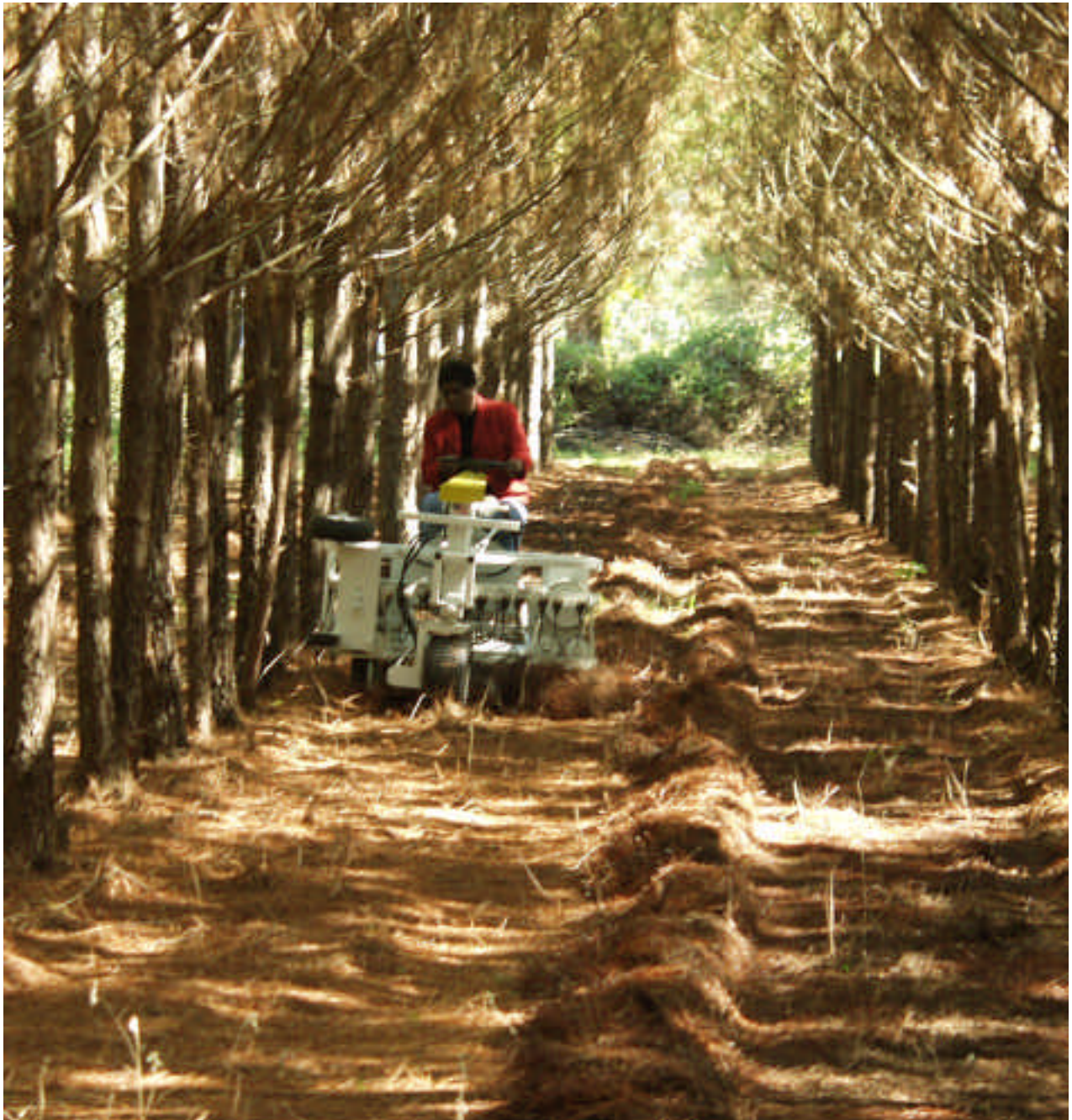


# Managing Your East Texas Forest



**for the Production of Pine Straw**

<http://TexasPineStraw.tamu.edu>



# Managing Your East Texas Forest for the Production of Pine Straw

by  
**Eric L. Taylor and C. Darwin Foster**

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## Highlights

- Pine straw is a popular landscape ground cover throughout the South.
- Pine straw has superior properties over other organic mulches.
- All four native pine in East Texas make a first-rate mulch.
- Pine straw is a renewable resource that may supplement forestland investments.
- Pine straw is retailing for \$5 to \$10 per 25 to 50 pound bale to landscapers, nurseries and garden centers.
- East Texas pine stands yield 80 to 120 bales per acre per year.
- The initial cost of preparing a stand for pine straw harvesting cost approximately \$200 per acre.
- Landowners can lease their land for as much as \$30 per acre for baling rights.
- Fertilizer may be essential to replenish nutrient loss to pine straw harvesting.
- Maintaining a basal area of about 90 square feet per acre is important in controlling understory vegetation as well as in maximizing straw yields.

- Removal of straw from stands is preferably done every 2 years.

## Advantages

- Production of pine straw will provide a source of income while trees are being grown for timber.
- Production of pine straw might provide some tax relief.
- The aesthetic appearance of the forest stand is improved by removing weeds and other understory vegetation.
- Landowners can contract with a harvesting company which will harvest the pine straw and have very little time invested.

## Disadvantages

- Removal of pine straw may affect the nutrient balance and reduce the long-term soil productivity in addition to decreasing the growth of the trees.
- Some wildlife species which normally reside in forest stands may be adversely affected by lack of cover and food supply.

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## Definition of Terms

**Basal Area** – A measure of the density or stocking of a forest stand. It is the cross-sectional area of the tree, including the bark, measured at 4.5 feet above the ground. Sum of individual tree basal areas on an acre of land equals the total basal area per acre expressed in square feet per acre.

**Cleaning** – Preparing the stand to rake pine straw by removing ground debris (such as limbs, cones, hardwood leaves, and trash) and low hanging limbs that will interfere with mechanical raking and baling.

**Pine Straw** – the fresh undecomposed pine needles that have fallen to the forest floor.

**Rotation** – The length of time between the initial establishment of a pine plantation and the final harvest.

**Understory** – All the plants growing under the main canopy of the pine trees.

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## Introduction

