CHAPTER SIX

# AGRICULTURAL TECHNOLOGY

**STUDENTS LEARN HOW THE TIMUCUA AND THEIR ANCESTORS UTILIZED DOMESTICATED PLANTS.**

## WHAT IS AGRICULTURAL TECHNOLOGY?

Maybe we should start by asking, "What is agriculture?" Agriculture is the growing of plants and the raising of animals. The purpose of agriculture is to provide people with food, fibers, fuel, labor, and other resources. These articles discuss the tools and processes that helped the Timucua solve agricultural problems. How can I prevent weeds from taking over the garden? How do I keep pests away from my crops? How should I store the grain so it won't spoil before we can eat all of it?

These problems are common to all farmers, whether they're living in a native village, working a small family farm, or employed by a modern corporation. The family farm (which has largely disappeared) developed a number of technological solutions. Cows pulled plows to break up the soil and discourage weed growth. Scarecrows kept birds off the corn. Barns provided dry places to store grain. The small farmer needed many different solutions because he was living the full definition of agriculture. His farm produced food, fibers, fuel, animals for labor, and more. He grew crops like corn, wheat, and rye to provide **food** for his family and their domestic animals. Other crops, like cotton and flax, provided **fibers** to make cloth (cotton and linen). Animals like pigs, turkey, and cows provided meat for food. Animals like cows, goats, and chickens provided milk and eggs for **food**. Sheep and goats provided furry **fibers** to make wool clothing. Dried plant stalks were burned as **fuel**. Horses, cows, and dogs were bred to be **laborers**, pulling wagons and plows or protecting property. The farm also produced other **agricultural resources** like linseed oil (a wood preservative made from flax plants), and cowhide leather (for clothing, furniture, and horse bridles). The family farm did it all. They possessed the technology to grow everything the family needed plus a bit more to sell.

Times have changed. Modern farms are owned by corporations, not families. These enormous farms raise a single crop or animal species. Their focus is high production, and they usually only produce one crop (monocropping). Because the farmer focuses on only one plant, he can put all of his time and energy into finding solutions relating to that species. Since a wheat farmer isn't wasting time milking cows, feeding goats, or hoeing corn fields, he can produce very high yields of wheat. This can lead to quite a profit, unless a drought or disease or insect pest wipes out the entire crop. Then monocropping becomes a catastrophe. Unfortunately, new technologies can't guarantee a happy ending.

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## THE DAWN OF AGRICULTURE

**How it all started:** America's earliest native peoples did not grow crops. Instead, they travelled around hunting animals and gathering plant foods. During their travels, many of these groups discovered single locations which met most of their needs. They began to settle down, spending most of the year in one spot. Their villages were often near rivers, which provided drinking water and highways for canoe travel. These rivers also provided habitat for the water plants and animals that native people used. Forest plants and animals flourish near rivers too, providing even more resources. Once native peoples became settled, they developed an intense understanding of the natural patterns of the plants and animals living there. This understanding eventually led to agriculture.

**Northeast Florida wasn't the best spot for agriculture.** Why? For one thing, the area has very sandy soils. Sand doesn't hold water well, and it often lacks important nutrients. As you travel north and west, soils become richer and more clay-like. Higher clay content helps the soils hold onto water and nutrients. As a result, agriculture became more important for the the Western (inland) Timucua and less important to the Timucua on the northeast coast of Florida.

When it comes to agriculture, rivers are even more important than soils. The earliest farmers settled near rivers that flooded every year. Why? Floodwaters deposited loads of silty soil across a wide floodplain. This nutrient-rich silt replaced the minerals used up by last season's crops. The floods actually fertilized the fields for next year's planting. North Florida rivers don't produce annual floods, so the soil minerals weren't being replenished. The fields just became more and more depleted with each planting season.

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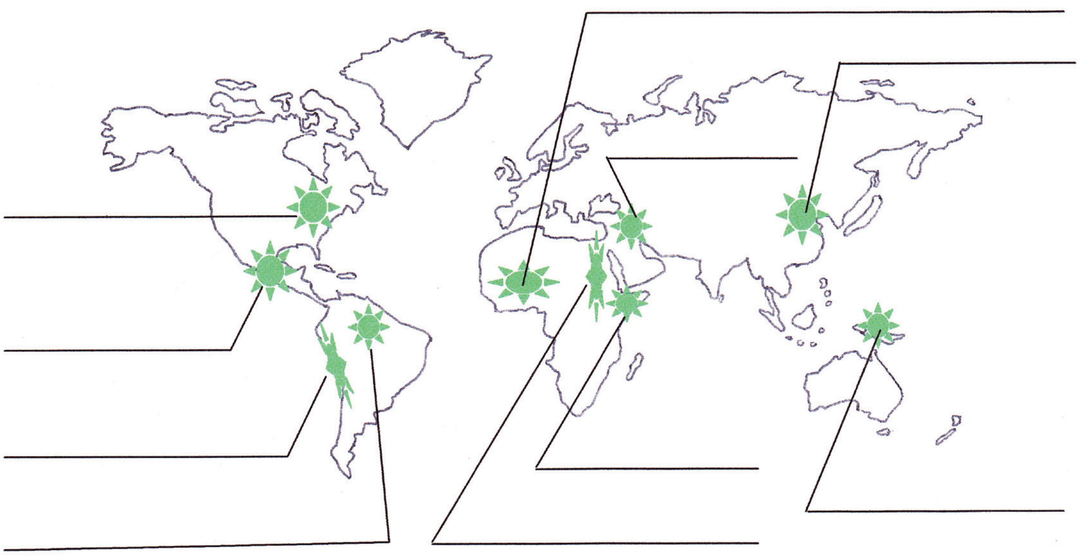
## ACTIVITY – WHERE DID AGRICULTURE BEGIN?:

**BACKGROUND**: In eastern North America, the prehistoric "hot spots" for agriculture were in Tennessee, Arkansas, Illinois, Kentucky, Missouri, and Alabama. Each of these sites was associated with an annually-flooding river. Scientists have discovered nine other locations around the world where man first domesticated crops.

**INSTRUCTIONS**: With a partner, review the list of locations below. On the map titled, "Sites of Early Plant Domestication," write in the names for each location where plants were first domesticated.

