Post Harvest to Preplant

Decisions made in the off-season are vital to cotton production. During this period, growers must make decisions on stalk destruction, tillage practices, fertility, crop rotation, variety selection and pest management.

Stalk destruction

The cotton plant can continue to grow even after harvest aid applications. Regrowth occurs when heat, soil moisture and nutrients are in excess of the developing fruit's demands for carbohydrates.

Because of the potential for regrowth, stalk destruction is an important component of cotton production in Texas. After harvest, stalks must be destroyed to prevent the development of regrowth and fruiting structures (flower buds) for insects to feed upon.

Stalk destruction is more important in the south and eastern parts of the state, where higher rainfall and warmer temperatures occur. In West and North Texas, freezing temperatures often kill the stalk before new fruit is produced.

When field conditions and weather are favorable for tillage, stalks can be shredded and then disked or plowed to destroy the plant. Stubble stalk pullers can also be used to uproot stalks.

Although these mechanical methods are highly successful, many growers are implementing reduced tillage systems to conserve soil moisture and surface residues. Consequently, these producers are using chemicals to terminate plant regrowth. Two methods are being developed for chemical stalk destruction.

Several herbicides are approved for cotton stalk destruction and produce favorable results. Growers must consider these factors when using chemicals to destroy stalks:

- Good spray coverage is essential. You must use the proper spray volume and nozzle orientation over the row.
- The plants must have adequate regrowth so there is enough surface area to absorb the herbicide. This minimal surface area can range from 2 to 8 inches of new stem growth, which can occur within 2 to 3 weeks after stalk shredding.

  Shred the cotton crop to a 4- to 8-inch height above the soil surface to allow uniform regrowth. The maximum regrowth allowable is 8 inches from the base of the stubble to the attachment of the last leaf present. At this point, new leaves should be big enough to receive treatment but not so big that they develop fruiting forms that could host boll weevils.

  Recent research in the Rio Grande Valley indicates that if the bark is roughened at harvest, the percentage of dead plants increases after treatment with 2, 4-D. The 2, 4-D applications should be made as soon as possible after harvest.
- Apply the chemicals only when environmental conditions are favorable. Conditions should encourage rapid growth so that the cotton plants are more susceptible to treatment. Conditions should also be favorable to discourage off-target spray drift.
- The product must not cause problems with successive crops in a crop rotation system. Although many approved chemicals have relatively short soil residuals, others may last for months. This is especially true if the soil stays cool and dry after the herbicide application.
- Because pesticide application is regulated in certain counties, you may need to obtain a permit from the Texas Department of

Agriculture before applying 2,4-D or dicamba to a field during harvest.

The Texas Department of Agriculture currently approves only 2,4-D (Barrage®, Salvo® and Savage®) dicamba (Banvel®, Clarity® and Weedmaster®) and Harmony® Extra for cotton chemical stalk destruction. This was the approved list in 2001 and may change in the future. Producers should be sure to have the most current labels before applying any pesticide.

Tillage practices

Three types of tillage systems are used in Texas: conventional, reduced and conservation. Each system offers advantages and disadvantages. The best system for a particular site depends on soil type, environmental conditions, weed pressure and availability of specialized equipment.

In conventional tillage systems, stalks are usually shredded and then plowed under. In the southern production regions, bolls and squares that are shredded should remain on the ground for 2 to 3 days to dry out. Daytime heating will desiccate (dry out) squares, limiting the survival of developing boll weevils, especially the early instars (immature stages).

The advantages of conventional (clean) tillage systems are that they:

- Provide for good seedbed conditions and allow the use of mechanical tillage to help control weeds.
- Help with disease and insect management at post harvest.
- Destroy food sources and reproduction sites for microorganisms responsible for cotton diseases as the residue is incorporated and decomposed.
- Reduce populations of tobacco budworm, bollworm and pink bollworm. These insects overwinter as pupae (the stage between larva and adult) underground. Disturbing the soil can reduce winter survival and insect emergence in the spring.