Managing pine forest for the production of pine straw is a promising new enterprise in East Texas that can potentially provide substantial supplemental income to Texas forestland owners. Use of pine straw as a ground cover mulch in landscaping around trees and in flowerbeds has recently seen rising popularity in Texas because it is clean, attractive, and provides exceptional value for most landscaping situations.

Pine straw popularity is fairly recent in Texas, but it has been a popular landscape ground cover throughout the South for the last 25 years. In fact, it is one of the most widely used mulches for all size projects ranging from residential flower beds to industrial complexes and highway landscapes. Landscapers, building contractors, and homeowners have discovered that pine straw has superior properties over other mulches. Unlike other dry organic mulches such as pine bark, leaves, grass clippings, and peat moss, pine straw helps provide favorable growing conditions and stimulates healthy plant development (Fig. 1) because it:

- Insulates tender roots from temperature extremes keeping the soil warm during cold spells and cool during warm spells,
- Conserves soil moisture by reducing water evaporation rates and moisture loss,
- Encourages water infiltration into the soil and reduces runoff,
- Eliminates erosion caused by wind and rain-splash impact,
- Protects against soil compaction by reducing the rain impact directly on the surface, and
- Aids in promoting favorable soil tilth for healthy root growth.

Pine straw may also hinder the establishment of weeds and soil-borne diseases. Pine needles interlock and hold together during hard rains, heavy winds, even on landscapes with considerable slope. Since pine needles interlock, pine straw will not wash out of beds like some other mulches.

Pine straw remains loose and friable and does not form a top crust like grass clippings, leaves, and some wood mulches. Loose mulch allows water to infiltrate readily into the soil for plant availability and avoids wasteful irrigation runoff. The large air pockets, however, help prevent it from remaining excessively wet and damaging

roots. Lastly, the fine texture and uniform color of pine straw is simply more aesthetically pleasing to some users. The attractive, earthy facade brings out the color, contrast and texture of landscapes.



