Lesson 1: Planning the Crop

The cotton plant is unique among the commonly grown row crops in the United States. Originating as a semi-tropical, perennial plant, cotton has been bred and cultivated for production as an annual that can grow in a wide range of temperate environments. By understanding the necessary environmental conditions, evaluating field history, and determining fertilizer needs, producers will be better prepared to make good management decisions concerning cotton production.

Environmental Conditions Necessary for Cotton Production

Cotton, like any other plant, requires specific conditions to grow well. Before a producer plants cotton for the first time, environmental conditions need to be examined to determine if cotton will grow under the existing conditions. The environmental conditions that have the greatest effect on cotton production include growing season, rainfall, and soil type.

Growing Season

Cotton is considered a warm-season crop, growing best during summer months in warm climates. Cotton requires a frost-free period (the number of days from the last frost in the spring until the first frost in the fall). This necessary frost-free period is the main reason that cotton will not grow in northern climates. Instead, it is mostly grown in southern regions of the United States including southeast Missouri. Some newer varieties, however, are able to produce in climates with shorter growing seasons. In Missouri, the growing season falls between early May and late October.

Cotton needs specific temperatures during the planting and germination stages. It should only be planted in the spring when the average soil temperature is at least 65°F for 3 consecutive days. Once the cotton is planted, the seeds will not germinate unless the average air temperature is at least 75°F, with 85°F being optimum. Both soil and air temperatures determine spring planting dates. In Missouri, cotton is typically planted between May 5 and May 15. Cotton planted before May 5 will risk cool soil temperatures but may be able to establish a stand in some years. Cotton planted after May 15 and before May 20 will probably not have significantly lower yields but can delay plant maturity and harvest. Planting after May 20 usually results in reduced yields and is not recommended.

The development of the cotton plant is directly tied to the temperatures it encounters. It develops very predictably at temperatures between 65 and 85°F. In other words, a cotton plant grows above a base temperature of 60°F with little or no development occurring below this threshold. To manage and monitor the crop, producers use a method of temperature measurement in heat units, called DD-60s. Heat units are calculated by averaging the maximum and minimum temperatures for a day and subtracting the base temperature. The equation for determining heat units is listed below:

[(max. temp. + min. temp.) ÷ 2] - 60 = heat units

For example, if today's high and low temperatures were 80°F and 60°F, respectively, then the formula would arrive at [(80°F + 60°F)÷2]-60 = 10 heat units, or DD-60s. Table 1.1 provides an outline of the DD-60s requirements for a cotton crop.

Table 1.1 - Average DD-60s Required for Missouri Cotton

Growth Stage	Heat Units DD-60s	Average Date[1]
Planting	0	May 1
Seedling Emergence	55	May 12
Add Nodes to Main Stem	45-65/node	3 days/node
First Square	500	June 17
First Bloom	850	July 6
Cutout[2]	1300-1400	July 28 - Aug 6
First Open Boll	1700	Aug 20
Harvest	2150-2300	Sept 21+

[1]Based on average DD-60 accumulation for Portageville, MO
[2]Assuming 20 main stem nodes and 10 to 12 effective fruiting branches

Studying DD-60s can be helpful in accessing and managing the crop's rate of development throughout the season. This is especially important in the Missouri Bootheel region because 2,250 DD-60s on average are accumulated from May 1 to October 1. Additional information and

listings of DD-60s can be found in some weekly farm magazines or in the monthly *Missouri Cotton News*, distributed by University Extension at the University of Missouri Delta Center.

Rainfall

Rainfall and moisture can affect the soil temperature. A good rainfall of more than 1 inch can drop soil temperature at least 5 degrees. Moisture in the soil may delay warming of the soil for 4 to 5 days. Therefore, cotton seeding should be done with weather forecasts in mind. The producer should strive for several clear days after planting to enhance germination.

Before first bloom, cotton needs ¾ to 1 inch of water weekly. During peak bloom, the water requirement is 1 to 1 ½ inch per weed. During late bloom to early maturity, no water is required. Careful monitoring of the crop will reveal times when the cotton needs water. This is evident by wilting, when the plant starts to lose strength, or turgor (cell wall strength that keeps the plant upright). If available, cotton responds well to irrigation. However, excessive water can lead to increased vegetative (stem and leaf) growth instead of reproductive (flower or boll) growth. Rain gauges should be used to monitor rainfall and irrigation.

Soil Type

Irrigation needs should be based on the soil type. Sandy soils will not hold water as well as other soil types and may need to be irrigated more often. Clay soils have better water-holding capacity, restricting drainage, and seldom need irrigation. However, excessive clay soils will resist root growth through the clay layer and can stunt cotton plants. Silty soils are the compromise between the clay and sand.

Evaluating Field History

Field history refers to the previous crop that was on that particular field. Knowing the previous crop can aid the producer in making management decisions. If the previous crop was not cotton, the weeds found on the field may pose a problem to cotton. The correct herbicide to kill the weeds found may affect the cotton plant. If weed problems are severe, germination and growth may be affected.

If the previous crop was not cotton, a soil test should be done to determine soil fertility and soil nutrients, especially if the plant was a legume, such as clover and alfalfa. Legumes naturally take nitrogen out of the air and put it in the soil through nodes on the roots. Excessive nitrogen may cause problems in vegetative and reproductive growth.

Previous crops may have also had particular insect problems that may impact the cotton crop. The correct insecticide to kill the infestation may also have affected the cotton. Many insects lay eggs in the ground and removing the previous crop will not necessarily kill the insects.

Fertilizer Requirements for Cotton

Like many other plants, cotton has certain fertilizer requirements for varying levels of production. Determining the correct rate of fertilization for cotton is difficult because many variables affect its growth.

Cotton does not respond well to stress because stress affects the amount of nutrients absorbed by the plant from the soil. Some items that may cause stress in the cotton plant include soil texture, drainage, field preparation, weather, variety of crop selected, planting date, planting and germination rate, emergence rate (the number of seeds that produce plants that come up from the soil), previous crop, and nutrients and chemicals in the soil. A current soil test will provide the best option for a balanced fertility program.

The amount of nutrients needed by the cotton plant varies throughout the plant's growing cycle. During spring and early summer when the temperature is low, the cotton plant requires relatively small amounts of nutrients. As temperatures and plant size increase, the amount of nutrients needed by the plant also increases. Peak nutrient amounts are typically needed in late June and throughout July.

The most important nutrients needed by cotton are nitrogen, phosphorous, potassium, and boron. These nutrients are normally found in the soil in varying amounts. To obtain maximum cotton yield and production, optimal levels of these soil nutrients are needed. Cotton prefers a soil pH of 6.0 to 6.5.

Nitrogen is commonly found in the soil in two main forms: ammonium nitrogen (NH_{4+}) and nitrate (NO_{3-}). Ammonium nitrogen is commonly found more often in clay soils, which will hold less of the nitrate form. Nitrogen is used in chlorophyll (the process of making new tissues in the plant). A process in the soil called nitrification (the conversion of ammonium nitrogen to nitrate by bacteria in the soil) changes the levels of each type of nitrogen in the soil. If excessive water is found in the soil, nitrification will be slowed or stopped. This will allow the nitrogen to be given off in the form of gas, which then escapes into the atmosphere and will not help the plant.

