Harvesting Understory Biomass with a Baler

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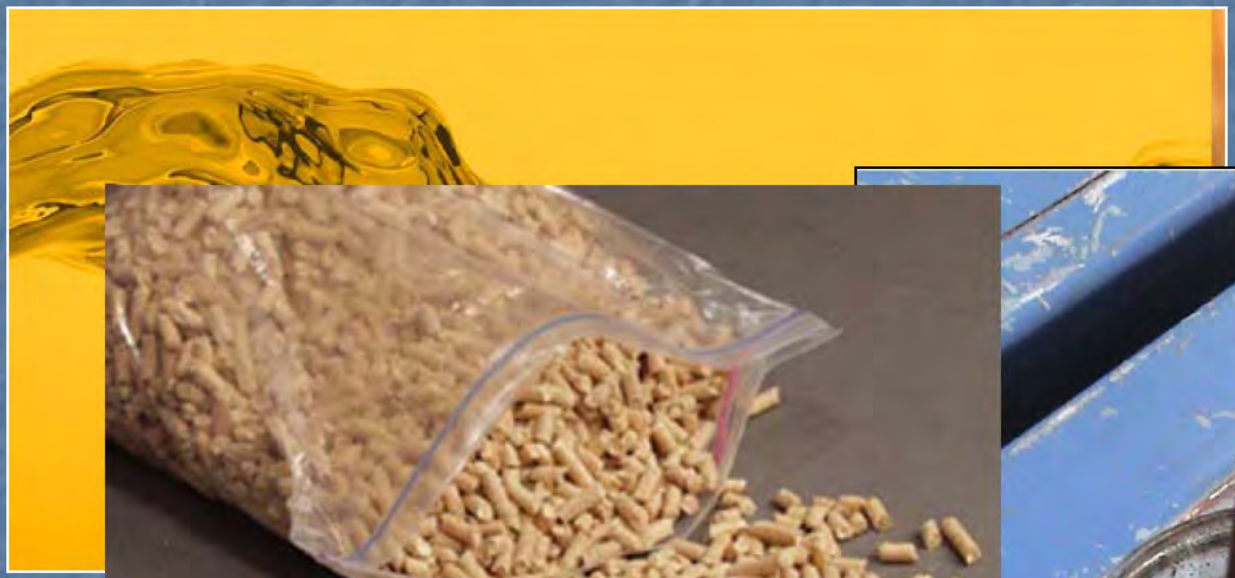
Cooperators

Anderson Group
Supertrak, Inc.
The Langdale Company

New Opportunities



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Pellet fuel

Fast pyrolysis
www.renewableoil.com

Why a Baler?

Questions to be Answered

1. Production rates?
   - bales/hr
   - tons/hr

2. Costs?
   - $/SMH or $/PMH
   - $/bale or $/ton

3. Performance?
   - effectiveness of harvesting
   - operational problems
   - fuel consumption

Questions to be Answered (cont.)

4. <u>Biomass reduction process?</u>
   - moisture content
   - heat and ash content
   - volume
   - density of biomass in transport form

Expected Benefits of Baling Understory Biomass

1. Potential for use as an alternative fuel source
2. Improve growth of leave trees
3. Improve health of stand
4. Manage WUI areas

Previous Work

- Schiess and Yonaka, 1983 – VPI Baler Prototype
- Fridley and Burkhardt, 1984 – Modified Vermeer 605F round hay baler
- Stokes, et.al., 1987 – Claas Rollant 62 round hay baler
- Canto, et.al., 2008 – Claas Rollant 250 and the Bio-baler

Previous Study (December 2007)

9 bales/hr

$34/ton
In-woods

Previous Study (December 2007)

Bio-baler (Modified New Holland – Univ. of Laval)