**Figure 1.** Pine straw serves as a quality mulch for landscapes and gardens.

## Types of Pine Straw Bales

Four species of southern yellow pines occur in Texas. Slash and longleaf pine are primarily distributed in Southeast Texas. Shortleaf is found chiefly in Northeast Texas, and loblolly is distributed evenly throughout all of East Texas.

Listed in order of needle length from longest to shortest, they are: longleaf, slash, loblolly and shortleaf. Regardless of the species, each makes a first-rate mulch; however, shortleaf is too short to bale but might be marketable in bags or by shrink-wrapping bales.

Pine straw is sold in round bales, square bales, and bags all weighing from 25 to 50 pounds and yields 3 to 6 cubic feet (Fig. 2). Square bales often measure 14 by 14 by 26 inches. Round bales measure are 18 inches in diameter and 26 inches long. Customers tend to prefer smaller, lighter bales. Collection points that buy loose straw from small growers and homeowners are distributed throughout East Texas.

About three inches of pine straw, that settles to 1.5 inches, should be used in new applications. That equals to half a pound of straw per square foot. An additional inch per year is required to maintain the proper depth. Compared to alternative organic mulch, pine straw is typically the least expensive option saving from \$1.60 to \$4.60 per 10 ft by 10 ft bed.



**Figure 2.** A 40 pound bales will cover about 100 square feet.

### Value to the Landowner

Pine straw is a renewable resource that can be harvested each year in Texas, and you don't have to cut down the trees to collect it. This characteristic provides owners of pine plantations with a unique opportunity to realize regular cash flow and offset the long investment period necessary to grow trees to a merchantable size (e.g., pulpwood and sawtimber). In other words, landowners can earn income from their pine plantations for several years before the trees are harvested for pulpwood and sawtimber.

With wise management, pine straw can substantially increase return on the landowner's forest land investment. Bales of pine straw are being sold retail for \$5 to \$10 per 25 to 50 pound bales of highly variable quality straw to landscapers, nurseries and garden centers.

Pine straw might also provide economic opportunity for marginal and poor quality forest land. That is, sites poorly suitable, or economically unproductive, for the sole production of wood fiber may provide reasonable economic return when a pine straw regime is implemented. Landowners may even manage the stand for the production of straw as the primary objective, and the production of wood fiber as a secondary objective.

Landowners have three choices when selling pine straw:

- harvest the straw and sell retail,
- lease their land for baling rights, or
- sell loose straw to a "bulk buying" service.

*Retail sales of Texas pine straw could increase if markets were expanded to the major urban markets.*

### Leasing Land for Pine Straw

Two types of leases are written for leasing land for pine straw harvesting. First is a "Pay per Harvest" contract in which the landowner is actually paid per bale harvested of the stand (approximately \$0.10 to \$0.25 per bale). This method is often preferred by harvesters because it offers more operational flexibility with smaller risk to the harvester. The landowner, however, must carefully account for each bale of pine straw. Consequently, landowners may not prefer this type of leasing methods.

Another type of leasing contract is a "Per Acre" basis. With this method, the harvester pays the landowner a set amount per acre per year to harvest pine straw on the landowner's plantation. Typical "Per Acre" baling rights range from \$12.50 to \$30 per acre depending on site cleanup costs.

Regardless of the lease type, the landowners should be compensation on a sliding scale that graduates through time to higher values as sites become cleaner and easier to harvest. Thus, landowners should obtain competitive bids for each year of baling.

The bottom line is that pine straw harvesting in East Texas can be highly profitable for all parties involved if best management practices are followed.

### Annual Yields

Typically, East Texas pine plantations yield 100 to 150 bales per acre per year if all conditions are right, or approximately two tons per acre each year. The quantity varies as much as 60 bales per acre on less suitable sites to as much as 200 bales per acre on exceptional sites. Factors such as tree age, species, stand density, soil fertility and season affect straw yields. Other variables that contribute to pine straw yields include interval between harvests, bale size, "cleanliness" of stand, and raking efficiency.

### Age

As a rule of thumb, vigorously growing younger stands produce more than overly mature, stagnant stands. This rule also holds true for wood production. Also, a well-managed, clean stand with several years' accumulation of needles



will not necessarily provide greater yield than a well-managed, clean stand with only two year needle fall because older needles disintegrate and become too brittle to bale. Only the fresh, red needles are desired by customers.