For optimal production, cotton must have the correct level of nitrogen throughout its growth cycle. Excessive nitrogen in the soil can delay plant maturity, slow flowering, cause excessive vegetative growth, increase insect infestations, reduce the plant's resistance to diseases, and increase the risk of boll rot disease and lint (boll fiber) quality. When the plant is young, very little nitrogen is needed. When the plant is flowering and forming the boll, large amounts of nitrogen are needed. A common rate of fertilization for nitrogen is 80 pounds per acre.

Fertilizer can be applied at seeding and just before blooming. Thirty pounds per acre is typically applied at planting. Fifty pounds can be side-dressed just before blooming. If the previous crop was corn or soybeans, there will probably be nitrogen left in the soil from previous fertilizations. The amount of nitrogen applied to the field should be reduced.

Phosphorous is another important plant nutrient. Unlike nitrogen, phosphorous does not move very well through the soil. Because of this, the plant needs help to get enough phosphorous. Mycorrhizal fungi associated with the roots of cotton plants take food from the plant but in return helps absorb phosphorous from areas around the roots. Cold soils inhibit phosphorous intake by the plant because the roots grow slowly. Typically winter crops like wheat need larger amounts of phosphorous. If the field was previously planted for wheat, the field will probably not need to be fertilized with phosphorous.

Potassium is also an important nutrient. Potassium is needed in larger amounts in the plant, especially during the period while the bolls are being set on the plant. Potassium is important in the pH balance of the plant's cells and for enzyme production. Potassium is taken directly into the roots without the assistance of fungi or other organisms. Desired potassium levels in soil for cotton vary according to the soil's CEC. These charged particles are important near the roots because the roots will be attracted to some particles and repel other particles.

Another group of soil nutrients needed by plants are secondary macronutrients: calcium, magnesium, and sulfur. Secondary nutrients are typically applied in the fertilizer but a soil test should be done to determine if sufficient amounts of each element are present in the soil.

Calcium helps strengthen cell walls, increase plant growth, produce proteins, move carbohydrates, and balance cell acidity. A calcium deficiency makes the plant more susceptible to diseases and leads to weaker plant stalks. Magnesium is used in making chlorophyll in the plant. Chlorophyll is needed in photosynthesis, the conversion of sunlight into plant food. Sulfur is used in producing certain amino acids, which are the smaller particles that make up protein.

A third classification of soil nutrients is micronutrients. These nutrients are needed in the plant in very small amounts. Micronutrients are rarely applied as fertilizer because the soil generally has a sufficient amount naturally. Common micronutrients are boron, molybdenum, zinc, iron, manganese, copper, and chlorine.

Boron is important in cell formation and in the production of fruit by the plant. Boron is usually plentiful in southern soils but found less in soils in northern cotton producing areas like Missouri. Soil moisture has a direct influence on boron availability to plants. As soils become drier, boron becomes less available to the plant.

Summary

Careful consideration should be given to the field conditions when considering growing cotton. Previous crops, moisture, irrigation, and other factors should be considered. A soil test can reveal information about soil nutrients. Macronutrients such as nitrogen, phosphorous, and potassium are very important to the plant, as is the micronutrient boron. Secondary nutrients are nutrients needed in smaller amounts, including calcium, magnesium, and sulfur. A third group of nutrients, called micronutrients, are needed by the

plants in very small amounts. Micronutrients in soil include boron, molybdenum, zinc, iron, manganese, copper, and chlorine.

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Lesson 2: Selecting a Variety

Once the decision has been made to plant cotton, a producer must choose which variety to plant. Due to research in cotton production and cotton growing conditions, many cotton seed varieties are available. With the help of cotton consultants, producers can make decisions about cotton varieties and disease management.

Cotton Consultants

To produce a high-quality cotton crop, many factors need to be controlled and/or managed. Finding the answer to these questions and finding the pertinent information may require more time than the producer has available. For this reason, many cotton producers employ cotton consultants.

Cotton consultants are hired professionals who aid producers in making correct management decisions based on local conditions. Cotton consultants are asked to perform a variety of tasks, including recommendations for variety selection, pest control, irrigation and water management, soil fertility determination, cotton classification, gin selection, and product marketing. They are often contacted during the growing season to evaluate growing fields for insect infestations, soil fertility problems, irrigation scheduling, and other problems. The consultant offers solutions to problems including alternative methods of solving the problem.

Selecting a Cotton Variety

Many factors are involved in selecting a cotton variety, including yield ability, maturity, plant size, hairiness, transgenes, fiber properties, seed size, herbicide program, tolerance, cost, and insects. Many producers select more than one variety of seed and use different varieties in different fields according to the conditions of each particular field. The variety selected should come from consultant recommendations and local production data.

Yield ability is perhaps the most important consideration in selecting a cotton variety. Yield ability is the total production of a variety of saleable cotton, which in turn determines crop income. How much cotton a variety produces varies from state to state, county to county, depending on local growing conditions.

Plant maturity is determined by the average number of growing days needed from seeding to harvest for the variety. Local climate information is important in deciding when the crop will mature. If the average planting date is known, the harvesting date can be determined by knowing how long a variety takes to mature. Cotton bolls need to open during hot, dry days, not during rain; rain will stain cotton. If August is normally a rainy month, a variety that will open its bolls in September is preferred.

Plant size is a measure of how tall the cotton plant will grow upon maturity. Cotton varieties differ in total plant height. Too much vegetative growth (plant height) will reduce boll production and cause harvesting problems. Growth regulators are sometimes used to limit plant height but is a cost that can be reduced or eliminated by selecting a shorter variety.

Some cotton varieties have hairs growing on the leaves. These hairs can pose a problem in harvesting by getting into the cotton fibers or lint and decreasing the cotton's value. Some varieties have smooth or semi-smooth leaves that reduce the amount of trash in the lint. Missouri does not typically grow varieties that have hair.

Transgenes refer to the varieties of cotton that have been developed that are resistant to particular herbicides like Roundup, Bromoxynil, and Buctril 4EC. These transgenic varieties enable producers to kill weeds with the herbicides without affecting the health of the cotton plant. These varieties are more expensive, however, and not as readily available. Varieties resistant to particular insects have also been developed and reduce the cost of insect control.

Fiber properties include staple length (fiber length), color, cleanliness, uniformity, fiber strength, elongation (how much a fiber will stretch before breaking), and fiber diameter.

Seed size is important in the ginning process because very small seeds are difficult to separate from the lint. Seed size also determines the number of seeds per pound, which is important in purchasing seed.

The herbicide program used to kill weeds should also be considered when selecting cotton variety. As mentioned, transgenic varieties are resistant to certain herbicides. Additionally, some varieties do

not compete as well with weeds as others. Knowing the weed history of the field is important.

Tolerance is another important factor to consider. Certain varieties seem to withstand damage from insects better. Tolerance also relates to how well the plant is able to withstand stress during the growth stages.

One of the biggest concerns for producers is the cost of the seed. Although some older varieties are less expensive, many new varieties are more productive and offset the cost. In addition, transgenic seeds cost more but allow for different management practices in pest control that may be more cost effective.

Insect resistance is an important factor in selecting a cotton variety. There are many insects that may infest cotton. Spraying for harmful insects unfortunately can kill beneficial insects. Also, harmful insects return sooner after spraying than beneficial insects, making the problem even worse.

