (Sevin) sprays or baits help to control heavy infestations. Remember always to read the pesticide label and follow the directions on mixing, application, and disposal.

Migratory waterfowl

Heavy crop damage can be inflicted by migratory waterfowl like cranes and geese in both the spring and fall. In the spring, early germinating varieties are especially susceptible to predation. Large flocks of returning migratory waterfowl can cause serious damage to small grain varieties merely by walking down the row and pecking out each newly emerging plant. Because many hullless grains are usually later maturing and susceptible to lodging they may still be in the garden when waterfowl begin their fall migrations. With their higher nutrient content and easier digestibility they are a favorite food for migrating waterfowl. If the grain is significantly lodged, damage can increase dramatically. Otherwise, they usually work the edges of gardens where they have a large field of vision. Planting a taller crop such as ornamental sunflowers around the grains will sometimes act as a deterrent, because cranes and geese cannot see over or through them. However, if your plot area is large enough and you have some lodging so the crop is below their head height then they may fly over any perimeter plants.

Canada geese and goslings.

—photo by Mila Zinkova, Wikimedia, GNU Free Documentation License



Harvesting, cleaning, drying, and storage

All small grains stop growing when they reach the hard dough stage. The heads are light yellow in color and the kernels cannot be dented when pressed with a thumbnail. The typical moisture content of the grain at this stage is between 25 to 35 percent. Grain can be harvested at this moisture content but artificial drying is required and significant losses in germination occur during storage. Continued ripening consists of moisture loss from the seed heads. The grain must be around 13 to 15 percent moisture for safe, long-term storage. Moisture conditions higher than this can result in the grain germinating or molding. Significantly lower moisture conditions can result in embryo damage reducing germination ability. Both situations reduce the quality of the stored grain. Harvesting prior to, or at, the hard dough stage has a fair amount of green, high moisture heads. This underdeveloped grain is low in yield, test weights, starch content, and value. The highest quality grain can be achieved when harvesting at the lowest moisture content.

To estimate a moisture content for the grain, snap off a couple of ripe heads (or enough to get a reading on your kitchen scale). Then using a pair of leather gloves rub the heads between your hands, threshing the seed from the heads. Drop everything—heads, chaff, and stems—into an aluminum pie tin. You can pick out the larger pieces of stems and chaff by hand. Then by blowing gently across the top of the seed the remaining chaff can be removed from the seed. Place the pie tin and seed on your kitchen scale and record the wet weight. Place the pie tin with the seed in your oven set at 140° to 150° F and allow the grain to dry for 12 hours or overnight. After 12 hours remove the

pie tin from the oven, allow it to cool to room temperature, and re-weigh the pie tin and seed. Record this as the dry weight. The weight of the pie tin will not change from being in the oven so the difference in the weights will be the moisture lost from the grain. The percent moisture of the grain = $[(\text{wet weight} - \text{dry weight}) / \text{wet weight}] \times 100$.

It is important to harvest the grain at the optimum moisture content and degree of ripeness. No plot area is completely uniform in ripeness, so timing of harvest is usually set around weather, and supplemental drying of the grain is used after harvest. Standing grain dries faster and suffers less damage from moisture but only when conditions such as the weather and plot uniformity are right. The plants can be cut with a hand scythe or a pair of pruning shears about three to four inches off of the ground when the grain is ripe enough for harvest. Place the cut plants head first into large paper or cloth sacks (never plastic) or lay them in a garden cart or wheelbarrow so you can transfer them inside a building or shed to get them out of the weather. If there are significant amounts of green tillers or weeds that would raise the moisture content of the grain at harvest, the plants can be stacked in a bundle (or shock) that will stand upright or loosely lay on stubble that is about one-third the total height of the grain to dry further outside. The excess moisture dries off of the plants and the grain in about 7 to 10 days after cutting in cool moist conditions and in 3 to 4 days in hot dry weather. The bundles or loose plants are then picked up and brought inside in the same way as the dried grain.