**LIST:** Amazon River, Andes Mountains, China, Eastern North America, Ethiopia, Fertile Crescent, Mesoamerica, New Guinea, Nile River Valley, West Africa

**SITES OF EARLY PLANT DOMESTICATION**



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## HOW IT BEGAN

*Chenopodium,*
*photo by Wikipedia*

**Welcoming the weeds:** Native peoples already knew which useful plants grew in each habitat. They knew when to harvest them. They knew how to prepare these plants as food or make them into tools. In time, they began to notice even more. When villages settled into one location, large open spaces were created. The newly disturbed, sunny earth was a perfect habitat for weedy species. Native peoples living in the river valleys of eastern North America recognized these weeds. They were already harvesting chenopodium from the wild. Its nutritious leaves, tiny, broccoli-like flowers, and incredibly small seeds were all edible.

How do archaeologists think agriculture began? Here's one possibility. When wild chenopodium seeds were being collected and processed, some fell to the ground and were forgotten. The next spring, they sprouted… right next to the grain-processing area. It was quite convenient, much easier to harvest.

During the next year, more of these useful weeds grew up from seeds that fell from adult plants. Perhaps a young native woman noticed a new batch of chenopodium springing up in a patch of freshly disturbed soil. With her digging stick, she breaks up more soil. Then she tosses in some chenopodium seeds left over from last season. Later that year, two large patches of chenopodium are flourishing. Her village has just started cultivating a grain crop.

**Bigger seeds**: But has she domesticated chenopodium? Not yet. Archaeologists consider a plant domesticated when its seeds show evidence of change. That means humans are selecting the traits they want their plants to have. How do they do this? Well, since the native peoples were eating chenopodium's seeds, they probably preferred plants that produced larger seeds. Larger seeds were easier to harvest and provided more food. Native peoples harvested seeds for food, and saved the largest ones to plant the following year. After many years of selectively planting larger seeds, native gardens were filled with plants producing bigger seeds than the wild variety.

*Seed Types starting from the Left:*

*quinoa (chenopodium quinoa),*
*sunflower seed,*
*pumpkin seed,*
*kidney bean,*
*corn kernel*

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**Thinner seed coats:** Archaeologists searched for additional clues to prove that plants were being domesticated. What they found was thinner seed coats. Thinner whats? The seed coat protects the seed, stopping moisture from reaching the tiny embryo inside. The seed cannot germinate until a natural process (like being eaten and pooped out by an animal) damages the seed coat. Once that happens, water can get in, and the plant embryo can grow.

Plants with thinner seed coats can't completely block out water, so they germinate more quickly. These early germinators were able to shade out their slower-growing cousins, so they survived to produce seeds more often. Most of the seeds were eaten, but some were saved for next year's planting. Years of this simple artificial selection produced even more early-germinating plants (with very thin seed coats). Once a seed coat has decreased to 21 microns (a micron = one thousandth of a millimeter), it is considered a product of a domesticated plant.

## WHAT CROPS DID THEY PLANT?

**Domestication was just the beginning.** The Late Archaic Period (3,000 BCE – 500 CE) was a time of great change in early Florida. Pottery was invented, and trade was expanding through the Southeast. This trade brought domesticated plants to Florida. Crop species weren't actually domesticated in Florida, but north Florida's native peoples were quick to adopt agricultural technology as it spread southward. Groups with access to good agricultural lands gained wealth and status. Leading individuals in these groups (like chiefs and shamans) now had much higher status than the average person. These strong central leaders were able to coordinate huge community projects, like the construction of sand mounds. (See the unit on Building Technologies.) Regional cultures were developing too. Before this time, most Archaic peoples had pretty similar ways of life. But once they started settling into villages, each group adapted to its own specific environment. These specialized groups would later become the Timucua, Apalachee, Calusa, and other historic native cultures.

**Squash may have been the first.** For a long time, people believed that squash (like corn, pumpkins, and beans) was domesticated in Mexico and later traded to the East Coast. However, by analyzing squash proteins, scientists have proven that two different strains of squash were domesticated. One was the parent to later pumpkins and zucchini. That was domesticated in Mexico. The other, parent to the yellow squashes, was domesticated in Missouri about 3075 BCE. But if we really want to talk about firsts, the bottle gourd wins the prize. It was actually transported into North America by Paleo-Indians migrating across the Bering Land Bridge. Paleo-peoples didn't grow the bottle gourd for food. Instead, they used its tough outer rind to make buckets, ladles, and floats for fishing nets.

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*Sunflower, photo by Wikipedia*

**Sunflowers: when did they join the show?** Wild sunflowers, with little 10 cm (4") flowers, are native to the east coast of North America, just like squash and chenopodium. They were domesticated about 2864 BCE in the Tennessee area. Archaeologists believe them to be domesticated because they discovered an increase in the width of the achene. *The width of the what?* An achene (ay-keen) is the thin hull that surrounds the actual seed in a sunflower. Native peoples were selecting for seeds with more nut inside, and replanting the biggest ones. In time, this artificial selection translated to wider achenes in the sunflower populations.

Scientists once thought that sunflowers were domesticated in two different places, the eastern US and Mexico. The earliest evidence of sunflower domestication occurs in both places around 2,800 BCE. However, genetic studies conducted in 2011 support a different conclusion. The two sunflower varieties are so similar that scientists now believe both are descended from a single domestication event, occurring on the East Coast. Perhaps sunflower seeds were traded west just like corn was traded east.

**Interesting Facts:** Sunflower seeds were eaten as nuts, boiled for their oil, and made into bread. The hulls were used to make a purple dye. The seeds were also used to make cough medicine. Did you know that this all-purpose plant is also great for environmental clean-up? Sunflower plants can absorb toxins (like arsenic) from the soil. In 1986, they were even planted around Chernobyl to absorb radioactive Strontium-90 released during the Chernobyl disaster.

*Sunflower seeds in and out of the hull, photo by Wikipedia*

**Chenopodium – 1,785 BCE - from sowing to cooking:** Early crops, like chenopodium, were fairly simple to plant. In springtime, the soil was hoed to remove weeds, soften the earth, and allow in air. Seeds were tossed into the soil and then covered. Since these plants were well adapted to that environment, they needed only rainwater, and a little weeding. Shoots and new leaves were harvested for salads only a month after planting. Older leaves were used as a boiled vegetable. At the end of the growing season, when the remaining leaves turned brown, the tiny seeds were ready for harvest. They were collected by running a hand across the tall seed heads and collecting the seeds in a basket.

The seeds of chenopodium did not require extensive processing (like peeling, soaking, or grinding), but they did have one major drawback. They taste just like soap. *Yeck*. These seeds (just like their modern cousin, quinoa [keen-wah]) are covered with a thin soapy layer. This awful flavor is a great defense against herbivores. Deer and birds won't touch chenopodium. To make it tasty for humans, the seeds must be thoroughly washed before they're boiled or pounded into grain. When cooked, quinoa's texture is fluffier than brown rice with a bit of a nutty taste.