Cotton Diseases

Cotton diseases are commonly caused by fungi, nematodes, and bacteria. The most common diseases found in cotton grown in Missouri include seedling disease, boll rots, bacterial blight, leaf spots, *Cercospora gossypina*, *Alternaria*, Fusarium wilt, Verticillium wilt, root knot nematode, Reniform nematode, and Lance nematode. Symptoms include stunted growth, poor color, reduced vigor, lower yields, and death. So far there are no varieties immune to all or even most cotton diseases. There are, however, varieties that have limited levels of resistance to certain cotton diseases, like root knot nematode, Fusarium wilt, and Verticillium wilt.

Seedlings are especially susceptible to diseases and usually die. Older plants are able to survive some diseases but with reduced production. Chemicals applied to the seed before planting aid in managing seedling diseases. Most cotton seed is treated with a fungicide.

A plant's ability to withstand disease is also relative to the amount of stress on the plant. Plants stressed from weather (drought or too much rain), too little fertilizer, air pollution, or chemical injury are more susceptible to disease.

There are several methods for managing cotton diseases. The three most common include rotating crops and crop varieties, planting resistant varieties, and planting in warm, well-drained soil. Integrating all three is the most effective method of reducing and controlling cotton diseases.

Fungicide can be applied to the seed, sprayed onto the plant, or injected into the ground after the plant is growing to fight several common cotton diseases.

Summary

Selecting the variety of cotton to plant is based on a number of factors. Utilizing a cotton consultant can make decisions much simpler. The variety selected should be based upon the cotton's yield ability, maturity, plant size, hairiness, transgenes, fiber properties, seed size, herbicide program, tolerance, cost, and insect problems. There are also many diseases that can affect cotton in Missouri: seedling disease, boll rots, bacterial blight, leaf spots, *Cercospora gossypina*, *Alternaria*, Fusarium wilt, Verticillium wilt, root knot nematode, Reniform nematode, and Lance nematode. Careful management can reduce these disease problems.

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Lesson 3: Tilling and Planting the Crop

Preparing the soil for seeding is an important task in producing any crop, and cotton is no exception. Many factors need to be considered when preparing the field for cotton seeding.

Seedbed Preparation

Correct cotton seedbed preparation means preparing a seedbed that is firm, well drained, free of vegetative growth like weeds, and provides a proper environment for the cotton seed to grow. For the cotton seed to germinate properly, the seedbed needs to be prepared for optimal growth. There are two main types of seedbed bed cultivation and seeding - conventional tillage with seeding and conservation tillage.

Conventional tillage for cotton involves plowing fields after fall harvest to shred stalks from the previous crop and mix them into the soil for use as fertilizer. Spring tillage may involve deep subsoil chiseling to break up hardpan clay. Disk and chisel plows follow these operations in the spring to mix any remaining residue and to incorporate herbicides into the soil. Next, beds are formed using a "hipper," a specialized tillage implement that mounds soil in rows leaving an irrigation trough between the mounded rows. Cotton seed is planted in the peak of the mounded rows, which restricts the root growth of the growing plants. Raised beds allow the soil to receive more sunshine, warming the soil and increasing germination. This procedure should be done 2 to 3 weeks before planting to allow rainfall to settle the soil. Table 3.1 outlines the advantages and disadvantages of conventional tillage operations.

Conservation, or reduced, tillage is also used to prepare cotton fields for seeding. The two methods, reduced tillage and no-till cotton, have met with mixed results. The advantages of conservation tillage methods include labor and fuel savings with fewer trips needed over the field. In reduced tillage and no-till, the crop is seeded directly into the mounds from the previous season. Fertilizer and herbicides are generally applied at the same time, along with insecticides and fungicides if needed.

A special planter is used for no-till seeding. The planter cuts through the crop residue, places the seed, covers the seed, and firms the soil over the seed. Stubble left from crop residue protects the seedlings from wind and sand.

Table 3.1 - Conventional Tillage Operations for Cotton

Tillage	Purpose	Advantages	Disadvantages
Shred stalks in fall	Allows stalk to decompose and reduce insect overwintering sites	Can reduce insect pressure the following season	None
Disk in fall	Mixes residue into top layer of soil	Hastens decomposition of residue	Less residue on soil surface can allow blowing soil in spring
Deep subsoil	Break traffic pan layer	Can improve rooting and water infiltration	Costly operation and pan traffic may reform if soil is tilled while wet after subsoiling
Disk/chisel in spring	Mixes residue in top layer of soil and/or herbicide incorporation	Removes any winter weed growth	Less residue on soil surface can permit blowing soil; traffic pan can reform if disking occurs while soil is wet
Form beds with "hipper"	Provides a fresh bed to plant on	Allows the soil to warm up before planting	May reduce surface drainage and require water furrows in some poorly drained fields

Row and Seed Spacing

Once the seedbed has been prepared, the producer is ready to begin seeding. To seed the crop, the proper seeding rate and row spacing should be determined. Row spacing for cotton ranges from 30 to 38 inches apart. Some research has been done on rows narrower than 30 inches but with diminished yields resulting. Row spacing is set by adjusting the planter units on the row crop planter. Seed spacing is generally set to place the seeds from 2 to 4 inches apart, or 3 to 4 plants per foot.

Another factor affecting seeding rate is seed germination, or the percentage of seeds that will actually grow. Typical cotton germination is about 80%. Most producers drop one extra seed per foot to make up for the germination percentage. Seeding rates need to be adjusted higher if the germination percentage of the seed is lower because fewer seeds will actually grow.

Typical seeding rates leave a plant population of 50,000 to 60,000 plants per acre. Overseeding of cotton can cause too many plants to grow, competing for limited water, nutrients, and sunlight. This will result in lower cotton production. Lodging may also occur. In extreme cases, the crop needs to be thinned to allow for maximum production.

Proper seeding depth for cotton is only about ¾ inch deep. The plant will begin to emerge from the soil 7 to 9 days after planting. A problem with cotton is that the seed cannot penetrate a heavy soil crust. This is a result of rain occurring just after seeding, leaving a harder crust on top of the soil. Some producers will increase seeding rate in anticipation of a packing rain.

If low germination occurs, some producers may opt for reseeding, or seeding again directly over the first crop seedlings. Planting rates on the second seeding will be adjusted to a lower rate.

Cotton Planting Calendars

Keeping accurate records is an important management tool in any area of agriculture. Cotton producers use many records. One important record is the cotton planting calendar. The planting calendar allows the producer to base the planting date on expected rainfall, temperatures, and other climate conditions when the cotton bolls are opening and later when the cotton is ready to be harvested.

By using a cotton planting calendar, the producer can maximize the cotton production. Generally, the earlier a cotton crop is planted, the more frost-free days are available for the cotton plant to grow, resulting in increased production. However, as mentioned in previous lessons, cotton should not be planted until soil temperature has reached at least 65°F. Therefore, a balance of early planting with soil temperature considerations should provide maximum production.

Most cotton is planted in Missouri between May 5 and May 15. Cotton planted after May 20 generally shows diminished production due to the shorter growing season.

Summary

Several very important decisions need to be made at or before cotton seeding. The seedbed must be properly prepared for the cotton to grow, and producers must decide whether to use conventional or conservation tillage. Once seeding begins, the planter should be set to provide proper row spacing, and proper seed placement in the soil. Cotton seeds are normally set 3 to 4 inches apart and only about ¾ inch deep in the soil. Cotton planting calendars allow the producer to compare records from prior years and to make more accurate management decisions to optimize growth for the current growing season.

Credits

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Lesson 4: Selecting a Weed Control Program

When producing any crop, a producer's major concern is weeds. Weeds can be present in any growing crop and every effort must be made to control weed growth.