Stands as young as seven years of age have been successfully harvested for pine straw. Landowners may begin raking younger stands, but the yields will be too low to warrant entry into the stand with mechanized equipment. Pine straw yield increases with stand age up to approximately 15 years of age, at which time the stand yields the maximum amount of straw. After 15 years of age, there is a slight decline in needle fall, but yields remain fairly constant for the remainder of a typical rotation (25 to 35 years).



**Figure 3.** A ten year-old stand after cleaning and mechanically raking pine straw into a windrow.

### **Stand Density**

Pine straw production increases as the total basal area per acre increases. Studies show that stands with a density of about 75 square feet per acre will produce approximately 125, 30-pound bales per acre. While more dense stands of 125 square feet per acre may yield 175, 30-pound bales per acre provided that all fallen needles are available to be harvested.

Care must be taken considering the health and productivity of the crop tree for the production of wood fiber. Although great quantities of straw

might be produced with high stand densities, overly dense stands slow individual tree growth and increase the risk of loss to disease, insects, natural mortality, and fire. A professional forester can provide assistance in determining the best stand density for a specific site.

### **Season**

Needles stay on the branches for about two years after which they turn brown and fall. Needles fall throughout the year, but the heaviest shedding occurs in September and October under normal weather conditions. December, January, and February are good months for raking, provided the bales can be carried directly to the dealer or stored under shelter. Unfortunately, wet weather during these months often precludes baling because the pine straw must be dry for raking, baling and for the general use of equipment in the forest. Harvesters that hand rake, may still collect pine straw during the wet season provided that they have an indoor pine straw drying facility to dry the straw before it is baled. Otherwise, in East Texas, August through November is established as the ideal months for harvesting pine straw.

### **Pine Straw Harvesting**

#### **Cost of Harvesting**

In Texas, costs for harvesting and marketing of loblolly pine straw tend to be greater than in other Southern states in which the pine straw market is more established (e.g., Georgia, Florida, Louisiana and Arkansas. For example, harvesters have successfully hand baled in Florida for some 15 years. This increased cost is largely due to the cost associated with preparing or “cleaning” an existing stand for the first time mechanical harvesting of pine straw. The cost of initial cleaning is estimated to be between \$180 and \$250 per acre. The cost of cleaning may be much lower if hand raking.

Harvesting equipment and infrastructure costs depend upon whether or not the producer is baling on a large commercial scale, or on a part-time small operation. Generally, small operations may only need \$200 worth of equipment to bale an averaged sized plantation, not including labor, because straw may be raked by hand and baled using a hand-powered baling box operation (Fig. 4). Pine straw baler plans can be found in Appendix A of this publication.



**Figure 4.** Pine straw can be baled with a simple hand-powered box baler.

Most small operations can bale and deliver straw with no need for storage. In addition, many forest landowners who also own farms may already have much of the necessary equipment for pine straw harvesting (e.g., dump rake, mechanical hay baler, small tractor, trailer, barn).

In Texas, the total costs for loblolly pine straw harvesting and marketing on a commercial scale are estimated to be between \$2.00 and \$2.50 per bale once the stand is established for straw harvesting. The first year, due to cleanup and marketing costs, harvesters have an estimated \$4 to \$6 tied up in each bale. A commercial scale operation may initially require more than \$50,000 in specialized equipment (Fig. 5) and labor to be competitive. Because of the large volume of production, commercial operation must have seasonal storage large enough truck to economically haul bales to market.

### **Good Pine Straw Stand requirements**

Not every plantation is suitable for pine straw baling. A candidate pine straw site should be free of any erosion concerns. Harvesters prefer to start harvesting in stands that are at least 10 years old but before the first thinning. Sites should carry from 90 to 110 sq ft of basal area to maximize both needle and wood production. At the very minimum a basal area of 70-75 square feet of basal area is required to provide enough

shade to eliminate grasses on the forest floor. A 25 to 30 percent crown-to-total-height ratio should be maintained to avoid overcrowding.