Care must be taken in harvesting to prevent or reduce losses from shattering, crinkling, and weathering. If you cut too high, short-stemmed heads do not get harvested. Light grains also have a tendency to settle into the stubble if they are left to dry outside. The grain may contact the ground where there is more moisture and start to sprout. Head shatter, or loss of the grain due to physical contact, occurs on overripe grains, although some varieties are more susceptible than others. Six-row varieties are more susceptible to head shattering than two-row varieties. Crinkling is when the heads bend over and “nod” toward the ground. The stems may break soon after maturity, especially in damp weather. Weathering, or sun bleaching, is when the grain swells when damp but does not shrink back after drying. The kernels are less dense and thus have a lower test weight although other quality measurements are unaffected. It is best to try and leave the barley standing in the field until the optimum moisture level of 13 to 15 percent occurs. This is considered good for safe, long-term storage conditions for both seed (for next year’s crop) and for food. Lower moisture content is better for processing grain into flour if the seed is to be used for human food.

When the plants have been harvested and taken inside, the seed needs to be threshed from the heads. This is where having large cloth sacks for harvesting comes in handy. With the plants still in the sacks, place them on the floor (or any hard dry surface). Then simply start walking on the sacks at the ends where the heads are located. Every now and then you can pull out

a small handful of stems to see how well the threshing process is coming along. Discard any handful of stems that have been threshed and continue until all the seed has been threshed. You want to be sure to reduce the incidence of peeling or skinning of the hull. This will happen if the threshing process is too forceful or if it continues for too long after all the seed has been threshed. When the hull is peeled the embryo becomes exposed and thus subject to potential damage during handling. Any damage to the embryo lowers the germination ability of that seed for next year. Every time grain is handled, more damage to the kernels occurs. This is not quite as important if the grain is being grown for food but becomes very important when grown for seed. The awns should be completely broken off of the kernels without cracking the kernels.

For feed (hulled) grains that are grown for dehulling or pearling the hulls are very strongly attached to the seed so it is less important to take care in the threshing process. For hullless grains continual checking for hulls left on the seed or cracked seeds and adjusting your threshing time is important, as food grade grain only allows 4 percent cracked hulls. For seed grade, a higher percentage of hulls can be left on to reduce the possibility of damage to the embryo. For food grade there cannot be any more than 15 percent of the hulls left on the seed. Additional buffing of the seed to remove hulls can be done, if needed, before processing. Food grade grains cannot contain any diseased kernels, other crops, or foreign material. Clean-outs can be used as animal feed.

To prevent damage to the seed after threshing and get the moisture levels to optimum, there are two things that should be done. First, clean the seed. Removal of weed seeds and other plant material that would contain high levels of moisture makes the drying process much easier and cheaper to accomplish. It also improves the overall quality of the crop prior to processing. There are a number of small-sized seed cleaners available such as the Clipper Office Tester by the A.T. Ferrell Co. that fit on top of a work bench. Seed cleaners like this one use two screens of differing size and shaped holes and air flow to clean seed. There usually is a large selection of screens with different sized and shaped holes for different crops. The top screen is called a scalper screen, and has holes sized and shaped (oblong for small grains) just a little larger than the seed that is being cleaned. It is designed to remove larger items such as stems, sticks, and in some cases diseased kernels from the seed, which falls through the top screen onto the lower screen. The lower screen is called a sifter screen, and has slightly smaller sized and shaped holes than the seed that is being cleaned. It is designed to remove smaller items such as dirt, chaff, weed seeds, and broken kernels, all of which fall through the lower screen. To facilitate the seed movement across these two screens they are mounted at an angle and are shaken back and forth. The seed that remains between the two screens then falls past a paddle fan. The airflow from this fan can be adjusted so that it is just strong enough to blow lighter weight things such as green, unripe seed as well as any stems or chaff that

still remain with the seed. Clean and ripe seed is deposited in a tray at the bottom of the seed cleaner. The fan and shaking action are run from a small 110V electric motor. A cheaper alternative to a seed cleaner is to purchase a set of seed cleaning screens that are mounted in the bottom of shallow trays. You would still pick out a scalping and sifting screen, stacking them one on top of the other with a solid tray underneath. Pour the seed on the top screen and gently shake the stacked set of screens back and forth until all the seed is between the two screens. Then you'll need a regular house fan and a large container like a plastic dish pan. Turn the fan on at a low speed and pour the seed past the air flow into the dish pan. You may need to play with the air flow of both systems a bit depending on the weight of the seed and how dirty the sample remains.