4 bales/hr

$37/ton in-woods

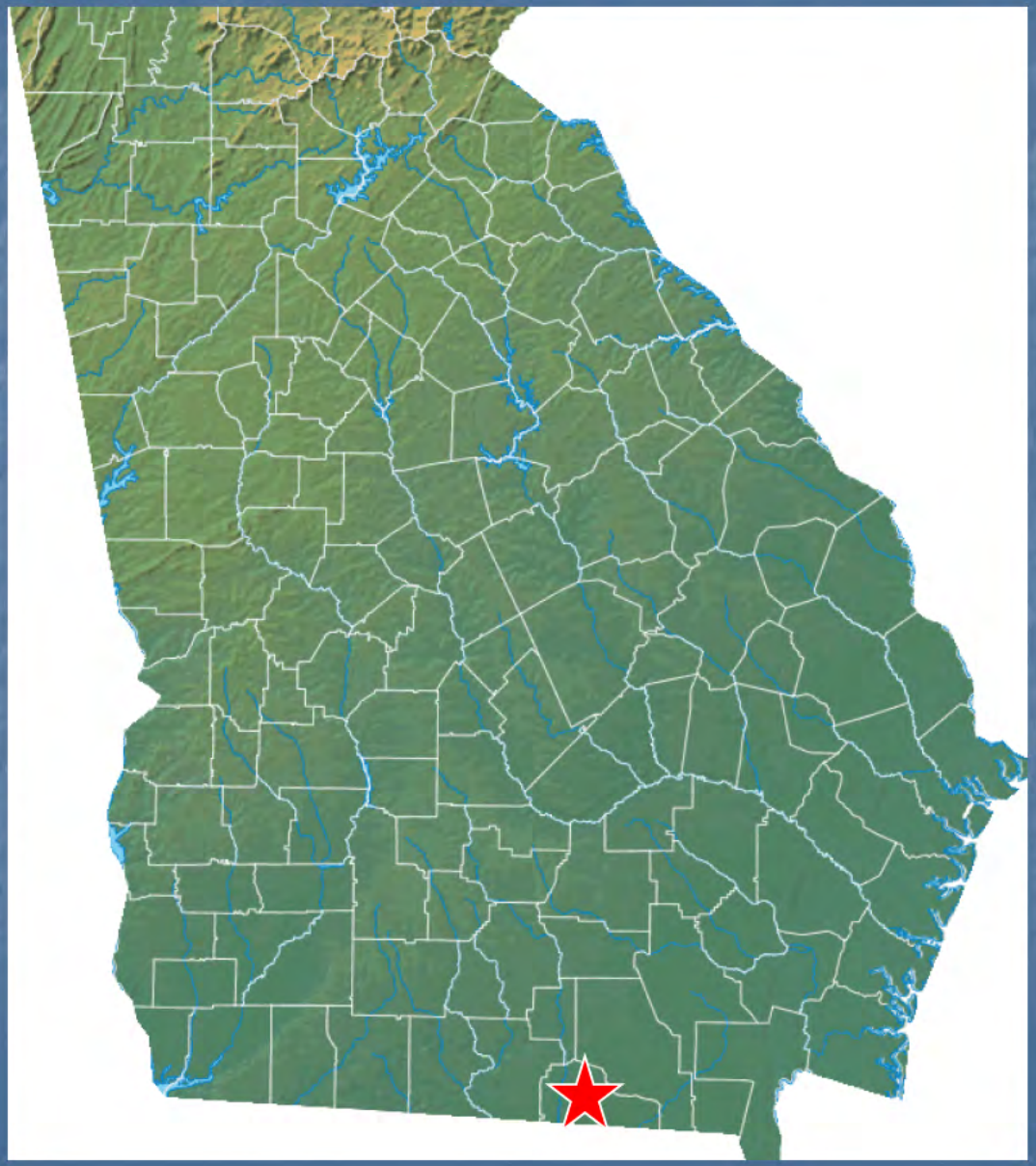
WB-55 Biobaler

www.grpanderson.com

Project Area

- Langdale Company land near Valdosta, GA
- 28-year old loblolly pine plantation thinned in 2007 with a 5th row removal
- Two site visits – Oct 2008 and Mar 2009