Because cotton is a relatively slow-growing plant, weeds can become easily established without much competition. Weeds grow faster than cotton and can quickly overtake the field. Estimates indicate that chemical weed control can cost producers $5 to $25 per acre beyond crop yield loss.

Factors Influencing a Weed Control Program

Weed control in cotton is not a simple process. When planning a weed control program for cotton, the following factors should be considered: field history, soil type and structure, use of herbicides, and method of application of herbicides.

A field history is needed to evaluate what crops have been planted before, including known weed problems and previous applications of herbicides. The carryover residue of some herbicides can affect the growth and health of the cotton plant. Research in cotton varieties has resulted in the development of transgenic varieties that are resistant to weeds. Prior use of these varieties may have an impact on the weed control method used for the current crop.

Soil type and structure may affect the weed control program selected. Soil type will determine how well the herbicide moves through the soil if injected into the ground, as does soil structure.

Only a limited number of herbicides have been developed specifically for cotton. Most herbicide research is conducted on crops for which millions of acres are planted annually, such as corn, soybeans, and wheat. Cotton accounts for a relatively small acreage compared with those crops. Cotton is a slow-growing broadleaf plant. Therefore, any herbicide designed to kill broadleaf weeds can injure or kill cotton plants. Weeds should not be allowed to grow taller than cotton because spraying the weeds then becomes more difficult and results in damage to the cotton plant. Because cotton is a broadleaf plant, many producers will opt for preplant and pre-emergence herbicides. These herbicides provide effective weed control on the soil surface before cotton germination. Currently, no selective, over-the-top sprayed broadleaf herbicides are effective in controlling weeds without harming the cotton plant. Herbicides designed to control grass-type weeds in cotton are very useful because they do not affect cotton plants.

Method of application for individual types of herbicides should be considered. Some herbicides work well only with certain application methods. For instance, not all herbicides work well in a hooded type sprayer, where a hood directs the chemical onto a specific area on the ground. The directions for application will be shown on the herbicide label; these directions should always be followed.

Weeds Specific to Cotton

Certain weeds are more problematic in cotton fields because they are difficult to control and steal valuable nutrients from the cotton. These common weeds include signalgrass, barnyardgrass, bermudagrass, fall panicum, foxtails, goosegrass, jimsonweed, hemp sesbania, hophornbean copperleaf, lambsquarters, pigweed, crabgrass, nutsedge, Johnsongrass, cockleburs, morningglory, velvetleaf, spurred anoda, and prickly sida.

Grass-type weeds can be controlled with any herbicide containing floumeturon that is applied directly onto the soil. Broadleaf weeds are more difficult to control, especially velvetleaf, prickly sida, and spurred anoda. The herbicide, Command, is especially effective in controlling these weeds.

Effect of Weeds on Cotton Yields

Weeds growing in a cotton field compete with the cotton for the available nutrients, including fertilizer and water. This competition can reduce cotton yield and ultimately producers' income.

The amount of crop loss due to weeds varies according to moisture levels, the soil fertility, and cotton's vegetative growth. If the weeds have more vegetative growth (leaves) than the cotton plant, more sunlight will be absorbed by the weeds instead of the cotton. The growth of the weeds will increase more, while cotton growth slows.

Keeping the weeds out of cotton is especially important just before harvesting, as the weeds will leave seeds and other plant parts in the harvested cotton, further reducing the crop's value.

Weed Control Options

Controlling weeds in cotton involves many different strategies and techniques. Most producers have found that preplant herbicide application will reduce problem weeds as seedlings begin to grow. Application before planting does not impact the cotton plant. Using herbicides to kill growing weeds before planting is sometimes called burn-down because weeds are killed quickly, and fields are left barren.

Most producers also apply herbicides just after planting, before the seedling emerges from the soil. Because cotton is a slow-growing plant, the weeds will generally emerge from the soil first and applying herbicide after planting reduces or kills the growing weeds.

As the cotton plant grows, weed control becomes even more difficult. If the herbicide used is for grass-type weeds, it can be sprayed on the cotton plant without any impact to the cotton. If a broadleaf weed herbicide is being used, care must be exercised to avoid spraying the cotton plant or it will also be injured or die. For this reason, producers will sometimes use a hooded sprayer, which sprays herbicide under a cover and only in the space between rows, not over the top of the crop.

During the growing season, it is important to scout the field for weeds. Scouting involves walking through the crop, looking for growing weeds, and marking on a field map where the weed infestations are located. These areas should be monitored, and when weed infestations become serious, they should be sprayed, not the entire field. Scouting will be discussed in more depth in the next lesson.

Some producers will use between-row cultivation to control weeds. This will kill the weeds growing between the cotton rows. Unfortunately, this does not remove weeds growing very close to plants or directly in the rows.

Research in cotton varieties has resulted in the development of transgenic varieties that are resistant to weeds. Use of herbicides developed for transgenic varieties more effectively control weeds without concern of damage to the cotton plant.

Summary

Careful consideration should be given when developing a weed control program for cotton. Weeds can dramatically decrease cotton production and require careful control strategies. Three common methods of weed control are preplanting, pre-emergence, and spraying between rows of growing cotton.

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Lesson 5: Scouting and Maintaining the Crop

After a producer has planted his or her crop, its growth and development are not guaranteed. The cotton plant requires continual maintenance to keep it free of pests. Sometimes it may be necessary to completely replant the cotton crop. A producer should continually scout the cotton crop and look for pests. If a pest problem is evident, the producer has several options. He or she can implement pest control strategies such as herbicide or pesticide applications. It may also be necessary for a producer to apply a growth regulator if the cotton is unable to adequately control its own growth cycle.

Evaluating the Growing Crop

Once the crop starts growing, several factors need close monitoring. Cotton is not a crop that can be ignored after planting and before harvest. Careful monitoring of the growing crop throughout the season is crucial to its overall health and production. Moisture, plant density, weeds, insects, plant health/soil fertility, and plant growth are all items that should be monitored.

Moisture level is important to a cotton plant. Moisture should be monitored in relation to irrigation and plant needs. If the plant appears to be wilting, more water is needed. Too much water, however, can limit the overall growth of the plant due to a lack of oxygen to the plant roots.

Plant density (spacing) can also affect the health and yield of the crop. If plants are too closely spaced, they will compete for limited water and nutrients. If plants are too widely spaced apart, replanting should be considered. Cotton seedlings should emerge in about 5 days. A crop that emerges in 5 days has a better chance of survival than a crop that takes longer, even as little as 3 days more. A crop that takes 10 days to emerge is more likely to produce only about one-third of the crop that emerges in 5 days.

The stage of growth and development of existing weeds should be considered when evaluating a cotton field. If weed populations are light, control and treatment are probably not immediately necessary. However, weed populations vary throughout the growing season. What may not be a problem now can become a problem in as little as a few days. If weed populations are heavy, control programs should be implemented.

Insect population resulting in plant damage should be carefully monitored. If insect populations are light, keep monitoring the crop. If insect populations are heavy, consider implementing an insect control program.

The overall health of the plant should be monitored throughout the growing season. The health of the plant is an indication of any soil fertility issues. If plants appear to be green and healthy, soil fertility is probably not a concern. If overall plant health begins to diminish, consider soil testing to determine what plants are lacking.

How the plant uses extra nutrients is another factor to monitor. Early in the plant's life, vegetative green growth is more common, while reproductive growth occurs later in the plant's life. Too much vegetative growth will limit the production of cotton lint. Too little vegetative growth may indicate plant stress.