If mechanically baling, sites must be clean and flat. Planted pasturelands with few or no terraces provide the ideal pine straw harvesting stand. Many stands have too much herbaceous material, and cows are a potential problem if your market does not want extra nutrients added.



**Figure 5.** Picture of a Star Mini-Roll round baler used for commercial scale operations.

If the site is to be mechanically baled, the optimum row spacing depends upon the size and shape of the equipment used for raking and baling. Old style equipment requires 12 to 16 feet between rows for equipment access. However newer, specialized equipment requires only 6 to 8 feet between rows to move the equipment. Yet, practical raking requirements still dictate 8 to 12 between rows, even for specialized equipment, to harvest pine straw efficiently. New plantations can be planted with wide row spacing to facilitate equipment use during harvesting. Wide row spacing also has advantages for timber production as well.

### **Harvesting Process**

Surprisingly, raking and baling are the easiest and fastest parts of the process. Cleanup, gathering, and transporting the bales are the more difficult, labor intensive and expensive steps. For example, a highly productive crew of five people will require two to three weeks to prepare, clean, rake, bale, and haul pine straw bales from a typical, 30 acre plantation.

Generally the process for machine harvesting a typical pine plantation for pine straw includes:



- Remove (prune) the lower limbs of every tree that might block the movement of equipment and laborers within the rows. Pruning may be performed by hand with machete or special saws for approximately \$0.85 per tree. Limb removal may also be accomplished more cost effectively by using a modified cutter attached to a small tractor as shown in figure 6. Hand raking operations may not find pruning necessary depending upon tree height.

**Figure 6.** A blade attached vertically to a tractor can be used to prune trees quickly.

- Remove all trees and shrubs that are within the baling rows. Special contractual arrangements might be made with the harvester to remove diseased trees within the rows as well.
- Remove all limbs and other debris from the baling rows. The debris must be picked up or raked off site. Often, the debris will be deposited in one out of every sixth row. This eliminates the need to move the debris great distances and reduces labor cost.



**Figure 7.** A prepared stand in which every sixth row is used as a debris rows.

- Rake the pine needles either by hand or by machine into windrows. Make sure to exclude

any insects (ants), excess litter, grass, hardwood leaves when baling that might reduce the value of the bale. Low-grade straw that contains extraneous debris or partially decomposed needles should be sold at a discount. Be careful to avoid seeds of noxious weeds, bahia grass and others flora that might present a problem in landscaping yards or flower beds.

- Bale either by hand or by machine. Twine should be tight enough to hold bale securely without breaking.



**Figure 8.** Pine straw baled by machine to produce rectangular bales.

- Transport bales out of woods.
- Deliver to markets or to a storage barn. Pine straw bales should be protected from rain to prevent molding and nutrient leaching.



**Figure 9.** A quality barn is essential to protecting and/or drying pine straw. .

## Environmental Considerations

### Fertility

Some forest managers are concerned that removing such quantities of pine straw may be detrimental to the productivity of the crop trees. Studies indicate that as few as two harvests

within three years can reduce wood production of some stands by 50 cubic feet per acre compared to site with no pine straw harvesting performed.

Straw contains important nutrients like nitrogen, phosphorus, calcium, and magnesium that return to the soil as the straw breaks down. Raking straw removes these nutrients from forest stands. As the nutrients are removed, tree growth and vigor may decline. As much as 40 lbs of Nitrogen is lost for every 100 bales of straw per acre harvested. Poor nutrition will increase rotation length of the crop trees, decrease vigor, and make trees more susceptible to insect and disease. Fertilizer regimes may be essential to replenish the nutrients lost to pine straw harvesting and maintain or even improve the growth rate of the crop trees.

Since forest stands respond differently to fertilization, it is best to determine the required rates of nitrogen, phosphorus, and potassium, by performing a correct and thorough soil and foliar analysis. The County Extension Agent or local Texas Forest Service forester can provide assistance.

Typical fertilization recommendations, however, generally suggest broadcasting 150 to 200 lbs of nitrogen per acre and 50 lbs of elemental phosphorus per acre every five years. Broadcast 250 lbs of DAP per acre will apply about 45 lbs of the nitrogen and the 50 lbs of phosphorus needed. The additional 100 to 150 lbs of nitrogen per acre can be applied as urea fertilizer. Trees use phosphorus to increase wood growth, and nitrogen stimulates foliage growth and thereby pine straw yields. Potassium might also be supplemented at a rate of 50 to 80 pounds per acre. Apply fertilizer in late January or early February. Typical application will cost between \$25 and \$55 per acre.

