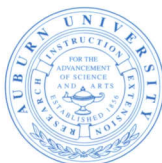




**BEST
MANAGEMENT
PRACTICES
FOR
ALABAMA
SOD
PRODUCTION**

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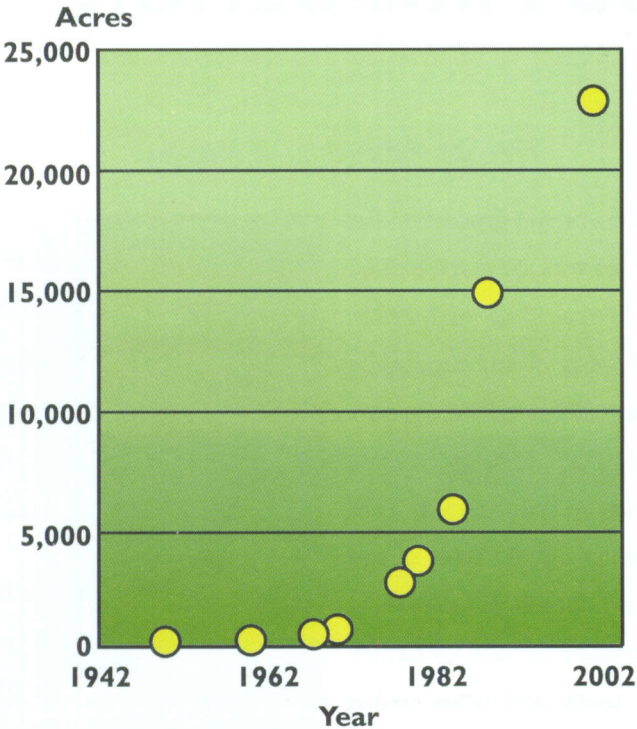
BEST MANAGEMENT PRACTICES FOR ALABAMA SOD PRODUCTION

WHY SOD PRODUCTION IN ALABAMA?

Alabama sod production has grown dramatically in the past 60 years. In the 1940s and 1950s, limited areas of sod production (less than 500 acres) were grown, primarily for use by golf course construction companies. By 1978 an estimated 2,900 acres of sod was in production, grown to meet the increasing demand for turf for home lawns and other urban uses. The last extensive survey of Alabama sod acreage was conducted in 1988, when it was estimated that 15,000 acres were in production. A 1995 Alabama Agricultural Experiment Station (AAES) publication titled “Economic Feasibility of Turfgrass-Sod Production” (AAES Bulletin



625) estimated that 25,000 acres were in production. Casual observation and conversations with sod growers indicate an estimated 33,000 acres in production in the year 2000.



Estimated sod acreage in Alabama, 1942 - 2001.

This dramatic increase in sod production has developed due to many factors, both agronomic and human. Agronomic factors include: (1) failures or profit loss in conventional commodity crops, making turf an attractive alternative; (2) development of new and high-quality turf cultivars; (3) the need to vegetatively propagate most high-quality warm-season turfgrasses; and, (4) immediate environmental

protection offered by sod (less sediment and water runoff than bare or seeded soil). Human factors include: (1) increase in retirees moving South who expect high-quality lawns, (2) urban and industrial development of Alabama, and (3) increase in the numbers of golf courses and sports fields and commercial enterprises that require high-quality turf.

In response to the increasing demand for high-quality sod the number of full- and part-time sod producers has risen since 1978 (when the first Alabama sod producer survey was completed). In 1978 there were 26 sod growers in Alabama, and most of these were either part-time or grew the sod along with other agricultural crops. By 1988 (when a second survey was completed) there were 79 growers, and a greater percentage of these were full-time producers. In 1999 a survey of county agents revealed that there was a total of 105 sod growers in Alabama, and the number of acres grown by many long-time producers had increased.

One dilemma with increasing acres of sod production is urban and agricultural competition for the level, sandy soil preferred for sod production. Urban expansion needs the same resources as sod production: level land, easy access to water, fewer rocks or stones in the soil, and close location to metropolitan areas. Established Alabama sod farms are more and more likely to find themselves located next to new residential developments, a situation that often causes intense scrutiny of the mowing, watering, and clipping disposal practices of neighboring sod farms. Residents of suburban developments are often unaware or uneducated of typical agricultural production practices, and may voice concerns about the impact of neighboring sod farms on water quality.

Sod - A Natural Best Management Practice

Established sod is an excellent Best Management Practice for protected environmental quality. Soils covered with plant residue or growing plants are often less susceptible to erosion, as the plant cover protects soil from the direct impact of raindrops. Established turf filters sediment and nutrients from water runoff, and slows the speed of water, further reducing erosion and sediment transport.

Adoption of Best Management Practices (BMPs) for sod production can help ensure the long-term survival of Alabama sod production, helping sod producers profit from their agricultural enterprise while protecting the surrounding environment. Examples of BMPs include proper use and selection of fertilizers to minimize leaching and runoff, proper rinsing and disposal of pesticide containers, installation of vegetative buffer strips along stream banks or crossings, and recycling and reuse of the nutrients in clippings. The objective of this Alabama Sod Producer Best Management Practices manual is to provide an information source for Alabama sod producers, helping them become efficient and environmentally safe producers of sod for our growing economy.

The Value of Sod

Sod is considered a high-value production crop, with a high per-acre value similar to vegetables or fruits. So, although the number of acres in sod production is relatively low when compared to a commodity crop such as cotton or peanuts, the per-acre value of the crop easily exceeds these agricultural commodity crops. Of the four major warm-season turfgrasses commonly grown for sod in Alabama (bermudagrass, St. Augustinegrass, centipedegrass, and zoysiagrass),

**Average Wholesale and Retail Prices
Charged for Selected Turfgrasses,
Alabama, 2001.**

	Wholesale	Retail
	Average price per square yard	
Bermuda	1.05	1.15
Zoysia	2.37	2.47
Centipede	1.41	1.50
St. Augustine	1.93	2.20
Fescue	1.30	1.44

Source: Cain, J.J. and J.L. Adrian. 2002. Turfgrass-sod Production in Alabama: Economics and Marketing. M.S. Thesis, Auburn University, Dept. of Agricultural Economics and Rural Sociology

Average wholesale and retail prices charged for selected turfgrass species, Alabama, 2001.

the most profitable is bermudagrass. In 1995 it was estimated that regardless of seasonal price fluctuations bermudagrass was the most profitable, with an average estimated price of \$1.00 per square yard. Since a typical sod yield is 4,000 to 4,300 square yards per acre the value of a bermuda sod crop quickly becomes apparent. Although centipedegrass and zoysiagrass have higher values (estimates of \$1.41 and \$2.37 per square yard, respectively) they are typically harvested once a year, as opposed to bermudagrass, which can be harvested twice a year.

AGRONOMIC ISSUES OF SOD PRODUCTION

Site Selection

It is not enough to find the natural resource base needed for sod production — this resource base must also be located close to a major market area and with quality roads that reach that market area. Sandy, level soil that is close to a quality water source has far less value as a sod farm if it can only be reached by traveling more than 20 miles of a rutted one-lane road. Typically, sod growers sell their product within a 300-mile radius of their farm, as the perishable nature of sod prevents longer shipping distances.

The most preferred soil types for sod production are sands or sandy loam soils (up to 80% sand), although Alabama sod production does occur on heavier soils, too. The site should be level, well drained, and free of rocks and stumps. One consideration in Alabama is that many suitable farm sites are old pasture land, so elimination of common bermudagrass from the site can be an expensive addition to the production process.

Both water quantity and quality are needed for efficient sod production. Every Alabama sod producer uses some type of irrigation, including center pivot, sideroll, or solid set sprinkler systems. A rule-of-thumb for water consumption needs should be a water supply great enough to supply one inch of water per week to every acre of sod on the farm. In times of drought or on very sandy soils water needs can increase up to three inches of water per week for every acre of sod on the farm.

The natural resources of land and water are critical, but the human resources of labor are also very important. A sod farm requires both full- and part-time labor, and both skilled and unskilled

labor are needed. Skilled labor could include a mechanic, accountant, tractor/truck driver, and spray or irrigation technician. Unskilled labor is needed to perform chores such as stacking cut sod or spot-spraying fields to maintain grass purity. In 1988 the average number of employees on an Alabama sod farm was 4.42 part-time and 7.0 full-time, not including the owner of the farm. Small farms (less than 100 acres) used more part-time labor than large farms, as the only full-time labor at small sod farms was likely to be the owner.

Soil Testing and Analysis

Proper soil testing is needed to ensure rapid sod growth with a minimum of environmental impact. A soil test provides information about fertilizer needs and levels of soil nutrients, and it provides fertilizer recommendations so that wasteful amounts of fertilizer are not applied. There are both private and state-run soil testing laboratories available to analyze collected soil samples, but it is important to choose a reliable laboratory that will supply soil-test results in a timely manner.

In Alabama, fertilizer recommendations are made for the nutrients phosphorus (P), potassium (K), magnesium (Mg), and calcium (Ca). There is not a standard soil-test recommendation for nitrogen (N). Because the forms of nitrogen that are plant-available are affected by soil microbes, and because changes can happen quickly, there is no accurate, calibrated test for soil-test N in the southeastern U.S. In the Southeast, N fertilizer recommendations are not based on soil-test N. Instead, N fertilizer recommendations are made based on crop need and response, and N recommendations will vary from crop to crop.

Soil samples in the Southeast are usually extracted with an acid-based extract called the Mehlich extract. The type of extract varies with region - in the western U.S. a different extractant is used than in the Southeast, and in the Midwest a third extractant is used. This is because years of testing has shown which extractant does the best job of removing the pool of soil nutrients most related to plant growth. Why does this matter to a sod grower? Use of the wrong extractant could produce soil-test results that over- or under-estimate fertilizer needs. The easiest way to prevent this is to simply send soil-test samples to a laboratory in your state or region. Alabama sod growers who send soil-test samples to a laboratory in Nebraska, for example, may receive poorly calibrated soil-test recommendations.

A typical southeastern soil-test will provide the following basic information: soil pH, soil P, soil K, soil Ca, and soil Mg. The information is usually reported in pounds per acre (lbs./A), and soil-test P and K may be reported as P_2O_5 and K_2O . This has nothing to do with the form of P and K in the soil, or the form of P and K needed by the plant. The use of P_2O_5 and K_2O is an old nomenclature left from the days when fertilizers were analyzed by burning them, and the amount of P and K was reported in the oxide form. It is still the way P and K content are reported on every bag of fertilizer, so soil-test reports use the same vocabulary so it is easy to compare between numbers.

