Fact Sheet EES-328

UNIVERSITY OF FLORIDA
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Using Fast-Growing Hardwoods in Florida[1]

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Fast-growing trees offer many environmental and resource benefits worldwide. In Florida, potential applications of vigorous hardwood species that can grow 10 or more feet per year include remediating environmental problems, providing energy feedstocks, and producing commercial products (Table 1).

Environmental Problems

Numerous environmental issues in Florida can be addressed by growing trees. Global warming and CO_2 mitigation concerns arising from the state's large population and high fossil fuel use could be somewhat offset by large-scale planting of fast-growing trees. Water quantity and quality concerns caused by wastewater and runoff (statewide, one and 60 billion gallons per day, respectively) may be remediated through the use of fast-growing trees.

Energy Feedstocks

Trees can provide energy feedstocks. To maximize the economic and energetic benefits of growing trees for energy uses, management may include practices such as: intensive culture (environmentally safe site amendment and weed control practices, close spacing of trees); short rotation (time from planting to harvest as short as 2 to 10 years); and coppice regeneration (rapid regrowth from the stump after harvest).

Commercial Products

Commercial markets currently exist and may be developed for these species. Hardwood demand and price are increasing in the Southeast. The eucalypts may provide multiple products: landscape mulch, energywood, pulpwood. *Eucalyptus* in southern Florida presently are harvested for landscape mulch. Energywood is needed for electricity generation in southern Florida. Considerable *Eucalyptus* pulp is imported into the United States, and Florida-grown *Eucalyptus* have very acceptable properties for pulp and paper making.

Key, fast-growing hardwoods, when planted on suitable sites and managed properly, are: cottonwood (**CW**) and three *Eucalyptus* species—*E. amplifolia* (**EA**), *E. camaldulensis* (**EC**), and *E. grandis* (**EG**) (Table 1). In Table 1 we present planting guidelines for these four fast-growing hardwoods and describe applications for which they are suited in Florida.

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Table 1. Guidelines on the establishment and management of Eucalyptus and cottonwood in Florida.

Species	***E. grandis***	***E. camaldulensis***	***E. amplifolia***	**Cottonwood**
Applications	F, E, I, P, M	F, E, S, I, P, M	F, E, P, M	F, E, P
Florida Growing Region	Southern	Central and Southern	Northeastern and Central	Northeastern and Northwestern
Site Requirements	Ag land or flatwoods	Ag land, flatwoods or sandhills	Ag or forest land SI[2]≥65; pH>5.5	Ag land or river bottoms
Culture	Disk on muck; Chop, burn, 1/2-ton Ground Rock Phosphate/acre, and bed on flatwoods; Add N up to 270 lbs/acre on flatwoods. Plant in summer	Chop and burn on sandhills; Chop, burn, and bed on flatwoods. Plant in summer	Disk and herbicide; Add N up to 250 lbs/acre and P up to 250 lbs/acre. Plant in spring or summer	Disk and herbicide; Add N up to 325 lbs/acre and P up to 240 lbs/acre. Plant in winter
Planting Stock	Seedlings, Rooted cuttings, or Plantlets of tested clones 2814[3,4] and 2817[3,4]	Seedlings, Rooted cuttings, or Plantlets of tested clones 4583[3] and 4590[5] or 4587[5,6]	Seedlings or Rooted cuttings of tested clones 4827[7] and 4854[7] or 4879[8] and 5030[8]	Unrooted cuttings of tested clones ST240[9] and ST244[9]
Growth	46 ft tall in 2.5 yrs on muck; 33 ft in 2 yrs and 55 ft in 5 yrs on flatwoods	30 ft in 2.75 yrs on sandhills; 26 ft in 5 yrs on flatwoods	46 ft in 3 yrs on ag lands	20 ft in 2 yrs on ag lands
Rotation	2 yrs on muck; 5 yrs on flatwoods	5 - 7 yrs	2 - 5 yrs	5 - 8 yrs
Coppicing (sprout from the stump)	Good in winter, poor in summer; 33 ft in 1.75 yrs on muck, 66 ft in 5 yrs on flatwoods	Good in winter and summer; 13 ft in 2.25 yrs on sandhills	Excellent in winter and summer; 16 ft in 6 mos on ag lands	Excellent in winter; 10 ft on ag lands in one yr
Productivity (dry t/acre/yr)	Up to 16	Up to 9	Up to 11	Up to 10

[1] F = energywood, E = Effluent, S = Stormwater, I = Irrigation, P = Pulpwood, M = Mulch
[2] Site Index (base age 25 years) for slash pine
[3] Plantlets from Twyford International, Santa Paula, CA
[4] Cuttings from Twyford International, Apopka, FL and Lykes Bros. Forestry Division, Palmdale, FL
[5] Plantlets from Simpson Timber Company, Corning, CA
[6] Stormwater applications only
[7] Seed from School of Forest Resources and Conservation, University of Florida
[8] Unavailable commercially
[9] Unrooted cuttings from Louisiana Dept. of Agriculture & Forestry, Baton Rouge, LA

PLANTING GUIDELINES

Successful establishment and management of these fast-growing hardwoods have several components:

Growing Region

No single species is the most productive in all regions of Florida nor most suitable for all applications. Species choice by region reflects freeze

hardiness differences, particularly in northern Florida, where only **CW** is naturally adapted. **EA** is freeze hardy enough to be grown in peninsular Florida where it has sufficient hardiness to go through a rotation with minimal freeze damage. **EC** has freeze tolerance appropriate for central and southern Florida. The limited hardiness of **EG** limits it to southern Florida.