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Chenopodium was a central food crop, but it became less important after corn was adopted. Why? Corn plants produce more grain than chenopodium, so it's a more efficient crop to grow. Unfortunately, corn does not have edible leaves or edible flowers. It also has fewer digestible proteins than chenopodium. When these early farmers dedicated more and more farmland to corn, they planted less and less chenopodium.

**Interesting Fact:** Like corn, chenopodium can be popped. Why? Both of these seeds have a thin waterproof shell. When they are heated, the moisture inside turns to steam, and the shells burst open, much lighter now without their water weight.

## ACTIVITY – WHICH CROP WOULD YOU CHOOSE?:

**BACKGROUND**: The Timucua and their ancestors had access to a variety of grain species. How did they decide which ones to plant? The species that produced the most grain per plant were prime choices. In this activity, you will weigh a variety of seeds (modern versions of the species available to Florida natives) and compare their value as food plants. Before you begin, make an educated guess about which plant species you think will provide the best seed yield per plant. Your options include bean, corn, pumpkin, quinoa, and sunflower.
Write your choice below.

____________________________________________________________

**INSTRUCTIONS**: Use a scale that reads in milligrams to weigh each kind of seed. Be sure to measure at least three of each species so that you can get an average weight. Use your data to fill in the column titled "Average Seed Weight in Milligrams." (For seeds too light to get a reading, try weighing 10 or 50 at a time, then divide this weight by the total number of seeds you used.)

The column titled "Yield per Plant in Milligrams" describes the weight of seeds provided by each plant. Multiply Average Seed Weight x Number of Seeds per Plant to fill in this column. Be sure to provide values for the lower and upper ranges for these weights.

The final column, "Yield per Plant in Pounds," will make it easier to compare these values, since modern Floridians are more familiar with pounds than with milligrams or kilograms. To convert mg to pounds, multiply milligrams by $2.20462262 \times 10^{-6}$. Round your answer in pounds to the nearest hundredth.

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**ACTIVITY – WHICH CROP WOULD YOU CHOOSE? continued:**

**YIELD FOR MODERN VERSIONS OF PLANTS AVAILABLE TO THE TIMUCUA PEOPLE**

| Name of Seed | Average Seed Weight in Milligrams | Number of Seeds per Plant | Yield per Plant in Milligrams | Yield per Plant in Pounds |
|---|---|---|---|---|
| Quinoa Grain (Chenopodium quinoa) | | 28,000 - 56,000 | | |
| Kidney Bean (6-7 pods per plant) | | 100 - 200 | | |
| Corn Kernel (2 ears per plant) | | 1000 - 2400 | | |
| Sunflower Seed (1 flower per plant) | | 800 - 2000 | | |
| Pumpkin Seed (2 pumpkins per vine) | | 200 - 1400 | | |

Based on your calculations, which crop produces the highest yield of seed per plant? Does this agree with your educated guess at the top of the page? ______________________

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## THE AGRICULTURAL LATECOMERS

Tobacco, photo by Wikipedia

**Tobacco makes an entrance.** Archaeologists begin to find evidence of tobacco cultivation (preserved seeds) around 300 CE. Tobacco was domesticated in Mexico, so it may have travelled across the continent along with corn. Dried tobacco leaves were smoked at ceremonial functions and used in herbal remedies. Obviously, the native people did not know this plant was carcinogenic. By the mid 1600s, the native tobacco, *Nicotiana rustica*, was replaced by a "better-tasting" hybrid tobacco called *Nicotiana tabacum*.

**The history of corn.** Corn arrived from Mexico, already domesticated. The original "corn" is called teosinte, and the early Mexican Indians began the domestication process around 4,300 BCE. The original teosinte didn't look much like corn. It actually looked like wheat. It had no cob, tiny hard seeds instead of kernels, and no husk around the cob. Teosinte looks so different that, originally, scientists thought it couldn't be the progenitor (parent) of modern corn.

The photo above shows teosinte to the left, corn to the right, and a hybrid in the middle.

Courtesy of Wikipedia

When the genetics of corn and teosinte were studied, scientists learned that these two plants differ in only five genes. A very few genetic changes made a very big difference in the corn. It turns out that the original teosinte had LOTS of genetic variation, meaning that some plants naturally produced plumper seeds, while others produced fewer stalks. The native peoples living in Mesoamerica preferred the plumper seeds over the tiny, hard, nut-like ones. As with sunflower, native peoples selected the larger teosinte seeds. A few thousand years of this artificial selection moved the crop towards a larger kernel.

The cob and husk were also selected by corn cultivators. Why? They both function to keep the seeds on the stalk. Wild grain plants disperse their seeds by dropping them after they are ripe. Some blow away, while others germinate near the parent. But if you are growing grain as a food crop, you don't want the seeds blowing away or falling on the ground. You want them on the stalk where they're easy to collect and eat. Both the cob and the husk hold the kernels on the stem until harvest. Corn was traded all across North America to many different native groups. Because each community of planters selected for slightly different traits, a variety of corn types were created. These variations made it to the East Coast of North America by 200 CE. Over the next 600-1000 years, corn was adopted up the East Coast to Canada and down to Georgia and western Florida. It wasn't until 1,450 CE, just before the arrival of the Europeans, that evidence of corn cultivation is found at pre-Timucua sites.

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**Interesting Fact:** It's been suggested that the kernels in teosinte were too small and hard to be used as an efficient food source. On the other hand, they do pop like popcorn. So the whole corn revolution may have started because somebody loved popcorn!

**Another Interesting Fact:** Did you know that modern corn stalks produce only two ears of corn? That's more than two meters (over six feet) in stalk height to produce just two ears of corn! Early corn plants produced six smaller ears. Modern farmers have selected for fewer ears so the plant will put all of its energy into producing a couple of big juicy ears instead of several scrawny ears.

**Corn – the big question:** If corn made it to the East Coast of North America by 200 CE, why did it take another 1,250 years for it to be cultivated in northeast Florida? For one thing, corn requires a lot more effort than other crops. The soil around corn seedlings must be weeded regularly. Otherwise, the weeds will out-compete the corn, stealing minerals, water, and sunlight needed by the baby corn plants. Weedier crop species, like chenopodium, required far less back-breaking garden work.