Study Location



Plantation Baling

Plantation Baling

Process

Cutting/baling material

Process at roadside

Extraction

Load/Transport

Equipment - Tractor

Fendt 818 tractor

185 hp

Nokia 16.9-28 TR tires front

Nokia 20.8-38 tires rear

Equipment - Baler

WB-55 Biobaler

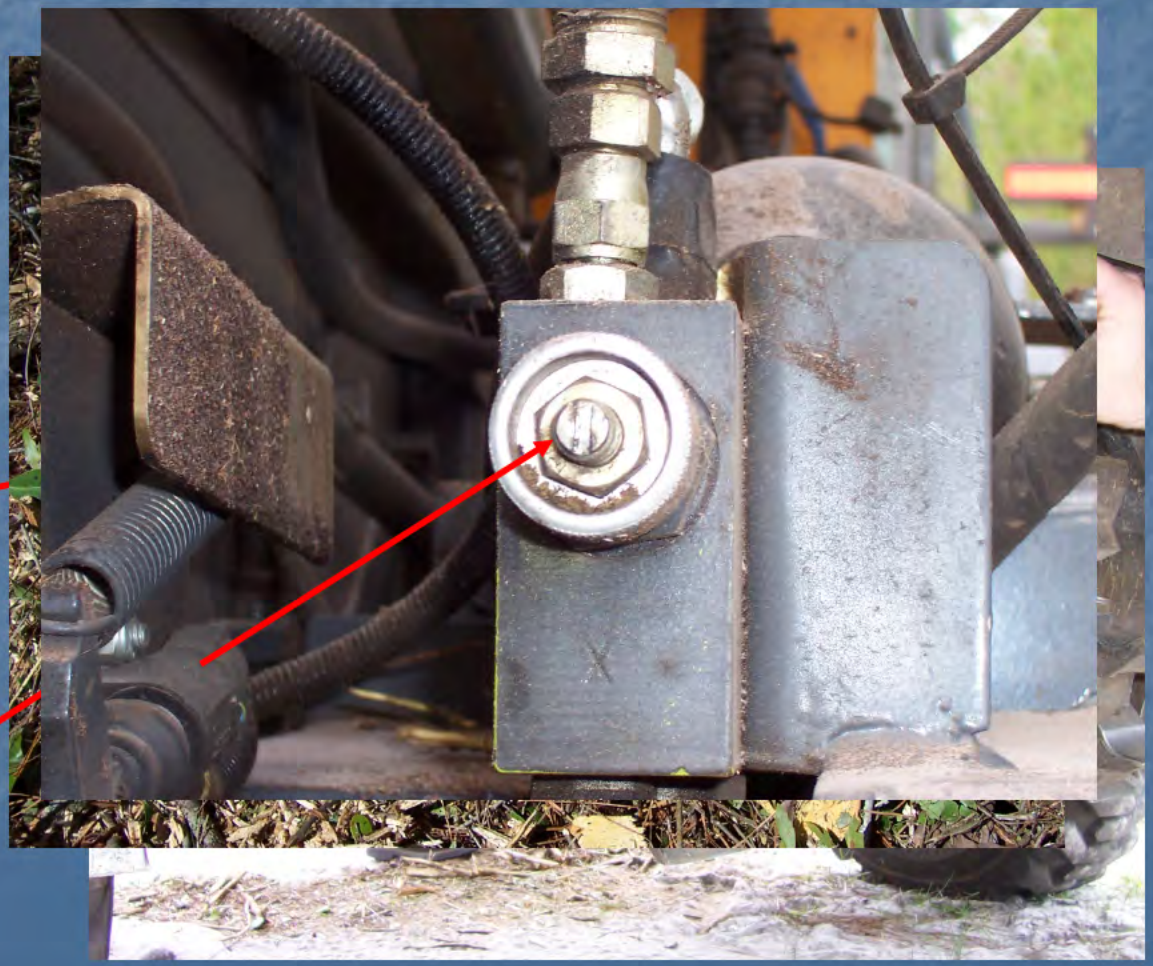
130 hp min.

