Growing and Processing Winter Wheat and Other Small Grains

Robin A. Fazio; Sonrisa Farm, Colquitt, GA

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Introduction

My long-term goal as a farmer is to make my farm part of a more healthy food system, where the food I grow helps to sustain my local community and the people in it. One way in which we do so is by growing winter small grains, mainly winter wheat. We mill much of our wheat into whole-grain flour and sell it retail and wholesale. We also sell wheat grain, we use it for cover crops, and we are able to save our own seed in most years.

There are many reasons to consider growing winter grains. The winter grains are grasses, which are excellent rotations for nearly all crops. They help build the soil and prevent erosion, as well as disrupt the spread of diseases and insect pests. Winter grains need very little care, have little insect and weed pressure, and very rarely need irrigating. Growing winter grains doesn’t require much specialized equipment and can add income to the farm’s bottom line. Besides, they are beautiful and green all winter, when most everything on the farm is brown and dormant.

In the sections below, I will first describe the life cycle of the winter wheat plant. Then, I will discuss farming operations that coordinate with the wheat’s natural cycle. Finally, I will discuss post harvest handling and marketing options. Much of this information is applicable to other small winter grains in the southeast region.

Life cycle of winter wheat

A basic tenet to growing sustainably is understanding as much as possible about the needs of the crop during its different life stages, and trying to time farming practices in accordance with the plant’s natural life cycle. Learning as much as I can about the crops that I grow is also one of my greatest joys in farming.

Winter wheat proceeds through the following stages of growth: germination and seedling emergence, tillering, vernalization, stem extension, heading, and ripening.

Germination begins after planting, when the seed imbibes water from the soil and swells. This swelling starts a chain reaction of chemical processes and release of enzymes that soon result in the embryo (or germ) erupting through the seed coat (or bran), and through the soil surface. The seedling grows quickly, provided adequate moisture and no temperature extremes.

Tillering, or the growth of lateral shoots, is one of the most important life cycles, both for the wheat plant and for the farmer. Tillering usually begins when the
seedling has three or more true leaves. The growth of tillers is important because each tiller has the potential to form a grain bearing head. Tillering begins in the fall and may or may not continue into the early spring, depending upon temperature.

Vernalization (from the Latin word for Spring) is the chemical change in the plant from vegetative growth to reproductive growth. Vernalization occurs when the temperature drops sufficiently to cause the wheat to become dormant and cold-hardy. During vernalization, the plant stops growing leaves and the reproductive structures of the winter wheat plant develop, although they are still below ground. Without adequate cool temperatures, as in the winter of 2012, wheat yield can be negatively affected due to inadequate vernalization period.

Stem extension occurs in the spring, when temperatures begin to warm. The wheat plant breaks its dormancy and begins to put on vegetative growth again. Until this point, only leaves can be seen above ground. From this point on, however, the wheat plant grows quickly throughout the spring, putting on both leaves and stem.

The stem extension stage ends in mid to late spring with the emergence of the flag leaf, which is a large leaf on top of the plant that flops over, signaling that heading will soon begin. Under the flag leaf, the stem is swollen with the immature grain head. The head soon emerges, grows quickly, and begins to flower. Almost all of the wheat heads in one field will appear simultaneously over a few days. Although insects may visit the flowering wheat, the plant is self-pollinating and pollination occurs quickly.

After pollination the heads begin to fill with the maturing grain kernels. Grain filling is determined by many environmental factors. This period is critical to grain yield, as any type of stress can affect filling of the kernels. Filling takes three to four weeks, and then the plant begins to die. It turns a characteristic golden color, and the kernel begins to ripen, or dry down to a seed containing little moisture. When moisture content of the kernels reaches around 15 percent or lower, the grain can be harvested. See the University of Kentucky website at the end of this article for help in determining moisture content as well as the appropriate time to harvest winter wheat.
Nutrient needs

Although the fertility needs of winter wheat are moderate compared to summer annuals such as corn, wheat can be sensitive to inadequate nutrients. We test our soil every year at least two months prior to planting to check the pH and insure we have adequate amounts of mineral nutrients. You can test your soil through your local county extension service, but I prefer to use a private lab, such as A and L labs. Their results arrive quickly via email in easy to read, color-coded graphs, and the cost is about the same as extension soil tests. If lime or any mineral nutrients (except nitrogen) are needed, apply them well ahead of planting if possible. Once planted, it is much more difficult and expensive to apply mineral nutrients.