Phosphorus fertilizer should always be applied according to the soil-test. Excess P in some Alabama soils has become a big environmental issue because surface P can move with water runoff and sediment to streams and lakes, decreasing water quality. Although sod farms are not as prone to P accumulation and P loss via runoff as

some other agricultural production systems it can be of concern if large amounts of poultry litter or other waste material (such as textile processing sludge) are applied to sod farms. Because P is not needed in the large amounts needed for N and K, application of waste materials that tend to have uniform amounts of N, P, and K (for example, fresh poultry litter is usually about a 3-2-2 product) can result in P accumulation. Soil-testing can help monitor such accumulation, and use of low-P fertilizers is needed when P accumulation becomes an environmental threat.

Although it may not pose a threat to surrounding water quality, excessive soil-test K, Ca, and Mg is not a cost-effective means of sod production. In very sandy soils soil K may leach, and loss of K from the rooting zone may require additional applications of K fertilizer. Typically, calcium and magnesium are supplied via the application of lime (CaCO_3) or dolomitic (Ca-Mg CO_3) lime, which is recommended as soil-test pHs become acid. However, in some soils calcium and magnesium may be needed when the soil pH does not signal a lime recommendation. Calcium and magnesium sources such as gypsum (CaSO_4), epsom salts (MgSO_4) or K-Mag can be used to supply Ca or Mg without affecting the soil pH.

The format of soil-test reports will vary from lab to lab, and reported information will also vary. Some information may be of use to a sod grower, while other information is of little use. For example, many soil-test labs report the “buffer pH,” a number used to determine the lime recommendation for acid soils. It has no real value for a sod producer — the soil pH and the lime recommendation (if there is one) are the numbers of value to a sod grower. On the other hand, some labs will report a “base saturation,” which may be of some use

to a sod grower. This percentage tells how much of the soil's ability to hold cations (K, Ca, Mg, and H) is occupied by the basic cations (K, Mg, and Ca). In general, a high (greater than 70%) base saturation is preferable because it indicates that there are sufficient levels of Ca, Mg, and K available for plant uptake and use. Some labs may also report the "cation exchange capacity" (CEC), which is a measure of the soil's ability to retain all cations (Ca, Mg, K, H, NH_4 , and Al) in the soil. A high CEC (greater than 20) is usually found in soils with a higher clay content, while sandy soils may have a much lower CEC (approximately 2). A low CEC indicates that fertilizers should be applied more frequently to avoid losses via leaching through the soil.

An example Auburn University soil-test report.

COPY 3 OF 4

REPORT ON SOIL TESTS
AUBURN UNIVERSITY
SOIL TESTING LABORATORY
AUBURN UNIVERSITY, AL. 36849-5411

COUNTY MONROE
DATE 7/11/02

NAME MARTHIA A. GARDNER
ADDRESS 539 PLEASANT GROVE RD
CITY HOMETOWN, AL 39876

LAB No.	SENDER'S SAMPLE DESIGNATION	CROP TO BE GROWN	SOIL* GROUP	SOIL TEST RESULTS				RECOMMENDATIONS			
				pH**	Phosphorus P***	Potassium K***	Magnesium Mg***	Calcium Ca***	LIME-STONE	N	P ₂ O ₅
					Pounds per acre			tons/acre		Pounds per	
20525	1 SEE COMMENT 224 SEE COMMENT 3 SEE COMMENT 27	BERMUDA & ZOYSIA/ST.AU	2	4.7	VH 105	VH 466	H 159	790	3.0	80	0

COMMENT NO. 224: Soil acidity (low pH) can be corrected with either dolomitic or calcitic lime.

COMMENT NO. 3: Follow limestone recommendation given for tilling the soil to establish plants. Where plants are established and limestone will be applied to soil surface without tilling, reduce application to 1.5 ton limestone per acre now and apply the remainder in 1.0 ton applications yearly until the total recommendation of limestone is met.

COMMENT NO. 27: Per 1,000 sq. ft. apply 1 pound N (3 pounds ammonium nitrate or equivalent) when spring growth begins and repeat in mid-summer. If more growth or better color is desired make additional applications of 1 pound N at 2-month intervals.

COMMENT NO. 26: 1.0 Ton limestone per acre is approximately equivalent to 50 pounds per 1,000 sq. ft.

COMMENT NO. 112: Final remark - For small areas, comments give examples of ways to meet the fertilizer recommendations. Other fertilizer grades or materials that supply equivalent amounts of plant nutrients may be used with equal results. If you need assistance in calculating amounts of other materials to use, contact your county agent or fertilizer supplier.

* 1. Sandy soils (CEC = 4.6 cmol.kg⁻¹)
2. Loams & light clays (CEC = 4.6-9.0 cmol.kg⁻¹)
3. Clays and soils high in organic matter (CEC > 9.0 cmol.kg⁻¹)
4. Clays of the Blackbelt (CEC > 9.0 cmol.kg⁻¹)

** 7.4 or higher - Alkaline 6.4-7.3 - Neutral
6.5 or lower - Acid 5.5 or lower - Strongly Acid

APPROVED _____

Grid Soil Sampling

New developments in geographic information system (GIS) technology have led many Alabama sod growers to use site-specific maps of their sod farms. GIS is a system that uses satellites to map fields, producing computer generated maps of each field on which data can be collected. The maps can be used to trace the history of each field, including pesticide application, fertilizer application, and harvest scheduling. One way GIS is used is grid-sampling of sod fields, where a soil sample is collected at one- or two-acre grid samplings in each sod field. The resulting spatial variability in soil-test values is a useful tool for varying fertilizer application across fields. This helps pinpoint fertilizer application so that over- or under-application of nutrients is lessened.

Land Preparation

Regardless of soil type or location, land prepared for sod production must be level, free of rocks or stumps, and smooth. Subsoiling is often required to break up subsurface compaction layers, especially if the site is a new sod site that had been previously used for cotton production. Some sod growers now employ laser leveling devices to ensure a completely smooth and level planting bed.

Possibly the most difficult part of site preparation is the removal of pernicious weeds, especially the sedges and common bermudagrass. The most effective treatment is fumigation with methyl bromide, but this is both expensive and time consuming. Methyl bromide fumigation can cost about \$1,800-2,000 per acre. Because the fumigant must be applied under a plastic layer, application is often performed by a custom applicator. Another nonselective weed control

method is multiple applications of glyphosate (Roundup[®]) to control common bermudagrass. While far less effective than methyl bromide, such applications may be more useful where only spot spraying is needed.

An emerging problem in sod fields are nematodes — microscopic roundworms that live either in the soil or within the roots of the turfgrasses. Damage caused by nematodes is often mistaken for insect damage, drought, or some other soil problem that inhibits rooting. Typically, the turf is thin and yellowed. Nematode damage occurs in irregularly shaped, patchy areas. The sod often lacks strength, and falls apart at harvest. The only way to pinpoint a soil nematode problem is to take a soil sample and send it to a qualified laboratory for analysis. The laboratory can determine the species and population of nematodes in the soil, and make recommendations about when and how control should be performed. Unfortunately, there are very few nematicides labeled for use on sod farms, and control can be very difficult. Thus, it is wise to also have a nematode

Removal of plastic covering after methyl bromide fumigation.



count performed on soil samples prior to planting a new sod field.

In general, preemergence herbicides are rarely used in sod production, and almost never in the establishment year. Many preemergent materials affect root and shoot growth of grasses, and newly sprigged turf will not grow and peg down if preemergence herbicides are in the soil. In fact, sod that will not hold together at harvest is sometimes the result of inappropriate or untimely application of preemergent herbicides.

A general order of land preparation would be: (1) site preparation (removing stumps and rocks, smoothing, and leveling); (2) primary tillage, including subsoiling; (3) fertilize and lime according to soil test; (4) secondary tillage to incorporate lime and fertilizer and prepare planting bed; and (5) fumigate if desired, or apply nonselective herbicides.

Establishment

Establishing Alabama sod fields almost always requires vegetative material. Currently, the only sod crops established by seeding in Alabama are tall fescue (200-250 pounds per acre), centipedegrass (10 pounds per acre) and common bermudagrass, although some seeded zoysiagrasses are in development and in use in Georgia. Common bermudagrass is used less and less, and recently established bermudagrass sod fields are almost always a hybrid type. Additionally, seeded grasses (especially tall fescue) are often seeded with a lightweight plastic netting, which aids in maintaining sod strength and shortening time to harvest.

A typical planting method for warm-season turfgrasses is sprigging. Sprigs are the horizontal shoot material, either stolons (aboveground) or rhizomes (belowground). If just stolons are used for

planting material the term “stolonizing” is used to describe the planting process. Because sprigs are shoots, they contain nodes from which roots and leaves develop, so that any well-watered sprig will root and spread laterally across the ground. Sprigs are typically spread across the prepared planting bed, incorporated via disking, and watered lightly and frequently for establishment. Sprigs may also be incorporated by “row-planting” where the sprigs are cut into the planting bed via a slit cut into the soil. Automatic sprig plant equipment is also available.

Turfgrasses that are slower growing, such as zoysiagrass, are often established by plugging. Plugs are small pieces of sod, two to four square inches in size that are planted on six- to 12-inch centers. Unlike sprigging or stolonizing, plugging transfers a small amount of soil in the planting process. Sprigging, stolonizing, and plugging can be performed either by the sod grower or by a custom applicator. Many

Turfgrass sprigger for planting bermudagrass sprigs.



smaller Alabama sod farms hire a custom sprigger to install new sod fields, avoiding the cost of specialized planting equipment.

Generally, one bushel of sprigs or sod is obtained from one square yard of sod. A bushel is also equal to 0.44 cubic feet. However, the definition of a “bushel” may vary from region to region (the “Texas” bushel is about three times larger than the ‘Georgia’ bushel), so care should be used when purchasing sprigs — make sure all parties agree on the definition of a bushel.

Hybrid bermudagrass should be row- or broadcast-sprigged at 250 to 600 bushels per acre. The rate will vary with sprig quality, water availability, and desired time to complete grow-in. If row-planted, centipedegrass and St. Augustinegrass should be planted at 100 bushels per acre. If the centipedegrass and St. Augustinegrass are broadcast-planted, use a higher rate of 200 bushels per acre. Plugged zoysiagrass and centipedegrass should be planted on six- to eight-inch centers using sod blocks that are two to four inches in diameter. This is equal to about 300 to 450 square yards per acre. St. Augustinegrass plugs can be planted at a slightly wider 12- to 18- inch spacing.