Site Requirements

All four hardwoods grow best on agricultural lands. Lands recently in agricultural use or marginal for agricultural production are typically ideal. **EA** and **CW** require high quality land, with **EA** also requiring high pH. **EC** has a wide site tolerance. **EG** grows very well on sandy or organic soils. **EG** grows more rapidly than **EC** on all but sandhill sites in southern Florida.

Alternatively, all species may be grown on poorer sites if amendments are added to raise nutrient levels and/or pH. **EC** is the most flood tolerant *Eucalyptus* species, but some **EG** clones have acceptable flood tolerance.

Cultural Practices

On poorly drained flatwood sites or in stormwater or irrigation applications involving wastewater flooding, bedding is an essential part of initial culture. Beds should be at least 1 foot high and allowed to settle for about three months before the trees are planted.

All four species survive and grow best when competing vegetation is well controlled during the first two years. The initial site preparation, if bedding is involved, is usually sufficient for vegetation control during the first growing season. With good tree growth during the first year, the trees typically dominate other vegetation for the rest of the rotation.

Planting Stock

Superior genotypes have been identified within each species for maximizing growth and nutrient uptake. The recommended genotypes can be produced in various ways and at different costs. Tested **CW** clones are available as unrooted cuttings for about $0.15 per tree. **EA**, **EC**, and **EG** can be propagated as seedlings or vegetatively as rooted cuttings or plantlets; the vegetative propagules grow more rapidly and uniformly than seedlings. However, plantlets are more expensive than cuttings (up to $.90 per plantlet compared to $.50 per cutting). Both cost more than seedlings. The best **EC** clones are currently available only as plantlets from California. Presently, very little **EA** planting stock is available commercially either as seedlings or cuttings.

Management

Rotation length varies with species, site, and application. For the fastest-growing species grown for energywood, the time from planting to harvest may even be shorter than two years if planted on a high-quality site at close spacing (e. g., **EG** planted on muck soils at 4,000 trees/acre). A species established on a poor site at wide spacing for pulpwood, such as **EC** planted on deep central Florida sandhills at 600 trees/acre, may need up to eight years to reach harvestable size.

All four species coppice (sprout from the stump) after harvest. In the coppice rotation, tree growth is typically faster than in the initial rotation, but the time of harvest is critical to coppicing success. **EA** coppices well throughout the year, while **EG** harvests must be done during the winter to insure good coppicing.

These exotic *Eucalyptus* species surpass virtually all native tree species for most applications in peninsular Florida. They have commercial value and are not invasive, having been present in Florida for 35 to 100 years without spreading. Florida's climate limits seeding in **EA** and **EC**, and close spacing and short rotations greatly reduce flowering of all three species. *Eucalyptus* has a considerable advantage for nutrient uptake and water use in remediation systems. **EC**, for example, has flood tolerance comparable to cypress but is much faster growing.

Table 2. Demonstrations of fast-growing hardwood applications in Florida.

Application	Species	Location	Description
Effluent Spray	CW	Tallahassee	Effluent applied to trees by center pivot irrigation
Effluent Pond	EA, EC, EG	Zephyrhills	Trees planted on berms
Stormwater Pond	EA, EC, EG	Tampa	Trees in 1.5-acre pond flooded with industrial stormwater
Irrigation Pond	EA, EC, EG	Belle Glade	Trees in 0.6-acre pond flooded with agricultural irrigation runoff
Energywood	EA	Gainesville	Clones and progenies planted at 6.6 x 3.3 ft spacing
Energywood	EC, EG	Mulberry	Clones on clay settling pond at 10 x 3.3 ft spacing
Energywood	EC, EG	South Bay	Trees on muck at various spacings
Mulch	EC,EG	Palmdale	Trees planted at 12 x 7 ft on bedded flatwood site
Mulch	EC, EG	Haines City	Trees planted at 10 x 3.3 ft on sandhills site

APPLICATIONS
Wastewater Systems

The potential applications for fast-growing hardwoods in Florida, ranging from innovative wastewater remediation systems to traditional forest products, are demonstrated in various locations (Table 2).