Also, corn requires a lot more effort to make it edible. Unless it was eaten fresh off the stalk, corn had to be dried, then soaked in lye, then washed thoroughly, then cracked, then ground up, then boiled, baked into bread, or cooked in some other way. In other words, corn is REALLY labor-intensive. Who wants all of that extra work? Archaeologists tell us that many native groups north of Florida were growing corn by 800 CE. But they only grew a small amount, not nearly enough to feed the whole village. Perhaps the corn was used only for special, ceremonial purposes, since it took so much effort to produce.

Eventually, despite all the effort required, corn did become an important crop. Archaeologists think this change was due to a combination of two factors: ease of harvest and yumminess (okay, that's not really a word). Why was corn easy to harvest? The cob and the husk keep all of the kernels on the stalk in a nice, neat little package. All you have to do is twist off the corn ear and toss it into a basket on your back. One historical record describes the harvest of an entire village's corn fields as a ten-day group effort. Archaeologists estimate that harvest of enough chenopodium to feed an entire village would take more than three times that long.

Another advantage of a corn husk is that kernels don't just fall off when an animal bumps the plant or a stiff wind blows through. Chenopodium loses its grains pretty easily in those cases. Once the grains are on the ground, there's no way to effectively harvest them.

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So, what about the yumminess factor? One kind of native corn was called "sweet corn." When it's very young, sweet corn is full of sugars that will later be converted to carbohydrates. These sugars provided a sweet taste the older grains just couldn't provide. In addition, the older grains could only be prepared in two ways: boiled (to be eaten in stews) or parched (toasted so the grains crack open to make a very chewy snack). Corn allowed MUCH MORE variety. It could be eaten raw or boiled. It could be roasted (i.e. grilled), parched, popped, cooked as hominy, ground into grits, baked into corn bread, mixed into stews, and prepared into plenty of other tasty recipes.

Corn had three major strikes against it. 1) It had less nutritional value. 2) It was harder to grow. 3) It was harder to process and cook. But boy, it tasted great.

*Bean vine, photo by Wikipedia*

**Pumpkins, beans, and amaranth:** Like corn, these three crops were domesticated in Mexico and gradually made their way to the East Coast. Pumpkins may have arrived around the same time as corn. Beans and amaranth arrived substantially later, around 1,200 CE.

Domesticated beans produced larger seeds than wild bean plants. In addition, they didn't drop their seeds when ripe. Many wild beans explode when they dry out, flinging their seeds in all directions. Domesticated bean pods do not split. They hold their seeds safely inside the pod until harvest.

*Pumpkins, photo by Wikipedia*

And what is amaranth? It's a lot like chenopodium, with edible seeds, flowers, and leaves. Archaeological records show that wild amaranth seeds were being collected and eaten in Florida as early as 2,000 BCE. However, Florida's early Archaic peoples never domesticated the plant. A totally different amaranth species was domesticated in Mexico and traded east.

*Amaranth, photo by Wikipedia*

Why didn't the French and Spanish explorers write about amaranth and chenopodium the way they wrote about corn? Many of them did write about tiny "peaze." Historians now think they were talking about amaranth and chenopodium.

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**ACTIVITY – WHY DID THE OLD GRAINS FALL OUT OF FAVOR?:**

**BACKGROUND**: Older crops like chenopodium were gradually planted less and less. Why? It may have been the result of crop yields. Crops that produce the most grain and require the least work are most desirable. The Timucua adopted newer crop technologies just like we do today.

**INSTRUCTIONS**: In this activity, you will compare crop yields from modern chenopodium (quinoa) and modern popcorn. This will function as a model for the change in grain yields observed by Timucua farmers when corn was first introduced to Florida.

*Ears of popcorn, photo by Wikipedia*

The earliest popcorn discovered dates back to 3,600 BCE. It was found in a cave in New Mexico, and its cobs were tiny - only 1.3 to 5.1 cm long (½"-2"). Florida's earliest corn plants probably measured somewhere between these prehistoric minis and our own modern popcorn, which has 10 cm (4") cobs.

For the purposes of this activity, we'll use data from a popcorn stalk that has 2 ears of corn. Each ear has 500 kernels. Each kernel weighs approximately 0.043 ounces. (For the questions below, round your answer to the nearest tenth.)

1. How much grain (in ounces) is produced by one popcorn plant? ____________________

*Work Space:*

2. 16 ounces = 1 pound. How many pounds of grain will one popcorn plant produce? ________

*Work Space:*

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## ACTIVITY – WHY DID THE OLD GRAINS FALL OUT OF FAVOR? continued:

3. Chenopodium farmers tell us that it takes about 10 plants to produce one pound of grain (that's only 1.6 ounces of grain per plant). How many chenopodium plants will it take to produce the same amount of grain as a single popcorn plant? ______________

*Quinoa grain, larger than life, photo by Wikipedia*

*Work Space:*

4. If you were a Timucua farmer, you would have been faced with a tough decision. Corn produces more seed, but does not produce edible leaves or flowers. Would you have continued growing lots of chenopodium, or would you have focused more on growing corn? Explain your choice.

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## WHAT TECHNOLOGIES DID THE TIMUCUA USE TO CULTIVATE THEIR FIELDS?

They began by using prescribed fire to clear the fields of weed growth and last year's crop stems. This also returned ashy nutrients to the soil.
**Technology: Fire**

Timucua men did the back-breaking work of hoeing up the soil. Loosening the top layer of dirt disrupted weed growth and allowed oxygen into the soil. The tiny germinating crop roots also moved more easily through the loosened dirt.
**Technologies: Division of Labor and Agricultural Science**

*A Theodore de Bry engraving of the Timucua planting their fields. Despite the MANY errors, these engravings can be a useful learning resource.*

Timucua hoeing tools had shell, bone, or stone blades hafted onto wooden handles. (Notice that the hoes in the pictures are not accurate.) The women and children probably handled the majority of the planting and weeding throughout the growing season. They used wooden digging sticks to poke holes for seeds which they carried in woven baskets.
**Technologies: Division of Labor and Tool-Making**

Despite what you see in the French engraving, Timucua fields were not tilled in rows. Planting in rows did not start until people began using animal-drawn plows, which worked best when dragged in a straight line. Instead, the Timucua men hoed dirt into hills about four feet wide (you can see this practice at the bottom of the picture). The women probably planted four corn seeds, 2 bean seeds, and 2 squash or pumpkin seeds in each hill. Why hills? They help retain water near the roots of the growing plants. The elevation also makes it easier to tell the difference between seedlings and weeds. You don't want to be ripping out your newly sprouted corn.
**Technologies: Division of Labor and Agricultural Science**

