Trees for Biomass

FRA Annual Meeting

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Increased Demand for Woody Biomass

Demand Drivers

- Pulp, Paper & Wood Products
- Pellets (Heat & Power)
- Electricity (Direct & Co-firing)
- Advanced Biofuels
As Demand for Woody Biomass Increases, ArborGen is Focused on Improving the Productivity of Trees

Biomass Demand

Demand Drivers Over Time

- Pulp, Paper & Wood Products
- Electricity Direct & Co-firing
- Advanced Biofuels

Biomass/Acre

Gallons/Acre

kWh/Acre

ArborGen Product Improvements Over Time
ArborGen: Global Leader in Tree Improvement

Global HQ
Summerville, SC

South America HQ
Campinas, Brazil

Australasia HQ
Whakatane, New Zealand
Who We Are: Focused on the Future of Forestry

- Leading producer of purpose grown trees
  - Produce nearly 300 million seedlings per year
  - Drawing on 50+ years of forestry and technology experience
  - Multi-national team of dedicated conservationists, biologists, foresters, researchers and scientists

- Technology leader
  - Innovative product platform: Pine and hardwood
  - Pipeline of world-class elite germplasm
  - More forestry field / regulatory trials than any other companies
Our Approach: Providing Better, More Sustainable Purpose Grown Trees

• Conventional tree improvement
  • Breeding and selection

• Accelerated improvements through advanced genetic technologies
  • Hybrids
  • Advanced propagation technologies
  • Introduced traits
  • Marker assisted breeding
Our system of refrigerated distribution centers means that your SuperTree Seedlings™ will never be very far from your planting site.
Biomass Trees

Loblolly Pine

- Most valuable and commercially important species in the southeast
- 1-1.5 billion trees planted every year

Major feedstock for pellet production

- Georgia Biomass – 750,000 tons/yr
- Green Circle – 560,000 tons/yr
FlexStands® as an alternative Pine management system

- Stands established to optimize production of multiple timber products for tomorrow’s uncertain markets
  - (that is, using different genetics to grow multiple products on your acres)

- Efficient use of genetic material
- Focus resources by product value
- Enables high value technology experience
Genetics

**Elite OP** (207 tpa) — 1 row

**MCP** (293 tpa)

2-rows

**Growth-Age-7**

**OP** Ht.=29.2’

Exh. SI=79

**MCP** Ht.=31.7’

Exh SI=84

**Yield Estimates**

**Thin12yr** =40 Gtons/ac

**CC23yr**

Pulp=18Gtons/ac

CNS=67Gtons/ac

ST=66Gtons/ac

**OP Biomass row-5’**

**Two rows MCP-7’**
MCP FlexStand ---Lowlands    Berkeley Co., SC

Broad crown-large branched OP planted as biomass take-out rows

Narrow crown –small branched MCP planted as crop trees

Exhibited SI-88
4’ x 20’= 545 tpa
Thin@ Age-8= 46Gt/ac
Age-8 Cash = $460.00

Establishment Cost
Mechanical---------$240
OP&MCP® Seedlings-$70
Herbaceous-2trt------$90
Fert@ 9yr----------$150
Total--------------$550

Exhibited SI-92
10’ x 20’= 218 tpa
Thin to 180 at 8yr
CC@ 25yr
CC Total Gt/ac= 207
CC revenue= $4282
P= $10, CNS= $10, ST= $28.

ArborGen Confidential
Purpose Grown Hardwoods for Bioenergy

Hybrid Eucalyptus (AGEH1)

- Hybrid of *E. grandis* x *E. urophylla*
- Fast growing & highly productive
- 20 to 33 green tons/acre/yr (2.5-3 year rotation)
- Suitable to grow in various soil types

*Hybrid Eucalyptus can only be grown in South Florida as it does not tolerate freeze*
Freeze Tolerant Eucalyptus (AGEH427*)

Rd29a:CBF2 confers freeze tolerance in chamber tests

* Not yet commercially available
Field Trial Examples of Freeze Tolerance

Results from first winter in South Carolina

- Control
- Lead Line

Results from second winter in Alabama

- Lead Lines + Control

Field results indicate freezing tolerance to ~16 F (-8 to -9 C)
Freeze Tolerant Eucalyptus Field Trials

2 year-old AGEH427 in Alabama

2nd growing season AGEH427 in Texas
Freeze Tolerant Eucalyptus

• Can be grown in North FL and around Interstate-10 over to East Texas

• Growth & productivity similar to AGEH1 in South Florida, but lower in the north due to cold stress

• No change in wood properties
Subtropical Eucalyptus
(*E. benthamii*)

- Best among several conventional cold-hardy eucalyptus species tested
- Fast growing & highly productive
- Suitable to grow in various soil types
- 14 to 18 Green tons/acre/yr (4-5 year rotation)

3 year-old *E. benthamii* in Alabama
E. bentamii Progeny Test

- Tests located in Florida, Alabama & Texas
- Includes 100 seedlots

7 month-old E. benthamii in Florida
Cottonwood/Populus

- Widely distributed in North America
- Fast growing & highly productive
- Potential for bioenergy applications
- 10 to 15 green tons/acre/yr (2-6 year rotation)
- ArborGen and Greenwood Resources formed Strategic Alliance to sell poplars in southeast US
Purpose grown hardwood portfolio

* Not yet commercially available
Purpose grown trees reduce supply risk

**Illustration**

### ArborGen Pine
- 8-13 green tons/acre/year
- 120,000 to 200,000 acres
- 20-26 miles

### ArborGen Populus
- 10-15 green tons/acre/year
- 140,000 to 180,000 acres
- 22-24 miles

### ArborGen Eucalyptus
- 14-33 green tons/acre/year
- 50,000 to 110,000 acres
- 13 to 19 miles

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**Forest Residues**
- 2 to 4 green tons/acre/year
- >570,000 acres
- ~45 miles

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- **SuperTree Nursery**
- ArborGen Headquarters
- Distribution Point
- Sales Office
- Orchards
- Bioenergy Field Trials (as of Nov. 2010)

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*Biopower Facilities*
- Electricity
- Liquid Fuels
- Pellets

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*Source: Forisk and ArborGen analysis

1. Includes only currently available products
2. Assumes access to 15% of the local land base
Summary

- Demand for wood is increasing every day
- Purpose grown trees have high per acre yield
- Increased planting densities and shortened rotations along with the ability to utilize whole-tree biomass increase productivity

- Tropical Eucalyptus (AGEH1)
  - 20 to 33 green tons/acre/year
  - 2.5-3 year rotation
  - 3 harvests

- Subtropical Eucalyptus
  - 14 to 18 green tons/acre/year
  - 4 year rotation
  - 3 harvests

- Populus
  - 10 to 15 green tons/acre/year
  - 2-6 year rotation
  - 3 harvests