SUMTER COUNTY COMPOST FOR FOREST CROPS
Final Report – April 2008

by
D. L. Rockwood and D. R. Carter
School of Forest Resources and Conservation,
University of Florida, Gainesville, FL, 32611-0410
352 846-0897, Fax: 352 846-1277, dlrock@ufl.edu

Abstract

This multiyear project addressed the need for environmentally sound, economically feasible, practical, and applicable solutions for recycling and utilizing organics by research on and demonstration of fast-growing forest tree responses to Sumter County Compost (C), development of guidelines for C use on these short rotation forest crops, estimation of associated economic and environmental benefits, and dissemination of this information. Our research and demonstration study planted at FORCE in September 2002 was doubled in size by planting over 2,000 trees in four cultural treatments in early 2004. To further extend the evaluation of C on forest crops, additional studies were also installed: 1) at the UF/IFAS Southwest Florida Research and Education Center (SWFREC) at Immokalee in July 2004 (partially replanted in July 2005), 2) on a sandhills site near Brooksville, FL, in January 2004 to assess cultural options including C for cypress (**TD**, *Taxodium distichum*), 3) a 2000 study assessing **TD** response to C, 4) a 2003 study evaluating C influences on tree-fern mixes for phytoremediation, and 5) 2006 and 2007 windbreak studies with C. Several older studies also contributed. Based on accumulated data, while C alone helps growth and survival of **TD**, cottonwood (**PD**, *Populus deltoides*), *Eucalyptus grandis* (**EG**), and *E. amplifolia* (**EA**), C plus irrigation produces the fastest growth and highest survival through midrotation, midrotation C applications enhance productivity, and the most productive genotypes within these species increase yields considerably. Under a base case scenario, compost application to fast-growing trees was profitable. More than 290,000 acres within 15 minutes, and another 945,000 acres within 30 minutes, of agricultural and forest lands proximate to 15 compost production facilities in Florida provide a substantial opportunity for growing forest crops with compost. The project was the subject of over 30 posters, presentations, papers, tours, and/or visitations.

Introduction

C considerably enhanced the productivity of forest tree crops increasingly in demand in Florida, namely **TD** and fast growing hardwoods, such as **PD**, **EG**, and **EA** that consume high amounts of water and nutrients. C increased **TD** growth in three studies, including Study 86 (Table 1) where C raised pH and greatly enriched the nutrient poor spodosol. Composted and bedded trees were statistically taller and had two and 10 times more biomass, respectively, than bedded-only and unbedded trees. Leaf and twig nitrogen concentrations were also higher in composted trees, which also had more foliage and dense fine roots surrounding clumps of organic matter in the rhizosphere, suggesting potential for rapid future growth. Across the studies, survival was noticeably greater with C, ranging from 8 to 18% higher than non-C treatments. C amendments also significantly increased the growth of **EA** in adjacent studies.

In response to effluent (E), E+C (EC), E+mulch (EM) and E+C+mulch (ECM) on sandhills west of Orlando (Study 72 in Table 1), **EG** more than doubled the biomass of **PD** after two years. EM, EC, and ECM increased yields by 131, 76, and 158% compared to E. The trees removed up to 534 kg N ha^{-1} and 198 kg P ha^{-1}. **EG**'s superior productivity has obvious value for phytoremediation and for potential commercialization in rotations as short as two years for mulchwood and energywood. **EG** plantations can increase water loading and reduce N and P leaching by up to 75% when E only is applied and 85% when M is added for weed control.

Our multi-year research project extended these preliminary findings to additional practical field applications of the "wet" form of C in forestry, identified market potentials, and disseminated information concerning practical applications and field implementations to appropriate public and private audiences. Thus, the project met the need for environmentally sound, economically feasible, practical, and applicable solutions for recycling and utilizing organics, development of guidelines for C use on forest crops, and estimation of economic and environmental benefits.

Table 1. Field studies contributing to assessments of **PD**, **EG**, **EA**, and **TD** receiving C.

Study	Location	Estab. Date	Species	Description
72	Orlando, FL	4/98	**PD, EA, EG**	1,076 trees from 3 clones, 6 and 6 progenies + C, mulch, and/or sewage effluent
74	Old Town, FL	6/98	**EA, EG**	80,000 trees from 50 and 15 progenies
79	Cross City, FL	1/99	**TD**	660 trees from 20 accessions + C
80	Old Town, FL	4/98	**EA**	1,500 trees from 59 progenies + C, etc., with I
81	Quincy, FL	7/99	**PD, EA**	4,850 trees from 1,100 clones and 50 progenies
82	St. Augustine	8/00	**PD, EA**	630 trees from 15 clones and 15 progenies + Toluene
84	Green Cove Springs, FL	12/00	**PE**	2,055 trees + 9 cultures on mined and unmined sites
86	Waldo, FL	2-3/00	**TD**	1,800 trees from 14 accessions + 6 cultures
90	Lakeland, FL	4-6/01	**PD, EA, EG**	200,000 trees from 6 clones, 6 and 6 progenies + 5 cultures
91	Palmdale, FL	8/01	**EA, EG**	980 trees from 4 progenies, 18 progenies, 4 clones, and 10 hybrids
92	Ft. Meade, FL	3/02	**PE, TD**	2,600 trees from 36 pure and hybrid progenies, 3 progenies and 6 accessions + 3 cultures
94	Lakeland, FL	12/01	**PE, TD**	1,700 trees from 33 pure and hybrid progenies, 9 progenies and 26 accessions
102; 102A	Sumterville, FL	09/02; 01-04/04	**PD, EA, EG; PD, TD, EA, EG**	2,100 trees from 11 clones, 9 and 9 progenies + control, C, irrigation, C+irrigation; >3,500 trees from 50 clones, 29, 10, and 16 progenies + control, C, irrigation, fertilization+irrigation, C+irrigation;
105	Archer, FL	4, 8/03	**PD, EA, EG**	770 trees from 44 clones, 8 and 30 progenies + 2 cultures + As
106	Brooksville, FL	01/04	**TD**	2,432 trees from 78 progenies in control, C, and fertilization treatments
107	Immokalee, FL	07/04; 08/05	**PD, TD, EA, EG**	1,120 trees from 16 clones, 5, 4, and 12 progenies + control and C;
117	Wimauma, FL	03-09/06	**PE, EA, EG, LI, MG, MC, SR, IC**	8,421 plants from 30 clones, 5 and 7 progenies, 4 and 4 varieties, and single sources, respectively - low, medium, and high C and F applications with and without I
119	Ft. Meade, FL	12/06-1/07	**TD**	100 trees from one source in control, and 3 C mixes
120	Citra, FL	03/13/07	**PT, EA, PE, JV**	1,364 plants from 1 clone, 5 progenies, and single sources, respectively - C application with I

Methodology

The genetics x silviculture Study 102, initiated in September 2002 at the FORCE 40 acre demonstration farm, was expanded to be the primary demonstration in our project. Study 102 had three species (**PD**, **EG**, and **EA**) and four cultural (irrigation, C, and/or fertilization combinations) treatments (irrigation (I), C, I+C, and a control coded subsequently as 100, 010, 110, and 000, respectively) in a split-plot, randomized complete block design (Rows 1-14 in Appendix Figure 1). The site was prepared by herbiciding the grass in 4' wide strips, which were rotovated two weeks later. The cultural treatments that included "wet" C were implemented by strip applying 2" of C that was then rotovated to an 8" depth. Irrigation was added to Rows 1-7 by stretching driplines that emit water as needed to maintain field capacity. Trees in Rows 1-6 and 9-14 were spaced 3' apart in rows that were 10' apart. To represent a "corn row" configuration that may maximize production by harvests at 1-2 year intervals with combine-like machines, trees in Rows 7 and 8 were planted in pairs 2.5' apart. The three species occurred in whole plots with an interior measurement row of nine to 11 genotypes: 11 **PD** Clones, 9 **EG** Progenies, and 9 **EA** Progenies (Table 2).

From December 2003 to April 2004, the study at FORCE was doubled in size (Rows 15-28 in Appendix Figure 1) to extend the evaluation of C on **PD**, **EG**, and **EA** and to include **TD** in the evaluation. In Study 102A, four cultural treatments (I, I+C, I+Fertilizer (F), and a control subsequently coded as 100, 110, 101, and 000, respectively) were incompletely replicated in a split-block design following procedures used in 2002 except that 8" of C was rotovated to an 8" depth. The fertilizer application of 8 ounces of Osmocote 15-9-12/tree supplied nutrients similar to the C. The 575 trees from 19 **TD** seed orchard progenies in Rows 21, 25, and 26 as 3-tree row plots also estimated genetic variation that can be used to increase **TD** productivity. All 1,486 unrooted cuttings of 50 **PD** clones (Table 2) were planted in a double row (paired trees 2.5' apart) configuration in Rows 15-20, 22-24, and 27-28. Representative rows of the FORCE studies were measured for tree height, DBH, and survival on June 22, 2004, and June 21, 2005, and all trees in Rows 1-28 were remeasured for tree height and/or DBH, vigor, and survival in October 2005. On May 25-26, 2006, 8" of C was broadcast between tree rows in the compost treatments in Rep 1 of Study 102 and Reps 1 and 2 of Study 102A (Figure 1); a nutritionally equivalent amount of Osmocote 15-9-12 (8 ounces/tree) was applied to the corresponding fertilizer treatment in Study 102A on May 30. On February 17, 2007, breast height 5mm increment cores were taken from 50 ramets of 26 **PD** clones in Study 102A to evaluate basic wood properties, and on June 19, 2007, 18 ramets of 13 **PD** clones were felled for multiple product analyses at the US Forest Service Forest Products Laboratory.