Second, provide supplemental drying. If the outside air has low humidity then forced air through the seed lot draws moisture away from the seed. If the outside air has high humidity then heat must be applied when aerating the seed to draw moisture away. Care must be taken not to provide too much heat during the drying or storage process. Too much heat can literally cook the seed, damaging the embryo and severely reducing the germination ability. Heat damaged kernels exhibit a dark brown or black discoloration on either the basal or awn end of the kernel (or both). To accomplish good drying all you need is a house fan, some aluminum pie tins, and some shelving in a warm, dry insect and rodent free space. Fill the pie tins with clean seed to about a half-inch from the top. You don't want them too full as that won't allow sufficient air flow past the seed for drying. Place the tins on the shelf in a warm dry area such as near the furnace in the garage. Turn on the fan so that you are forcing dry air over the seed and blowing moist air away. Continually check for moisture content using the same method that you used for harvesting the seed. Once the seed lot has reached the optimum moisture content (13–15 percent) then you can stop the air flow and transfer the seed into tightly sealed gallon plastic freezer bags. The plastic bags won't stop all moisture transference but it will slow it down until you can process the seed into flakes or flour. Stored in a cool, dry, and dark place the grain will keep the germination viability as well as nutritional quality for as long as a year or more, although the germination viability will decline in succeeding years. It will also keep out insects that like to eat stored grain and grain products such as **dermestid beetles** (*Dermestes lardarius* (L)). The more mature, ripe, cleaner, and proper moisture content your seed lot is the longer it will store and maintain its viability. It will also produce a higher quality product. Dirty, immature, high-moisture seed will go rancid quicker and produce a poor quality product. Seed that will be used for next year's crop (or at any future time) should be stored in the freezer. Frozen seed will maintain its viability for a long time. However, you should keep a close eye on the moisture level inside the plastic bags, as you can get freezer burn on your seed lots. All barley varieties actually require a cold treatment to improve seed germination so freezing is recommended.

Processing the Grain

Dehulling

The third question that must be asked is, what do you want to do with the grain now that it has been harvested and cleaned? As mentioned previously, the fibrous hull on all feed and forage grain remains on the kernel. Before hulled grain can be consumed by humans the outer hull must be first removed through a dehulling process. This consists of an abrasion wheel inside a large spinning closed container which sands or separates the outer fibrous hull from the inner bran-covered kernel (or in oats, the groat). The lighter hulls are then blown off and the dehulled kernels are collected. The bran and germ are still part of the kernel so dehulled grain is considered whole grain. There are a number of manufacturers of large-scale commercial equipment that will perform this process very efficiently. However, there are not very many small-scale kitchen appliances that will dehull small grains very well. Most are made as kit attachments for kitchen flour mills (both electric and hand crank mills). The quality of dehulled grain depends on the feeding rate and volume of grain that goes into the mill, the speed at which the abrasion wheel is turned, and the amount of cracked and partially dehulled grain left afterward. There might also be problems in separation of the fines (the fibrous hull material) from the dehulled grain kernels. Remember that oats contain more lipids than other grains so dehulling oats can literally gum up the works. In hullless barley and oat varieties the hull is thin and papery and detaches from the kernel when harvested, exposing the embryo and leaving a hullless or naked kernel. Because the hull is not attached to the kernels on hullless grains, dehulling is not needed. Because the bran is still on the kernels, storage of dehulled grains should be in tightly sealed containers in a cool, dry, and dark place. They will keep for as long as a year. If they are kept in a freezer or a refrigerator, this can be expanded by many more years.