**Corn, beans, and squash were called the "Three Sisters" because they were always planted together.** Why? Corn plants demand a lot of nitrogen from the soil. This can deplete the soil quickly so that crops grow poorly in following years. Modern farmers add fertilizers to replenish the soil. Five hundred years ago, the Timucua solved this problem by planting beans. Bean plants have a symbiotic relationship with soil bacteria. In this relationship, the bacteria help bean plants stick nitrogen onto their roots, and the bean plants supply the bacteria with carbon. It's good for the beans, good for the bacteria – and good for the Timucua. Much of the nitrogen affixed to the beans' roots stays in the soil after the harvest. This provides the nutrients for next year's corn. Sustainable agriculture at its best!
**Technologies: Biological Science**

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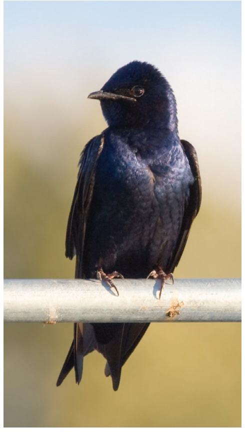
But it doesn't end there. Beans are a climbing vine. They need to reach up to sunlight to produce their largest, healthiest beans. Lucky for them, corn stalks grow straight and tall, providing a perfect ladder for the beans to climb. Squash also grows as a vine, but instead of climbing, it crawls along the ground. Its large leaves cover the soil, forming a kind of living mulch. Mulch traps moisture in the soil, preventing evaporation. It also blocks sunlight so any weed seeds below the leaves don't germinate. This cuts down on competition for water and soil minerals. Finally, squash plants have rough, spiny leaves and stems. These scratchy leaves discourage herbivores from roaming the fields for a snack. It seems that the Three Sisters and the native farmers had developed a symbiotic relationship of their own.
**Technologies: Agricultural Science**

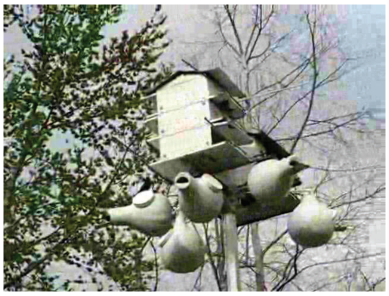
*Bottle gourd, photo by Wikipedia*

The Timucua did not clear cut their cropland. Instead, they left some fruit and nut trees standing. These trees provided shade for resting planters as well as roosting space for birds. In fact, the Timucua hung gourd birdhouses in the trees to encourage Purple Martins to move in. Why? Martins are insectivores (bug-eaters). Without modern pesticides, the Timucua depended on biological pest management. The birds ate crop-munching bugs (protecting the Timucua crops) and the Timucua provided the birds with homes and a steady source of food. Another symbiotic relationship. **Technologies: Agricultural Science, Tool-Making**

**What about the other crops?** Bottle gourds were planted, probably along one edge of the field. Tobacco was planted as well. Sunflowers were often grown along the northern rim of the field so they didn't shade the other growing plants. Those big, tasty sunflower seeds would have attracted seed-eating birds from far and wide. So, how did the Timucua prevent the seed-predators from taking their crop? They built guard huts along the edges of the fields. These were manned by older members of the village. If a flock of birds settled on the crops, the guard would frighten them off. Plus, if an enemy village decided to attack, these field guards could provide early warning. Giving elders the responsibility for guarding the crops allowed them to contribute to the community's survival and maintain their own self-respect.
**Technologies: Division of Labor, Structures**



*Purple Martin, photo by Wikipedia*



*Martin house with gourds, photo by Wikipedia*

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Florida has a long growing season, so corn was planted twice. The first variety of corn (called "early corn") was planted in March. It matured quickly and could be harvested after only two months. This corn was often fire-roasted in the husk. Several times during the growing season, women hoed the planting hills to prevent weeds from taking the nutrients needed by the corn. "Late corn" was planted in June. This was actually a different variety of corn. It matured more slowly, with kernels that were not soft enough or sweet enough to eat fresh. When the corn ripened, the Timucua twisted the ears downward on the stalk (to ensure that rainwater did not cause rot), and the ears were left there to dry.
**Technologies: Agricultural Science**

After the women and children harvested the ears of late corn, they stripped the husks away and rubbed the kernels off the cobs. These hard kernels were inedible without further processing. Soaking the kernels in a lye solution softened them up for pounding. The lye also broke down corn proteins, changing the vitamin niacin into a digestible form (niacin is important in the diet because it prevents the disease pellagra).

The softened corn kernels were cracked using a wooden mortar (deep bowl) and pestle (wooden striking pole). After the women had cracked the corn, they used a loose-weave basket to sift it, separating the cracked outer peels from the corn seed inside. The bits of cracked corn could be made into a porridge, like grits. They could also be pounded into fine corn flour. Fire ashes were added as a leavening agent to help corn breads rise.
**Technologies: Fire, Tool-Making, Health Science**

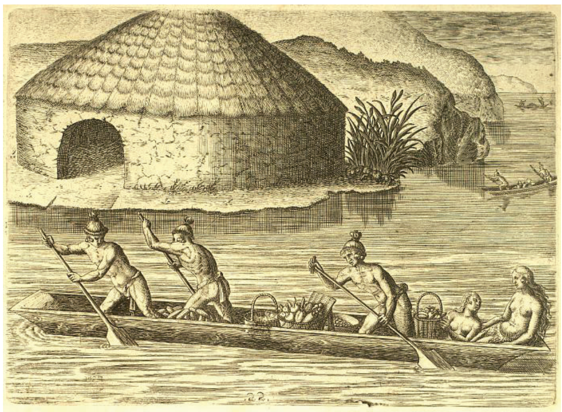
The kidney beans grown by the Timucua were not meant to be eaten whole right after picking. They were left to dry on the vine until they rattled in the dry pods. After the pods were picked from the vines, the Timucua shelled them and used wind and sifting baskets to remove the chaff and bits of non-bean material. Dried beans, like dried corn and corn flour, had to be stored out of the elements to ensure that it would last the winter.
**Technologies: Tool-Making**

Tobacco leaves, bottle gourds, and thin slices of squash were sun dried to preserve them for later use. They too required storage space. And what about the sunflowers? They could be allowed to dry on the stalk. Of course, some seeds would be lost to birds and to the ground. Alternatively, the flower heads could be cut and hung indoors to dry. But this might have required more indoor space than the Timucua had. Once the flower heads were dry, simply rubbing a hand across the seeds would dislodge them. Next, native peoples removed the hulls. Then they added the seeds to breads and soups, boiled them to make sunflower oil, or ate them raw. Like the other crops, plenty of space was needed for processing and storing the seeds.