Fixed tooth rotor

48 tooth capacity

7.5 ft cutting width

4 – 5 inch max. cutting diameter



Operation and Productivity

Biomass Inventory Plots

- Installed 24 plots
- Plot size – 1 m^2
- Species – gall berry with small amounts of wax myrtle, and palmetto

Biomass Inventory Plots

8 tons/acre

Biomass Loading

Species	N	Mean (gt/ac)	Std. Dev.	Min.	Max.
Gall berry and other	24	10.3	4.04	3.8	19.4
Red Maple	24	0.3	1.23	0.0	6.0
Pine	24	0.8	3.49	0.0	17.2
Total	24	11.3	5.49	3.8	29.9

Operation and Productivity

Variables Measured

Time study – travel, turn, wrap/drop bale, delays

Distances – between bales, turn

Fuel consumption– gallons per day

Bale Measurements

Summary of Bale Measurements

Variable	N	Mean	Std. Dev.	Min.	Max.
D_H (ft)	24	4.2	0.15	4.0	4.6
Dv (ft)	24	4.0	0.19	3.6	4.3
Width (ft)	24	4.1	0.08	4.0	4.2
Weight (lb)	24	991.6	54.62	893.5	1063.5
Volume (ft^3)	24	53.6	3.43	47.7	62.4
Circumference (ft)	24	12.9	0.40	12.1	13.7
Density (lb/ft^3)	24	18.6	1.53	16.3	21.3