To determine these factors, a scouting program should be used. Scouting is a systematic and regular inspection of the cotton field for insects and their damage. Scouting can also include determining levels of weeds, plant vigor, water needs, and other factors. Further discussion of scouting will follow later in this lesson when discussing insect pressure.

Plant mapping is an effective technique that growers can use to ensure that they keep their crop on schedule. By quantifying several growth parameters of the cotton plant, growers and consultants can identify potential problems or opportunities for managing their cotton. This requires the time and effort to collect and interpret simple plant maps. Sampling a cotton field involves going to four areas of a field and measuring five plants in each area. Three sampling periods are important: prebloom, bloom, and postbloom. (Detailed guidelines for plant mapping is available in the University of Missouri Extension publication, *Cotton Plant Development and Plant Mapping*, G4268.)

Replanting Considerations

The main concern of producers once the plant has begun to emerge from the ground is the quality of the stand. All cotton seeds planted will not grow

into plants. Although seed germination percentage is used in variety selection and to determine seeding rate, the field may still appear to have uneven stands.

To determine if replanting is appropriate, remember that the ideal seeding for cotton is three to four plants growing per foot. If the average of the field is slightly less than that, replanting is probably not appropriate. If the field appears to have much less than three to four plants per foot, serious consideration should be given to replanting.

Replanting decisions should be based mostly on economic and financial factors. Just because a field looks uneven does not justify replanting.

The most important factor to consider is timing. If the decision to replant is made too late, the crop will not have enough growing days to produce, making the second seeding a waste of seed, time, and money.

The producer must realize that the added cost of replanting may exceed the projected income from the harvested crop. Replanting also causes minor damage to the existing plants. Many plants will recover, but some will not, impacting the seeding rate on the second seeding. No matter how heavy or light the crop appears at seedling time, the field will always look better later in the season as plants continue to grow. Thin spots in the field will not look as thin later.

Weed Considerations

Good weed control is more difficult to achieve in cotton than in corn or soybeans because cotton grows more slowly and herbicide options are limited. Determining whether to use herbicide or mechanical removal of weeds during the plant's vegetative and reproductive growth stages is a difficult decision. Weeds compete with the plant for nutrients and water. Weeds can be especially harmful during the reproductive stage because the cotton plant needs even more nutrients when the cotton bolls begin filling. Once the bolls begin to open, the amount of nutrients the plant needs begins to diminish; weeds have less of an effect on the plant at this time.

A producer should take several steps in making the decision to use herbicides or mechanical removal of weeds.

- Analyze the height of the weeds in relation to the height of the cotton plant. Will the herbicide make more contact with the cotton than with the weeds and damage the cotton plant?

- Determine the density of weeds in relation to the density of the cotton. If there are more weed plants per square foot than cotton, treatment is highly recommended.

- Determine the impact on the crop if mechanical removal methods are used. Can enough plants withstand the stress of cultivation to maintain a profitable crop?

- If vegetative growth appears to be stunted or diminished, consider a weed control treatment. Vegetative growth leads to reproductive growth and overall plant health.

Insect Considerations

As a crop, cotton can be damaged by a number of insects. If insects are not properly controlled during the growth season, overall yield or production can be reduced 25 to 85%. In addition, insects can diminish crop quality by feeding on the lint and seeds or by delaying crop maturity.

To determine the amount of pest damage in a crop, fields should be scouted at least once a week and more often during the flowering stage when the plant is most susceptible to insect damage. As stated earlier in this lesson, scouting is a systematic and regular inspection of the cotton field for insects and their damage. The purpose of scouting is to get an accurate estimate of the types and numbers of insects in the field by checking a limited number of plants.

By knowing the type, number, and location of insects and damage within a field, a producer can make sound decisions about insect management and justify the time and expense of scouting.

There are some general guidelines to follow when scouting a field.

1. At planting, place boll weevil traps. Place a minimum of one trap per 50 acres.

2. From emergence of the plant until the plant makes the third true leaf
   a. Check for thrips, cutworms, mites, and aphids.
   b. Make initial stand counts.
   c. Check boll weevil traps weekly.
3. From the third true leaf until the fifth node stage
   a. Check terminals (end of plant stems) for eggs, larvae, and weevils.
   b. Check for damage on plants by plant bugs and weevils.
   c. Sweep the borders of the field for plant bugs.
   d. Record node height and position of pinhead squares (square-shaped part of the stem at the fifth stage).
4. From fifth node to first bloom
   a. Remove and store boll weevil traps.
   b. Check terminals for eggs and larvae (minimum of 25 plants per field).
   c. Calculate percent square set (check minimum of 25 plants per field). The square is the unopened flower bud on the cotton plant. Count the squares on the top five fruiting nodes and assess percent set.
   d. Begin sampling 100 green squares per field when 15% of squares reach one-third grown or larger. Check these squares for boll weevil, bollworm or plant bug damage.
   e. Assess weekly mean node height and mean number of squares per acre.
   f. Count number of plant bugs and beneficials per 100 sweeps per field using a sweep net.
5. Post first bloom
   a. Pull one-third grown or larger squares (100 per field minimum) for worm and weevil damage counts.
   b. Check top 6 inches of plant for eggs and larvae.
   c. Check whole plants (10 to 20 per field) for eggs, egg masses, and boll damage.
   d. Check blooms for weevils, worms, and clouded plant bugs.
   e. Assess weekly number of squares and bolls per acre.

Correct identification of the insects that can cause damage to the cotton plant is essential. Once the insects have been identified, knowing a threshold level for each insect is important.

- Cutworms - if the cotton plant stand is reduced to fewer than three plants per row foot
- Thrips - one or more thrips per plant are found on seedling cotton (Thrips are extremely hard to find due to size and mobility. Large numbers of damaged plants are an indicator of thrip presence.)
- Fleahoppers - one plant bug found per 10 feet of row (not usually a problem in cotton in Missouri)
- Boll weevils
  With traps: one trap per 10 acres, clustered with other traps (four traps for 40 acres clustered together) Threshold is two per trap per week prior to emergence.
  Without traps: threshold level is 10% of squares damaged the first 2 weeks in July, 15% of squares damaged in the last 2 weeks in July, and 20% of the squares damaged in August
- Bollworms - 10% of bolls damaged by moth flight
- Aphids - low populations start to increase
- Spider mites - if 50% of leaves are infested
- Clouded plant bugs and Lygus Plant Bug
  1st week of squaring, 6 to 8 plant bugs per hundred squares
  2nd week of squaring, 8 to 10 plant bugs per hundred squares
  3rd week of squaring, 10 to 12 plant bugs per hundred squares
  4th week of squaring, 15 to 18 plant bugs per hundred squares
  After 4th week squaring, not ususally a problem
- Armyworms - 5 egg masses and live larvae per 100 plants, or 4 or more worms in 100 blooms and bolls
- Whiteflies - when 50% or more of the plants are infested (not a problem in Missouri)
- Root worm nematodes - found in the soil, testing of the soil is necessary

An important component of insect control is the use of integrated pest management (IPM). Integrated pest management is the use of natural predators of harmful insects to control pests. The use of IPM can reduce the cost of pesticides to the producer. Beneficial insects unfortunately tend to be specific to a particular insect pest. Multiple beneficial insects may be needed and can be purchased; however, this is not practical in most cases. IPM's major advantage over chemical use is that the insects are specifically targeted. However, if chemical control is used, many of the beneficial insects will also be killed.