A disadvantage of conventional tillage systems is that the residue may encourage the growth of the seedling pathogen *Rhizoctonia solani*. This pathogen is a strong saprophytic (dead plants) colonizer of crop debris, so that in some environments, the presence of cotton crop residue could increase seedling disease in later crops.

Even though conventional tillage approaches have been used for years, economic conditions are causing many producers to shift to reduced tillage systems. Reduced tillage systems allow producers to farm large acreage while minimizing equipment and labor costs. Reduced tillage in this book refers to making fewer trips with tillage tools (moldboard plows, chisel plows, cultivators, etc.) than in a conventional system.

The benefits of reduced tillage systems include protection of the soil from wind and water erosion, reduced fuel and labor inputs, fewer equipment requirements and increased soil moisture retention.

On the other hand, reduced tillage systems may increase the risk of seedling disease in fields where residues do not decompose. Growers can minimize this risk by applying in-furrow granular or liquid fungicides to supplement fungicide treatment on seed.

Conservation tillage is similar to reduced tillage, but the goal is to have 30 percent or more of the field surface covered with crop residue.

One conservation tillage approach used in many irrigated farms in the High Plains is called the terminated small grain system. Rye or wheat is drilled into prepared seedbeds after cotton harvest, and the small grain is terminated with herbicide 2 to 4 weeks before planting the cotton. The standing small grain stubble reduces wind and water erosion and protects the young cotton from wind and sandblasting.

Fertility

A strong cotton fertility program provides the foundation for high yields and good fiber quality. Without adequate nutrients, plant performance will suffer.

Compared to many other crops, cotton has a lower nutrient demand, which generally results in lower annual fertilizer expenditures. Relatively small amounts of nutrients are removed from the field at harvest. However, during the reproductive stages of development, proper fertility is extremely important. Once cotton begins fruiting, nutrient needs increase dramatically.

The primary goal of a cotton fertility program should be to achieve optimum fertilizer use efficiency (FUE), which is the conversion of applied nutrients into harvestable yield.

The first step in attaining a high FUE is to determine what nutrients the plants need to achieve the production level desired. The key to nutrient management and a high FUE is soil testing.

A soil test is an estimate of the nutrient-supplying power of a soil. The test identifies the degree of deficiency or sufficiency of a given nutrient. Although soil testing is not an exact science, it is the best tool available for determining the proper amounts of nutrients necessary to attain a given yield.

However, the information and recommendations provided by any laboratory are only as good as the samples collected. Consequently, good sampling techniques are critical.

The best method for taking soil samples is to collect soil from 12 to 15 locations in each field, mix them together thoroughly and ship the mixture immediately to a soil-testing laboratory.

In conventional tillage systems, collect a standard 0- to 6-inch soil sample. However, in reduced and no-tillage fields, some plant nutrients can become stratified (accumulate in the upper 1 to 3 inches of soil).

For instance, phosphorus (P) is highly subject to stratification in these systems because:

- P is a very immobile, especially in clay soils.
- Reduced tillage limits soil mixing and nutrient incorporation.
- Fertilizer is often applied at or near the surface.
- Crop residues and the nutrients they contain (which have been mined from throughout the rooting zone) are placed on the surface rather than incorporated back into the soil.

Conventional soil sampling techniques (0- to 6-inch depth) do not account for stratification. They may indicate that enough P is available for production, when in fact it may be located in a position in the soil that makes it inaccessible to the plant.

Consequently, to determine if the nutrients have become stratified, take two soil samples. Collect one sample from the 0- to 3-inch depth and another from the 3- to 9-inch zone. Test the soil layers every 3 to 5 years to track nutrient placement in the field.

Growers can eliminate stratification by deep tillage operations and subsurface banding of fertilizer.

The primary nutrients of interest in cotton production are nitrogen (N), P and potassium (K). Secondary nutrients include calcium, magnesium, sulfur and the micronutrients iron, zinc, manganese and copper.