The amounts of water and nutrients taken up by **CW**, **EA**, **EC**, and **EG** in wastewater systems depend on climatic limits, tree age and vigor, and the timing and extent of the wastewater applications. The upper limit on annual water uptake is approximately 65 inches. A pond bioremediation system may reduce total dissolved phosphorus in surface water up to 48%. Annual nutrient accumulations by vigorous **EG** may reach 190, 35, 95, 80, and 25 pounds/acre of nitrogen, phosphorus, potassium, calcium, and magnesium, respectively. The water use efficiency of *Eucalyptus* species is advantageous for taking up the greatest amount of nutrients.

In wastewater bioremediation systems, the management goal is to reach full canopy development as rapidly as possible, maintain active growth, harvest as soon as productivity diminishes, and successfully regenerate through vigorous coppicing. Coppice growth in the second rotation should exceed growth in the first rotation by some 20% and should shorten the time to the second harvest by at least one year. Coppice cycles may be repeated up to six times.

Combining tree crop production with wastewater recycling has many mutual advantages, including increasing tree growth, recycling nutrients, renovating wastewater, and producing commercial products. Wastewater impacts on water quantity and quality may be reduced by utilizing trees' evapotranspiration and nutrient uptake potential. **EA**, **EC**, **EG**, and **CW**, variously tolerant of high water and nutrient levels, may bioremediate: a) effluent from sewage treatment facilities, b) stormwater in urban and industrial areas, and c)agricultural irrigation water needing purification to meet environmental standards.

Effluent Remediation

Sewage effluent produced by a rapidly expanding population must have nutrients removed to meet water quality standards. Effluent amendments can considerably enhance tree growth and even make growth possible on poor sites. The successful growth of **CW** on sandhills at Tallahassee (Table 2) is the result of applying about 3" of effluent weekly.

Sewage effluent pond berms can be easily and inexpensively converted from grass cover to tree cover, as has been done at Zephyrhills (Table 2).

The drawdown of effluent in the pond depends on several factors: excess of evapotranspiration over rainfall, amount of berm occupied by trees, tree access to the effluent, and the ratio of berm area to pond area. Larger ratios of berms to ponds increase drawdown, while smaller ratios decrease it.

An alternative for increasing drawdown is to deliver pond effluent to individual trees on the berms by drip irrigation or sprinklers. Drip irrigating each tree from the time of planting leads to more rapid early growth, quicker access to the pond through root contact, and fuller crown development for maximum transpiration of effluent. Another innovative approach is to install trees in or around an in-ground effluent disposal field.

Stormwater Remediation

Stormwater runoff is the major source of surface water pollution in the state. Most wet detention systems for stormwater fail to achieve the 80% reduction in pollutant loads that Florida requires for new developments. The Tampa stormwater holding pond (Table 2) is designed to provide 100% treatment of the "first flush" (1 inch) of stormwater runoff. **EC** tolerates the extreme flooding that occurs in tree-stormwater systems. For successful establishment and rapid early growth, the trees must be planted on beds at approximately 1,100 trees/acre, and site amendments such as fertilizer, mulch, compost, or sewage sludge should be added to low fertility sites. Stormwater should not be introduced into the pond until the trees are 20 feet tall. **EC** coppicing is vigorous, but harvests during or preceding extended flooding should be avoided.

The cost of a stormwater retrofit is approximately $1,600/acre of capture area to capture and deliver stormwater and less than $9,000/acre of pond to install and plant a holding pond. The target design ratio for holding pond size to stormwater collection area is 0.27 acre of pond/1.0 acre of collection area. The resulting total installation cost for a retrofit is less than $4,000/acre of stormwater discharge basin.

Irrigation Remediation

Purification of nutrient laden water from agricultural operations is often needed. An irrigation runoff holding pond such as at Belle Glade (Table 2) is a low-cost option for bioremediating agricultural wastewater. With existing irrigation equipment, the only cost is for construction of 1.6 foot berms around the pond. A delivery system is needed to deliver runoff to the high end of the pond, and an outflow structure is needed at the low end.

EC clones may be best for runoff systems that are heavily flooded, but two **EG** clones may combine tolerance to floods of three month duration with faster growth. Prolonged flooding does not affect tree growth or survival of 4-5-year-old **EC**. Fifteen-month-old **EG** clones on muck soils may be over 20 feet tall.

Energy

To maximize the economic and energetic benefits of growing these species for energy uses, as demonstrated at Gainesville, Mulberry, and South Bay (Table 2), short-rotation, intensive culture system methods may be followed: 1) high planting densities of 2,000 to 4,000 trees per acre, 2) intensive cultures including site amendment and weed control practices, 3) rotations as short as 2 to no more than 10 years depending on species, planting density, and culture, and 4) as many as six rotations before replanting. Woody biomass has numerous energy-related applications including direct combustion, thermo-chemical gasification, methane production, and potentially alcohol production.

Forest Products

Traditional culture of these species in Florida, e. g., at Palmdale and Haines City (Table 2), is less intense and consists of: 1) planting about 600 trees per acre, 2) basic amendment only as needed by the site and minimal weed control, 3) 8-10 year rotation, and 4) two to three rotations. Their wood is suitable and even preferred for pulp and paper; **EG** is used for mulch.

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