Growth Regulators

There are times in the life cycle of a cotton plant when the producer may want to control the growth of the cotton. Cotton's growth is managed using compounds called growth regulators. By nature, cotton has its own built-in growth control mechanism that is usually adequate in unstressed plants. Growth regulators are generally necessary because cotton is naturally a semi-tropical plant, preferring climates not found in cotton producing areas. The farther north cotton is produced, the more crucial the supply of boron becomes. Boron, a micronutrient, performs a key function in the growth and fruiting process. This is why it is so important to the plant. Boron allows the plant to transfer sugars from leaves to the fruit.

If the plant is under insect stress, growth regulators are needed. The most effective plant growth regulator is used when the plant begins to produce fruit. This regulator naturally slows vegetative growth and encourages reproductive growth. Growth regulators are generally used during early bloom to speed up the flowering process. This provides for more a more uniform flowering and harvesting. Common growth regulators used in cotton production today are PIX (Mepiquat Chloride), which is used to shorten plants, and PGR IV, Maxxon, and Cytokin, which are used to help roots develop and bolls set.

Summary

Cotton is a crop that requires intense management during the growing season. The crop must be regularly scouted and evaluated for moisture, plant density, weeds, insects, plant health/fertility, and plant growth. Replanting decisions should be based primarily on economic and financial factors. Replanting may exceed the projected income. Management decisions regarding weed and insect infestations have to consider the pressure that the cotton plant can withstand. Growth regulators may be necessary in the northern portion of the growing region to encourage reproductive growth.

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Lesson 6: Harvesting the Crop

After spending the entire season monitoring and managing a crop, every producer is eager to harvest. Harvesting any crop is a stressful time due to the crucial management decisions to be made. Deciding when to harvest is just one of the many management decisions a producer needs to make. Cotton is generally harvested when a high percentage of the bolls are open and the leaves have fallen off the plant.

Factors Determining Harvest Timing

Cotton harvesting generally starts in October and can sometimes last through mid-winter. Cool weather and frost can speed up cotton harvesting because cool weather causes leaves to fall off the plant, referred to as defoliation. Leaves can cause problems by clogging mechanical harvesting equipment, which is the most common cotton harvesting method. Defoliation reduces trash and green leaf stain in the harvested lint. This trash is generally from chopped up leaves and other vegetative plant parts harvested with the lint.

To manage harvest time properly, cotton producers use chemicals to defoliate plants. These chemicals are referred to as crop harvest aids. In addition to defoliation, these chemicals suppress further growth and encourage the cotton bolls to open.

Timing of defoliation is crucial to ensure ideal lint quality and optimum yields. Defoliation applications should be timed so that harvesting can keep up with defoliation. Defoliating too early reduces the oil content of the seed and reduces viability and total yield. Defoliating too late may result in diminished results, since the defoliating compounds rely on warmer temperatures to be effective.

Defoliation is typically done when at least 60% of the bolls are open. Defoliants are sprayed directly onto the plants. Correct timing of defoliation can be determined by several different methods. One method involves plant mapping. Plant mapping is analyzing and recording the various growth stages of the plant. Using this method, producers apply defoliants when plants have at least four nodes above the lowest cracked boll (a boll showing visible lint). In fields where there are less than two plants per foot per row, the number of necessary nodes decreases to only three. The plants have reached the end of the effective boll loading period or "cutout" at this time.

Another method of determining defoliant timing is to count the number of nodes above the white flower. Commonly called NAWF (nodes above white flower), Missouri producers find this method to be very reliable. The NAWF occurs at or near the eight or ninth node. An NAWF of five usually occurs around August 10 to 12 and indicates correct timing for defoliation.

After defoliation, it normally takes the boll approximately 4 to 6 weeks or 750 to 850 heat units to mature. Cool temperatures increase this time frame. Other factors that determine timing of defoliation include boll firmness, percent of open bolls, seed coat coloration, heat unit accumulation (a weather measurement), and visual assessment. Generally, the 60% open bolls rule is followed for determining defoliation, and later, harvesting.

The timing of the harvest also affects the harvest method used. Harvesting the cotton crop can be accomplished using two different methods. Some producers prefer the once-over method of harvesting; all cotton bolls are harvested at the same time. Usually this method reduces time, fuel, labor, and other harvesting costs. The two-harvest approach has an early harvest of those bolls ready for harvest and then a later harvest of the rest of the bolls. A second harvest operation is more expensive but the potential return may justify the cost.

Harvesting the Cotton

Historically, much of the cotton grown in our country was harvested by hand, a laborious, painstaking task. The most common method of harvesting cotton today in much of the United States is with a mechanical cotton picker.

Cotton pickers are a product of advanced engineering. The cotton picker has spindles that pull the fiber from the boll, remove the trash and lint, and cut the fibers away from the seeds. Later in the ginning process, the seeds are removed and processed.

The cotton picker is a row-crop harvester and harvests each row separately. Generally, cotton pickers are limited in width due to the complexity

than one row picker is used at the same time in the a field.

A cotton stripper is used in some areas of Texas and Oklahoma where the stalks do not grow very tall. The cotton stripper plucks the entire boll from the stalk rather than picking the fiber from the boll like a cotton picker. When a cotton stripper is used, all bolls should be open. The stem is destroyed as the bolls are striped from the plant. Multiple harvests of the same plant are not possible and unopened bolls are lost. The ginning process cleans the stems and other plant debris from the lint.

Cotton should be harvested when the dew leaves the field and stopped when the dew returns in the evening. Cotton with a moisture content lower than 12% can be harvested and stored without mold damage. Many cotton pickers have moisture monitors on the machine to detect the moisture level in the cotton. If a moisture meter is not used, moisture level can be determined by biting the cotton seed. If the seed cracks, the moisture is low enough for the crop to be harvested.

Crop Losses During Harvest

As with harvesting any crop, reducing crop loss is an important consideration. Most crop losses are due to the improper condition of the cotton picker. Worn or damaged spindles can result in crop loss.

Misalignment and misadjustment of the spindles to moisture pads and doffers reduce the efficiency of the picker, also resulting in crop loss. Improperly adjusted spindles will leave some cotton on the spindle, twisting and damaging the fibers.

Excessive trash in the lint can reduce its value. Trash in the lint can be caused by incomplete defoliation where leaves are taken into the picker with the lint. Picking units and basket grates should be cleaned regularly with the trash and low-quality fibers discarded.

Storing Cotton

Once the cotton is harvested, the lint is usually stored for a short time prior to ginning. A common method of storing lint for short periods is in a unit called a module. Modules are bundled lint, covered with water-resistant tarps, stored in the field.

Modules should be monitored for moisture content during the first 5 to 7 days. If moisture levels are too high, the internal temperature of the module will begin to rise. A rapid and continuous rise in temperature of 15 to 20 degrees indicates too much moisture, and the module will need to be ginned as soon as possible. If the internal temperature of the module exceeds 110°F, the module must be ginned immediately.

Place modules in a field location that is relatively free of gravel, stalks, and other debris to prevent these items from working into the lint and reducing the quality. Modules should be placed on well-drained sites that are accessible during wet weather by module trucks or the producer.

Summary

If proper management decisions are made during cotton harvest, a high-quality crop will be the result. Harvesting not only involves the actual picking of the cotton, but also the planned defoliation. The use of defoliants will increase the value of the crop by reducing the amount of trash from chopped-up leaves. Once the cotton is harvested, modules are used for short-term storage. These tarp-covered cotton bundles are stored in the field.