Figure 1. May 2006 C applications to Study 102 (left) and Study 102A (right).

Some 290 tons of C were applied in late January 2004 in the 3.4-acre **TD** Study 106 near Brooksville, FL, on a sandhills site on the Withlacoochee State Forest (WSF) in collaboration with the Florida Division of Forestry. No, C (8" deep rotovated into 4' wide strips), and F (8 ounces of Osmocote 15-9-12/tree) amendments were applied in split-blocks of 30 replications of a randomized complete block design, with 78 **TD** progenies (19 common to Study 102A) planted systematically in single tree subplots at a 20' x 3' spacing on January 30-31, 2004. Tree height and survival were measured in June 2004, and survival was reassessed in October 2004.

Table 2. **PD** clones and **EA** and **EG** progenies in five field studies. (,#/# = # of 2/17 and 6/19/07 wood samples)

	Study				Clone\	Study				
Clone	102	102A	107	117	Progeny	102	102A	107	117	120
PD					**PD**					
3-1		X,2			111733		X			
9-5		X,3			112127		X			
50B-3		X	X		112740		X,1			
72C-1		X,2			Ken8	X	X,4/2			
72C-2		X			S7C1	X	X,4			
72C-7		X,2/1	X		S13C20	X	X,2/2	X		
73-2		X,1			**EA**					
74F-1		X,1			4899			X		
76-1		X			4925				X	X
77-4		X			5021			X		
79-4		X,2/2			5025	X	X			
80-2		X			5030					X
80-3		X,1			5033	X	X			
81B-5		X			5035	X	X	X		
83-2		X,1			5050	X	X	X		
84A-6		X	X		5061				X	X
90-3		X,1	X		5068	X	X			
90-7		X,1			5091	X	X			
91B-4		X	X		5093				X	X
92-4		X			5107	X	X			
93-1		X			5108	X	X	X		
93-6		X			5116				X	
93-7		X,2			5117				X	
94-1		X,2/3			WC14		X			
94-3		X,1			**EG**					
94-4		X,7			1016			X		
95A-6		X,1			2310			X		
100-3		X			2814	X	X	X		
105-1		X,1	X		3019	X	X			
109-7		X,1/1			3198	X	X			
115-1		X			3204			X		
119-6		X,2			3309	X	X	X		
120-4		X			3329				X	
133-3		X			3431			X		
134-1		X	X		3467			X		
142-5		X			3469			X		
147-1		X,1/1			3604				X	
151A-1		X,2			3680	X	X			
154A-1		X			3773				X	
158A-4		X			3816			X		
189-4		X,2			3879	X	X			
ST-66	X				3951	X	X	X		
ST-71		X			3971			X		
ST-72	X				4047			X		
ST-124	X				4064			X		
ST-148	X				4199			X		
ST-163	X				4204	X	X	X		
ST-240	X				4272			X		
ST-259	X				4328			X		
ST-261	X				4330				X	
110531		X			4340	X	X		X	
110807		X			4366				X	

Study 105 (Table 1) at Archer, FL, evaluated C's importance in the phytoremediation of arsenic. Along with **PD**, **EG,** and **EA**, the study had Chinese brake fern, an arsenic hyperaccumulator, in pure and mixed plots with and without C as part of an intensive investigation to identify critical factors in cleaning up arsenic contaminated soil and groundwater throughout Florida. Study 105 was measured for tree height, DBH, and survival on June 23, 2004, June 22, 2005, and December 15, 2005, and several trees damaged by hurricanes in August-September, 2004, were harvested for biomass and arsenic analyses.

Study 107 (Table 1) was established at the SWFREC near Immokalee, FL, on July 6-8, 2004, to evaluate the opportunities for growing **TD**, **PD**, **EG,** and **EA** with and without C in the vegetable producing sand lands of southwestern Florida. **TD** was represented by five progenies (97, 104, 168, 251, 334), **PD** by eight clones (Table 2), **EA** by four progenies (Table 2), and **EG** by 16 progenies (Table 2). Due to droughty conditions at and following the planting which resulted in survivals ranging from very high (**TD**), high (**PD**), moderate (**EA**), to low (**EG**), dead trees were replanted on August 12 with the same or best available genotypes of **EG,** **EA**, **TD**, and **PD**. C as a site amendment there increased organic matter, fertility, and water retention, and composted trees were expected to reduce leaching of nutrients when planted as a riparian buffer or other component of agroforestry systems. Tree height and survival were measured on December 3, 2004. Slash pine genotypes were added to the study on May 12, 2005. Due to continued low survival of **EG**, these plots were redisked and replanted on July 15, 2005, with eight progenies of **EG** (1016, 3309, 3469, 3816, 3951, 3971, 4047, 4064) and two of **EA** (4899, 5108). At the last measurement in November 2006, foliage samples were collected from **PE**, **PD**, and **EA** in plots with and without C in three reps to determine compost related nutrient differences (Table 3).

Table 3. Number of foliage samples taken by **PE**, **PD**, and **EA** genotypes in Study 107 in November 2006.

Species	Without Compost	With Compost
PE Clone 8312	3	3
PD Clone 91B-4	3	3
EA Progeny 5050	3	3

Study 117 at the UF/GCREC assessed the effects of 1) eight species - crape myrtle (*Lagerstroemia indica*, **LI**), wax myrtle (*Myrica cerifera*, **MC**), dahoon holly (*Ilex cassine*, **IC**), saw palmetto (*Serenoa repens*, **SR**), southern magnolia (*Magnolia grandiflora*, **MG**), **PE**, **EG,** and **EA**, 2) two within row spacings - 3' or 6', 3) row configurations - 3, 5, or 8 staggered rows, 4) several cultures including low, intermediate, and high C and F applications at establishment with and without I, and 5) various management practices (Table 1) on windbreak development. Species, spacing, configuration, and culture combinations were allocated to 100' long segments of the 7,400' of windbreaks established in 2006; each combination was replicated two to five times. All segments were disked and/or rotovated before planting or C application. C supplied by Sarasota County Utilities was applied at rates of 67, 153, 209, and 468 tons/acre and rotovated in to a depth of 8". Fertilization involved applying Osmocote 15-9-9 with micros at the rates of 4 or 8 ounces per plant split between two holes on opposite sides of the plant. I was supplied by driplines. Establishment required several months, and species representation ranged from single native sources (**MC**, **SR**, **IC**) to commercial varieties (**LI**, **MG**) to clones or progenies (**PE**, **EA**, **EG**) (Table 2) as subplots within species. Post-planting weed control was practiced periodically using manual and/or chemical techniques. All plants were measured for height after establishment and for height and\or survival on November 5, 2006.

A study near Ft. Meade assessed the effect of soil mixing rate for Sumter County C on **TD** root development in the clay settling areas (CSA) common to phosphate mined lands (Table 1). Five soil mixes (0, 25, 50, 75, or 100% Sumter County C with the heavy CSA clay) in 1' wide by 1' deep holes, arranged in two repetitions of a Latin Square design at 10x10' spacing, were planted with 1-year-old bareroot seedlings of one **TD** source in March 2007. A similar greenhouse study involving one repetition of the same five soil mixes in 2 gallon pots planted with rooted cuttings of the **TD** hybrid 'Nanjing Beauty' was initiated on March 27, 2007. In June 2007, these five soil mixes were repeated in 1' wide by 1' deep holes within row plots of five **TD** progenies in Study 86 (Table 1). Soils and roots were harvested and analyzed beginning December 2007 with the Ft. Meade study.

Study 120 at the UF/IFAS Plant Science and Education Unit at Citra assessed the effects of four species **- PE**, *P. taeda* (**PT), EA**, and *Juniperus virginiana* (**JV**) – at 3' within row spacing within two row configurations (2 or 3 rows 8' apart), and high C application at establishment with I on windbreak development (Table 1). Species and configuration combinations were allocated to various segments of the 1,600' of windbreaks established in March 2007 around a 450'x280' citrus block. Sumter County C was applied at a rate of ~200 tons/acre and rotovated in to a depth of 8". I was supplied by above ground emitters. Species representations were single native sources (**PE**, **JV**), five progenies (**EA**), and a commercial clone (**PT**) (Table 2) arranged as subplots within species blocks. Post-planting weed control was practiced periodically using manual and/or chemical techniques. All plants were measured on March 13, 2007, for initial height and on December 13, 2007 for height and survival.

Other established studies (Table 1) provided supplemental comparisons for using C. Studies 72, 74, 79, 80, and 86 include C and no C treatments, with Study 86 having received C in 2003. Studies 81, 82, 84, 90, 91, 92, and 94 benchmarked **PD**, **EG, EA**, **TD**, and slash pine (**PE**) productivity on a range of sites for contrast with growth rates observed with C. The C portion of Study 86 was measured for tree height, DBH, and survival on June 28, 2004, June 27, 2005, December 13, 2005, and March 8, 2007.