To insure adequate nitrogen, we rotate a legume crop (in our case peanuts) ahead of the wheat crop. Without a leguminous crop in the rotation, the extension service advises that farmers apply one third of the wheat crop’s nitrogen at planting. However, I tried this strategy one year and was not happy with the results. Nitrogen is easily leached out of the soil, and unless your soil has a high Cation Exchange Capacity (CEC) or you are applying the nitrogen in composted form, you can lose much of the early-applied nitrogen. Instead, we apply liquid nitrogen at a rate of 50 pounds per acre (a low rate by most recommendations) in late winter as the crop is breaking dormancy. We also apply 5 to 10 pounds of sulfur with the nitrogen.
Land preparation and planting

Winter wheat is quite hardy and germinates readily. I have even seen it germinate in my driveway a few days after spilling some seed! However, it is critical that you get a good stand of plants established as quickly as possible after planting. For that reason, we till the soil just before planting. The ground is loose after peanut harvest (mid-October), so one or two passes with a disk is typically adequate to prepare the soil into a clean, level seedbed. Wheat can be sensitive to compaction problems, and some studies have shown an increase in wheat yields after subsoiling. Our peanuts are planted with a subsoiling ripper/bedder, so we don’t subsoil prior to wheat planting. However, one year the field was unevenly disked, with wavy high spots and low spots, and the low compacted spots grew significantly less grain and had more weed competition.

We plant with a grain drill. Seeding rate for winter wheat for grain is 100-120 pounds per acre (about two bushels). We have tried planting by broadcasting and lightly incorporating the seed, but we’ve had better results with the drill. Wheat can also be planted no-till, but for grain the field needs to be relatively clean of competing weeds. No-till wheat for grazing works very well. Irrigation after planting is normally unnecessary unless it is an extremely dry fall. The best scenario is to try and plant a few days ahead of a slow but soaking rain.

Planting dates

Winter wheat has different planting dates, depending upon whether the crop is for grazing, for grain, or for a cover crop. A basic rule of thumb for winter wheat is that wheat for grain needs to be planted from a week before the first fall frost to a week after. Wheat for grazing should be planted four to six weeks earlier. Cover crop wheat is more flexible, normally depending upon the farmer’s rotation, but most farmers plant around the same time as wheat planted for grain. We grow our wheat for grain, so we have a two-week window to plant in the late fall. Our first frost date in our area (southwest Georgia) is around November 19, so we usually plant the week preceding Thanksgiving. Plant too early, and the wheat may grow so much before winter that there is a risk for some freeze kill. However, wheat planted too late may not have the opportunity to put on enough growth, especially tillers, before winter dormancy.

Choosing seed

Much of the wheat grown in the southeast is winter wheat, and most of that is soft red winter wheat. Nearly all the varieties that southeastern growers plant are varieties of soft red winter wheat. This type of wheat yields very well in mild temperatures and has a short vernalization requirement. The extension service publishes a list of recommended varieties every year. I spend a lot of time each year researching seed, even in years when I save my own. I mainly select my varieties based upon disease and pest resistance, as well as a low tendency for lodging (lodging is when the plant falls over in the field prior to harvest).
I also talk to other farmers to find out what varieties are doing well in the area. Unless I have a problem with weed seeds in my wheat, I normally save my own seed. Every two or three years I do buy seed in order to try out different varieties and to add genetic diversity to the farm. I buy some seed from seed dealers and some from reputable farmers who save seed. I ask them if they have had the seed tested for germination and about the presence of weed seeds. I prefer to buy from farmers, but keep in mind that you’re only guaranteed a weed-free crop if you buy certified and tested seed.