Credits

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Lesson 7: Marketing the Crop

The final step in the harvesting of the cotton crop is marketing. Cotton is unique in the various methods used in marketing the crop. A producer has various options to consider and often these decisions must be made well in advance of the harvest.

Marketing Cotton

The first step in marketing the cotton is to schedule a gin. Ginning is the process of separating the lint and seed. It also includes drying the cotton and cleaning the lint to remove trash. After the cotton was harvested, the raw cotton was probably placed into modules and stored in the field. Depending on the moisture level and the temperature rise in the module, the gin should be scheduled as quickly as possible.

It will be necessary to call the local cotton processor to schedule a time to process the crop. It may be necessary to negotiate times, price, and transportation of the modules. Once the gin is scheduled, the cotton is delivered and processed.

The price received by the producer for the ginned cotton and cottonseed oil can be determined using two different markets - the cash market or forward pricing, using cash contracting or hedging.

Cash market pricing relies strictly on the current market price. Generally, like most crops, the price of cotton is at the lowest price of the year during harvest due to the excess supply compared to the demand.

Some producers will opt to contract their crop. The crop is contracted with an established price at a prior date to the actual processing and delivery. With cash contracting, a sale price is firmly established and does not reflect fluctuations in the cash market at harvest time. Cash contracting has disadvantages. If the market moves upward to higher prices at harvest, the producer will receive only the negotiated price. Also, if the producer experiences crop disasters or failures, the negotiated amount of the crop is expected to be sold, and the producer may be required to purchase cotton to meet the contract.

Some producers will pursue hedging, or using the futures market. Hedging is a complex procedure where the producer first sells contracts, or a set quality and quantity of cotton. As the season progresses, the producer must later buy the same number of contracts back, hopefully at a lower price, to get out of the futures market. Hedging allows the producer to use basis, or the difference between futures and cash price, to strive for a profit. Unfortunately, for every person making money in the futures market someone loses money, so there is great risk. The futures market should not be used by the inexperienced person due to the great risk.

Cotton Quality Factors

The price the producer received for cotton is especially dependent upon quality. Standards have been established by the U.S. Department of Agriculture to ensure uniformity in grading, resulting in standard quality and pricing that are consistent throughout the world. Cotton quality is measured by many different factors.

One factor that determines cotton quality is color grade. Color refers to the degree of whiteness and yellow in the lint. Ideally, lint would be pure white, but it can be discolored due to improper defoliation and wet weather damage to the crop. Color grades include white, light-spotted, spotted, tinged, and yellow-stained.

Another important factor in cotton quality is fiber length. Fiber length is typically measured by computerized machines and is given in lengths of thirty-seconds and hundredths of an inch. Longer fibers are more desirable, making the spinning process more efficient with stronger, more uniform yarn.

Measurements are taken on the cotton with an instrument called a micronaire to determine the diameter or fineness of the cotton fiber. Fiber diameter affects yarn appearance, uniformity, and strength. Finer diameters are preferable.

Strength of the fiber is a factor in cotton pricing and is relative to the variety of cotton raised. Cotton fibers are clamped between two jaws 1/8 inch apart, and the fiber is stretched until breaking. Measurements of cotton strength are reported in grams per tex. A tex is equal to the weight in grams of 1,000 meters of fiber. Fiber strength directly relates to yarn and fabric strength, and spinning efficiency.

Length uniformity measures the uniformity of the length of the fibers in a sample. Fiber length uniformity is related to uniformity of the yarn, spinning efficiency, and overall yarn strength.

As mentioned in the last lesson, having trash in the cotton is not desirable. When cotton is graded, a trash measurement is taken using a machine called a video trashmeter, which measures the percentage of trash on a cotton sample's surface. This sample measurement will provide an estimate of the total amount of waste in the cotton bale.

Cotton Checkoff Program

Much like other crops, cotton is supported by money from the federal Farm Bill. Cotton checkoff dollars originated in the U.S. Farm Bill, with the first inclusion in the Farm Bill of 1967.

Cotton checkoff dollars are funds raised from the sale of cotton in the United States. Each time cotton is sold, a set amount of money is charged against the sale, with the funds collected by a controlling agency. With cotton, the money is sent to the U. S. Cotton Board and is administered from that office. Typically, the amount charged to the sale amounts to about ½¢ for a man's cotton shirt. Foreign imports contribute more to the fund, sometimes twice as much.

Cotton checkoff funds are used for advertising and marketing to help cotton compete with artificial fibers and to maintain and expand domestic and foreign markets for U.S. cotton. Funds are also used for research to develop new seed varieties, herbicides and pesticides, and methods of processing.

Although there is some opposition to the checkoff program, millions of dollars are raised each year to help the cotton industry. As a result, cotton consumption has steadily increased each year since the inception of the program.

Summary

The marketing process used in the cotton industry is very complex. Unlike many other crops, cotton is often contracted for price well in advance of harvest. Producers can also choose the local cash price or can opt to use the futures market but must be aware of the risk of the futures market changing. Cotton pricing reflects the quality of the cotton, and cotton is graded on color, fiber length, fiber diameter, fiber strength, trash, and uniformity of the fiber length. The cotton checkoff program provides funds for research and to promote the cotton industry.

Credits

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Lesson 8: Figuring Crop Costs

Once the crop has been harvested, the producer must determine his or her profit from the crop. To determine profit, an accurate listing of costs must be assembled. Costs can be broken down into two categories: variable and fixed.

Variable Costs

Variable costs of cotton are those costs associated with inputs necessary to produce a specific crop yield calculated on a cost-per-acre basis. By figuring the cost per acre, the producer realizes a profit or loss for each field. By knowing the profit or loss of each field, the producer can decide if another crop should be considered for that particular field. Seed, fertilizer, chemicals, fuel and oil, labor, harvesting, and interest on borrowed capital are all variable costs associated with cotton production.

Seed costs can vary depending on seeding rate, the number of times the field was seeded, and the variety of seed purchased. Seed from varieties used for a number of years will tend to be less expensive. Newer, transgenic varieties will be more expensive due to the company's need to recover research costs in developing these varieties. However, the added cost of the seed may be offset in the reduced cost of weed control. Another factor to consider in seed cost is the quality of cotton produced by a particular variety. Varieties producing higher-quality lint will generally be more expensive but result in higher profits.

Fertilizer costs vary since the condition of each field is different. To determine fertilizer requirements accurately a soil test should be taken. Recommendations from the test results can be used to estimate costs.

Chemicals are used extensively in crop production. These variable costs are often recorded separately so producers can realize where the most or least dollars are being spent. Common types of chemicals used in cotton production are insecticides, fungicide, growth regulators, and defoliants.

Insecticides can dramatically add to the total variable costs if insect problems are significant. A thorough scouting program can accurately monitor insect populations. Timely applications of insecticides before insects become a severe problem will reduce costs.

Herbicide costs also vary from field to field, because different fields will not have the same level of weed problems. Significant weed problems can be determined at the same time as insect scouting and appropriate measures can be taken. Cotton herbicides are fairly expensive; applications should be timed to gain the most value in production but limited to control costs.

Fungicides are generally only applied before or at seeding time. Occasionally, fungal problems are severe enough to warrant a second application on growing crops and added costs will result.