The resulting FORCE data were used in an SRWC Decision Support System (DSS, Langholtz et al. 2007) to approximate the economics of using compost in SRWC systems. SRWC productivity at FORCE was first compared to that on phosphate mined lands (Langholtz et al. 2007). Land availability for SRWC production within a given haul cost radius for each facility was assessed, accounting for potential compost supplies from adjacent facilities. GIS generated a haul time surface based on existing road infrastructure for each facility and assigned speed limits to road features and divided road lengths by speed limits to estimate travel time. Haul time was increased by 25% to account for operational delays and rerouting for bridges with gross vehicle weights less than 36 Mg (40 tons), and ArcGIS© Network Analyst (Langholtz et al. 2006) was used to calculate service areas based on travel time in 15 minute haul-time intervals. Forestry and agriculture parcels from county tax appraisers' datasets within these haul-time intervals were then selected for each facility and summarized by areas in each haul time interval for each facility. Finally, the SRWC DSS was used to estimate the total delivered cost that might be spent on compost application while still maintaining a profitable system (land expectation value (LEV) >$500/acre and internal rate of return (IRR)>7%). As a specific example of the methodology, the cost of compost delivered from FORCE and applied to SRWC plantations at various distances from FORCE was incorporated into the DSS. For a range of compost production and delivery costs, SRWC production rates, and stumpage prices, feasible compost use was then estimated.

Results and Discussion

As summarized in Tables 4 and 5, species and cultural treatments had significant impacts on growth of **EA**, **EG**, **PD**, and **TD** in Studies 102, 102A, 106, and 107. In October 2005, the most encouraging species and cultural treatment combinations included **EA**, **EG**, and **PD** receiving C or F along with I (Figure 2). Through 8 months, **PD** was the most vigorous species when C was combined with I, and **EA** and **EG** were taller after 8 months of I following F equivalent to 0.075, 0.045, and 0.06 pounds of N, P, and K, respectively, per tree (1089, 653, and 871 pounds of N, P, and K, respectively, per acre). However, 18 months after C application, tree vigor for I+C declined compared to I+F (Table 5). In July 2006 in Study 102A, the I only treatment was noticeably inferior for all species, while the I+F and I+C treatments resulted good tree growth (Figure 3).

The importance of I during establishment years with periodic droughts was clearly evident. In Study 106, **TD** initiated growth earlier in the C culture than in the F or Control cultures, but after the April-May drought virtually all trees were dead, as compared to 75% or better survival in the irrigated cultures in Study 102A (Table 4). Initial survival of **EA**, **EG**, and **PD** in Study 107 suffered because of dry conditions at and after planting, whereas these species had 70% and higher survival with I in Study 102A. I with C in Studies 102 and 102A also considerably increased tree growth and vigor compared to C with no I in Studies 102 and 107

(Tables 4 and 5).

Table 4. Height (H, in m), DBH (D, in cm), vigor (V), and/or survival (S, in %) trait summaries by species and culture (000=Control, 010=C only, 100=I only, 110=I+C, 101=I+F) at ages 27, 8, or 5 months (27, 08, 05), respectively, in Studies 102, 102A, 106, and 107.

Trait	Culture	Species				
		EA	EG	PD	TD	All
Study 102: FORCE Rows 1-14						
Number of Genotypes		9	9	11	-	
H27	000	2.0b*	1.8a	1.4c	-	1.7B
	010	5.3a	7.3a	2.5b	-	4.2A
	100	2.3b	2.5a	1.2c	-	2.0B
	110	4.8a	3.7a	3.5a	-	4.0A
	All	3.6A	3.5A	2.2B	-	3.0
D27	000	1.5a	1.7a	0.6b	-	1.1C
	010	4.8a	7.8a	1.2ab	-	3.4A
	100	3.6a	2.5a	0.2b	-	2.5B
	110	4.3a	3.7a	2.3b	-	3.4A
	All	3.7A	3.7A	1.4B	-	2.9
S27	000	75.0a	12.5c	75.0a	-	54.2B
	010	75.0a	12.5c	68.8a	-	52.1B
	100	100.0a	50.0b	87.5a	-	79.2A
	110	100.0a	93.8a	87.5a	-	93.8A
	All	87.5A	42.2B	79.7A	-	69.8
Study 102A: FORCE Rows 15-28						
Number of Genotypes		10	16	50	29	
H08	100	0.64b	0.86b	1.26b	0.70c	0.91*C*
	110	1.86a	1.89a	3.06a	1.40a	2.23*A*
	101	1.87a	2.08a	1.82b	1.05b	1.83*B*
	All	1.48AB	1.66AB	2.12A	1.10B	1.71
V08	100	3.6b	2.7b	2.2b	1.6b	2.7*C*
	110	2.0a	1.3a	1.2a	0.3a	1.3*A*
	101	1.9a	1.3a	1.6a	0.7a	1.5*B*
	All	2.5C	1.7B	1.6B	0.8A	1.8
S08	100	92.0a	79.7a	71.8a	75.7a	79.2*A*
	110	80.8b	71.7a	71.4a	89.0a	76.0*A*
	101	85.0ab	83.8a	69.4a	79.2a	77.7*A*
	All	85.5A	78.2AB	70.8B	82.2AB	77.5
Study 107: SWFREC						
Number of Genotypes		4	12	8	5	
H05	000	0.6b	0.6a	0.8b	1.1a	0.7B
	010	0.8a	0.7a	1.2a	1.0a	0.8A
	All	0.7A	0.7A	1.0A	1.1A	0.7
S05	000	100.0a	91.1a	81.8a	100.0a	92.9A
	010	95.2b	74.1a	84.4a	87.5a	80.6B
	All	97.6A	82.6A	83.1A	93.8A	86.8
Study 106: WSF						
S05	000	-	-	-	0.0	-
	001	-	-	-	0.0	-
	010	-	-	-	0.0	-

*Lower case letters in a trait indicate significant differences among cultures within a species; Uppercase letters in a trait indicate differences among cultures across species or among species across cultures

Table 5. Height (H, in m), DBH (D, in cm), and/or survival (S, in %) trait summaries by species and culture (000=Control, 010=C only, 100=I only, 110=I+C, 101=I+F) at ages 41 or 18 months (41, 18), respectively, in Studies 102 and 102A.

Trait	Culture	Species				
		EA	EG	PD	TD	All
Study 102: FORCE Rows 1-14						
Number of Genotypes		9	9	11	-	
H41	000	3.0b*	2.8a	1.8c	-	2.5C
	010	8.8a	14.2a	4.2b	-	7.2A
	100	3.6b	3.7a	1.9c	-	3.0C
	110	5.8a	5.3a	4.2a	-	5.1B
	All	5.2A	5.3A	3.0B	-	4.4
D41	000	3.1a	2.8a	0.7b	-	2.7D
	010	4.0a	5.8a	3.0a	-	4.7B
	100	4.1a	4.0a	1.5b	-	3.6C
	110	6.0a	5.9a	3.0a	-	5.4A
	All	4.7A	4.8A	2.3B	-	4.3
S41	000	86.7a	35.0c	10.5a	-	31.6B
	010	84.4a	30.7c	25.8a	-	47.0AB
	100	94.5a	50.4b	16.4a	-	39.9B
	110	97.7a	62.5a	36.7a	-	65.6A
	All	90.8A	44.8B	18.2C	-	43.7
Study 102A: FORCE Rows 15-28						
Number of Genotypes		10	16	50	29	
H18	100	0.92b	1.62b	1.73b	-	1.41*B*
	110	3.75a	4.79a	4.05a	0.74a	4.14*A*
	101	5.45a	6.88a	3.25b	0.52b	5.19*A*
	All	3.35A	4.56A	3.00A	1.34B	3.59
D18	100	0.57b	0.85b	0.80b	-	0.78*C*
	110	3.80a	4.50a	3.47a	-	3.69*A*
	101	3.88a	4.60a	1.83a	-	3.28*B*
	All	3.59C	4.06B	2.38B	-	3.10
S18	100	84.5a	63.5a	71.5a	20.0b	63.5*A*
	110	80.0b	69.2a	71.7a	54.2a	70.5*A*
	101	77.3ab	72.8a	69.8a	38.1c	67.7*A*
	All	80.3A	68.9AB	71.0B	37.4C	67.5

*Lower case letters in a trait indicate significant differences among cultures within a species; Uppercase letters in a trait indicate differences among cultures across species or among species across cultures

Genetic and cultural factors continued to influence SRWC growth in Studies 102, 102A, and 107 through December 2006. As earlier, **EA** and **EG** receiving C or I+C in Study 102 or **EA** and **EG** with I+F and **PD** with I+C in Study 102A were still the most productive species and cultural treatment combinations. Another year of measurement detected that peak productivity was reached in Study 102 in 2006 at age 5 years, and potentially in 102A at age 3 years, for the genetics-culture combinations with maximum growth. High C amounts were beneficial, with the 8" applied in Study 102A perhaps being ideal prior to establishment as opposed to the inadequate but still enhancing 2" used in Study 102. Early planting was better than late planting to insure adequate survival, particularly of the freeze susceptible **EG**. The same **PD** clones and **EA** and **EG** progenies noted earlier continued to excel (Table 6). The May 2006 reapplication of 8" of C between tree rows (Figure 1) and equivalent amounts of Osmocote in portions of Studies 102 and 102A visually enhanced tree growth and vigor.

Within species variation was important to maximizing response to C amendments. In comparison to the species averages given in Tables 4 and 5, the spread of genotype means around these averages was often large (Table 6). For example, the best **EA** and **EG** progenies and **PD** clones were as much as 50% larger than their species averages in December 2005. **PD** clones 112740, 95A-6, and 80-3, **EA** progenies 4899, 5035, and 5050, and **EG** progenies 1016, 2814, and 3431 appeared to be the most productive genotypes. In the case of **EG**, freeze resilient progenies had much better survival in Study 102. A limited availability of propagules constrains wide-scale use of the most productive genotypes.