Reestablishment

Once sod fields are established they are harvested repeatedly for many years. Two basic methods are used to reestablish a field of harvested sod: clean-cut and ribbon-cut. Ribbon-cut sod is harvested so that a one- to two-inch strip of sod is left in place in the sod field, with a strip left between each strip of harvested sod. The ribbons are then disked or cultivated to cut them back into the soil, the surface is rolled and the field is left to regrow for the next harvest. Typical

yield from a ribbon-cut (with two-inch ribbons) sod field is 4,000 square yards per acre. Because St. Augustinegrass and centipedegrass do not have rhizomes they are much more likely to be reestablished from ribbon-cut, and not clean-cut sod. Centipedegrass fields may also be overseeded with additional seed to help speed the regrowth process.

Clean-cut fields are completely harvested, and no turf is left at the surface. Regrowth from these fields is from rhizomes (underground shoots) of bermudagrass or zoysiagrass. If centipedegrass is clean-cut it is likely the field will be reseeded, too. Typical yield from a clean-cut sod field is about 4,300 square yards per acre.

The type of harvest method may also vary with the time of year. Bermudagrass fields that are spring harvested may be clean-cut, as the fields are entering their period of most rapid growth and recovery. Fields harvested in late summer may be ribbon-cut, leaving more turf for regrowth and to help avoid winter injury. The newer trend of large roll sod (30 to 48 inches wide and 100 feet long) may also cause more sod fields to be clean-cut rather than ribbon cut.

Harvested sod field with ribbons left to help reestablish new crop.



BEST MANAGEMENT PRACTICES FOR ENVIRONMENTAL PROTECTION ON SOD FARMS

Conservation Buffers

Buffers are strips or areas of land in permanent vegetation. These areas are not used to produce sod, and instead serve as filter strips to intercept runoff, filtering pollutants such as sediment, nutrients or pesticides. Research has shown that buffers can remove up to 50% of nutrients and pesticides and 75% of sediment. They can help stabilize a stream bank, provide places for wildlife, reduce noise and dust, and improve the appearance of the sod farm.

Filter strips are strips of grass used to trap field sediment and pesticides. On a sod farm, a field strip might be as simple as 50-foot wide strip of sod that is left unharvested and not mowed. Placed next to sensitive areas such as streambanks, filter strips work well in a sod production system.

Riparian buffer areas are lands directly adjacent to water bodies such as streams, lakes, and wetlands. A riparian buffer system can easily be installed to protect such sensitive areas. Unlike a grass filter strip, the system consists of a mixture of trees, shrubs, and grasses, all suited to grow in their particular environment. A riparian buffer system intercepts runoff, which removes nutrients, sediment, pesticides, and organic matter before they enter the water area. The area can also help reduce flood velocity, stabilize stream banks, and improve aquatic habitat. An added benefit of such an area is that it produces excellent wildlife habitat.

A successful riparian buffer zone on an Alabama sod farm will likely have a 15-foot swath of native trees, shrubs, or grasses planted immediately next to the stream to be protected. These species, which

An example BMP of a riparian zone with mixed grass and trees next to a sensitive water area.



should be adapted to the wet environment, help stabilize the stream bank and control flooding. Any species of tree, shrub, or grass adapted to Alabama stream-bank conditions will work in a buffer zone.

After the 15-foot swath immediately next to the stream, the next

80 feet should be a protected zone that can be actively managed. Active management could include some mowing to keep the area neat, or selected removal of trees to enhance appearance. On an Alabama sod farm this protected zone could be sod that is mowed but does not receive fertilizer or pesticide. If the sod grower has alternative crops, the zone could be used for hay production or some other enterprise that does not expose bare soil.

No-Spray Zones

No-spray zones are swaths of sod or other vegetation that do not receive any applications of pesticides or fertilizer nutrients.

A no-spray zone surrounding the edge of a sod field.



Serving as a filter strip, a no-spray zone helps prevent movement of nutrients and pesticides into surrounding water. A no-spray zone should be at least 50 feet wide, and can easily be marked for employees by the use of colored turf paint.

Clipping Management and Composting

A 1991 survey of Alabama sod growers revealed that 78% of sod producers removed their clippings regularly. Every grower removed their clippings when growth was excessive. Disposal of clippings was always a problem: some burned the clippings, others used landfill pits, and most used on-site above ground dumping.

Decomposing clippings can create environmental problems for a sod grower. First, piled clippings can emit an undesirable odor as they rot. Second, the clippings themselves can be transported into streams or lakes, negatively affecting water quality. Third, runoff or leachate

Improperly dumped clippings at the edge of a sod field.



from decomposing clippings can carry nutrients from the clippings to water, harming water quality.

Some simple adjustments in clipping disposal can help limit the environmental impact of the clippings. If the clippings are being dumped above ground do not dump the

clippings near streams, ponds, or lakes. Do not dump the clippings on excessively sloped ground (greater than 5%) and avoid stacking them near houses, buildings, or places where people congregate.

An advanced step to managing the clippings is to compost them. Composting turns solid waste into a useful end product by biologically decomposing the wastes. The compost can be returned to sod fields as an organic amendment or made available to homeowners or other clientele as an organic amendment for gardens or potting media.

Composting

A low-technology method for composting clippings is to combine the clippings with leaves or shredded brush. If the sod grower does not have a large supply of leaves or shredded brush a nearby town or municipality might be willing to supply yard waste trash, but it will need to be ground. Grass clippings cannot be composted by themselves, as they pack easily, and limit air flow to the pile. Mix the clippings with leaves, wood chips, yard waste, or sawdust (add sawdust only up to 10% of the total pile volume).

The “windrow” composting method uses a mix of three parts leaves or brush (or something high in carbon) to one part clippings (high in nitrogen), and the mix is placed in piles that are six feet high and 12 to 14 feet wide. Water is added to maintain moisture at 50% and the pile is allowed to stand for one week. Temperatures inside the pile should reach 140 to 160 degrees F within the first week of composting. Use a front end loader or other turning device to turn the windrow every three to four months, with a completion time for the compost of nine to 12 months. The compost is finished if the windrows do not reheat after turning and a sample sealed in a plastic bag for 48 hours does not smell offensive when opened.

An example of a low-input pile for composting clippings. Turning the compost occasionally will help speed the composting process.

If composting, the site should have a slight slope (1%), but not more than 5%. Position the windrows so that they are per-



pendicular to the slope of the site. Do not locate the composting area near wetlands or within one-quarter mile of any water source. Divert surface water around the composting site to prevent erosion and sedimentation.

If the composted clippings were obtained from a sod field that has had herbicides applied, use caution if applying the compost to gardens or shrub beds. Studies have shown that low levels of some herbicides (2,4-D, pendimethalin, clopyralid) can be detected in well-decomposed yard waste mixtures. Usually, the level of residual herbicide is not enough to pose a risk in the garden. However, in one case, turfgrass clippings in 10-week-old compost contained enough clopyralid to cause abnormal growth in some plant species.

Other composting systems may include bin-type structures made from woven wire fencing. Typically four to five feet in diameter and four to five feet high, the bins are simply filled with the materials for composting, and water is added. Another type of bin may consist of three chambers, each four to five feet high, three to five feet deep, and three to five feet wide. The front of each bin consists of removable boards so that the compost can be easily removed and added. The use of three bins allows for three batches of compost, each in different stages of decomposition.

There are fine references on composting available on the Internet.

Streambank Stabilization

Each time a stream is crossed, the potential to pollute that stream exists. Continued use of the same stream crossing will erode sediment from the bank and harm vegetation growing on the bank.

However, if stream crossings must be used there are some methods for stabilization.

First, always cross the streambank at a right angle (90 degrees) to a straight section of the stream. Although the crossing will naturally slope into the stream, try to find a section to cross with a grade of 3% or less. To prevent rutting or erosion of the entry and exit, use rock to protect the approaches. Make sure the stream crossing provides a way for normal passage of aquatic animals and water.

To stabilize eroding banks anchor logs or brush against the bank to redirect and slow the stream current. Once the stream current is slowed the area should fill with sediment, and native vegetation will begin to grow, providing additional stabilization. Combine this streambank stabilization with riparian and filter strip buffer zones, using wider filler strips in areas with steep slope.

An example of effective use of a stream used as a source of irrigation water for a sod farm. The streambank quality has been maintained, and stream flow has not been blocked.



An excellent Alabama resource for information about Best Management Practices for streams is Alabama Cooperative Extension System publication ANR-911 “Streams: A National Heritage Worth Preserving.” This publication is available on the Web at <http://www.aces.edu/department/extcomm/publications/anr/ANR-911/anr911main.html>.

For More Information

Information about buffer strips, streambank stabilization and many other techniques for maintaining soil and water quality may be found at your local county NRCS (Natural Resources Conservation Service) office. In some cases there are programs to help develop such management practices on farms, and the NRCS has staff that can come and assist you with your planning. Look in your phone book for the county office (usually called something like “County Name” NRCS or just “Natural Resources Conservation Service”). Information can also be found on the NRCS Website at <http://www.nhq.nrcs.usda.gov/>.

Irrigation

Typical Alabama farm irrigation is from a stream, creek, or pond. Some sod growers may irrigate from a well, if a well is practical in their area. Use of a well, surface water, or a combination of the two will vary with local conditions and should be evaluated on a case-by-case basis. Whatever the water source, Best Management Practices to maintain water quality should be followed.

Keys to maintaining irrigation water quality include: 1) reduce sediment entering the surface water from which you pump by use of

A center pivot irrigation sprinkler with dropped spray nozzles. Dropping the nozzles closer to the turf surface will help lower evaporation losses and deliver more water directly to the turf.



buffer and filter strips, 2) minimize loss of water in the distribution of water from the source to the farm, 3) prevent aquifer contamination at the wellhead, 4) maintain your irrigation system for optimum performance, 5) manage your production program to minimize leaching and/or runoff of nutrients or clippings, and, 6) maintain streambank quality and stream integrity so that aquatic animal and water movement is not affected.

Minimizing water loss from the source to the farm

In some cases an open ditch may be used to transport water to the irrigation pump. If these ditches are earthen, they will lose water as it seeps through the ditch, and via evaporation from the water surface. Lining the ditches with concrete, swelling clay, or a membrane lining can help prevent seepage and loss of water. Converting the ditches to pipe will eliminate both seepage and evaporation loss. Monitor all pipes for leaks, and fix as necessary.

Maintain your irrigation system for optimum performance

Many irrigation systems suffer from poor distribution of water, resulting in some areas of the field that are under-watered and others that are over-watered. Check to be sure that the sprinkler heads have the correct combination of spacing, operating pressure, and nozzle type to ensure proper overlap. Check for worn or plugged nozzles.