The production of one bale of cotton removes about 50 pounds N, 40 pounds P, 30 pounds K, 2 pounds calcium, 4 pounds magnesium and 3 pounds of sulfur (Table 3.1). Only very small amounts of the micronutrients are required.

Nitrogen is, by far, the most important nutrient for cotton production. If the soil lacks nitrogen, the crop may suffer reduced growth and development, early cutout, lower fruit retention, reduced root health and limited water and nutrient uptake.

Excess N also causes problems, such as delayed maturity, excessive growth, reduced boll retention, greater incidence of boll rot, higher pest insect populations and reduced fiber quality.

When calculating the amount of nitrogen to apply to a field, base your estimates on realistic yield goals. Test the soil every year, and collect

Table 3.1. Typical nutrient content of a bale of cotton.

	Above-Ground Plant (leaves, stems, fruit)	Seed Cotton	Lint
	Pounds per Bale		
Oxygen	2,100	700	250
Carbon	1,650	550	190
Hydrogen	360	120	35
Nitrogen	62	35-40	1
Potash (K_2O)	61	15	3
Phosphate (P_2O_5)	22	13-20	0.3
Calcium	27-62	1	0.2
Magnesium	11-27	5	0.3
Sulfur	8-16	1-2	trace

Source: K. Hake et al. 1991. Cotton Nutrition-N, P and K. Cotton Physiology Today. National Cotton Council Physiology Education Program Newsletter 2 (3): 1-4.

deep samples (0 to 12 inches and/or 12 to 24 inches) when possible to account for N that has accumulated deeper in the soil profile.

Although the deep-sampling approach is uncommon, recent research indicates that N can accumulate with depth. Crediting this N to the total for the field could reduce overall N fertilization needs.

Apply nitrogen fertilizer in a tandem approach by applying 20 to 30 percent of the total N required at preplant and the rest side-dressed at squaring. If the crop is irrigated, you can apply N through the pivot.

In addition to commercial fertilizer, producers can use manures, municipal sludges and other organic amendments to supply nutrients for crop production (Table 3.2).

Along with nutrients, these manures supply valuable organic matter that helps improve soil structure, tilth and workability, as well as water- and nutrient-holding capacities. Manures also increase the activity of beneficial soil microbes (microorganisms).

Table 3.2. Average nutrient values for manure at the time of land application

Source	Dry Matter %	Nitrogen	Phosphorus	Potassium
		Pounds per Ton		
Cow (fresh)	25	15	8	10
Beef (feedlot)	65	27	24	36
Dairy (corrals)	65	28	11	26
Dairy (stockpile)	80	28	12	23
Broiler (litter)	65	58	51	40
Layer	35	30	40	20
Swine	18	10	9	7

Sources: A. C. Mathers, et al. 1973. Effects of cattle feedlot manure on crop yields and soil conditions. Technical Report No. 11. USDA Southwest. Great Plains Research Center. Bushland, TX.

Crop rotation

Crop rotation decisions are usually based on production costs and current market conditions. Cotton fields should be rotated to another crop when soil-borne diseases, nematodes and resistant weeds become significant problems.

Much of the production in the western part of Texas remains continuous cotton culture, with no rotation to other crops. The reasons for remaining in a monoculture include income generation, nutritional efficiency and farm policy.

Depending on local conditions, one possible rotation plan is a 3-year rotation of cotton, grain sorghum or corn, small grains or other crops. Some of the clovers and other soil-building crops may also be used in the rotation program. However, moisture limitations in Texas minimize the use of soil-building crops.

Table 3.3 provides some of the benefits of rotational crops and cotton production.

Weed management

Weed management varies with every production scheme. Many fields in Texas receive preplant-incorporated dinitroaniline herbicides (trifluralin (Treflan®, etc.), pendimethalin (Prowl®, etc.). This herbicide class is used to control pigweed, Russian thistle, kochia and annual grasses.

At planting, herbicide treatments [prometryn (Caparol®, etc.), diuron (Karmex®, etc.), fluometuron (Cotoran®, etc.) or metolachlor (Dual Magnum®, etc.)] are applied to control broadleaf annuals and yellow nutsedge that are unaffected by preplant herbicides.