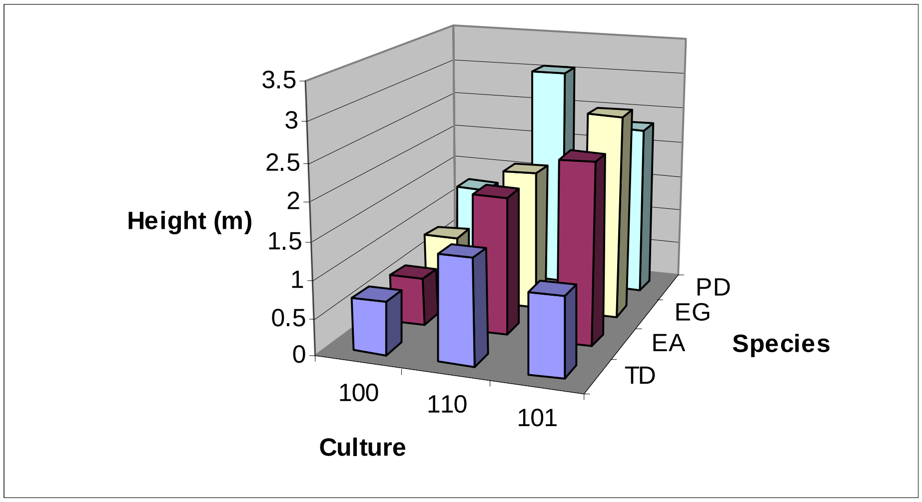


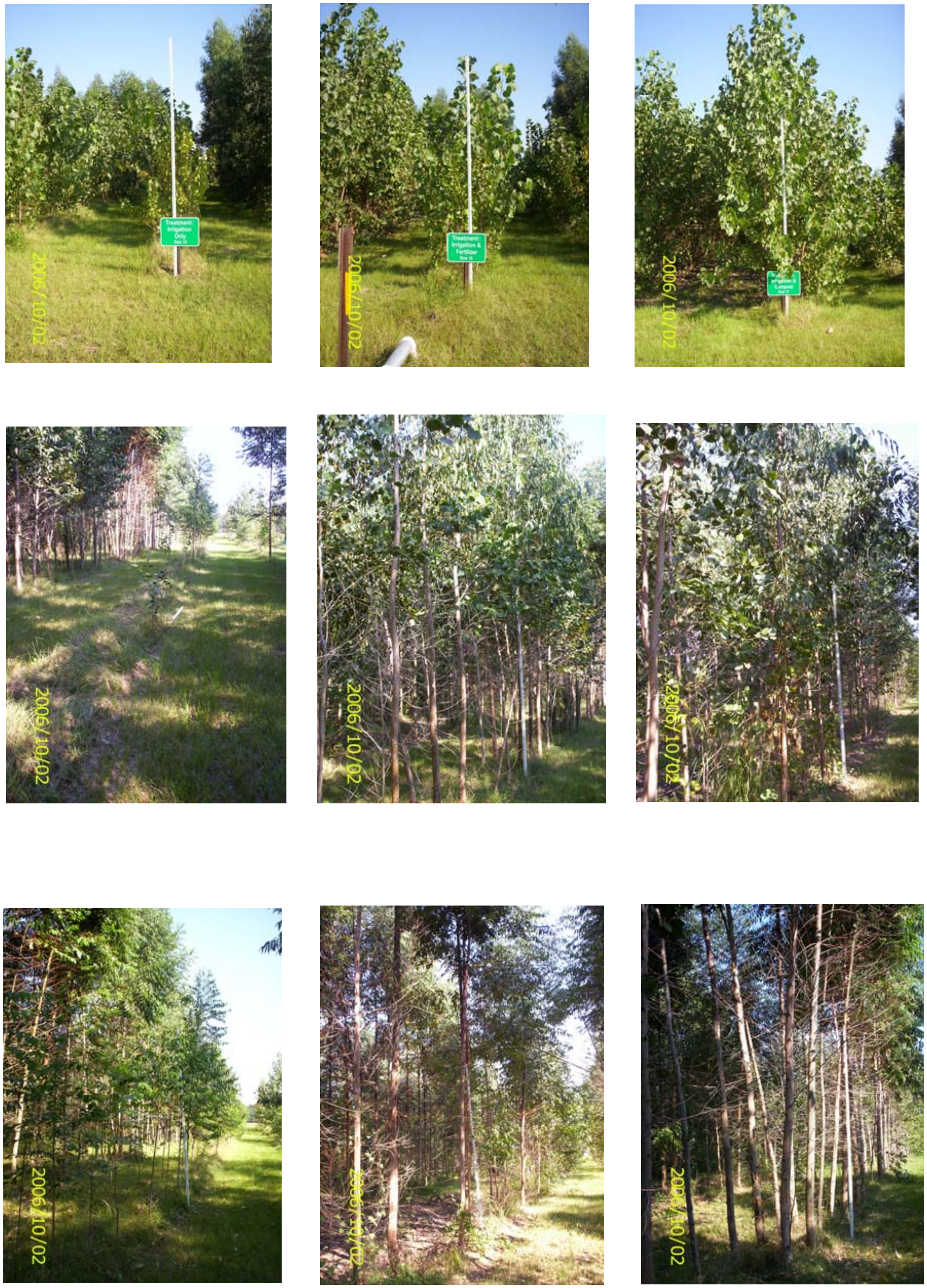
Figure 2. Age 8 month tree height by species and culture (100=I only, 110=I+C, 101=I+F) in Study 102A.

Table 6. Number, mean, range, and best of ***PD***, ***EA***, and ***EG*** genotypes for 18-month height, survival, and BAH in Study 102A.

Species	No.	Mean	Range	Best Genotypes
PD	50	3.0m[B] 71.0% 1.6m^2/ha[C]	1.8 – 4.0m 0 – 100%* 0 - 5.6m^2/ha*	112740 95A-6 80-3
EA	10	3.4m[B] 80.0% 2.9m^2/ha[B]	2.9 – 3.7m 48 – 90% 1.9 - 3.9m^2/ha	4899 5035 5050
EG	16	4.6m[A] 69.0% 4.0m^2/ha[A]	3.1 – 6.1m 50 – 78% 1.8 - 5.6m^2/ha	1016 2814 3431

* following a range indicates significant differences among genotypes within a species;
Different uppercase letters following a trait mean indicate differences among species across cultures

Through October 2007, cultures and species had major influences in Study 102A (Figure 4). At 42 months, **EG** had the tallest trees, while **PD** was the shortest, as was the case since age 8 months. The I+C8 culture had taller trees than I alone, but the May 2006 C8 reapplication increased height growth. The I+F trees appeared to have lower height increments. The same **PD** clones and **EA** and **EG** progenies noted earlier continued to excel (Table 3).



PD

EA

EG

I I+F I+C

Figure 3. October 2006 comparisons of cultures I only (left), I+F (middle), and I+C (right) in Study 102A by species **PD** (top), **EA** (middle), **EG** (bottom).

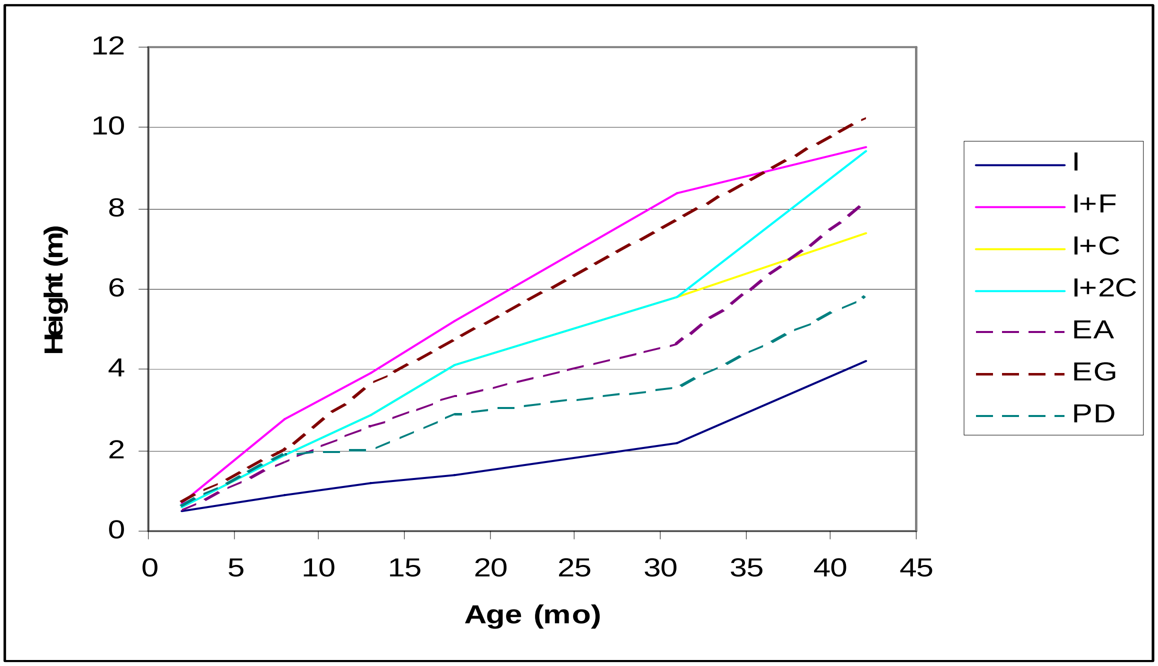


Figure 4. Average tree height through 42 months for four cultures (across species) and three species (across cultures) in Study 102A.