If possible, operate in low wind, and avoid mid-day irrigation, when evaporative loss is greatest. However, this is often difficult to do in sod production, when irrigation often runs around the clock. If using center pivot sprinkler irrigation, consider using a drop nozzle to apply water closer to the turf surface, lessening evaporative loss.

Prevent aquifer contamination at the wellhead

Any activity that could introduce nutrients or pesticides into a wellhead should be avoided. Do not store, load, or mix chemicals near the wellhead. Do not fertilize the area around the wellhead. Do not store clippings near the wellhead. Wells should have a backflow preventer installed, stopping back siphonage/flow of chemicals or nutrients that might be applied during fertigation.

For More Information

A complete discussion of irrigation management issues can be found at the Alabama Cooperative Extension System Website: The page contains many documents about irrigation scheduling, irrigation systems, and the relative costs of each.

Water Quality

It is difficult to conduct complete water quality testing for pesticides, nutrients and other components of water quality. Pesticide testing, especially, is expensive, and the tests require sophisticated equipment. If you are not sure which pesticide is present the cost gets even higher, as “scans” for many chemicals must be performed.

However, there are several indicators of water quality that can be easily measured by the sod grower, or cheaply measured by local laboratories. Among these are temperature, pH, turbidity, dissolved oxygen, total alkalinity, and total hardness. Monthly collection of this data is fairly easy to do, and collection of such data over the long term may alert a farmer that changes in water quality have occurred. In Alabama, the Alabama Water Watch (Dept. of Fisheries and Allied Aquacultures, Swingle Hall, Auburn University, AL 36849; 334-844-4786) can assist with the collection of such data.

Temperature

Water temperature will follow the same pattern as air temperature, but will usually lag behind a few degrees. Changes in this pattern may indicate that flow into the stream has been altered in some way.

pH

A pH test measures the concentration of hydrogen ions in the water. The greater the concentration of hydrogen ions, the more acid the water. A pH of 7 is neutral, below 7 is acid, and above is alkaline. Water pH from 6 to 9 is usually suitable for most organisms. A pH below 5 or above 10 will harm almost all organisms.

Turbidity

Turbidity is the cloudiness of the water, created by suspended particles. Cloudy, turbid water indicate that soil erosion is occurring, or there may be input of nutrients from runoff. Turbid irrigation water is a concern to sod farmers, as the suspended sediment may plug or wear irrigation nozzles.

Dissolved Oxygen

Dissolved oxygen concentrations (DO) in streams may range from 0 to 15 ppm, with a DO between 5 to 10 ppm sufficient to support a healthy stream. If a stream has organic (such as from an algal bloom, possibly caused by excess P fertilizer) or nutrient pollution, the DO reading may be low, indicating aquatic organisms may have difficulty surviving in the stream.

Eutrophication of surface water sources can occur when excess phosphorus moves to water, triggering algae growth.



Total alkalinity/Total Hardness

Alkalinity is a measure of the carbonate and bicarbonate in the water, and hardness is a measure of the Ca and Mg in the water. Alkalinity values range from 10 ppm or less in the Coastal Plain to 200 ppm in regions with limestone outcroppings. Hardness may range from 0-20 (soft water) to >180 ppm (hard water). In unpolluted waters in Alabama, alkalinity and hardness values are usually similar.

For More Information

“Streams: A National Heritage Worth Preserving” Alabama Cooperative Extension System Publication ANR-911.

Alabama Water Watch. Dept. of Fisheries and Allied Aquacultures, 203 Swingle Hall, Auburn University, AL 36849-5627, 334-844-4786

Fertilization

It is important to be aware of the environmental impact over-fertilization can have on water that may be surrounding the sod farm. Understanding the biological and physical pathways that control soil nutrients can help sod growers plan their fertilization programs, producing quality sod with a minimum environmental impact.

Nitrogen

Nitrogen is the primary fertilizer nutrient that is controlled by a biological cycle for plant availability. Only two forms of nitrogen are available for plant uptake and use: nitrate nitrogen (NO_3^-) and ammonium nitrogen (NH_4^+). That is why soluble N sources such as ammonium nitrate (NH_4NO_3) are rapidly available for plant growth — the forms do not need to be converted into plant available nitrogen.

Other forms of nitrogen, such as organic N in poultry litter or clippings, must be converted by microbial decay into nitrate and ammonium. The term for this is “mineralization,” where organic N is converted by microbes into ammonium, and then by other microbes into nitrate. This is why organic N sources are often thought of as slow-release sources. In very hot weather this conversion may occur rapidly, but in very cold weather it may not occur for some time (a year or more). This means that the timing of N availability from some organic sources is less predictable.

Nitrogen can be lost from the plant root zone through several pathways. First, ammonium may be converted to ammonia, a gas that then volatilizes into the air. Ammonia volatilization can be a problem when urea is surface-applied and not watered in. Although it is currently not a large environmental issue in the United States, several European nations are imposing air-quality standards for ammonia gas. This is largely due to emissions from poultry producing houses, but losses from agricultural fields may also become an issue.

If ammonium is converted to nitrate, and if this nitrate is moved out of the root zone, it may leach into groundwater supplies. Nitrate contamination of water supplies is a concern, and water that contains greater than 10 parts per million (ppm or 10 ug/ml $\text{NO}_3\text{-N}$) is considered a health hazard for pregnant women, nursing babies, and elderly people with circulatory problems. Nitrate leaching is of particular concern in sandy soils that may have had over application of soluble fertilizer. Steps to avoiding nitrate leaching include frequent, small applications of N fertilizer and use of slow-release sources. Care should also be taken to avoid over-irrigation.

Denitrification of N occurs when nitrate is converted by

microbes into the plant-unavailable forms of NO, N₂O, and NO₂. These forms are all gases, so N is lost as gas to the environment. As with ammonia volatilization concerns are being expressed about the amount of gaseous N released to the environment through denitrification, and studies are currently underway to quantify the amount of N lost from agricultural fields via denitrification.

Another N conversion that creates plant unavailable N is immobilization, where nitrate is converted back into organic N by microbes. Immobilization occurs when materials that have a high carbon content are added to soil. In a rough sense, immobilization can be viewed as the reverse of mineralization, where immobilization takes available N and converts it into a plant unavailable organic form, while mineralization releases available N from organic nitrogen.

In summary, the most immediate environmental concern in N fertilization of sod fields is the prevention of nitrate loss to groundwater via leaching. Because soluble N is prone to downward movement and does not tend to accumulate on the soil surface, it is less of a concern for movement via runoff, although such losses may occur in heavy rainfall or if bare soil is present. Keys to minimizing nitrate leaching includes the use of slow-release N, split applications of soluble N, and avoiding over-irrigation.

Phosphorus

Unlike nitrogen, phosphorus (P) is not largely controlled by biological processes. The vast majority of soil phosphorus (90%) is held in plant unavailable forms as calcium phosphates, iron phosphates, and aluminum phosphates. Added fertilizer phosphorus is rapidly con-

verted to unavailable forms, and only becomes slowly available through weathering and exchange over time. The percentage of P in the soil solution that is plant available at any time is less than 1% of total P in the soil.

Phosphorus becomes an environmental hazard when it accumulates at the soil surface, which can happen when excessive P is applied or when P is consistently applied to the surface without incorporating tillage, such as in pastures or sod farms. Surface accumulated P is susceptible to movement in runoff water, as it moves attached to clay particles eroded by moving water. Phosphorus in surface runoff can end up in streams and lakes, where elevated levels of P can lead to decreases in water quality as algal blooms and fish kills occur.

Methods to reduce the risk of P contamination of surface water include soil testing to monitor soil-test P levels and fertilization only to meet soil-test P recommendations. This is of particular concern when waste materials are applied to sod farms, as materials such as poultry litter applied to supply N may over-supply P. Have the materials analyzed at a local testing laboratory to determine the correct analysis.

PEST CONTROL - ENVIRONMENTAL & MANAGEMENT ISSUES

Principles of Pest Control - Integrated Pest Management (IPM)

It is easy to think of IPM as only a tool for managing insects. Actually, IPM is a whole-system tool for managing the crop, and involves many steps for keeping pests of all kinds at a manageable level. Use of pesticides should be considered the last step in any IPM management program.

The first step in any pest control is to identify the pest. Although this seems simple, knowing exactly which weed, insect, or disease has cropped up on the sod farm is the key towards selecting the proper control procedure. Weeds are a particular problem in many Alabama sod farms. As new problem weeds emerge correct identification is important. County agents or state specialists can help identify weeds, and some states now have Web-based weed identification programs that assist growers through the weed identification process.

Once the pest has been identified, the available control methods must be identified. An emerging problem in sod production is that available control methods for some of our most serious pests have become limited. For example, nematode control options for sod farms are not plentiful, even though nematodes pose a serious threat to many southern Alabama sod farms. Once control methods have been identified, the benefits and risks of each method(s) should be evaluated.

Choose the control method that causes the least harm to the environment, and is the most effective. Use the method only when the pest causes more damage than is reasonable to accept. Determining this threshold requires frequent examination of sod fields, scouting for emerging weeds, insects, or disease problems that will lower the value of the crop.

Integrated Pest Management Methods Other Than Pesticides Resistant Varieties

In southern turfgrass production there are several cultivars resistant to various turfgrass pests. The first is chinch bug resistance, found in several commonly grown St. Augustinegrasses. Most of the St. Augustinegrasses coming from Florida breeding programs ('Floritam' and 'Floratine') are resistant to chinch bugs, while 'Raleigh' is not. Some St. Augustinegrasses are resistant to St. Augustinegrass decline (SAD), a viral disease of St. Augustinegrass. Most other warm-season turfgrasses (bermuda, zoysia, and centipede) grown in Alabama are not resistant to any other disease, insect, or nematode.

Of the cool-season grasses, many tall fescue varieties have specific resistance to a variety of turf diseases. Using data collected from the National Turfgrass Evaluation Program (NTEP), a sod grower can select varieties that have demonstrated resistance to a variety of diseases. The Web address for NTEP is: <http://www.ntep.org/>.

Biological Control

Most biological control options for sod production are still in experimental stages, but their use for the control of various insects or nematodes is coming. Current examples of research in the area of biological control is the release of a predatory wasp for fire ant control, or use of predatory nematodes for destructive nematode control. A nematode-trapping fungi for control of nematodes is also under study. A list of EPA registered biopesticides can be found at the URL: <http://www.epa.gov/pesticides/biopesticides/>.