Pearling

Pearled grain takes dehulled barley or other grain and removes the outer bran and some of the germ through a steam and polishing process. This is also a process that can be done very efficiently in large commercial operations. The steam portion of this process swells the dehulled kernel slightly so that when it cools down again the germ and endosperm separate from the bran. The polishing process is simply a finer grit sanding to remove the bran. Producing pearled grain in the home can be done by leaving the grain sample in the dehulling attachment of your kitchen flour mill until the bran has also been sanded away. Loss of the bran and germ also reduces the amount of nutrients in pearled grains. If you wish to make dehulled or pearled grain be sure to do a little research to see what type of mill will work best for your

needs. Then practice with a small amount of hulled grain until you know the most efficient method to get the best final product for your tastes. Since the outer bran has been removed in the pearling process, oxidation of the fats in the remaining germ will begin to occur. Therefore, pearled grains should be kept in tightly sealed containers in a cool, dry, and dark place, and can be stored for up to six months to a year. In the freezer or refrigerator they can be kept for up to a year or more.

Flaking (Rolling)

Dehulled and hullless grain can also be turned into flakes (or rolled grain). This process uses two large smooth or corrugated steel rollers spinning at the same speed in opposite directions. In commercial operations there are three sizes of flakes depending on the size of the kernels that go through the rollers: regular, medium, and thick. Quick oats are small, thin flakes of oats. As with the dehulling attachments made for kitchen flour mills there are many different models of grain rollers (both electric and hand crank types). The best types are those that use stainless steel rollers which have adjustable spacing between the rollers. Many grain kernels such as hullless barley can be quite hard. If softer rollers made from aluminum are used, the aluminum can actually be dented or chipped leaving residues in your flakes. Adjustable spacing allows you to set the distance between the rollers for the size of flake that you want. They also can be set farther apart for a first pass through the rollers on harder grains, then set closer together for a second pass to produce thinner flakes with less loss from cracked and broken kernels. Because of the high fat content in oat grain the rolled flakes (as well as dehulled and pearled oats) can become rancid in about four days if the fat isn't first stabilized. When the hull is removed and the groat is exposed to the air, enzymes in the groat start turning the lipids into free fatty acids. It is these free fatty acids that cause rancidity. To stabilize this, all dehulled and processed oats need to be heated (kilning) in an oven at 240° F for 30 to 60 minutes. The length of time depends on the moisture content of the kernels. The drier the kernels, the less time that is needed. Oat flakes that are made from dehulled oats must be dried to 6 percent moisture prior to rolling to keep them from going rancid. If you wish to make flaked grain be sure to do a little research to see what type of roller mill work best for your needs. Then practice with a small amount of grain until you know the most efficient method to get the best final product for your tastes. To produce the best flakes the moisture in the kernels needs to be reduced. Since this is done at a medium heat the fats in the exposed germ have already been stabilized. Therefore, storage of rolled flakes in tightly sealed containers in a cool, dry, and dark place can be for six months to a year. In the freezer or refrigerator they can be kept for up to a year or more.

Flour

Whole grain (dehulled and hullless) can be ground into various grades of flour. There are many different types and models of kitchen-scale flour mills available. These can be anything from as simple as a mortar and pestle or hand-cranked coffee mill to electric seed grinders and food processors. If you decide to turn your grain into whole grain flour (bran, germ, and endosperm) then the yield will be 95 to 100 percent of what you started out with. The small amount of loss is usually due to transfer and clean out between the mill and the storage container. The quality of all whole grain flour is highly dependent on the quality of the mill. Generally, the better quality flour comes from a mill where uniformity of the feeding rate—the volume of grain that goes into the mill and the speed at which the milling wheel is turned—can be maintained. Harder grains such as hullless barley and wheat can leave larger pieces of the bran in the flour that will not grind down into smaller flour particles. The hard bran particles are higher in ash content, which reduces the baking quality of the flour. If you want a higher quality flour (for confectionary products) then there are a number of screenings and re-milling steps to remove portions of the bran. This will also wind up removing portions of the germ as well. The higher-end kitchen grain mills will come with screens or sieves that attach to the bottom of the mill. They will have openings in the screen that will only allow ground flour particles which are that specific size or smaller to pass through. The average flour return using this milling process is 72 percent. The remaining 28 percent (called shorts or standard middings) that do not pass through the sieves are removed. These byproducts can be used in dairy, swine, and poultry feeds. As with the dehullers and roller mills, if you wish to make flour be sure to do a little research to see what type of mill works best for your needs. Then practice with a small amount of grain until you know the most efficient method to get the best final product for your tastes.