Another weed-control decision made during the off-season is whether to plant transgenic, herbicide-resistant cotton varieties. The variety chosen should match your specific field and weed problem. Producers who choose these varieties must consider the weed spectrum, varietal adaptation (full-season and/or open-boll types) and technology fees.

Insect management

Every production region in Texas encounters various caterpillar pests. Transgenic cotton varieties have given growers another tool for managing these insects.

The first transgenic plants introduced were developed primarily to control tobacco budworms and pink bollworm (Table 3.4) These plants have a gene from *Bacillus thuringiensis,* a soil bacterium. The gene causes cotton plant cells to produce crystal insecticidal proteins, often referred to as Cry-proteins. The difference in control of bollworms in Table 3.4 between prebloom (90 percent) and blooming (70 percent) cotton is because of reduced expression of the

Table 3.3. Rotation crops and the benefits in reducing soil problems in cotton production.

Rotational Crop	Nematodes: Root-knot	Nematodes: Reniform	Verticillium Wilt	Seedling Diseases	Organic Matter
Wheat + summer fallow	Good	Good	Good	Good	Some
Corn	Good	Good	Good	Good	Good
Grain sorghum	Good	Good	Good	Good	Good
Peanut	Good	–	–	–	Some
Fallow	Some	Some	Some	Some	Minimal

Source: K. Hake et al. 1991. Crop Rotation. *Cotton Physiology Today*. National Cotton Council Cotton Physiology Education Program Newsletter 3(1): 1-4.

Table 3.4. Estimated percent control of various lepidopterous species to the Cry1Ac protein (Bollgard®).

Species	% Control (Percent mortality of larvae)
Bollworm, pre-bloom	90
Bollworm, blooming	70
Tobacco budworm	95
Pink bollworm	99
Cabbage looper	95
Beet armyworm	25
Fall armyworm	20 or less
Saltmarsh caterpillar	85 or more
Cotton leafperforator	85 or more
European corn borer	85 or more

Source: G. C. Moore et al. 2000. *Bt Cotton Technology in Texas: A Practical View*. B-6107.

insecticidal protein in pollen. Producers may have to treat if bollworm populations are high because of this reduced expression.

The value of transgenic species varies by region. Producers must balance the cost of the technology with any potential increase in yield. This technology has been most popular in areas that average two or more insecticide applications for bollworm/tobacco budworm and/or pink bollworm and where yields average more than 400 pounds of lint per acre.

An important consideration when choosing transgenic cottons with the Cry-protein is that growers must plant refuge areas to prevent resistance to the technology. Moths are produced in these refuges that have not been exposed to the Cry-protein, thus making their potential offspring susceptible to it.

Variety selection

Although the introduction of transgenic technology has complicated variety choice, some basic principles still apply. Growers should choose cotton varieties based on the limiting factors on the farm, maturity ratings for the production region, boll characteristics and fiber quality of the cotton variety.

Limiting factors: The first step is to identify the primary limiting factors on your farm. If weeds or insects are the primary limiting factor, consider planting transgenic varieties. If verticillium wilt is a problem, select a variety that offers resistance to the pathogen.

If the field has no identifiable problems, select the variety with the best yield potential. Evaluate as many variety tests as possible and look for varieties with yield stability. A variety that consistently ranks among the top five in yield over a 4-year period is a better choice than a variety that ranks fourth one year and tenth the next.

Producers should try new varieties on limited acreage, especially recently introduced varieties with limited testing (less than 3 years).

Maturity ratings are also important in Texas. Producers in the eastern and Trans-Pecos regions of the state can grow full-season (140 to 160 days) varieties because of their longer growing seasons. Because producers in the Rolling Plains and High Plains have a shorter growing season, planting full-season varieties involves higher risks.