Cultural Control

Examples of cultural control of pests are less common in sod production. Cultural control can include crop rotation, change of planting pattern, or use of different tillage practices. Since sod production is a uniform production system that does not provide much flexibility in terms of tillage or planting it is difficult to use cultural controls for pest control.

Mechanical-Physical Control

Mechanical or physical control in sod production is similar to biological control — there are many experimental methods on the horizon, but nothing is in everyday use. Examples of mechanical/physical control include fire to control weeds, loud noise to repel birds, microwaving or solarization to sterilize the soil, or sticky traps to catch insects.

Sanitation

Sanitation is one pest control method that is quite helpful on Alabama sod farms. Proper cleaning of mowers when moving from field to field can help eliminate contamination from invasive grasses or weeds. When mowers are used to maintain multiple species of grass they must be inspected regularly to make sure one grass species is not inadvertently transferred to another. Another sanitation tool is to maintain clean, bare areas around sod fields, preventing encroachment of weeds or other grass species into the edge of the sod field.

PESTICIDES

HOW PESTICIDES WORK

Pesticides are chemicals used to destroy, prevent, or manage pests. Pesticides may also attract or repel pests, or regulate plant growth. Pesticides are made from many different compounds, and may be inorganic (from minerals such as arsenic, lead, or zinc), synthetic organic (such as 2,4-D or atrazine), living micro-organisms (such as the bacterium *Bacillus thuringiensis*), derived from microorganisms (such as *Strobilurin* fungicides and antibiotics), or plant-derived organics (such as pyrethrins and strychnine).

Pesticide Terms

Contact - a pesticide that kills by touching or contacting the pest, not taken into the vascular system of the plant.

Systemic - a pesticide taken into the vascular system of the plant and translocated throughout plant to kill.

Fumigant - a gas that kills.

Selective - a pesticide that is more toxic to some plants or groups of plants than others; only kills selected pests.

Nonselective - a pesticide that is toxic to most pests.

Preemergence - a herbicide applied before the weed emerges. Kills only emerging weeds.

Post emergence - a herbicide that is applied after the weed has emerged. Best control is usually obtained while the weed is small and actively growing.

The Pesticide Label

The pesticide label describes the risks, benefits, and proper use of that pesticide. Federal regulations require that certain information appear in certain locations on every pesticide label. All labels should contain the following information:

Brand Name - The most identifiable name for the product. Brand names are usually capitalized. An example is Roundup.

Chemical Name - The scientific name for an active ingredient. An example is 3-(3,4-dichlorophenyl)-1,1-dimethylurea.

Common Name - A name commonly used and accepted by the EPA to identify the active ingredient in the pesticide. These names are usually not capitalized. An example is glyphosphate.

Formulation - The form in which the pesticide is sold to be handled. The formulation is how the pesticide was prepared so that it can be applied and spread evenly over an area. Common formulations include:

Dust (D) - a finely ground, ready-to-use powder.

Granule (G) - ready-to-use dry mixture of active ingredient and a dry carrier.

Wettable powder (WP) - A dry preparation that is mixed with water for application. Form a suspension in the spray tank and must be agitated to dissolve.

Water dispersible granule (WDG) or dry flowable (DF) - Disperses in water to form a suspension. Less dust than with wettable powders.

Emulsifiable concentrates (E or EC) - This liquid formulation is soluble in oil and forms an emulsion in water.

Flowable (F or L) - Very finely ground material suspended in a liquid. This liquid is mixed with water for application.

Ingredient Statement - Lists the total amount of active ingredient as a percentage by weight or pounds per gallon of formulation. Also lists inactive ingredients such as fillers.

Net Contents - States the amount of formulation in that package

Name and Address of Manufacturer - Name and address of the company that made the product.

Registration and Establishment Numbers - These numbers are different for every product. The registration number is usually found on the front panel of the label and shows that the product has been registered with the EPA. The establishment number tells what factory made the chemical, and will be found somewhere on the container.

Signal Words and Symbol - These are provided to give an idea of the relative toxicity of a product. The words are set by law, and the correct one must be used on every label:

DANGER - Highly toxic, a taste to a teaspoonful will kill a 150-pound person. Accompanied by the picture of a skull and crossbones and the word "Poison" written in red.

WARNING - Moderately toxic, a teaspoon to a tablespoonful will kill a 150-pound person.

CAUTION - Low toxicity, an ounce to more than a pint will kill a 150-pound person.

Precautionary Statements - Includes hazards to humans or domestic animals. Will tell you of special protective steps, such as protective equipment necessary to take when using the pesticide.

Environmental Hazards - Contains specific environmental cautions, such as toxicity to bees, wildlife, or fish.

Statement of Practical Treatment - Includes first aid measures for all types of exposures, and includes information for the physician for how poisoning should be treated.

Statement of Use Classification - The EPA classifies pesticides for either General or Restricted use.

Restricted Use: Could cause some human injury or environmental damage even when used as directed on the label. Restricted use pesticides can only be sold to and used by certified applicators or persons under their direct supervision.

General Use: Generally will not cause unreasonable adverse effects on the environment when used in commonly recognized practices in accordance with the label. These pesticides are normally available to the public.

Directions for Use - Lists pests or pest controlled, crop or site approved for use, rate of application, approved application equipment and techniques, and when the pesticide should be applied.

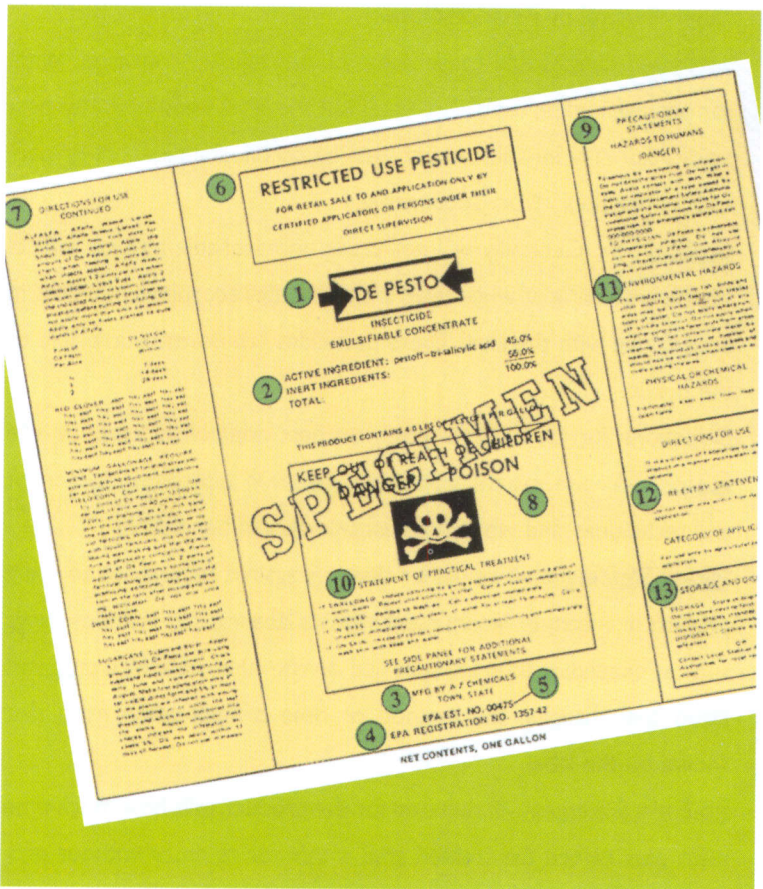
Misuse Statement - A reminder that it is against Federal law to use a product in a manner inconsistent with its labeling. This includes things such as exceeding the rate specified on the label, treating a crop not listed, and changing the method or time of application from that shown on the label.

Re-Entry Statement - If required for the product, tells how much time must pass before the treated area is safe for re-entry without protective clothing.

Waiting Period - If required by the product, this section tells how much time must pass between pesticide applications, harvest of the crop, or planting.

Storage and Disposal Directions - Tells how to store the product and dispose of empty containers.

An example generalized pesticide label.



PESTICIDES AND THE ENVIRONMENT

How Pesticides Can Harm the Surrounding Environment

Direct Kill of Nontarget Organisms - Drift from sprayed sod fields can injure nearby plants and animals, while runoff can carry harmful residue to streams, lakes, or ponds. Drift increases when: (1) distance from ground to nozzle increases, (2) droplet or particle size decreases, and (3) wind speed increases. Avoid spray drift by: (1) spraying at low pressure, (2) using spray tips with narrow discharge angles, (3) using the largest practical nozzle openings, and (4) spraying during the calmer parts of day (often early morning or late afternoon). Establish no-spray buffer zones around bodies of water or stream banks. Spray when wind velocity is low to minimize drift and use a shielded boom.

Persistence and Accumulation - Persistent pesticides break down slowly, and may stay in the environment for a long time before breaking down. While this is useful for long-term control of weeds it may begin to accumulate in the environment. Sometimes a loss of sod strength (will not knit together at harvest) may be due to residual herbicides in the soil, especially if a preemergence herbicide was applied too close to harvest time. A close examination of herbicide selection and persistence of the material may help determine if sod strength is affected by a particular pesticide.

Water and Pesticides - Pesticide in runoff water can damage water quality in surrounding streams or other bodies of water. Pesticide residues that leach through the soil can contaminate groundwater supplies, polluting wells. Use buffer strips (discussed in detail previously in this handbook) and no-spray zones around streams or water, providing an area that can filter runoff from fields.

Proper irrigation will help minimize excessive leaching, and never exceed the labeled rate for any pesticide. Techniques to use when cleaning sprayers and tanks to avoid environmental harm will be discussed later in this handbook.

PESTICIDE HANDLING

Storage

Keep all pesticides in a locked room, cabinet, or separate building designated solely for the storage of these materials. Post the area or building with a sign that reads “PESTICIDES - POISONS, KEEP OUT.” A pesticide storage facility should have a cement floor, an exhaust fan, good lighting, and a lock on the door. The storage building should be located away from where people and animals live, and where there is no chance that runoff or drainage could contaminate surface or underground water.

A drainage system should be built to collect any runoff water. Pesticide residues from tank rinsings, equipment cleaning, or seep-
Chemical storage locations must be clearly marked and kept locked.



age from storage should be contained in dikes, collecting pools, or a treatment container to avoid water contamination. All collected runoff water should be treated as surplus pesticide and disposed of accordingly.

Store all pesticides in the original container. Check often for leaks or breaks. If a container is damaged transfer the pesticide to a container that has held the same pesticide. Clean up spills correctly by sweeping up granules, or using earth, sand, or adsorbent clays to contain liquid spills.