Flour storage

An important consideration in storage of all whole grain flours is that the shelf life is much shorter than highly processed flour (regardless of the milling process). This is due to the presence of the germ in the flour. The germ usually contains a higher amount of fats than either the bran or endosperm. These are unsaturated fats which, when exposed to the air after milling, can become rancid. All grains and grain products can go stale, or suffer from a biochemical breakdown over time if stored open in a cool and dry cabinet (much less time if it is warm and moist). The moment at which this occurs can be delayed if the flour is stored in tightly sealed containers (kept away from the air) and in the freezer or refrigerator.

Barley flour has a very short shelf life of a couple of months if stored in tightly sealed containers in a cool and dry cabinet. If it is stored in the freezer or refrigerator this can be extended

to four months. Oat flour has a shelf life of three months if it is stored in tightly sealed containers in a cool and dry cabinet and up to six months if it is stored in the freezer or refrigerator. Whole wheat and spelt flour will only store for a couple of months if it is stored in tightly sealed containers and if kept cool and dry in a cabinet. This can be extended to six months to a year in the freezer or refrigerator. Finer grade flours (bread flour and “all purpose” flour) will store for six to eight months if stored in tightly sealed containers and kept cool and dry in a cabinet. This can be extended to a year in the freezer or refrigerator. Whole grain rye and triticale flour will have a very short shelf life of only a couple of months if stored in tightly sealed containers in a cool and dry cabinet. This can be extended to six months in the freezer or refrigerator. Finer grade flours (light rye) can be stored for up to a year in the freezer.

Appendix: Addresses for Seed

ALASKA PLANT MATERIALS CENTER
Department of Natural Resources
Division of Agriculture
Bodenburg Loop Road
HC 04 Box 7440, Palmer, Alaska 99645
phone: (907) 745-4469 • fax: (907) 746-1568
webpage: http://dnr.alaska.gov/ag/ag_pmc.htm

ALASKA SEED GROWERS ASSOCIATION
Plant Materials Center
Bodenburg Loop Road
HC 04 Box 7440, Palmer, Alaska 99645
phone: (907) 745-4469 • fax: (907) 746-1568
webpage: <http://alaskaseedgrowers.org/>

CANADIAN SEED GROWERS ASSOCIATION
Stock Seed Distribution Committee
Box 8455, Ottawa, Ontario K1G 3T1 Canada
phone: (613) 236-0497 • fax: (613) 563-7855
webpage: www.seedgrowers.ca

CANTERRA SEEDS, LTD.
1475 Chevrier Blvd.
Winnipeg, Manitoba R3T 1Y7 Canada
phone: (204) 988-9750 • fax: (204) 484-7682
webpage: <http://www.canterra.com/>

SECAN ASSOCIATION
501-300 March Rd.
Kanatu, Ontario K2K 2E2 Canada
phone: 1-800-754-5487 • fax: (613) 592-9497
webpage: www.secan.com/

UNIVERSITY OF ALASKA FAIRBANKS

Agriculture and Forestry Experiment Station
303 O'Neill Resources Building, UAF Campus
P.O. Box 757200, Fairbanks, Alaska 99775-7200
phone: (907) 474-7188 • fax: (907) 474-6184
webpage: www.uaf.edu/snras/