Elemental Time Study Summary October 2008

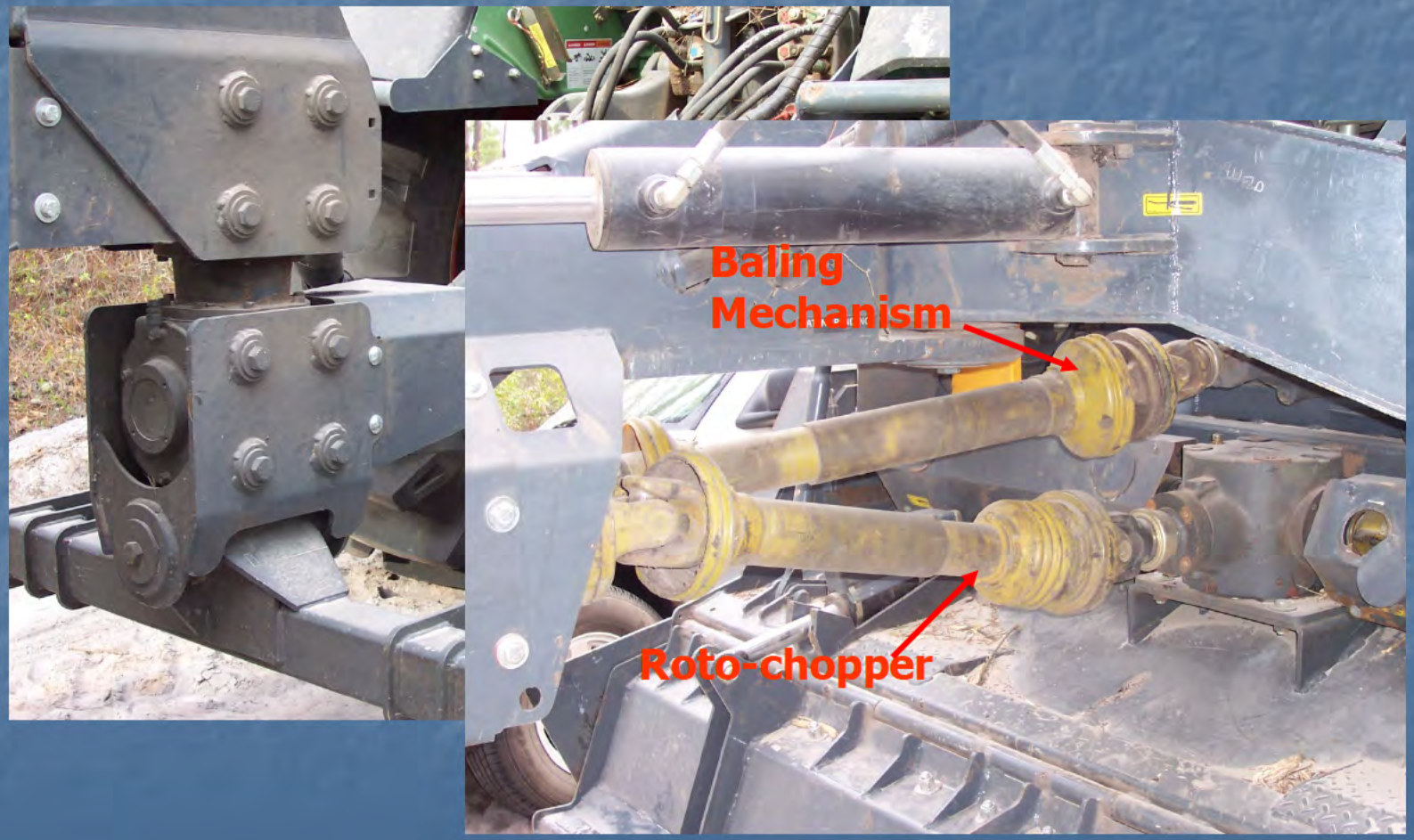
Mean time per bale – 11.9 min

Travel distance - 1682 feet

Net Productivity - 5.2 bales/hour (2.6 gt/hr)

In-woods cost - $22/bale or $43/ton

Modifications



Modifications

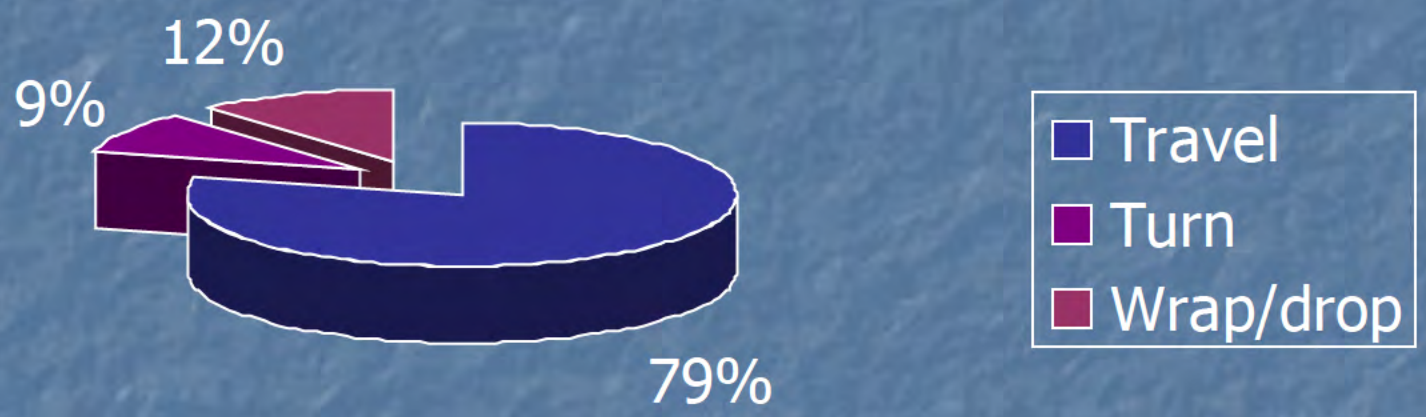
Elemental Time Study Summary March 2009

	Oct 08	Mar 09
Mean time per bale (min)	11.9	4.3
Travel distance (ft)	1682	752
Net Productivity (bales/hr)	5.2	14.7
(gt/hr)	2.6	7.3
In-woods cost ($/bale)	22	8
($/gt)	43	17