Keep an up-to-date inventory of the pesticides you have in stock. Keep your inventory sheet stored with a copy of the label of each pesticide and the Material Safety Data Sheet (MODS) for each pesticide.

Mixing

Mixing and loading pesticides is a potentially dangerous task because people are working with concentrated pesticides. Pesticide applicators who are mixing and loading should be educated about the materials with which they are working, and should wear all required safety equipment. Simple rules to follow when mixing pesticides include:

- Have detergent, soap, and adequate water supplies available.
- Be sure all equipment (such as pumps) is functioning properly.
- Have material available to clean up spills.
- Do not work alone - have help available.
- Make sure the respirator (if required) fits properly and has the correct canister cartridge.
- Reread the label and follow the directions.

An example chemical containment system on a sod farm. In this case the tank contains metham sodium, a soil fumigant.



- Work in a well-lighted, well-ventilated area.
- Stand with your back to the wind so that fumes or dust are blown away from you.
- Mix and load on a concrete slab where spills can be contained. Avoid mixing near a well-head or surface water.
- Mix and pour concentrated pesticides below waist level. Never pour at eye level. Stand with your head well above the spray tank while pouring and wear splash-proof goggles.
- Never pour pesticides directly into a spray tank — always mix and dilute in a small container.
- Pour the pesticide into water, never water into the pesticide.
- Never stir by hand.
- Make sure all workers thoroughly understand pesticide labels and follow all precautions.

Cleaning

Any leftover pesticide in the tank should never be emptied onto the ground. Empty the tank by spraying the entire contents onto vegetation or other areas for which it was intended. In the best situation, never mix more pesticide than you need. Leftover pesticide that cannot be sprayed on an appropriate area must be stored and disposed of properly. Remember, contaminated water from cleaning or rinsing is considered hazardous, and must be disposed of properly. All mixing and loading pails and other measuring devices from mixing the pesticide should be triple-rinsed, and the rinse water added to the spray tank.

- Empty pesticide containers should be cleaned as follows:
- Empty the container into the tank - let it drain for 30 seconds.
- Fill it one-quarter full of water.
- Cap the container and rotate so all the sides are rinsed.
- Drain into tank - let drain for 30 seconds.
- Repeat steps 2 through 4 two more times.

Sprayers and other pesticide equipment should also be triple-rinsed, with rinse water from these processes, stored or contained in a recycling system until disposal. Rinse water should be placed in the sprayer, the sprayer turned on, and rinse water sprayed through the boom in an appropriate area. All nozzles and screens should be removed and cleaned. Never clean a nozzle, screen, or hose by blowing or sucking on it with your mouth.

Worker Safety

The terms toxicity and hazard are both factors that affect the danger of the pesticide for a worker. Toxicity is the capacity of the

Always check the product label to determine the level of personal protective equipment (PPE) required.



substance to cause injury or death. Hazard includes both toxicity and exposure.

Toxicity is expressed in terms of an LD₅₀ (lethal dose), which is the amount of a pesticide needed to kill 50% of a large population of test animals. LD₅₀s can be expressed as acute oral (via mouth) or acute dermal (via skin) doses in terms of milligrams (mg) of toxicant per kilograms (kg) of body weight of the test animal. The lower the LD₅₀, the more poisonous the pesticide. Acute LD₅₀s do not reflect chronic (long term build-up) effects of any pesticide.

Required protective clothing and equipment are described on the pesticide label. The amount and type of clothing needed will vary with toxicity, formulation, application equipment, and degree of exposure. Typical protective clothing could include:

Body coverings - Wear at least a long-sleeved shirt and long-legged trousers, or a coverall. If your coverall will be in a mist or wet for any reason wear a liquid-proof suit. After use, wash the clothes separately with a detergent and water.

Gloves - Always wear unlined elbow-length neoprene gloves. Some pesticide labels may list a special type of glove, as some fumigants are absorbed by neoprene. Check for holes in the gloves by filling with water and gently squeezing. Wash the gloves with detergent and water before removing them.

Boots - Wear lightweight neoprene or rubber boots. Keep pant legs outside the boots.

Goggles or face shield - Wear tight fitting goggles and a full face shield whenever the chemical could contact your eyes. Watch the headband of your eye protection - the material may absorb pesticide.

Hat - Wear something to protect your head. Rubber or plastic rain hats, hard hats, or waterproof parkas with hoods are all good choices as they can be washed. Avoid cotton or felt hats because they absorb pesticides.

Respirators - Read the label to see if a respirator is needed. Many nematicides and soil fumigants require a respirator. Respirators are needed if you are exposed to a pesticide for a long time, if the pesticide you are using is highly toxic, or if you are working in an enclosed area. Surgical masks or a dust mask are not respirators. They may help when mixing dry formulations of low toxicity pesticides but are not effective around fine mists. They do nothing to stop vapor inhalation.

Care of Clothing Worn During Pesticide Application

Remove the clothes while still outdoors. Do not launder the clothes with other laundry, and have a separate container for them until they can be laundered. Pre-rinse before washing, wash after each use, and wash in hot water. Use a heavy duty laundry deter-

gent, and wash with a full water level in the machine using a long wash cycle. Line dry whenever possible, as sunlight helps break down pesticides.

MAINTENANCE OF ESTABLISHED SOD

Mowing

Mowing is one of the most time-intensive chores in sod production. Mowing maintains a high-quality turf surface and encourages lateral growth in regrowing sod. Mowing at the proper frequency also minimizes thatch accumulation and reduces the need to remove clippings from the turf surface. As a rule of thumb turfgrasses should be mowed so that no more than 30% of their leaf area is removed at any one time. Mowing less often will result in clipping accumulation, scalping, and depletion of photosynthetic reserves.

Two general types of mowers are used in maintaining turfgrass on sod farms: rotary and reel mowers. **Mowing at the correct frequency eliminates turf scalping, reduces the need to collect clippings, and encourages lateral turf growth.**

Although reel mowers have a much higher quality of cut they also require intensive maintenance because each reel unit has many reels and cutting blades that must be kept sharp. Flail or rotary mowers do not offer the same quality



of cut, but are cheaper to maintain. A small (less than 100 acres) sod farm will typically have at least one five-gang reel mower that is pulled behind a tractor or truck, and two or more six-foot flail or rotary mowers. It is critical that mowers be washed between fields so that contamination of a grass species or cultivar by mower traffic is minimized, and to prevent the spread of pests between fields.

Pest Control

Weed, disease, and insect control are some of the most problematic issues facing any sod producer. Because chemical labels can rapidly change, and because sod farms are often the focus of special chemical labeling, this BMP manual will not list specific pest control practices.

Best Management Practices for pesticide application on sod farms include: (1) reading the label, (2) applying only at labeled rates, (3) applying only on labeled grasses, (4) following all directions for application (eg., water in after application), and, 5) following all directions for disposal of empty containers, unused pesticides, and runoff from equipment washing. Specific questions regarding label directions or uses can be addressed to a variety of experts, including state Extension specialists, chemical company technical representatives, or product sales representatives. Every year Alabama publishes new “Weed Control for Commercial Turf” and “Disease and Insect Control for Commercial Turf” guides, which can be obtained by calling your county Extension agent and requesting a copy. These guides contain up-to-date recommendations for weed and pest control in sod fields.

Fertilization

With the exception of nitrogen (N), sulfur (S), and iron (Fe), the majority of sod farm fertilization should follow recommended soil-test results. The most common nutrients applied according to soil-test are phosphorus (P) and potassium (K). If the soil-test recommends lime, liming with dolomitic lime will supply needed calcium (Ca) and magnesium (Mg).

Phosphorus, potassium, and lime are most commonly applied at establishment and reestablishment, and are best applied and incorporated as a part of the renovation process. Applying and incorporating P, K, and lime materials ensures that the plant nutrients will be located in the rooting zone, and fertilizers applied to bare soil are less susceptible to loss via runoff in water. Typically, P and K are applied through a granulated homogeneous fertilizer such as 8-8-8 or 10-10-10. Larger sod farms may order a bulk blend material with triple superphosphate and potassium chloride as the P and K sources, respectively.

The most common sources of N fertilizer are soluble sources with a rapid rate of release and turf response. Typical sources are ammonium nitrate (34-0-0), ammonium sulfate (21-0-0), and urea (45-0-0). A typical rate is no more than 50 pounds N per acre per growing month. Adding additional N can cause increased shoot growth at the expense of root development, and also increases mowing frequency. These sources are all soluble, relatively cheap per pound of N, and available as a granular product. Another source of N is waste material, such as poultry litter or sewage sludge, which typically contain about 3% nitrogen. However, such wastes often contain as much P as N, so over-application of phosphorus is likely. To avoid

this environmentally damaging situation frequent (at least yearly) soil testing and analysis of the waste material is needed.

Centipedegrass does not respond to frequent applications of N, and on high pH soils (greater than 7.5) applications of iron (as Fe chelate or Fe sulfate) may produce a greening response without additional nitrogen. On sandy soils that have a higher pH, iron fertilizer may be needed for warm-season turfgrass.

Irrigation

Sufficient water resources should be available to supply one inch of water per week to every acre of sod on the farm. In extremely hot and dry weather or on farms with very sandy soil the need may increase to two inches of water per week. Alabama sod producers use several different water sources, including rivers or creeks, natural constructed lakes or ponds, and groundwater wells. It is far less likely for a sod grower to use a public water utility as their primary source of water.

Effective BMPs for irrigation management include regular evaluation of the irrigation system, including an assessment of the uniformity of water coverage.



Many Alabama sod growers utilize center pivot or linear sprinkler irrigation systems as their primary means of irrigating their fields. A center pivot system can irrigate anywhere from 40 to 135 acres, while large linear systems can irrigate up to 400 acres. Traveling gun systems are often used for smaller fields and spot watering. Traveling gun systems are flexible, and can be moved from field to field. However, that does increase labor costs to move and set up the equipment. Although early morning irrigation is preferred (to lessen chances of disease) in hot weather larger sod farms may irrigate their fields around the clock.

SOUTHERN TURFGRASSES FOR SOD PRODUCTION

How is Turfgrass Selection a BMP?

Proper selection of grass species for an environment is a first step in protecting the environment. Poorly adapted grasses will not survive, leaving bare ground susceptible to erosion and sediment loss. Grasses prone to disease, or those that are inefficient users of water or nutrients are not environmentally compatible, and may require more frequent applications of fungicides or water than adapted grasses. Typically, in Alabama we grow warm-season turfgrasses, which prefer warm temperatures for growth and development. These grasses are green and growing in the spring and summer, and go dormant in the fall and winter.

THE SPECIES

Bermudagrass (*Cynodon* spp.)