At 42 months in Study 102A, responses to the cultures tended to vary with species (Figure 5). All species had taller trees and higher basal areas as a result of the second C8 application in May 2006, suggesting that top dressing with compost as frequently as every two years is beneficial on these infertile sandy soils. The I+F and I+2F cultures resulted in higher **EA** and **EG** basal area but did not enhance **PD** growth more than I+C8 and I+2C8. **EG** had significantly higher productivity with I+F in spite of lower initial survival.

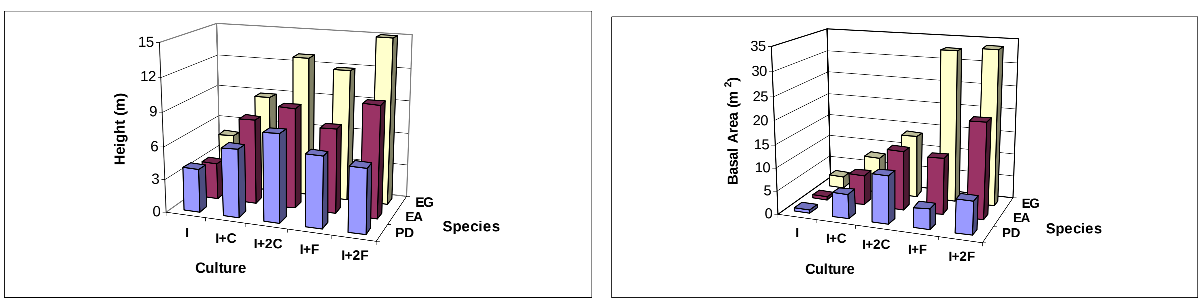


Figure 5. Tree height (left) and stand basal area (right) at 42 months by five cultures and three species in Study 102A.

At 65 months in Study 102, stand basal area responses to cultures also varied with species (Figure 6). Both the initial C2 and subsequent C8 amendments always increased growth of each species. Due to the poor initial survival and high first winter mortality of **PD** and **EG**, respectively, **EA** was the most productive species through six growing seasons. The beneficial midrotation C8 amendments in Study 102 and Study 102A suggest that compost applications at the initial harvest, approximately four years after planting, and every two years thereafter, may be warranted.

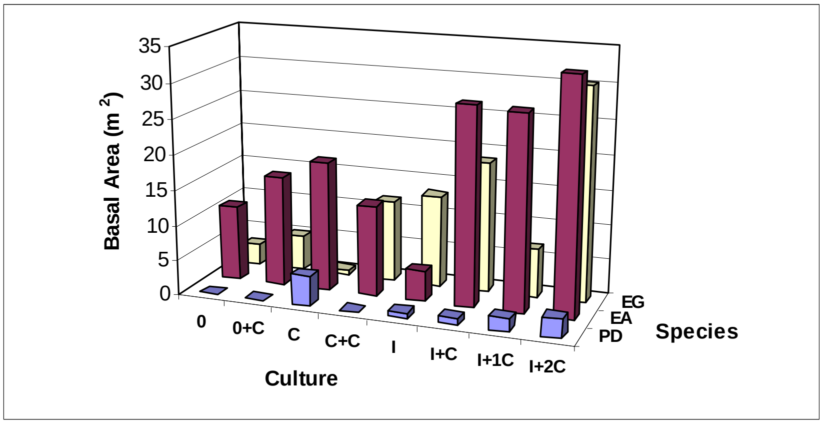


Figure 6. Stand basal area at 65 months by eight cultures and three species in Study 102.

The increment cores taken in February 2007 and the trees felled in June 19, 2007, in Study 102A estimated basic wood properties and product opportunities for **PD** grown with C (Table 7). The range among clones for specific gravity and other properties suggested **PD** potential for various composite products and bioenergy applications. Of three clones evaluated, only one was suitable for making medium density fiberboard.

Table 7. **PD** wood properties by three clones and by clonal groups.

Property	Clone			Clonal Group[1]		
	79-4	Ken8	S13C20	Low	High	Ave
Specific Gravity (kg/m^3)	375	389	351	324	389	357
Moisture Content (%)	158	147	161	117	164	144
Arabinan (%)	0.2	0.2	0.2	0.2	0.2	0.2
Galactan (%)	0.5	0.7	0.5	0.5	0.7	0.6
Glucan (%)	38.0	40.4	40.1	38.4	42.0	39.9
Xylan (%)	16.7	15	14.6	14.0	15.5	14.8
Mannan (%)	2.6	2.3	2.3	2.1	2.8	2.4
Acid Insoluble Lignin	23.4	23.8	24.9	23.2	25.1	24.3
Acid Soluble Lignin (%)	2.4	2.4	2.3	2.2	2.8	2.4
Total Lignin (%)	25.6	26.2	27.2	25.6	27.7	26.7
Carbohydrates (%)	57.9	58.4	57.6	56.6	59.0	57.9

[1] 13 Clones (72C-2, 72C-7, 76-1, 79-4, 81B-6, 94-1, 109-7, 134-1, 142-5, 147-1, 154A-1, Ken8, and S13C20) for Specific Gravity and Moisture Content; 9 Clones (9-5, 79-4, 93-7, 94-4, 151A-1, 189-4, Ken8, S7C1, S13C20) for other properties

The opportunities and challenges for growing **TD**, **PE**, **PD**, **EG,** and **EA** with and without C on sand lands in southwestern Florida were evident in Study 107. C amendments increased soil OM, pH and Mehlich 1-extractable P, K, Ca, and Mg concentrations (Rockwood et al 2006, Ozores-Hampton et al., 2004). Still, initial survival in Study 107 ranged from very high (**TD**), high (**PD**), moderate (**EA**), to low (**EG**) because of dry conditions at and after planting in July 2004, whereas these species had 70% and higher survival with I in Study 102A. I+C in Studies 102 and 102A also considerably increased tree growth and vigor compared to C alone in Studies 102 and 107 (Figure 6). Survival and growth after replanting in August showed a modest C advantage for **EA** and **TD** height but slight survival decrease for **EA** survival in December 2004. The addition of I to Study 107 in 2005 increased survival of the replanted **EA** and **EG**, but none of the replanted trees grew appreciably, and the trees initially planted grew little even with C. By November 2006, **EA**, **EG**, and **PD** displayed a positive response to C, as their tree heights with C were typically doubled those without (Figure 6). **TD**'s poor response to C may be attributable to heavy competition from **PD**.

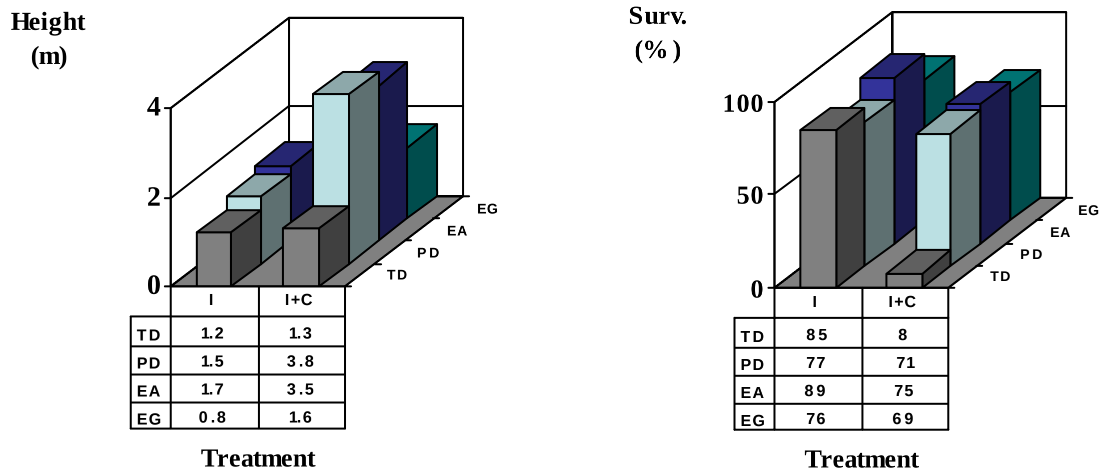


Figure 6. Tree height and survival for four species and two cultures (I, I+C) in Study 107 in November 2006.

As with tree growth, C typically increased foliage nutrients in the November 2006 samples (Table 8). Just as C amendments increased soil OM, pH, P, K, Ca, and Mg concentrations (Rockwood et al 2006, Ozores-Hampton et al., 2004), C increased foliar N and K in each species. **PD** tended to have higher foliar N, Ca, Mg, Fe, Zn, and B than **PE** and **EA.** C appeared to bind Mn, especially in **EA**.

Table 8. Foliage N, P, K, Ca, and Mg in % and Fe, Mn, Zn, Cu, and B in ppm by treatment-species, species, and overall for **PE**, **PD**, and **EA** in Study 107 in November 2006.