CHAPTER SIX

# AGRICULTURAL TECHNOLOGY

This de Bry engraving shows the Timucua transporting produce to a storehouse. In addition to storage huts within the community, larger storehouses like this one were also used. Why? The chief levied a tax on all of the plant foods produced. These foods were stored away to redistribute when food ran low. They were also used as status gifts to other chiefs and European explorers. (**Archaeological Note:** The hut in this engraving should not have mud walls. Palm thatching should cover the entire structure.)
**<u>Technologies:</u> Agricultural Science, Structures**



*De Bry engraving of Timucua taking food to the storehouses*

**<u>How healthy was Timucua food?</u>** Their diet was mainly nuts, fruits and vegetables, grains, lean meat, and lots of fish and shellfish. Because gummy vitamins hadn't been invented yet, every bit of nutrition had to come from their food. The use of lye enabled the Timucua to digest niacin when they ate grits or cornbread. However, corn still lacks two important proteins (lysine and tryptophan). Beans provide both of these proteins, so corn and beans were often cooked together in soups.

**Interesting Fact:** The older grains, amaranth and chenopodium, included a full complement of proteins. Eaten alone, they were nutritionally complete. For that reason, modern Floridians are expressing renewed interest these old grains.
**<u>Technologies:</u> Nutritional Science**

**<u>What crops did the Spanish introduce?</u>** By the 1600s, Spanish soldiers, missionaries, and townspeople from St. Augustine were in regular contact with the Timucua. They introduced new crops and new ideas. Many villages, particularly those with a mission church, began to cultivate these exotic crops. Archaeologists have found evidence that watermelons, peaches, figs, hazelnuts, garbanzo beans, and oranges were grown at some Timucua villages. Spanish crops and metal tools were adopted by the Timucua. However, native style homes, pottery, and canoes remained unchanged.

# CHAPTER SIX AGRICULTURAL TECHNOLOGY

## WERE THE TIMUCUA PRACTICING MODERN SCIENCE?

The Timucua had always been observers of their environment, with a clear understanding of how living and non-living things interact. Careful observation is the basis of collecting empirical data, the beginnings of science. When the Timucua started to grow crops, they also started to make the transition towards the use of modern science. How? They weren't just observing; they were making educated guesses, controlling variables (like seed size), and actually testing their ideas. They used the results of these experiments to improve their agricultural technologies. How might native peoples have applied the basic scientific method?

*Question: If I plant the biggest seeds, will the next generation have bigger seeds too?*
*Hypothesis: I think planting bigger seeds will cause the next generation seeds to be bigger.*
*Method: I'll separate the biggest and smallest seeds from the crops. Then I'll plant them in different parts of the field. At harvest, I'll check to see if there's a size difference in seeds produced in these two sections of the field.*
*Conclusion: The plants grown from bigger seeds also produced bigger seeds.*
*New Technology: Next year, we'll save the biggest seeds for planting and use the rest for food.*

Asking questions and then setting up experiments to find the answers is at the heart of scientific discovery. Did the Timucua actually follow the modern scientific method (as in the example above)? There's no way to be sure. The Europeans recorded what they observed the Timucua doing. But they had to make educated guesses about the thought processes behind Timucua actions. Read this description of a Timucua planting ceremony.

*"Every year, a little before their spring (at the end of February, in fact), the chief Outina's subjects take the skin, complete with antlers of the biggest stag they have been able to catch. They stuff it with all kinds of the choicest plants that their land produces, sew it up again, and deck the horns, the throat, and the rest of the body with their more special fruits made up into wreaths or long garlands. Thus decorated, it is carried away to the music of pipes and singing into a very wide and beautiful plain, and there it is placed on a very tall tree trunk, with its head and chest turned towards the sunrise, prayers being repeatedly uttered to the sun that he should cause to grow again in their kingdom good things similar to those offered to him."*

The de Bry engraving to the right shows a planting ceremony that took place each spring. The Timucua processed a deer hide so that it still held the shape of the living animal, then stuffed it full of fruits and grains. While chanting and celebrating, they raised the stuffed deer hide on a pole - as an offering to the Sun. This ceremony was an attempt to ensure a good harvest. This historical data suggests that the big questions in Timucua life were answered by religion, not by science.

*De Bry engraving of Timucua planting ritual*

# CHAPTER SIX
# AGRICULTURAL TECHNOLOGY

## AGRICULTURAL SCIENCE IN MODERN FLORIDA

For modern Floridians, science explains how the world functions. Droughts and illnesses are explained through meteorology and germ theory, not as actions of a sun spirit or an angry shaman. Our lives are very different from those of the people who lived here 500 years ago. We eat animals that are raised in feed lots instead of hunting them from the wild. We eat crops that are genetically modified to resist herbicides. In fact, we eat food that has no food value at all: no carbs, no fat, no calories. The Timucua would have been baffled.

Why create food that has no food in it? Five hundred years ago, agriculture was about producing food crops, shooing rabbits out of the fields, and keeping the weeds under control. The Timucua understood weeds. They spent a great deal of time hoeing the hills to keep competing weeds away from their crops. Even so, they would have been amazed at the weed problems modern man has created.

*Palmer's Amaranth, photo by Wikipedia*

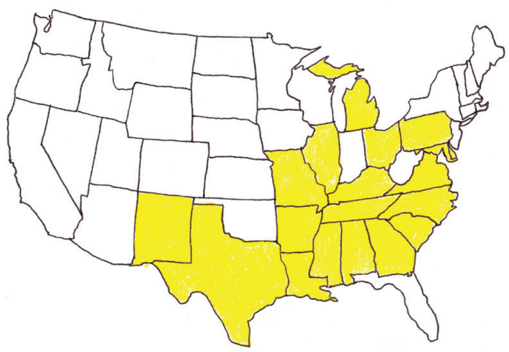
The Southeast's most aggressive weed species is called Palmer's Amaranth *(Amaranthus palmeri)*. Another of these super weeds is called Lamb's Quarter *(Chenopodium album)*. Do these names sound familiar? They're related to the same early plants cultivated by native peoples across North and Central America. Amaranth and chenopodium were good survivors then, and they're still good survivors. Palmer's Amaranth grows so quickly, that even during a drought, it can grow an inch a day. It reaches 2.1 meters (7') in height. This is tall enough to shade out cotton plants so they don't get enough sunlight to produce cotton. Each female amaranth plant produces more than 500,000 seeds a season. This combination of fast growth, high reproductive rate, and the ability to shade out other plants makes Palmer's Amaranth a very successful weed. These qualities also made it an excellent choice for early native gardens.