Bermudagrass is the most widely grown turfgrass in the South and Southeast, and two species of bermudagrass are grown for sod production in Alabama. One species, *Cynodon dactylon*, is common bermudagrass. *Cynodon dactylon* is the only species of bermudagrass that produces viable seeds, and it is used in breeding programs to produce hybrid bermudagrass. Hybrid bermudagrass (typically a cross between *Cynodon dactylon* and *Cynodon transvaalensis*) does not produce viable seeds and must be reproduced from sod or other vegetative planting material such as rhizomes, stolons, or plugs. The bermudagrass species *Cynodon transvaalensis* is the other bermudagrass species grown in Alabama, but it is never grown alone, and only exists as part of the crossing needed to produce the hybrid bermudagrasses commonly grown at Alabama sod farms.

Both hybrid and Hybrid bermudagrass.

common bermudagrasses are characterized by rapid growth and fill-in, excellent wear tolerance and recovery, and good drought and heat tolerance. Because of these benefits bermudagrass is grown on almost all Alabama athletic fields and golf course fairways and is used on the major-



ity of golf course putting greens. It is also widely used as general maintenance turf surrounding businesses, hospitals, shopping centers, and cemeteries.

Bermudagrass is not shade tolerant, and when grown in as little as 20% shade the turf will thin and become sparse. Additionally, the majority of high-quality bermudagrass grown on sod farms is hybrid bermudagrass, which must be established via sprigs or plugs because seeded hybrid bermudagrasses are not available. Vegetative establishment means that homeowners largely must establish their high-quality Alabama lawns by laying sod. This is a benefit for the sod industry.

Lastly, as with all warm-season turfgrasses, bermudagrass goes dormant in winter (when temperatures consistently reach 50 degrees F), turning brown in color until spring, when warming temperatures will cause it to green again. This dormancy causes some communication problems among homeowners, especially new southern residents, who mistakenly believe that their sod is dead. A few sod growers may overseed dormant bermudagrass with a cool season grass (perennial ryegrass), creating sod with a winter green color from the cool season turf planted into the dormant sod. The cool season grass dies out in the heat of spring as the bermuda greens. This is not a common practice because it is difficult to profit from overseeded turf; however it may be found in very high-value turf where a winter green color is desired at installation.

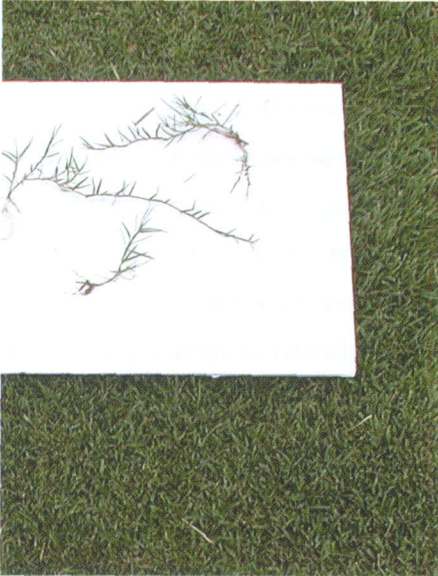
Zoysiagrass (*Zoysia spp.*)

Zoysias are all characterized by slow growth, so most zoysia is sodded and rarely sprigged. They have better shade tolerance than bermudagrass, and will tolerate up to 40% shade. Zoysiagrass also has

excellent wear tolerance, but once worn bare it is very slow to fill in, so it is less suitable as an athletic field turf. Zoysias are most often used for home lawns, businesses, and municipal turf. A few Alabama golf courses have zoysiagrass fairways, and some may use zoysia as collars around putting greens or on tee boxes in shady locations.

Three species of zoysia are grown in Alabama, either alone or as part of a zoysia hybrid. The species are *Zoysia japonica*, *Zoysia matrella*, and *Zoysia tenuifolia*. *Zoysia tenuifolia* is not found in Alabama as a separate species, and is only found as a part of the *Z. tenuifolia* x *Z. japonica* hybrid cultivar ‘Emerald,’ which will be discussed later in the handbook. The three species vary in leaf texture (wideness of the leaf blade), and also exhibit some differences in shade tolerance and winter hardiness. Of the three, *Zoysia japonica* is the only species available with viable seed. Such seed is usually sold as ‘Korean common’ seeded zoysia, and it is not widely avail-

Zoysiagrass.



able or recommended for planting, as current stocks often have uneven germination and slow establishment. The most common cultivars of *Z. japonica* grown in Alabama do not produce viable seed, and must be planted as plugs or sod. *Zoysia japonica* has the coarsest texture of the three species, the best

cold tolerance, and is the most aggressive of the three zoysia species.

Zoysia matrella has a finer leaf texture than *Z. japonica*, but its cold tolerance is not as good as *Z. japonica*. One reason for continued interest in *Z. matrella* is that it may have better shade tolerance than the other two zoysia species. A selection of *Zoysia matrella* was released in the late 1940s in Alabama as a cultivar called 'Matrella zoysia,' and zoysia lawns of older homes from that period may still contain the grass. It is not commonly grown on Alabama sod farms, although a few in the state still do have active fields of 'Matrella zoysia.' Additionally, active zoysia breeding programs in some states, especially at Texas A&M, have produced some new zoysia cultivars and hybrids that utilize selections from *Z. matrella*.

Centipedegrass

Only one species of centipedegrass [*Eremochloa ophiuroides* Munro Hack.] is used in Alabama sod production. Often considered the turf of choice by homeowners seeking a low maintenance turf, centipedegrass is used primarily for home lawns or business turf.

Centipedegrass has a very coarse leaf blade, and has a more open turf than zoysiagrass or bermudagrass. Although not as cold tolerant as bermudagrass or zoysiagrass, it can withstand moderate shade (40-50%), and will also tolerate more acid soils (pH 5) than other warm-season grasses. This tolerance of some shade, coupled with its low maintenance requirements (little nitrogen, less mowing), makes centipedegrass a popular selection for many sod producers.

Centipedegrass can be established by seed, and many sod growers make their initial centipedegrass establishment from a

direct seeding. A successful centipede grass seeding re-quires a finely prepared seedbed and adequate, frequent watering to ensure germination.

Centipedegrass.



St. Augustinegrass

The warm-season turfgrass with the coarsest texture, St. Augustinegrass [*Stenotaphrum secundatum* Walt. Kuntze]

is grown in Alabama for use in the central and southern part of the state. It is widely used as a lawn grass along the Gulf Coast, and its tolerance of shady sites (up to 70% shade) has moved use of the turf inland to many home lawns in the southern region. Although it has good shade and heat tolerance, it is not cold tolerant and many cultivars of St. Augustinegrass are less well adapted to northern Alabama.

When well fertilized and intensively maintained St. Augustinegrass has a lush, green appearance. However, lush growth can render the turf susceptible to pests, and St. Augustinegrass is especially prone to attack by chinch bugs and diseases such as gray leaf spot. It is maintained at a higher mowing height than bermudagrass or zoysiagrass, and its lack of tolerance to traffic makes it an unacceptable choice for athletic fields.

St. Augustinegrass decline (SAD) is an especially damaging disease caused by a virus. No control measures exist. The only way to

Saint Augustinegrass.



manage SAD is to plant cultivars of St. Augustinegrass with resistance to the virus.

Seashore Paspalum

Far less common on sod farms than the four major warm season turfgrasses discussed previously, seashore paspalum (*Paspalum vaginatum* Swartz) is gaining popularity as a turfgrass for golf courses and athletic fields that must be main-

tained under very saline conditions. Several sod farms in the Southeast have cultivars that are for sale, and the University of Georgia has an active breeding program to further the development of seashore paspalum.

Currently, only vegetative cultivars of the grass are available. The defining characteristic of seashore paspalum is its tolerance to saline soils, well beyond that of St. Augustinegrass or bermudagrass. This has made use of seashore paspalum an attractive option for golf courses in coastal areas, or for those using low quality irrigation water. Seashore paspalum can be mowed at a wide variety of mowing heights (including putting green height), and it tolerates traffic well. Seashore paspalum does not have the cold or drought tolerance of bermudagrass or zoysiagrass, and information about disease and insect tolerance is largely missing at this writing.

Buffalograss

Although there are a few sod farms in Alabama that produce buffalograss (*Buchloe dactyloides*) it is not a turf recommended for Alabama sod production. Attempts have been made to use the turf in Alabama because it is extremely low maintenance and drought tolerant, as it is adapted to regions of low rainfall (less than 25 inches per year). It has been marketed as an excellent choice for low-input athletic fields or low-mow applications, such as parking lot islands. However, typical amounts of Alabama rainfall are too much for this turf, and the end result is that after a few years bermudagrass or grassy weeds will invade the buffalograss. Also, buffalograss has separate male and female plants, which means that seeded types produce a widely varied patchy turf. Buffalograss sod is usually all female plants, which eliminates unsightly seed stalks but does force vegetative reproduction of a turf that is supposed to be inexpensive and low maintenance.

Because of its lack of environmental adaptation it is not currently recommended that buffalograss be grown for Alabama sod production. Although the turf may appear useful for low-input situations the most likely result of any Alabama buffalograss planting is that common bermudagrass will eventually invade.

Tall Fescue

The only cool season turf grown on Alabama sod farms, tall fescue (*Festuca arundinacea*) is largely produced for sale in North Alabama and Georgia. Because tall fescue has year-round green color and will tolerate shade, many Alabama homeowners attempt to manage the turf as a year-round grass. However, this is only an option in North Alabama, and attempts to grow the turf year-round in Central

and South Alabama usually result in severely thinned or dead turf by August, with fall reseeding needed to maintain year-round growth.

Unlike most of the warm-season grasses planted for sod production, tall fescue sod is established by seeding. Because tall fescue does not have extensive creeping stolons or rhizomes the sod does not knit well, and it is usually grown with plastic netting to help sod strength. If the sod is produced in Alabama it is usually a fall planted crop and is harvested within a short time period.

Unlike warm-season turfgrasses, which frequently have a limited number of available cultivars, cool season turfgrasses often have hundreds of cultivars developed out of many grass breeding programs. However, most Alabama sod growers tend to seed just a few tall fescue cultivars, with the most common being 'Rebel' or one of the 'Rebel' offshoots such as 'Rebel Jr.' or 'Rebel 3D.' These cultivars are turf-type tall fescues, having a finer texture and better ability to persist at a low mowing height than KY-31 pasture type tall fescue.

Some sod growers use a fine netting in their tall fescue or centipede-grass production. This helps the sod knit, and is especially useful in large roll systems.