Boll characteristics: Producers in the High Plains and Rolling Plains also must consider boll characteristics. Varieties with storm-proof bolls (lint held tightly in the boll) are better adapted to stripper type harvest and the weather extremes that can occur in these regions. If a variety has open bolls, budget for an appropriate harvest aid program to get the crop out as early as possible.

Fiber quality must also be considered. Because fiber length, uniformity index and fiber strength are heavily controlled by genetics, variety selection is important. Micronaire is also influenced by genetics, but environment can greatly affect final micronaire values.

Remember: If you choose varieties on the basis of premiums or discounts received, your income could vary because of fundamental supply and demand relationships. If you select a variety based on premium expectations, be sure that the premium is enough to offset any potential yield reductions.

No cotton variety meets all needs for all regions. The number of varietal choices will only increase as new transgenic traits are introduced and plant breeders develop varieties adapted to different environments and production systems.

Producers should evaluate two to three new varieties on their farms each year. A simple test is to plant alternate strips of two varieties with similar maturities in a field. Harvest each variety separately. If you plant 12 or more strips, yield differences of 5 percent can be significant.

Nematode sampling

Nematode problems are identified by sampling. Nematode populations are at their highest late in the season and population estimates are more reliable. Otherwise, collect samples soon after harvest, when nematode populations are at their highest and estimates are more reliable.

A regular soil probe can be used to sample for nematodes to a depth of 6 to 12 inches. A sample should represent 10 acres of one soil type and should consist of 20 to 30 soil cores.

In larger fields, sample obvious problem areas and keep these samples separate from those from more productive areas. Fields that are split, having had separate crops the previous season, should also be sampled separately.

Collect samples from within the row and below the top 2 inches of soil, where nematode populations are likely to be the highest and to coincide with areas of active root growth. Mix the cores from the 10-acre section in a plastic bucket, and place about 1 quart of this composite sample in a plastic bag.

Keep the samples cool, moist and out of the sunlight. Do not allow the samples to dry or freeze. Send the samples overnight to the Texas Plant Disease Diagnostic Laboratory.

Sample submission forms can be obtained from local Extension agents.

The threshold levels for nematodes are different for samples taken late in the season or shortly after harvest than for those taken for the next planting season. The difference in thresholds reflects the natural decline of nematode populations during fallow months (months with no crop present).

The High Plains region has the most acreage with nematode-infested soils, primarily the root-knot nematode. About 40 percent of cotton acreage in this region is infested. The yield loss potential of this infested acreage varies from high to zero.

The threshold for root-knot nematodes is 200 to 500 juveniles per pint of soil in the fall and 50 juveniles per pint just before planting. The root-knot nematode occurs in lighter textured soils and can be found in most areas of Texas.

In contrast, the reniform nematode prefers sandy loam soils and can limit yields on heavier soils. This nematode is especially prevalent in the Lower Rio Grande Valley, but it has also been found in other production areas of the state. The threshold for reniform nematodes is 5,000 per pint of soil in the fall and 1,000 juveniles per pint just before planting.

No thresholds have been set for other species of plant parasitic nematodes in Texas because these species have not been shown to cause economic damage to cotton.

Irrigation

In the western part of the state, fields are pre-irrigated because of limited rainfall in the winter and spring. The timing of pre-irrigation depends on water availability, soil texture and the time required for the soil to drain adequately before planting.

Seedbeds should have time to reach temperatures of 60 degrees F to allow for quick germination at planting. The 60 degrees F is actually a 10-day average of temperatures taken from an 8-inch depth at 8 a.m. each day.

The amount of water applied depends on rooting depth, available moisture-holding capacity and current soil moisture levels. Table 3.5 shows the potential rooting depth and moisture-holding capacity of different soil types.

Table 3.5. Rooting depth and moisture-holding capacity of different soil types.

Texture	Unrestricted Root Depth (feet)	Available Moisture Holding Capacity (inches/foot)
Coarse (sand, loamy sand, sandy loam	5-6	0.75-1.2
Medium (fine sandy loam, loam, silt loam)	5-6	1.2-2.0
Fine (clay loam, silty clay loam, clay	3-6	2.0-3.0