References

- Bliss, R.M., 2010. Oats, Cooling Inflammation and Unhealthy Cell Proliferation. *Agricultural Research* 58(2):10
- Long, K. and K. Trateng. 2007. Using Alaska's hulless barley in a new food product. *Agroborealis* winter 2006-2007: 32–35.
- Recipetips.com staff. Flour Storage Tips. Tecstra Systems Corporation. December 21, 2009. [On line] available at: www.recipetips.com/kitchen-tips/t--1039/flour-storage-guide.asp
- Suszkiw, J. 2010. Markers Point the Way to New Oat Traits. *Agricultural Research* 58(2):12
- Van Veldhuizen, R.M. and C.W. Knight. Oct 2004. *Performance of Agronomic Crop Varieties in Alaska 1978–2002*. Bulletin 111, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks, Fairbanks, Alaska. [On line] available at: www.uaf.edu/snras/afes/pubs/bul/B111.pdf.

Further reading

Logsdon, Gene. 2009. *Small-Scale Grain Raising: An Organic Guide to Growing, Processing, and Using Nutritious Whole Grains for Home Gardeners and Local Farmers*. Second Edition. Chelsea Green Publishing, White River Junction, Vermont.

Fairbanks Experiment Farm: grain harvest in the early Twentieth Century.
—photo by Albert Johnson, AFES Collection



About the Agricultural and Forestry Experiment Station

The federal Hatch Act of 1887 authorized establishment of agricultural experiment stations in the U.S. and its territories to provide science-based research information to farmers. There are agricultural experiment stations in each of the 50 states, Puerto Rico, and Guam. All but one are part of the land-grant college system. The Morrill Act established the land-grant colleges in 1862. While the experiment stations perform agricultural research, the land-grant colleges provide education in the science and economics of agriculture.

The Alaska Agricultural Experiment Station was not originally part of the Alaska land-grant college system. In 1898, the station was established in Sitka, also the site of Alaska's first experiment farm. Subsequent branches were opened at Kodiak, Kenai, Rampart, Copper Center, Fairbanks, and Matanuska. The latter two remain as the Fairbanks Experiment Farm and the Matanuska Experiment Farm. The USDA established the Fairbanks experiment station in 1906 on a site that in 1915 provided land for a college. The land transfer and money to establish the Alaska Agricultural College and School of Mines was approved by the U.S. Congress in 1915. Two years later the Alaska Territorial Legislature added funding, and in 1922, when the first building was constructed, the college opened its doors to students. The first student graduated in 1923. In 1931, the experiment station was transferred from federal ownership to the college, and in 1935 the college was renamed the University of Alaska. When campuses were opened at other locations, the Fairbanks campus became the University of Alaska Fairbanks.

Early experiment station researchers developed adapted cultivars of grains, grasses, potatoes, and berries, and introduced many vegetable cultivars appropriate to Alaska. Animal and poultry management was also important. This work continues, as does research in soils and revegetation, forest ecology and management, and rural and economic development. As the state faces new challenges in agriculture and resource management, the Agricultural and Forestry Experiment Station continues to bring state-of-the-art research information to the people of Alaska.

Agricultural and Forestry Experiment Station

University of Alaska Fairbanks
AFES Publications Office
P.O. Box 757200
Fairbanks, AK 99775-7200
fynrpub@uaf.edu • www.uaf.edu/snras
907.474.6923 or 907.474.5042
fax: 907.474.6184

NOTE: Circulars are published by the Alaska Agricultural and Forestry Experiment Station to provide information summarizing research, and are usually written for a specific lay audience. Circulars often present information about ongoing or inconclusive applied research and experiments, such as variety trials. They may consist of secondary information or be a bulletin or journal article summary.

To simplify terminology, we may use product or equipment trade names. We are not endorsing products or firms mentioned. Publication material may be reprinted provided no endorsement of a commercial product is stated or implied. Please credit the researchers involved, the University of Alaska Fairbanks, and the Agricultural and Forestry Experiment Station.

The University of Alaska Fairbanks is accredited by the Commission on Colleges and Universities of the Northwest Association of Schools and Colleges. UAF is an affirmative action/equal opportunity employer and educational institution.