### **Soil and Water**

As with the landscape bed, pine straw on the forest floor has many other benefits. One of which is the moisture holding capacity of partially decayed straw important for tree survival and growth during hot summer months and water stress periods. In fact, plant growth reduction is often attributed to water stress. Straw also helps to insulate the soil from temperature extremes that can also reduce tree growth.

Another concern is that the removal of pine straw exposes the soil causing erosion and loss of topsoil. To this end, it is important for harvesting operations to leave a thin layer of straw and organic matter.



**Figure 10.** A layer of pine straw on the forest floor is an essential part of the forest ecosystem.

### **Other Concerns**

Raking straw can impact the diversity and richness of plant and animal species. Harvesting pine straw from the site can dramatically alter the natural, ecological system because pine needles provide food and habitat for many animals that help decompose litter, improve soil tilth, and serve as food for wildlife. Furthermore, harvesting pine straw may have long-term effects on soil chemistry (e.g., from acidic to neutral or basic) that are not yet fully understood. For these reasons, it is desirable to identify unique and/or sensitive areas and shield them from straw production. Raking every 4 years may also reduce any long-term deleterious effects.



**Figure 6.** Sensitive areas such as this stream side should be protected from regular pine straw removal.



## Tending Stands for Pine Straw

Seldom is a stand of pine, newly considered for straw harvesting, desirable for the production of straw. A great deal of effort and planning is required to prepare East Texas stands for the harvesting of pine straw bales that are free of cones, leaves, limbs, trash. In fact, at least two years of preparation is often required before quality, clean straw may be harvested with minimal effort. Steps required for successful management

- 1) *Develop a management plan:* Managing a successful forest resource enterprise, like any other business, involves planning and decision-making prior to its establishment and throughout the life of the enterprise. Some of the general steps that need to be followed to successfully begin and manage an alternative enterprise are:
  - Define realistic, clear, and concise objectives and your level of involvement.
  - Investigate the marketing potential of the pine straw in your area.
  - Investigate the biological and management potential and/or concerns of harvesting pine straw on your land.
  - Identify any major limiting factors such as financial or taxation constraints which may limit your success.
  - Enlist the help of professionals.
- 2) *Competition control:* understory vegetation interferes with raking and reduces the quality of the bale. Control unwanted shrubs, weeds and trees with herbicides or mowing.
- 3) *Prune:* remove lower limbs of pines to facilitate harvesting. The lower limbs can interfere with the harvesting equipment and/or people. Live limbs not receiving partial light may also cause unwanted stress on the crop tree, and pruning may improve wood quality.
- 4) *Clean:* the next step is to clear the area of all twigs, pine cones, and tree limbs. This can be done manually on a site that has an especially desirable quantity of straw. Otherwise an alternative is to mechanically rake all debris, including some straw out and not harvest straw that year
- 5) *Fertilize:* Tree growth may be improved with fertilization on many, but not all, sites. Fertilization may also increase straw

production by increasing the amount of foliage on each tree. Studies have shown that two to five times more needle biomass may be produced after fertilization. Growth of herbaceous vegetation will be increased by fertilization and will need to be eliminated before raking.



**Figure 12.** Poultry litter being ground broadcasted in a 17 year-old pine plantation.

### Stand Establishment

If establishing a new pine straw site, select a site (10 acres minimum) that has been previously used for crops or pasture and is relatively level. Perform the necessary site preparation steps (subsoiling, tilling) needed to ensure survival and productivity of newly planted seedlings. Purchase quality pine seedlings from a nursery that has a good reputation for seedling quality and care. Don't wait until planting season to order seedlings. Seedling orders should be placed in April or May. Carefully plant trees in well-marked rows 10 feet apart. To ensure the best chance of survival and productivity, follow guidelines in *Loblolly Pine Planting manual* by Taylor and Murphrey (2001). While trees are growing, be sure to control underbrush and other trees that may hinder survival and growth and cause problems later with the raking of the pine straw.