Today, Palmer's Amaranth has an even greater advantage. It has developed resistance to the herbicide, glyphosate. *Resistance to what?* Glyphosate is better known as Roundup, a weed killer developed by Monsanto Corporation. At one time, the use of Roundup to kill weeds in cotton fields was highly beneficial. It reduced the amount of tilling (hoeing) needed to prevent weed growth. Less tilling meant less erosion and less disruption to soil organisms. That's a good thing. In addition, farmers no longer needed to apply chemical herbicides over and over. Decreased chemical use was also better for the environment. So…what's the problem with Roundup?

# AGRICULTURAL TECHNOLOGY

The problem is that Roundup kills all grass-type plants, not just weeds. So, if it was sprayed after the crop had sprouted leaves, the crop would die along with the weeds. Roundup could only be sprayed before the crops germinated. Monsanto Corporation addressed this problem by genetically engineering soy, cotton, and corn plants to resist Roundup. Now, if you bought Monsanto's engineered seeds, you could apply Roundup herbicide throughout the growing season. And it worked great…for a while. Unfortunately, a few of the weeds weren't killed by the Roundup. They were still susceptible…if farmers sprayed them before they were 8 cm (3") tall. But after that, no matter how much Roundup a farmer sprays, Palmer's Amaranth keeps on growing. Whole fields in Georgia have been abandoned because this weed has taken over. Some of these fields are actually in old Timucua territory. Fortunately, this weed hasn't taken hold in Florida. Look at the map below to see which states are fighting the battle against glyphosate-resistant Amaranth.

The Timucua might have suggested harvesting the edible leaves, flowers, and seeds instead of treating amaranth like a weed. Sounds reasonable, right? Here's the problem. Amaranth is excellent at absorbing nitrogen from the soil. Because we apply so much nitrogen fertilizer to our crop soils, Amaranth absorbs a tremendous amount of nitrogen. In fact, it absorbs so much that it becomes toxic to animals and people. Our use of genetically modified seed, coupled with heavy herbicide use, has created a weed that is almost impossible to control. Our excessive use of fertilizers has made this weed useless as a food source.



*States Affected by Roundup-Resistant Palmer's Amaranth in mid 2011*

Modern farmers are taking aggressive measures to stop Palmer's Amaranth. What measures? For one thing, they're going back to the days of mechanical weed control - hoeing up the soil to prevent weed growth. They're also returning to repeated application of different herbicides. That kills most of the amaranth. But one surviving female plant means 500,000 more seeds. That's a challenge.

Like any technology, GMOs (genetically modified organisms) can provide benefits as well as problems. These plants can resist diseases, handle drought, and fight off insects – all of which lead to much bigger crop yields. It's hard for farmers to say "no" to this kind of technology. The Timucua faced the same quandary when they were introduced to corn, beans, and pumpkins.

# CHAPTER SIX
# AGRICULTURAL TECHNOLOGY

**Interesting Fact:** In a sense, all food crops have been genetically modified. Plant domestication occurs when man selects for certain traits that show up in the plant's offspring (so, the genes in the offspring are different now, modified by man). This kind of artificial selection has been happening in Mexico since teosinte seeds began their journey towards becoming corn. And it's happening today, when scientists enhance the genes of certain crops. GMOs differ from traditional methods because now, instead of the slow process of crossing different plant breeds to get better ones, scientists can take the speedy route - inserting genes from other plants or bacteria into the genome of the crop.

In the late 1990s, scientists engineered corn to produce a chemical that would stop European Corn Borers. This moth caterpillar was doing serious damage to the corn crop. The engineered corn was tested for safety, and the corn seeds were planted. As the corn matured, its pollen blew onto nearby milkweed plants. Monarch caterpillars ate the pollen-covered milkweed, and guess what? The chemical designed to kill one caterpillar is good at killing other caterpillars.

Since monarch caterpillars don't eat corn, no one expected them to be exposed to the chemical. Of course, milkweed is a common weed in corn fields…but no one can control for every variable in the environment. Nature's simply too complex. It's impossible to accurately predict whether the negatives will outweigh the positives for a particular GMO crop.

Some GMO grains, for example, are being altered to grow in desert regions where people face starvation on a daily basis. In these cases, the crop's genetic modifications (like resistance to drought and increased nutritional value) could be life-saving. GMOs, like all scientific issues, have many pros and cons. What would the Timucua have thought about GMOs?

# AGRICULTURAL TECHNOLOGY

## ACTIVITY – GROWING YOUR OWN CROPS:

**BACKGROUND**: Today, because virtually all foods can be purchased at local grocery stores, restaurants, or on the internet, many modern Floridians go their whole lives without ever growing their own food. Whether you produce a successful crop and eat your own produce - or cultivate a field of weeds and caterpillar food - gardening is a worthwhile experience. Because your ability to eat this winter isn't dependent on your gardening success, it can be an enjoyable activity, rather than a tough job.

**INSTRUCTIONS, Part I**: Your teacher will decide how many of each plant species your class will grow. These instructions assume that each student will start one pot of each species. Species to be planted include popcorn, kidney beans, quinoa (chenopodium), pumpkin, and sunflower. Plant each species according to instructions. Label your pots with your name, the species planted, and the date.

The seeds should be started indoors in late February. Use cleaned yogurt cups as pots. The Timucua reused everything they possibly could, including crates and other containers that washed up from Spanish shipwrecks. We'll follow their example by re-using the plastic cups as pots. Fill the pot with potting soil. Water it lightly, until it is damp, not muddy. Place the pots in a bright window. You can create a simple greenhouse by placing the pots inside the kind of plastic box you buy spinach in at the grocery store. This speeds germination by increasing warmth and preventing the escape of evaporating water.

After the last frost, the seedlings can be planted outside in soil that has been hoed and mixed with compost or manure. As they grow, you'll need to thin them, pulling out the less successful plants, to allow the remaining ones adequate access to water and minerals.

**Popcorn**: Plant 2 seeds per pot at ½" deep. They will germinate in 10-12 days. Corn is wind-pollinated. This means that when you plant them outside, you need to arrange them in a block (rather than a long line) so the pollen will blow to all of the plants. Time to harvest is 85-120 days. The ears of corn should dry completely on the stalk before harvest. To pop them, strip the husk, and put the ear of corn in a paper bag. Fold down the top and put in the microwave like store-bought popcorn.

**Kidney Beans:** Soak beans in water overnight. Plant 1 seed in each pot, ½" deep. Water well, but do not make the dirt into mud. Seeds germinate in 2-3 days. These are not the kind of bean sprouts you can eat. They contain a chemical called phytohemagglutinin and are toxic.