Growth regulators are used to control vegetative growth, speed up plant blooming, and help retain bolls. The number of applications of these chemicals depends on crop management plans and the weather. These costs should be figured into the variable costs of the crop.

Harvest aids (defoliants and boll openers) are used to chemically remove the leaves from the plant and force bolls to open in a uniform manner. This causes the plant to focus on blooming, thus decreasing the time until harvest. Defoliants are usually only applied once but are considered a critical harvest aid for Missouri's cotton production. Using a combination of these harvest aid chemicals can reduce variable costs by as much as $30 per acre as only once-over harvest is needed.

Other variable costs that must be closely monitored are fuel and oil. A record should be kept of all fuel and oil used in cotton crop operations. To determine the cost per acre for fuel and oil, total costs are divided by the total cotton acres. Any other regular maintenance of machinery should also be figured.

One commonly omitted factor in agricultural operations is the cost of labor. Many producers include the cost of hired labor, including crop consultants, scouting services, and other hired services but fail to include their own time into the costs. Producers must recognize that their own time is worth as much, or more, than any of the hired services and should be included in the variable costs of the operation.

Harvesting costs should be included in the variable costs, whether one is using the producer's machinery or hiring someone else to harvest the crop. If the producer's own machinery is used, the wear and tear costs should be included because they will cost the owner/producer money to fix and maintain them.

Ginning the cotton is considered a variable cost. If the crop were not produced, obviously this cost would not be needed. Ginning costs are generally charged to the producer by weight, not acreage, so an average yield needs to be determined (production per acre) to establish the cost per acre on an individual lot of ginned cotton. This allows the producer to determine the costs on each individual field. Although not as accurate, most producers just divide the total cost of ginning by the number of acres to determine the cost per acre of all fields. This method does not give the costs per each field. Transporting the modules of cotton from the field to the gin is included in the ginning fee.

If the cotton has to be stored, and the storage facility is rented, a variable cost will result. Many producers will store the raw or ginned cotton until later dates to maximize profits, since the price of cotton is generally lowest at harvest time. However, the crop may diminish in value due to storage.

In production agriculture, income from a crop is usually received only once or a few times a year. Some producers may need to borrow money in the form of an operating loan to pay expenses during the growing season and repay the loan when the crop is sold. Any interest on this borrowed money would be considered a variable cost, since the interest would not be there if the crop were not produced, and the money had not been borrowed.

Any other costs that occur during the growing season due to producing the crop are considered variable costs.

Fixed Costs

Fixed costs are costs that do not vary with the level of production. They are generally regarded as whole farm, or whole enterprise costs. Fixed costs are not normally charged on a per-acre basis but should be divided by the number of acres to make profit and loss calculations easier to perform. In some cases fixed costs can amount to more cost per acre than variable costs. Examples of fixes costs include taxes, insurance, loan payments, rental fees, utilities, and depreciation.

Taxes are considered a fixed cost because tax payments must be made regardless of production. The most common type of fixed cost tax would be property taxes, which are charged in many states including Missouri.

Another type of fixed cost is insurance. Producers should carry insurance on the entire operation, especially if hired labor is present. Insurance costs include liability insurance, fire insurance, hail/disaster, and even earthquake or hurricane insurance in certain areas of the country.

Any time money is borrowed to purchase land or machinery, the loan payments would be considered fixed costs. These payments must be made on both land and machinery, regardless of production.

If equipment or land is rented, the payments would be considered a fixed cost, again for the same reason: purchased equipment payments are a fixed cost. Even if the crop is not produced, the rental charges still must be paid.

Farmstead utilities are a fixed expense. Utilities include electricity, sewer, water, and other services used on the farmstead. Caution should be observed when considering utilities, because at times utilities would be considered a variable expense. An example of this would be an electric charge for operating an irrigation pump. If the pump were not used, there would not be a charge. If the pump was used, this expense would be a variable cost and should be figured into that category.

One fixed cost often overlooked is depreciation expense. Depreciation is the decline in value of a piece of machinery or other equipment due to wear, tear, usage, and aging. Although a producer does not pay anyone money for depreciation, money should be set aside in a bank account yearly so that the machine can eventually be replaced with a new model from the money saved in the account from accumulated depreciation expenses. Producers who do not include depreciation expenses in fixed costs are not providing for later equipment replacement. Unfortunately, if the producer is "trying to make ends meet," this is the first expense ignored and not figured into the profit calculations. By not

including replacement equipment costs, the enterprise or operation might show a false, or inflated, profit.

Cost per Acre

Once the fixed and variable costs have been figured, calculating total costs is very important, yet relatively simple. After total fixed and variable costs are calculated, the two costs should be added to get a total cost value.

A total cost value is useful to the producer because it gives the total amount of money spent on the crop. However, if a producer wants to compare with other years, total cost is not that useful, since the number of acres planted in that crop may have changed or inflation may have caused prices to increase substantially.

Total cost is also not very useful when determining the price needed to break even for the crop, because the crop is sold in pounds, which is easily converted to pounds per acre. For these reasons, most producers will divide the total cost by the number of acres planted to get cost per acre.

By knowing cost per acre, the producer can more readily determine a break-even price (divide the cost per acre by total pounds produced per acre). Knowing the break-even price can help the producer determine an acceptable return on investment.

Return on Investment

Once the income and expenses are known, the producer is then able to calculate a profit or loss from the crop or the whole farm. Obviously, producers like to maximize profits. With agricultural prices lower than most producers would like, a determination must be made of what is the acceptable level of profit.

Return on investment can be defined as money received by the producer above costs, which can be used for farmstead improvements or investments. Return on investment is also commonly called "profit," or what supports the farm family through the coming year. If the overall return on investment for the entire farm is not enough to support the family and its lifestyle, decisions and changes must be made.

To determine an acceptable return on investment, several factors should be considered. If the producer needed to borrow money to produce the crop, the return on investment should be sufficient to cover the cost of borrowing the money. In addition, the producer should consider alternative uses for the money compared to investing in a growing crop. As an example, if bank interest rates on certificates of deposit are higher than the return on investment from the crop, raising the crop was probably not a sound financial decision, especially when figuring the stress and decisions of raising the crop compared to investing in certificates of deposits.

Another factor to consider would be whether an alternative crop would raise the return on investment. If another crop had lower costs, and higher income from higher prices, a switch to that commodity might need to be considered.

Like everything else, there are exceptions to the above rules. If the land has never been used to plant cotton, one season may not be enough to evaluate the return on investment accurately. Succeeding years may result in higher returns on investment, due to the producer's experience and more sound management decisions.

Another factor that may affect these rules is abnormal weather conditions. If a drought occurs that particular year, the following years may be closer to normal and return on investment higher.

Government Programs

Cotton is affected by governmental regulations and subsidies. Cotton production, for instance, is addressed in the Farm Bill. Most programs in the Farm Bill are designed to increase production and competition with foreign markets.

The cotton portion of the Farm Bill addresses increased production and paying producers to raise more cotton to compete with the other markets in the world. Producers enrolled in the cotton program receive an incentive payment from the government, which can increase the overall crop income.

Summary

Once the crop is harvested, a financial analysis should be done to evaluate the success of the crop and the producer's decisions. Variable and

fixed costs need to be calculated, which figure into the total costs of the crop. Once total costs are known, the cost per acre can be calculated, allowing the producer to determine what will be an acceptable return on the investment. Finally, because cotton is a part of the federal Farm Bill, there are programs that reward the producer financially for producing cotton and increase the total profit of the crop.

Credits

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