### Conclusions

Pine straw production has the potential to supplement the income of landowners during the years when no income will be received from a timber harvest. The production of pine straw is a natural process and requires very little management to produce an adequate supply for the market. However, if the landowner decides to

purchase the equipment needed to bale pine straw and transport it to a market, expenses may exceed income for many years of pine straw production. The method that provides the most profit immediately to the landowner is contracting with a baling service company which will pay per acre for baling the forest stand. The landowner should be aware that a supplemental fertilization regiment will likely be needed if baling pine straw regularly.

Maintaining a basal area of about 90 square feet per acre is important in controlling understory vegetation as well as in maximizing straw yields. Removal of straw from stands is preferably done every 2 years to provide sufficient time for pine straw to accumulate and to reduce detrimental affects caused by annual raking such as increase soil compaction, soil erosion, and lower wood and straw productivity.

### Reference Material:

- Duryea, Mary. 1998. Pine Straw Management in Florida's Forests. Florida Cooperative Extension Service, IFAS, University of Florida, Circular 831.
- Haywood, J.D. General Guidelines for Fertilizing Forest Stands Managed for Pine Straw. USDA Forest Service Fact Sheet. Pineville, LA.
- Kidder, G., N.B. Comerford and A.B. Mollitor. 1987. Fertilization of slash pine plantations. Florida Cooperative Extension Service, IFAS, University of Florida, Gainesville. Circular 745.
- Mills, R., and D.R. Robertson. 1991. Production and Marketing of Louisiana Pine Straw. Louisiana Cooperative Extension Service, Publication 2430.
- More, B.J., F.A. Roth, II., H.A. Pearson, and J.D. Haywood. 1992. Pine Straw Harvesting – A New Arkansas Agricultural Enterprise. Cooperative Extension Service, University of Arkansas, Publication MP382.
- Pritchett, W.L. and R.F. Fisher. 1987. *Properties and management of forest soils*. Second Edition. John Wiley and Sons. New York. 494 p.
- Stanton, W.M. 1986. Longleaf pine straw production. Woodland Owner Notes. North Carolina Agriculture Extension Service, Raleigh, North Carolina. No. 18.
- Stevens, J.C. 2002. Fertilizing Pine Forests in Louisiana and Texas. Louisiana State University Agricultural Center, Publication 2691.
- Taylor, E.L. and C. Alverson. 2002. Pine Straw vs. Traditional Mulches: Cost Comparison. Unpublished data. Texas Cooperative Extension. Overton.
- Taylor, E.L. and M. Murhprey. 2002 21<sup>st</sup> Century Forestry Workshops: Loblolly Pine Planting. Texas Cooperative Extension, Publication B-6115.
- Taylor, E.L., and J. Tate. 2002. Pine Straw as a Ground Cover Mulch. Texas Cooperative Extension. Department, Publication 805-111.



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## Appendix A: Pine Straw Hand Baler Plans



Part	Description	Stock (inches)	Length (inches)
A	Handle	2 x 3	50
B	Lever	bolt 1-2	2 x 3
		bolt 2-3	2 x 3
C	Compressor Arm	2 x 4	24
D	Compressor Pad	1/2 plywood	10.5 x 12.5
E	Pad supports	2 x 4	10.5
F	Lever fulcrum	2 x 4	20
G	String holder see Fig. A-2	Nails	2.5
H	Front brace	2 x 2	18
I	Plywood sides	1/2 plywood	43 x 12
	Plywood back	1/2 plywood	43 x 15.5
J	Corner Supports	2 x 4	43
K	Door	1/2 plywood	15.5 x 38
L	String retainers see Fig. A-3	I-bolts	1
M	Deck	1/2 plywood	59 x 15.5
N	String	nylon	

**Figure A-1.** Illustration of a typical, easy to construct hand-powered, box baler showing the main components.



**Figure A-2.** A rear view of the top of a box baler showing the nail used to hold the baling string in place as pine straw is loaded into the baler.



**Figure A-3.** A view of the four eye-bolts at the bottom of the baler that are important to hold the string in the proper alignment as the pine straw is loaded and compressed.