# AGRICULTURAL TECHNOLOGY

**ACTIVITY – GROWING YOUR OWN CROPS continued:**

DO NOT EAT THE SPROUTS. These beans grow on a bush. Put a stake in the ground next to each seedling soon after you plant it outside. This will support the bush as it grows. Beans need lots of watering. Harvest occurs in 90 days. The beans contain the same toxin as the sprouts. They must be boiled for a MINIMUM of 10 minutes to destroy the toxins.

**Quinoa (chenopodium):** Plant a few seeds ¼" deep. The seed will germinate in 3-4 days. Quinoa doesn't really like temperatures over 32°C (90° F), so it needs to be planted as early as possible in Florida. It prefers well-drained soils, so don't overwater. It ripens in 90 days. Because the seed coat of quinoa contains saponins, harvested seeds need to be thoroughly rinsed before cooking.

**Pumpkin**: Soak seeds for 1-2 hours. Do not use giant species of pumpkin because the seed-coats are extra thick, making germination difficult. Plant 2 seeds per pot, at 1-2" deep. Orient them on their sides or with the pointed ends down. They germinate in 4-6 days. Water every other day to prevent over-soaking them. Give them as much direct sunlight as possible. When you transplant them outside, bury the stems to just below the bottom set of leaves. Harvest after 120 days.

**Sunflowers**: Soak seeds for 1-2 hours. Do not use mammoth sunflower seeds. You'll end up spending lots of time staking the plants to prevent them from leaning and collapsing under the weight of the large flower heads. Grow a smaller species. Plant 2 seeds 1- 1.5" deep. They germinate in 11 days. These plants require lots of nitrogen fertilizer to be successful. (You can buy it at the store. The Timucua got it by alternating the locations they planted sunflowers with locations they planted nitrogen-fixing beans each year.) As they grow, they will need staking. The Timucua varieties produced smaller flowers, so they may not have required staking. They tolerate drought very well. They're in full bloom in 60 days. Wait until the flower heads droop and the petals fall off before you harvest.

**INSTRUCTIONS, Part II:** Keep a log of plant growth, beginning when you plant the seeds. Record how many seeds of each species were planted, whether they're in a "greenhouse," and whether they are in direct sunlight, indirect sunlight, or a growth lamp. Spritz with water each day. Do not pour water into the pot unless the surface of the soil is dry to the touch. Record any signs of germination. Record when the first set of leaves appears.

If you plant the seeds outside, record what kind of soil amendments (compost, manure, fertilizer) were used. Use hill agriculture (instead of rows) like the Timucua did. In each hill, plant 1 corn

**ACTIVITY – GROWING YOUR OWN CROPS continued:**

plant (by gently removing its soil from the pot), one bean, and one pumpkin. This forms the Three Sisters Trio that worked so successfully for the Timucua. Plant the sunflowers at the north end of the garden in hills so they won't shade out the other crops. You can plant a bean next to each sunflower if desired. The quinoa can be planted in hills by itself.

Record the spacing between hills and what was planted in each hill. Each hill should have a label stake which notes what was planted there. Sketch the layout of the garden. Rotate responsibilities for watering the crops to ensure it is done regularly. Until the plants are at least 6" tall, be aggressive about pulling weeds. Taller crops will shade out the weeds, so weeding will be less necessary later. Why are weeds bad? They compete for the water and minerals your crops need to survive. Do your crops need to be thinned? If so, record this information. The thinned seedlings can be replanted in new hills.

Observe the garden for ten minutes each week, taking digital photos of each species. Record observations, including the date, the height of each plant species, development of flowers and seeds, evidence of predation (by caterpillars, birds, rabbits, deer), evidence of disease, etc.

**INSTRUCTIONS, Part III:** Time to harvest your crops. Record descriptions of the harvest process. Take digital photos of students engaged in this task. Before you prepare any as food, you need to collect seeds to plant next year. The corn, bean, sunflower, and quinoa seeds should be mostly dry at harvest. Spreading them on a screen inside for a few days is a good way to make sure they're dry enough to last until next spring. The Timucua had to ensure the safe storage of seeds or there would be no garden and no food crop the following year. This included keeping them dry and protecting them from rodents.

Harvesting pumpkin seeds is a little messier. Use your hands to strip the big hunks of stringy goo away from the seeds. Then spread the sticky, stringy seeds on a screen or on newspapers where they can dry in the sun. Once completely dry, the strings will just rub off, and the dry seeds can be stored for next planting season.

**Note:** Today, most of the seeds you buy are hybrids. Hybrid seeds combine useful traits from two parent plants, for example, disease resistance and drought tolerance. That's good for this year's crop. However, next year's crop will be a genetic mix of the plants in your garden. Some will have both traits. Some will just have drought resistance. Others will only have disease resistance. As a result, modern gardeners buy new seed each year if they are using hybrid species.

# AGRICULTURAL TECHNOLOGY

**ACTIVITY – GROWING YOUR OWN CROPS continued:**

**INSTRUCTIONS, Part IV:** Finally, you can prepare your harvested seeds according to the safety guidelines provided by your teacher. You can also harvest the flesh of the pumpkins. Go ahead. Taste the fruits of your labor. It only took 120 days. Record your sensory observations (taste, texture, smell, etc.) and take digital photos of the seeds and pumpkins you cook.

**INSTRUCTIONS, Part V:** The harvest is over. The garden hills are full of tall corn and sunflower stalks, dried bean bushes, pumpkin vines, and quinoa bushes. When removing bean bushes, be sure to leave the roots in the soil. The roots have fixed plenty of atmospheric nitrogen to their surfaces. As they decompose, that nitrogen will return to the soil, enriching next year's crop. If you pull the bush out by the roots, all of that nitrogen will be lost.

Now, the top of the bean bush and the rest of the stalks should be removed, shredded, and added to a compost pile. After the leaves and stems rot into compost, they can be returned to the soil to enrich next year's planting. Any unused pumpkin flesh can also be composted. Instead of composting, the Timucua burned their fields. The fire reduced last year's stems to ash, returning the nutrients directly to the soil. Record your experiences closing down the garden for the season and creating a compost pile. Photograph each step.

**INSTRUCTIONS, Part VI:** Record any final observation, thoughts on agriculture in general, and impressions of the Timucua agricultural experience. Use your records, observations, and digital photos to create a PowerPoint presentation. It should explain the gardening process as though speaking to upper elementary students (4th-6th grades), and compare modern processes to processes used by the Timucua. Deliver your presentation to the target audience.