**Care Throughout the Growing Season**

The winter wheat growing season lasts from planting to harvest – in Southwest Georgia from late November to late May. The growing season will be longer (two to four weeks earlier for planting; two to four weeks later for harvesting) the further North your farm is located. After planting in late November, winter wheat needs little attention. Provided adequate rainfall and relatively normal temperatures, it will grow quickly then become dormant as temperatures drop. It will then begin to grow again in mid to late February, and will grow very quickly, head out in early April, begin to die in late April, and will be ready for harvest by late May.

In early February, however, we do spread a one-time, minimal application of conventional nitrogen fertilizer, mainly because it is cost prohibitive on my operation to purchase certified organic fertilizers. We tried to eliminate the fertilizer application a couple of years ago, relying on the residue from the preceding leguminous peanut crop to provide adequate Nitrogen. It worked in spots, but growth over the field was patchy. Also, we lost some parts of the field to weeds, and our yield was reduced significantly. Although we’re a few years from making it happen, I think that it is possible to produce all of the adequate Nitrogen for wheat through good rotations, cover cropping, and organic soil amendments.

Some farmers choose to apply poultry litter, but thus far I have chosen to avoid it because I do not have large scale composting facilities. The litter in our area comes from conventional poultry houses, where the birds are fed antibiotics and other substances that I do not want to spread on my farm.
After February, there’s nothing much to do except hope for enough rain. Even in notoriously dry southwest Georgia, we normally get enough winter and spring rains to finish the crop without needing to irrigate. However, it may be necessary to consider irrigating in years with a dry spring. Drought stress during heading and pollination can lead to decreased yields.

**Pest and weeds**

An important facet of growing wheat for flour is not using pesticides, since nearly all of our customers want chemical-free food. We do not utilize any fungicides, herbicides, or pesticides in any aspect of our wheat production. The only real insect pest that can attack winter wheat with severity is the Hessian fly, but most modern varieties have some resistance. A good rotation coupled with resistant seed varieties will normally keep disease pressure to a minimum.

Weeds are another matter. Winter wheat competes very well with weeds and you will likely not encounter much of a problem, unless you have an uneven or weak stand, or if you have a history of persistent winter weeds in your fields. The three weeds that are most harmful to our wheat production are annual ryegrass, wild radish, and ragweed. Ryegrass is a winter grass in the grain family and can compete with wheat. Wild radish, while not largely competitive, can produce seeds that will be harvested along with the wheat, which will ensure that your wheat crop cannot be used for seed. Ragweed is a problem with uneven stands and in years with a wet spring. It grows late in the season, after the wheat has already dried down, mainly in places where the wheat did not grow a thick even stand. Ragweed can seriously interfere with combining, and can render parts of the field unharvestable. Regardless, we do not use herbicides, but instead try to grow a solid, fast growing, healthy stand.

**Harvest**

Harvesting is one of the main factors that keeps many smaller farmers from growing wheat for grain. Combines are large, expensive machines. Old combines (30 years old plus) can be purchased for a few thousand dollars, but it is difficult to find one that is not worn out. We do own and use an old combine, but we are constantly repairing it. If you can hire a custom operator to harvest your grain, that is probably the best way to go. However, finding an operator who will combine a small acreage in a timely manner may be challenging.

We harvest from late May to early June. Winter wheat should be harvested as soon as it has fully ripened and the moisture content is around 15% or less. The longer the wheat stays in the field, the more potential yield and quality is lost. Wet or overcast weather makes it difficult to harvest wheat, as the grains absorb moisture from the atmosphere. We’ve sometimes had to wait as late as three o’clock in the afternoon to start combining. You can tell the grain is ready to harvest when you can chew a few kernels and they “crack” easily in your teeth. If they are a bit chewy, they’re still not ready.
Rye

Although we mainly focus on growing wheat, we grow rye as well. Winter rye for grain is planted at the same time as winter wheat and has virtually the same growing practices. Rye is planted at about half the seeding rate as wheat (about 50 pounds of rye seed per acre), and can be broadcast as well as drilled. Rye is more cold-hardy, and will grow faster than wheat. The nitrogen requirement is a bit lower, and too much nitrogen can cause it to lodge (fall over). Rye matures two to three weeks earlier than wheat and should be combined as soon as it is mature, as it has a tendency to lodge. Rye yields can be sporadic, and are generally one third to one half that of wheat. Rye can be cleaned and milled in the same manner as wheat.