Trt	Sp	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
C	**PD**	2.18	0.30	0.50	2.64	0.74	101.45	20.97	337.83	9.99	133.33
N	**PD**	1.73	0.23	0.40	1.73	0.55	161.63	19.81	107.12	8.00	65.65
	PD	*1.95*	*0.26*	*0.45*	*2.19*	*0.64*	*131.54*	*20.39*	*222.48*	*9.00*	*99.49*
C	**PE**	1.36	0.17	0.43	0.35	0.10	19.30	29.58	61.67	4.65	10.87
N	**PE**	0.88	0.17	0.22	0.37	0.10	21.42	63.43	43.75	3.22	11.84
	PE	*1.12*	*0.17*	*0.33*	*0.36*	*0.10*	*20.36*	*46.51*	*52.71*	*3.94*	*11.36*
C	**EA**	1.41	0.57	0.51	3.32	0.30	30.93	69.87	64.95	10.64	60.00
N	**EA**	1.27	0.66	0.45	2.30	0.42	36.22	425.80	72.33	13.26	54.35
	EA	*1.34*	*0.62*	*0.48*	*2.81*	*0.36*	*33.58*	*247.84*	*68.64*	*11.95*	*57.18*
	Ave.	**1.47**	**0.35**	**0.42**	**1.79**	**0.37**	**61.83**	**104.91**	**114.61**	**8.29**	**56.01**

Study 117 at the UF/GCREC estimated the best species\species mixes, designs, and establishment and management techniques for windbreaks. Through November 2006, of the eight species, **LI** grew most and was most tolerant of varying cultures (Table 9). **MC**, **IC**, and **MG** grew modestly. **PE** response to treatment factors was limited by accidental herbiciding, and **SR** grew very little but survived well. **EG** and **EA**, primarily planted in September, had yet to differentially respond to treatments. Within **LI** and **MG**, variation among commercial varieties was already evident.

Table 9. Height (H, in m) and/or survival (S, in %) summaries for eight species and four cultures (I, I+C low, I+C medium, I+F) in Study 117 in November 2006.

Trait	Culture	Species							
		EA	**EG**	**PE**	**MG**	**LI**	**MC**	**IC**	**SR**
Number of Genotypes		5	7	49	4	4	1	1	1
H	I	0.3	0.3	0.9	0.3	-	0.6	0.6	na
	I+Cl	0.2	0.2	1.0	0.4	1.1	0.8	-	na
	I+Cm	0.3	0.3	1.0	0.5	1.1	0.8	-	na
	I+F	0.2	0.2	1.0	0.3	1.1	0.6	-	na
S	I	27	30	29	73	-	58	76	na
	I+Cl	93	89	83	91	100	90	-	na
	I+Cm	80	18	85	82	100	82	-	na
	I+F	79	77	86	81	97	58	-	na

Cultures including three C levels and F applications at establishment had not influenced plant growth, primarily because of weed competition. Irrigation alone was insufficient for early survival on these nutrient poor sandy soils.

Three studies assessed the effect of Sumter County C mixing rate with heavy clay soil on **TD** root development (Table 1). Increasing Sumter County C with the heavy CSA clay at the Ft. Meade site tended to reduce the high pH associated with the clay, but the low root volumes (due to poor seedling growth and survival as a result of drought) had no particular tendency. In the greenhouse study, root volumes appeared to decrease with higher C in the soil, which was just the opposite of the results in Study 86. Further analyses involving several soil and root parameters are underway.

Table 10. Soil pH and root volume (V, g) for **TD** planted in a field study near Ft. Meade study, a greenhouse study, and in Study SR-86.

% C	Ft. Meade		Greenhouse		SR-86	
	pH	V	pH	V	pH	V
0	7.6	2.3	na	158.8	na	12.1
25	7.6	2.5	na	41.4	na	14.2
50	7.6	4.5	na	61.4	na	17.0
75	7.5	1.0	na	91.9	na	20.8
100	7.4	0.5	na	72.4	na	50.7
Ave.		2.2		85.0		22.3

In the windbreak study at Citra, a high C application at establishment with I profoundly affected **PE**, **PT**, **EA**, and **JV** (Table 11). The potted **PE** and **JV** trees were larger initially than the bareroot **PT** and containerized **EA**, but many **PT** died soon after planting and **PE** grew very little due to high pH. After 7 months, **EA** was growing vigorously as two of the four progenies averaged over 3m in height.

Table 11. Height (H, in m) and survival (S, in %) at 7 months of four species in I+C culture in a windbreak study with two row configurations at Citra.

Trait	Culture	Configuration	**EA**	**PE**	**PT**	**JV**
		Number of Genotypes	5	1	1	1
H	I+C	2 rows		1.6		1.4
S	I+C	2 rows		98		100
H	I+C	3 rows	2.5	1.6	0.5	1.4
S	I+C	3 rows	81	98	55	100

Study 80 extended evidence of **EA's** responsiveness to C (Table 12). Using basal area per hectare (BAH94) as the best estimator of growth differences, Compost+Lime (C+L) applied at establishment produced more than Fertilizer+Lime (F+L). The Manure+Lime culture (M+L) grew the least. Tested progenies have an advantage as Florida Orchard progenies (AO92 Ave) tended to surpass the Australian accessions (Acc Ave), but there were fast growing progenies in each group (e.g., 4820 and 4871 in the accessions, and 5111 in the Orchard group).

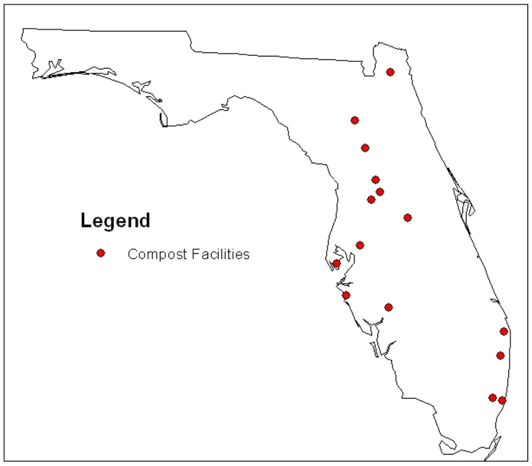
Table 12. Survival at 8 months (S08, in %) in two replications and survival, height, DBH, basal area/ha, and tree quality at 94 months (Sur08 and Sur94 in %, H94 in m, D94 in cm, BAH94 in m^2/ha, and Q94) in one replication of Study 80 for four cultures and two **EA** progeny types.

	Both Reps		Rep 1 Only										
	Sur08			Sur08	Sur94	H94		D94		BAH94		Q94	
	n	Ave	n	Ave	Ave	n	Ave	n	Ave	n	Ave	n	Ave
Cultures													
C + L	358	93.0	155	97.4	72.9	55	8.5	121	9.3	147	18.0	112	3.5
F + L	358	90.5	156	96.8	49.4			90	9.4	155	14.0	77	3.0
L Only	358	84.6	156	92.3	51.3			91	10.8	154	14.2	80	2.8
M + L	360	88.1	156	94.9	64.7	60	8.0	112	8.2	149	12.5	99	3.4
Progenies													
4820	25	84.0	10	90.0	80.0	3	12.2	10	14.5	10	47.2	8	2.9
4871	24	87.5	11	100.0	100.0	3	12.4	12	13.3	11	48.0	11	2.6
Acc Ave				*94.9*	*59.6*		*8.0*		*9.0*		*14.1*		*3.3*
5111	24	83.3	11	100.0	63.6	3	13.6	7	16.3	11	36.6	7	1.9
AO92 Ave				*97.7*	*52.8*		*10.6*		*11.8*		*21.3*		*2.7*
Overall	**1434**	**89.1**	**623**	**95.3**	**59.6**	**115**	**8.3**	**414**	**9.3**	**605**	**14.6**	**368**	**3.2**

While compost is an effective soil amendment for SRWCs in Florida, compost use in the preparation and establishment of SRWCs will have economic limits. These limits will include transportation costs from some 15 compost production facilities (Table 13, Figure 7) in the state. Some 218 yard waste processing facilities throughout Florida (Figure 7, FDEP 2007) could provide more localized sources of desirable mulch to use as a soil amendment or ground cover.

Table 13. Name, location, and estimated compost production (tons/year) of 15 compost production facilities in Florida (*Ozores-Hampton and Obreza 2004).

Name	Location	Production
City of Miami*	Miami	10,000
Solid Waste Authority*	West Palm Beach	60,000
Walt Disney*	Lake Buena Vista	7,500
City of Sarasota*	Sarasota	1,500
Comp-Lete Food*	Nocatee	18,000
Enviro-Comp*	Jacksonville	40,000
City of St. Petersburg*	North St. Petersburg	2,200
Sumter County Solid Waste Facility*	Sumterville	12,000
Black Gold	Oxford	NA
Amerigrow Recycling	Delray Beach	NA
C&C Peat Co.	Okahumpka	84,680
EPS Organics	Hialeah Gardens	NA
Mother's Organics Humus Farm	Seffner	NA
Ocala Organics	Reddick	5,000
Wood Resource Recovery	Gainesville	11,000



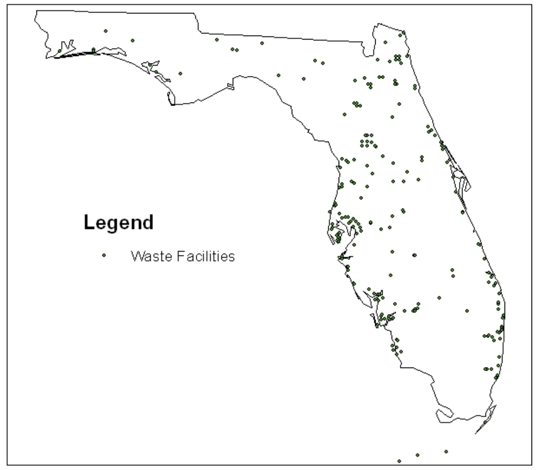


Figure 7. Distribution of 15 compost production (left) and 218 yard waste processing facilities (right) in Florida.