WARM SEASON TURFGRASS CULTIVARS

The term “cultivar” is shorthand for “cultivated variety,” designating a turfgrass that is specially bred or selected. After years of evaluation for characteristics such as texture, disease resistance, adaptation to mowing height, and cold tolerance, a promising cultivar is released as a named variety. A cultivar may be a hybrid, or it may be a vegetative selection from a patch of grass that contains a desirable characteristic. Many warm-season cultivars are only available via vegetative reproduction, which means they can only be reproduced by sprigs, plugs, or sod.

Bermudagrass Cultivars

Tifway (419)

The most popular hybrid bermudagrass grown on Alabama sod farms, ‘Tifway’ bermudagrass is also commonly known as ‘419.’ Many sod purchasers know one name or the other, often not realizing that they are the same cultivar. Other purchasers may know the grass under a vague name such as “Tifton” bermudagrass. The correct cultivar name, however, is ‘Tifway’ bermudagrass.

‘Tifway’ is a hybrid between a *Cynodon dactylon* and *Cynodon transvaalensis*, and was released by Dr. Glenn Burton of the United States Department of Agriculture/Georgia Agricultural Experiment Station (USDA/GAES) in 1960. Superior to common bermudagrass in turf quality, it has a darker green color, finer texture and dense turf. ‘Tifway’ must be propagated by sprigs, plugs, or sod, and viable seed is not available. ‘Tifway’ is commonly used on athletic fields, home lawns, golf course fairways, and anywhere a higher-quality utility turf is needed.

Tifgreen (328)

Like 'Tifway,' 'Tifgreen' also is known by both a name and a number, and both are commonly used in the sod industry. In this case 'Tifgreen' is also known as '328.' A *C. dactylon* x *C. transvaalensis* hybrid, 'Tifgreen' was released in 1956 by USDA and GAES. A low-growing, dense turf with a fine texture 'Tifgreen' can still be found on many Alabama sod farms. It was originally used for putting greens, high-quality home lawns, tee boxes, and athletic field areas such as tennis courts and baseball infields.

However, the use of 'Tifgreen' in home lawns has largely been replaced by 'Tifway,' and its use on putting greens has largely been replaced by 'Tifdwarf.' 'Tifgreen' is still an excellent option for baseball infields, tee boxes, and golf courses seeking a low-input putting green surface that can be maintained at a slightly higher mowing height. In fact, many small-scale golf courses that have limited equipment and supplies do not consider 'Tifgreen' when sprigging a putting green, although it still might be the best option for their course.

Tifdwarf

A hybrid bermudagrass specifically developed for use on putting greens, 'Tifdwarf' was released in 1960 by the USDA/GAES. Unlike 'Tifway' and 'Tifgreen,' this grass was a vegetative selection from a patch of 'Tifgreen.' This patch had smaller leaves, better green color, and fewer seedheads than 'Tifgreen,' which allows it to be mowed at lower mowing heights. Currently 'Tifdwarf' is the standard for use on southern bermudagrass putting greens.

'Tifdwarf' is not commonly grown on Alabama sod farms. Several Alabama sod nurseries grow the grass, and a large portion of their sales consists of sprigs or rhizomes for use in planting new or reno-

vated putting greens. The turf is not recommended for use on home lawns or athletic fields.

Tifway II

An improved selection of 'Tifway,' 'Tifway II' was released because it was thought to have superior cold tolerance and quicker spring green-up than 'Tifway.' It is widely found on Alabama sod farms, and is often sold as 'Tifway' or a generic Tifton bermuda. It has not overtaken the strong market niche filled by 'Tifway,' however.

TifSport

A new entry on the turf market, 'TifSport' is a certified hybrid bermudagrass, with certified and patented genetic purity. An irradiated mutant from 'Midiron,' 'TifSport' has superior cold tolerance when compared to 'Tifway.' It can only be purchased through member growers of the Tift 94 Growers Association, Inc. Currently there are two Alabama sod growers who are producing 'TifSport' for sale. High quality athletic facilities and golf courses seeking an improved hybrid bermudagrass have been the main purchasers of 'TifSport.' Additional information about 'TifSport' can be obtained at the Web site at <http://www.tifsport.com/default.htm>.

T-10

Another new certified hybrid bermudagrass, 'T-10' has a natural dark bluish-green color. It has a coarser texture than 'Tifway,' and is intended for use in low-maintenance conditions. Although there are no Alabama sod producers currently growing this grass it is available from some Georgia growers.

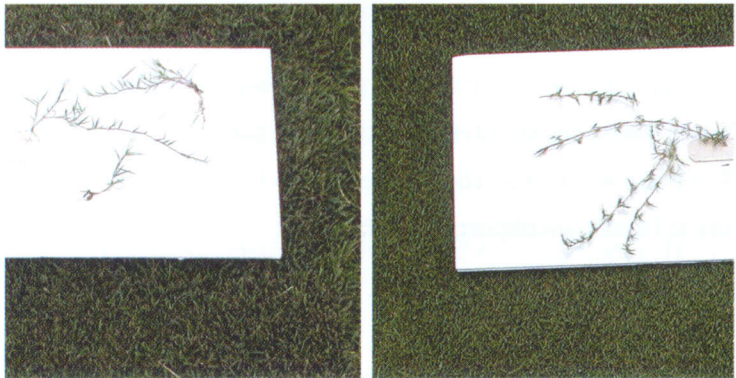
Zoysiagrass Cultivars

Meyer

An improved strain of *Zoysia japonica*, 'Meyer' is only available by vegetative reproduction as sprigs or sod. It is sometimes also called 'Z-52.' Because 'Meyer' zoysia is slow to grow, it is almost always sold and laid as solid sod. On sod farms new fields of 'Meyer' zoysia are established by planting plugs at a six- to 12-inch spacing.

'Meyer' is characterized by a coarse leaf texture, excellent cold tolerance, and ability to grow well in partial shade. It is primarily used for lawns or other high-quality utility turf (such as business landscaping). There are a few Alabama golf courses that have 'Meyer' zoysiagrass fairways.

Two common zoysiagrass cultivars found on Alabama sod farms. Meyer (left) is a *Z. japonica* type, while Emerald (right) is a finer textured hybrid of *Z. japonica* and *Z. tenuifolia*.



Emerald

A hybrid zoysiagrass (*Zoysia japonica* x *Zoysia tenuifolia*), 'Emerald' zoysia must be propagated vegetatively. 'Emerald' has a finer texture than 'Meyer,' but is not as cold tolerant. It is grown on sod farms throughout Alabama. 'Emerald' and 'Meyer' are the two most popular zoysias grown on Alabama sod farms.

Matrella

A vegetative release of *Zoysia matrella*, ‘Matrella’ zoysia is often found in older (1950s) Alabama home lawns. A few Alabama golf courses also use the grass as the separating collar between putting green and fairway grasses, as the very slow growth of the ‘Matrella’ zoysia helps prevent grass encroachment. ‘Matrella’ zoysia has a texture and general appearance similar to ‘Emerald’ zoysia, and it is thought to have slightly better shade tolerance. The grass has largely fallen from popular use, although there are a few sod farms in Alabama that still have the turf in production.

El Toro

Another vegetative *Zoysia japonica*, ‘El Toro’ has a coarse leaf blade and faster growth than ‘Meyer’ zoysia. Although not widely grown on Alabama sod farms it can be found in the Southeast, and it usually marketed as a faster spreading, more aggressive alternative to ‘Meyer’ zoysia.

Other Zoysias

Zoysiagrass breeding is a rapidly growing area in turfgrass research, and several new cultivars have been released in the past few years. Many have excellent promise, and may well make their way onto Alabama sod farms. Examples of such cultivars include ‘Belair’ and ‘De Anza,’ newer cultivars from the University of California, which were released as aggressive growers with good winter color retention. Texas A&M University has several new entries into the zoysiagrass market, including ‘Diamond,’ ‘Cavalier,’ ‘Palisades,’ and ‘Crowne.’ ‘Diamond’ and ‘Cavalier’ are vegetative selections of *Z. matrella*, and are fine textured zoysiagrasses. ‘Palisades’ and ‘Crowne’ and vegetative selections of *Z. japonica*, with coarser texture and faster growth for home lawns, golf courses, and utility turf.

Seeded Zoysiagrasses

Although not yet commonly used, seeded zoysias do show promise for use on sod farms, and a few sod farms in the South are growing and selling seeded zoysiagrass. Selected from *Zoysia japonicas*, the most common seeded zoysiagrass is 'Zenith.'

St. Augustinegrass Cultivars

A great majority of the St. Augustinegrass sod planted in Alabama is a sterile vegetatively-propagated selection of common St. Augustinegrass. Cultivars were developed from this common St. Augustinegrass in the late 1950s, but there are still relatively few improved cultivars of St. Augustinegrass grown on sod farms. If they are produced, improved cultivars of St. Augustinegrass were usually released for: (1) improved cold tolerance, (2) fine texture, (3) resistance to St. Augustinegrass decline (SAD), or (4) chinch-bug tolerance.

Floritam

Released in 1972, 'Floritam' has resistance to SAD and is chinch-bug tolerant. It has a very coarse leaf texture, and spreads rapidly from profuse aboveground stolons. Because it is not very cold tolerant it is largely found at southern Alabama sod farms and in many Florida sod farms.

Raleigh

Released in 1980 by the North Carolina Experiment Station, 'Raleigh' is the St. Augustinegrass cultivar that can be found at a few northern or central Alabama sod farms. Finer textured than 'Floritam,' 'Raleigh' does not have chinch bug tolerance. 'Raleigh' does have resistance to SAD, and is one of the more cold-tolerant St. Augustinegrasses.

Bitter Blue

An older (before 1960) cultivar selected from common St. Augustinegrass, 'Bitter Blue' has a deep blue color and a very coarse texture. There are several southern sod farms that still have this cultivar growing in their sod fields.

Seville

Released in 1980, 'Seville' has much finer texture than many other St. Augustinegrass cultivars. It does not have good cold tolerance, and very few Alabama sod farms produce this cultivar.

Palmetto

A registered and privately released cultivar of St. Augustinegrass, 'Palmetto' was released in 1995 as a cultivar with good cold hardiness and excellent spring green-up.

Centipedegrass Cultivars

Most centipedegrass sod sold in Alabama is a common centipedegrass that was originally planted from seed. There are very few developed cultivars, and of those the only one found on any Alabama sod farm is 'AU Centennial,' a centipedegrass released by Auburn University for its finer texture and better cold tolerance. However, this cultivar largely failed to find a market niche, and common centipedegrass comprises the vast majority of centipedegrass sold in Alabama.