The real value of rye is as a cover crop. Rye is one of the best grass cover crops in that it grows quickly and grows tall, and is allelopathic (it produces chemicals that inhibit the growth of other plants). Farmers that can grow rye successfully can usually find a good market in selling the seed for cover crops.
Other small grains

I have never tried growing heirloom or ancient varieties of wheat, but I would consider it in the future if I had an adequate market. From what I have read, these varieties are hardy and tasty, but don’t yield very high, don’t mature uniformly, and tend to lodge easily. Nonetheless, with the growing interest in heirloom grains it might be worth investigating.

Cultivation of other types of winter small grains, such as oats and barley, is very similar to wheat and rye. Oats will winter kill more easily then wheat or rye, and in the south are often planted as spring oats. Oats also have a husk or hull, which is not removed in the combining process. Oats must be run through a de-huller before processing.

I do not have any experience growing other types of winter grains besides wheat and rye. Moreover, spring planted small grains have different planting dates and cultivation practices than winter grains. Farmers considering other winter grains or spring grains should consult their local county extension service and/or research them on the Internet. I have included links to a few helpful websites at the end of this article.

Post Harvest Handling

The work of most wheat farmers stops after harvest. Wheat is usually sold directly to a commodity broker or grain elevator, or is stored in grain bins. Although we do sell some of our wheat conventionally, we clean and save most of our wheat, then mill it into flour for retail sale.

We harvest our grain into wagons, and haul the wagons to our local grain cleaner about forty miles away. If you are growing certified organic wheat, be sure the
cleaner (and all other processors of your product) are set up to handle certified organic grains. Although we do not grow certified organic wheat, we have to ensure that our grains are separated and not treated with insecticides at any time during processing.

The wheat is cleaned and bagged in one-bushel (about 60 pound) bags and palletized forty bags to a pallet. After cleaning, we take some of the wheat to be milled right away, and we store the rest in the cleaning facility. We can only store our grain there for a couple of months, because the likelihood of weevil damage increases significantly with time.

Although it is quite expensive, we freeze all of our grain for a minimum of one month, which is the only effective chemical-free control for weevils that works for us. We have found that freezing the grain, provided that it was harvested at correct moisture (around 15% or below), has no effect on either baking properties or germination. We freeze our grain at a local food service business, since they have drive in freezers and can handle palletized loads. After a month in the freezer, we move the grain to storage, and we remove what we need from there throughout the rest of the year. We purchased a used 20-foot shipping container for our long-term grain storage. Shipping containers work well for storing grain, because they are waterproof, animal proof, and nearly indestructible.

**Milling**

The wheat kernel is composed of three major parts: the bran (the outer coating), the endosperm (the white starchy part), and the germ (the plant embryo). The bran contains mostly fiber, the endosperm contains mainly carbohydrates, and the germ is made up of protein, vitamins, minerals, and a trace amount of oil. We only sell whole-wheat flour, as opposed to white flour. White flour has had the bran (the outer coating) and the germ (the plant embryo) removed in the milling process, leaving only the starchy white endosperm. Whole-wheat flour, on the other hand, is just that – it is the milled whole grain, with nothing removed, and is therefore nutritionally superior.