Considerable agricultural and forest lands are proximate to compost production facilities in Florida (Table 14). More than 290,000 acres are within 15 minutes. Within 30 minutes are over another 945,000 acres. Over 129,000 acres are within 30 minutes of the FORCE facility (Figure 8).

Table 14. Agricultural and forestry land availability (acres) for SRWCs by time from 15 compost production facilities in Florida.

Facility Location	Time from Facility (minutes)			
	0-15	15-30	30-45	45-60
Miami	1,378	227	-	-
West Palm Beach	2,431	22,600	94,066	101,696
Lake Buena Vista	10,924	37,230	124,908	150,087
Sarasota	3,048	42,623	94,984	64,247
Nocatee	49,372	132,874	207,339	229,263
Jacksonville	9,531	45,409	219,833	326,468
N. St. Petersburg	134	297	689	1,961
Sumterville	47,286	82,071	78,849	22,805
Oxford	10,615	5,670	706	246
Delray Beach	34,824	70,071	38,488	32,186
Okahumpka	16,400	54,162	39,688	38,662
Hialeah Gardens	2,394	1,654	0	7,721
Seffner	20,192	97,478	177,530	86,243
Reddick	52,354	156,199	209,953	79,186
Gainesville	33,770	196,819	358,797	416,031
Total	294,652	945,384	1,645,831	1,556,804

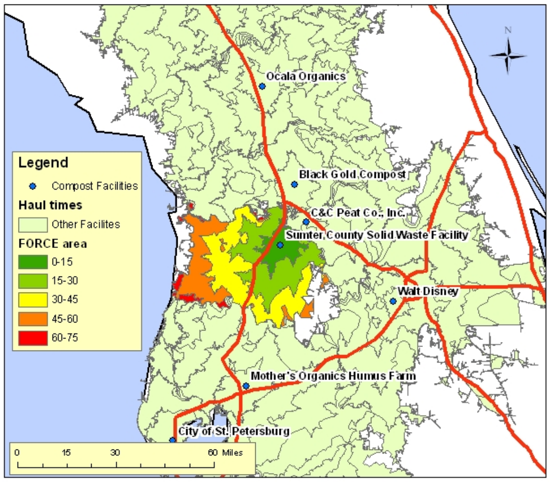


Figure 8. Areas associated with 0-15, 15-30, 30-45, 45-60, and 60-75 minute hauling times from compost production facilities in central Florida, with emphasis on the FORCE facility.

The growth of **EG** and **EA** in response to FORCE compost is somewhat similar to their productivity on phosphate mined lands (Langholtz et al. 2007) where after ~2.5 years, ~6" DBH trees can be harvested from November to March with feller-bunchers equipped with chain saw type cutting heads to facilitate coppice regeneration. Successful coppicing can lead to subsequent rotations as short as two years. At a stumpage price of $10/ton and the costs tabulated in Table 15, a LEV of $2,967/acre and an equalized annual earning of $118/acre/year are possible. A coppice scenario with a 3.5-year initial rotation and three 3-year coppice rotations would have slightly higher yield and economics (Langholtz et al. 2005). Currently, there is a strong demand for mulchwood from **EG** and **EA.** **PD** is not currently used for mulchwood but is suitable for pulpwood and energywood.

Table 15. Values assumed to calculate operational costs of compost application.

Cost	Value	Cost	Value
Fertilizer cost/cubic yard	$ 10.00	Haul cost/hour/load	$ 80.00
Tons/truckload	25	Haul cost/hour/cubic yard	$ 1.76
Tons compost/cubic yard	0.55	Application cost/cubic yard	$ 0.04
Cubic yards/truckload	45.5	Total cost/cubic yard/1 hour haul	$ 12.35
Load and unload cost/truckload	$ 25.00	Total cost/acre @ 30 $yards^3$/acre	$ 370.42
Load and unload cost/cubic yard	$ 0.55	Total cost/acre @ 60 $yards^3$/acre	$ 740.83

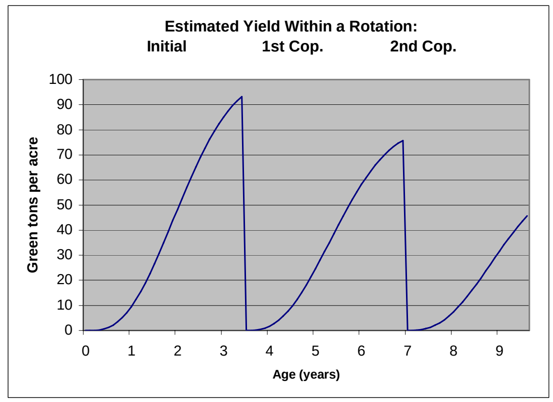
We used the SRWC DSS to evaluate the profitability of SRWC production using compost. Values assumed in calculating total compost application costs are shown in Table 15, and base case operational cost assumptions used in the DSS are shown in Table 16. Compost purchase price was estimated to be 82% of the total of the applied cost (Figure 9). The DSS was used in conjunction with a dynamic optimization model in Mathcad (Langholtz 2005) to determine the optimum number of harvests per rotation and the length of each growth stage. Under the base case scenario, the system was profitable, yielding a LEV of $1,202/acre and an IRR of 10.7%, assuming four growth stages of 3.0-3.4 years per growth stage. This reasonably high profitability suggests there is some room to cover additional costs of compost application, which can be expensive due to high volumes of application/acre compared to chemical fertilizers. To estimate a maximum compost cost that might be incurred, the fertilizer cost category of the DSS was increased until LEV was reduced to $530/acre and IRR 7.2%. This was achieved by increasing fertilizer costs at the beginning of each rotation from $400/acre to $725/acre. Under the compost application costs show in Table 15, $400 and $725/acre cover the costs of 30 and 60 cubic yards of compost application within a one-hour one-way haul.

Table 16. Illustrative management costs, productivities, and economics for SRWCs receiving compost.

SRWC Decision Support System:
Land Expectation Value (LEV), Equal Annual Equivalent (EAE), Internal Rate of Return (IRR), and Net Present Value (NPV) Calculator

INPUTS	
Stumpage Price, Incentives, Capital Cost	
Stumpage price ($ green ton^{-1})	$10
Renweable Energy Porfolio Incentive ($ green ton^{-1})	
Other Incentives ($ green ton^{-1})	
Total stumpage value ($ green ton^{-1})	$10
Capital cost (annual interest rate)	5.0%
Start-up Costs	
Herbicide ($ acre^{-1})	$200
Site Prep ($ acre^{-1})	$0
Disk ($ acre^{-1})	$90
Bed ($ acre^{-1})	$0
Total:	**$290**
Costs at the Beginning of Each Rotation	
Fertilize ($ acre^{-1})	$725
Propagule price (per tree)	$0.11
Trees per acre (1,700-3,400)	3,400
Cost of Trees ($ acre^{-1})	$374
Planting cost ($ acre^{-1})	$150
Total	**$1,249**
Costs at the Beginning of Each Coppice	
Weed control ($ acre^{-1})	$40
Annual Costs	
Annual maintenance/administration ($ acre^{-1})	$10
General Parameters	
Inside bark or total above-ground biomass	Total above-ground biomass
Expansion factor for branches and leaves	1.7
Number of coppices per rotation	4
Age of first harvest	3.4
Harvest age of first coppice	3.5
Harvest age of second coppice	3.4
Harvest age of third coppice	3.3
Total Rotation Length	13.6
Initial harvest yield (as % of first harvest)	100%
First coppice yield (as % of first harvest)	80%
Second coppice yield (as % of first harvest)	60%
Third harvest yield (as % of first harvest)	40%

OUTPUTS	
LEV ($ acre^{-1})	**$534**
EAE ($ acre^{-1})	**$27**
IRR	**7.2%**
NPV benefits ($ acre^{-1})	$3,734
NPV costs ($ acre^{-1})	$3,201
Benefit/cost ratio	**1.17**
NPV after 1st Rotation ($ acre^{-1})	**$120**
NPV after 2nd Rotation ($ acre^{-1})	**$353**
NPV after 3rd Rotation ($ acre^{-1})	**$470**
NPV after 4th Rotation ($ acre^{-1})	**$530**
NPV after 5th Rotation ($ acre^{-1})	**$560**



Yields (green tons acre^{-1}) by harvest age within a rotation	
Initial harvest at 3.4 years of age	93.2
First coppice at 3.5 years of age	75.7
Second coppice at 3.4 years of age	55.9
Third coppice at 3.3 years of age	36.6

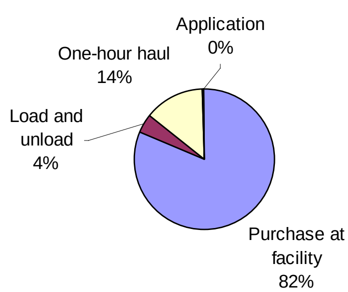


Figure 9. Cost composition of compost applied at a one-hour haul distance.