Every few weeks, we take grain to the mill to be ground into whole-wheat flour. Due to the consolidation in the milling industry, there are very few flour mills left, and most of them are owned by large corporations that will not custom mill flour. We lucked into striking a deal with a historic water-powered mill – Falls Mill in
Belvidere, Tennessee. The owners agreed to trade our grain for their milling services, as they were in need of wheat grain for their own milling business. For every two bushels of wheat we bring them, they keep one bushel for themselves, and grind and bag the other bushel of wheat into flour for us. We are fortunate in that we have a mill relatively close by, as many farmers will not find themselves close to milling facilities. If you want to mill yourself, you will need to purchase a mill and house it in a state health-inspected facility. Mills can be bought new or used from Meadows Mills in North Carolina, the last company in the United States still manufacturing stone flourmills.

We only mill enough flour for two to three weeks of sales, thereby insuring a fresh product at peak nutrition for our customers. Also, it is safer for us to store grain rather than flour, as whole-wheat flour will eventually spoil at room temperature.

The mill puts our flour in 25-pound food-grade bags. We sell to our wholesale customers in the same bags; for farmers’ markets, we bag the flour in one and five-pound bags, as very few market customers want to purchase 25 pounds of flour at a time.

**Baking characteristics of winter wheat**

To sell flour to people who are going to bake with it, you need to know a bit about the properties of wheat. Excluding the heirloom varieties, wheat is either winter or spring, hard or soft, and white or red. Spring wheat is rarely grown in the southeast. The most common variety grown in the US is hard red winter, but almost all of that is grown in the western states. In the more northern parts of the southeast, it may be possible to grow hard winter wheat, either red or white. However, the hard varieties need a dry, very cold winter, which is the opposite of the winter weather we normally have in the southeast. Due to relatively warm, wet winters, nearly all of the wheat grown in the southeast is soft red winter.

With regards to baking properties, the soft wheats are lower in gluten than the hard wheats. Gluten is sticky protein found in wheat; in baking bread, gluten traps air bubbles in rising yeast breads. Therefore, the higher the gluten content of the wheat, the better the bread rises. Soft wheats are traditionally used in cakes, pastries, breakfast breads (pancakes, biscuits, muffins, etc.), and other baked goods.
that don’t need much leavening. However, we have found that, when properly prepared, whole-wheat flour from soft red winter rises very well, especially in pizza dough and whole wheat sourdoughs.

**Marketing and profitability**

We sell to one pizzeria, a few bakeries, and at one farmers’ market. In addition to the whole-wheat flour, we also sell the whole grain (wheat berries), wheat bran, rye grain, and rye flour. Aside from our Facebook page, we advertise at the farmers market and in several local food guides.

With regards to profitability, selling retail has been more profitable than selling grain to a commodity broker. However, it is much more labor intensive, and when we factor in the added transportation, freezing, milling, advertisement, and countless other expenses, it is not an endeavor that will make a farmer rich.

There are many other benefits besides making money. Our flour business involves my family and my brother’s family, rather than my working the farming enterprise on my own. Learning about my wheat has made me more equipped to farm sustainably. I am more conscious of the nutritional quality of the food I’m growing and how my growing practices affect that quality. Most importantly for my family and myself, there is more value in providing food from our farm directly to consumers than can be measured in money. We have made many new friends at the markets, and our interaction with customers and fellow farmers is the highlight of our week. We have a loyal customer base that frequently compliments us on how much they enjoy baking with our flour. We go out in the community and see restaurants proudly using our products. We feel as if we are part of our local food system.

**Conclusion**

Winter wheat is a fairly easy crop to grow, provided the grower has a good rotation, cares for the soil, and times farming operations properly. Winter small grains can contribute to the ecological well-being of your farm and can provide additional income. I’m always happy to discuss growing winter grains; please feel free to contact me at the address below if you are interested.

*Robin Fazio is a teacher and a sixth generation family farmer. His farm is located in Colquitt, Georgia. Robin can be reached at robin.fazio@gmail.com*

**Helpful resources:**

http://www.uky.edu/Ag/GrainCrops/ID125Section10.html

http://www.caes.uga.edu/publications/pubDetail.cfm?pk_id=7810 (the University of Georgia small grains resource Handbook)

http://www.smallgrains.ncsu.edu

http://www.meadowsmills.com