Our project's target audience of potential users of C with forest crops was reached through presentations (see appended Project Presentations list), publications (see appended Project and Related Publications list), and a variety of tours. The presentation "Compost Use on Forest Crops" at the Compost School on May 5, 2004, at the SWFREC at Immokalee, FL, was heard by ~60 representatives of the agricultural industry, forestry agencies, extension agents, regulatory agencies, and municipalities. One day visits to FORCE were completed on June 22, 2004, and June 21, 2005, by 12 and 19, respectively, Alachua County School science teachers and students in the NSF-sponsored Summer Science Program, two and one, respectively, high school students participating in UF's Summer Science Training Program (SSTP), and two representatives of the Florida

Center for Solid and Hazardous Waste Management, who documented the NSF activities through still and video imagery. In July 2004, the two SSTP students successfully completed their research projects, one based on Study 102 and the other based on Study 105, with an award-winning presentation and poster, respectively, to the 97 SSTP students and some 12 SSTP faculty and staff. The project was the subject of a poster, presentation, paper, and/or tour at the December 7, 2005, Composting Workshop held at FORCE, at AGRItunity 2006 held at the Sumter County Fairgrounds on December 2, 2006 and attended by ~200 people, at Recycle Florida Today in Orlando on June 5, 2007, at AGRItunity 2008 at the Sumter County Fairgrounds on January 26, 2008, and at the 14^{th}, 15^{th}, and 16^{th} USCC Conferences in 2006, 2007, and 2008. On October 2, 2006, Peter McClure of Evans Properties toured the FORCE study to view opportunities for combining organics application with SRWCs. An educational opportunity for approximately 7,000 visitors annually to the UF/IFAS/SFRC Austin Cary Memorial Forest near Gainesville, e.g., the Yale University Southern Forestry Tour on March 9, 2006, to learn about C use is the strategically positioned Study SRWC-86 and associated kiosk and self-guided tour that documents C applied to **TD**.

Future Activities

Studies 102, 102A, 105, 107, and other appropriate studies will be remeasured and utilized as possible through 2009. Further analyses of project data will be conducted, and several publications are anticipated.

Acknowledgments

Our FORCE project activities were also assisted by direct and/or indirect support from the following:

Florida Center for Solid and Hazardous Waste Management (FCSHWM), UF
Soil and Water Science Department, UF
UF/IFAS Southwest Florida Research and Education Center (SWFREC), Immokalee, FL
UF/IFAS Gulf Coast Research and Education Center (GCREC), Wimauma, FL
UF/IFAS Citrus Research and Education Center (CREC), Lake Alfred, FL
UF/IFAS Plant Science and Education Center, Citra, FL
Knight’s Sawmill, Cross City, FL
Withlacoochee State Forest, Florida Division of Forestry
The Common Purpose Institute, Temple Terrace, FL
The Florida Institute of Phosphate Research
Sumter County DOC
USDA Forest Service Forest Products Laboratory, Madison, WI
Ray Hodges, Old Town, FL
Mosaic Company, Bowling Green, FL
Gary Peter and Xiabo Li, University of Florida, Gainesville, FL

Project Presentations and Publications

Presentations

“Short-rotation woody crop production utilizing compost from municipal solid and agricultural waste” at the Status, Trends, and Future of the South's Forest and Agricultural Biomass Conference, August 29-31, 2005, Athens, GA.

“Silviculture applications with MSW compost” at the BioCycle Southeast Conference in Charlotte, NC, on November 15, 2005.

“Short Rotation Woody Crops” at the American Farm Bureau Federation Annual Convention at Nashville, TN, on January 8, 2006.

“Compost Benefits for Short Rotation Woody Crops” at the 14^{th} USCC Conference in January 2006.

“SRWC-Based Phytoremediation Systems for Florida and the Lower Southeast” at the 7^{th} Biennial Meeting of the Short Rotation Woody Crops Operations Working Group in Pasco, WA, on September 26, 2006.

“Compost Use for Woody Crops” component of the one-day pre-conference workshop “Compost Use in Agriculture, Horticulture and Landscaping” at the 15^{th} USCC Conference in Orlando on January 21, 2007.

“Compost Benefits for Fast Growing Trees Used in Windbreaks” at the 15^{th} USCC Conference in Orlando on January 26, 2007.

“Compost Benefits for Using Fast Growing Trees in Various Applications in Florida” at Recycle Florida Today’s Annual Conference in Orlando on June 5, 2007.

“Cost Analysis for Using Compost for Fast Growing Trees in Florida” at the 16^{th} USCC Conference in Oakland on February 10, 2008.

Project and Related Publications

Rockwood, DL, DR Carter, GR Alker, and DM Morse. 2002. Compost utilization for forest crops in Florida. In: Proc. Recycle Organics ’02, Composting in the Southeast Conf. and Expo., October 6-9, 2002, Palm Harbor, FL. CD

Rahmani, M, DL Rockwood, DR Carter, and WH Smith. 2003. Co-utilization potential for biomass in Florida. In: Proc. International Conf. on Co-utilization of Domestic Fuels, February 5-6, 2003, Gainesville FL.

Rockwood, DL, GR Alker, RW Cardellino, C Lin, N Brown, T Spriggs, S. Tsangaris, JG Isebrands, RB Hall, R Lange, and B Nwokike. 2003. Fast-Growing Trees for Heavy Metal and Chlorinated Solvent Phytoremediation. In: Proc. 7^{th} Bioremediation Symposium, June 2-5, 2003, Orlando, FL. CD

Rockwood, DL, CV Naidu, DR Carter, M Rahmani, T Spriggs, C Lin, G R Alker, JG Isebrands, and SA Segrest. 2004. Short-rotation woody crops and phytoremediation: Opportunities for agroforestry? In: Advances in Agroforestry 1: New Vistas in Agroforestry – A Compendium for the 1^{st} World Congress of Agroforestry, 2004, Kluewer Academic Publishers, Dordrecht, p. 51-63.

Stricker, JA, GR Alker, DL Rockwood, GM Prine, DR Carter, and SA Segrest. 2000. Short Rotation Woody Crops for Florida. Short Rotation Woody Crops Operations Working Group. Third Biennial Conference. October 10-13. Syracuse, NY.

Rockwood DL, B Becker, A Lindner, A Pacheco, C Lin, N Brown, T Spriggs, S. Tsangaris, J Isebrands, R Hall, R Lange, E Aitchison, and B Nwokike. 2005. Genetic testing prerequisites for effective tree-based phytoremediation systems. Proc. 8th International In Situ and On-Site Bioremediation Symposium, June 6-9, 2005, Baltimore, MD, Battelle Press, Columbus, OH.

Becker, B, D Rockwood, B Tamang, and E Maehr. 2005. Short-rotation woody crop production utilizing compost from municipal solid and agricultural waste. In: Status, Trends, and Future of the South's Forest and Agricultural Biomass, August 29-31, 2005, Athens, GA.

Rockwood, DL, and DR Carter, 2005. Silviculture applications with MSW compost. BioCycle46(10): 42.

Rockwood, DL, B Becker, MP Ozores-Hampton, and PA Stansly. 2006. Compost benefits for short rotation woody crops. In: Proceedings of the 14th USCC Conference, January 22-25, 2006.

Becker, B, D Rockwood, B Tamang, E Maehr, and L Ma. 2006. SRWC-based phytoremediation systems for Florida and the Lower Southeast. Proc. 7th Biennial Meeting of the Short Rotation Woody Crops Working Group, September 25-28, 2006, Pasco, Washington.

Rockwood DL, B Becker, B Tamang, M Andreau, MP Ozores-Hampton, and CK Chandler. 2007. Compost benefits for fast growing trees used in windbreaks. In: Proc. 15th US Composting Council Conf., January 21-24, 2007, Orlando, Florida.

Rockwood DL, and B Becker. 2007. Compost benefits for using fast growing trees in various applications in Florida. In: Proc. 2007 Recycle Florida Today Annual Conference and Exhibition, June 4-6, 2007, Orlando, Florida. http://proceedings.recyclefloridatoday.org/2007_06_04_AnnualConference/p_bec.htm

Rockwood DL, MH Langholtz, B Becker, B Tamang, DR Carter, M Andreau, MP Ozores-Hampton, and CK Chandler. 2008. Cost analysis for using compost for fast growing trees in Florida. In: Proc. 16th US Composting Council Conf., February 10-12, 2008, Oakland, CA. (in press)

Zhu J, DL Rockwood. 2008. A novel pretreatment process for robust bioconversion of lignocellulose. Proceedings 30th Symposium on Biotechnology for Fuels and Chemicals, New Orleans, May 4-7, 2008. (poster).

Rockwood DL, JE Winandy. 2008. Resin and pressing requirements for making MDF from Florida-grown Eucalyptus grandis, E. amplifolia, Corymbia torelliana, and cottonwood. Proceedings Forest Products Society 62nd International Convention, St. Louis, June 22-24. (in press).

Rockwood DL, and JE Winandy. 2008. Variation among and within *Eucalyptus grandis*, *E. amplifolia*, *Corymbia torelliana*, and cottonwood grown in Florida USA for wood composite production. For. Prod. J. (in review)

McKinstry, WV. 2008. Soil influences on *Taxodium distichum* root development. MS Thesis, University of Florida, Gainesville. (in preparation).

Figure 1. Rep-Species-Treatment Map of 2002 and 2004 Studies at FORCE