Time Study Summary March 2009

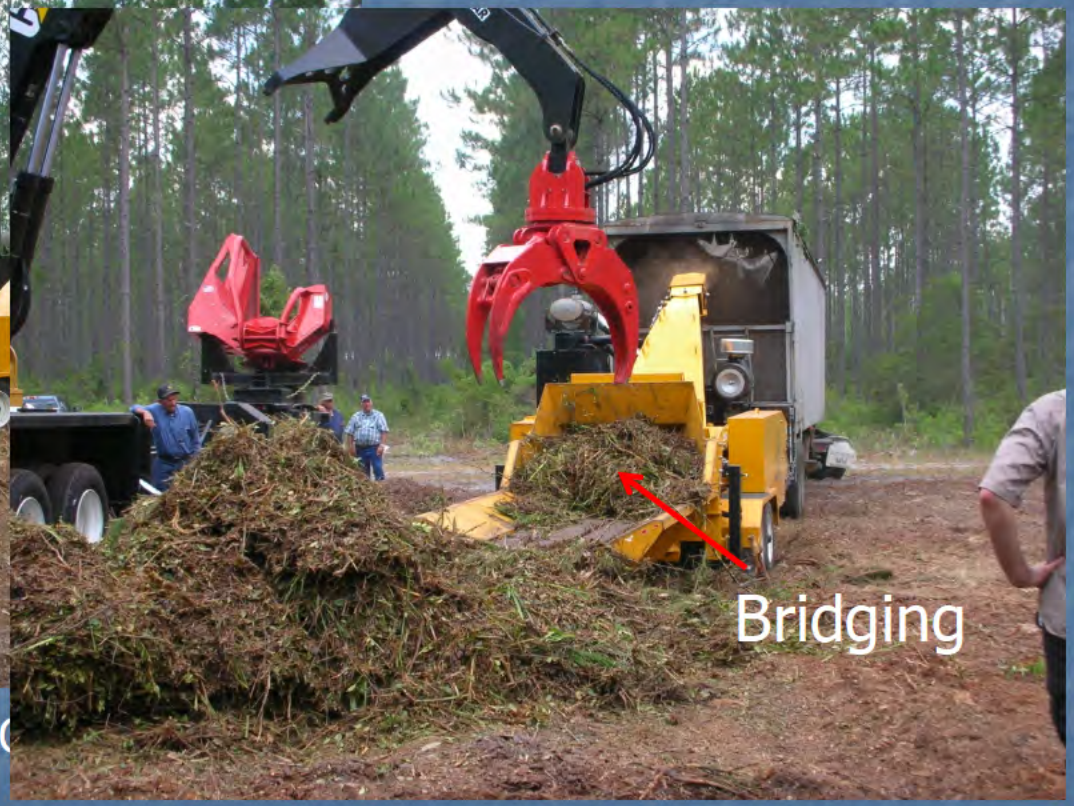
Variable	N	Mean	Std. Dev.	Min.	Max.
Travel (min)	26	3.4	0.86	2.1	5.6
Turn (min)	26	0.4	0.38	0.0	1.6
Wrap/drop (min)	26	0.5	0.14	0.2	0.9
Total time/bale (min)	26	4.3	1.01	2.7	6.7
Travel distance (ft)	26	752	136.4	508	975
Turn distance (ft)	26	42	35.6	0	95
Net productivity (bales/hr)	26	14.7	3.2	9.0	22.1

Percent of Total Time



Processing

Woodsman Model 334 C



Processing

H-1100 Haybuster

Processing

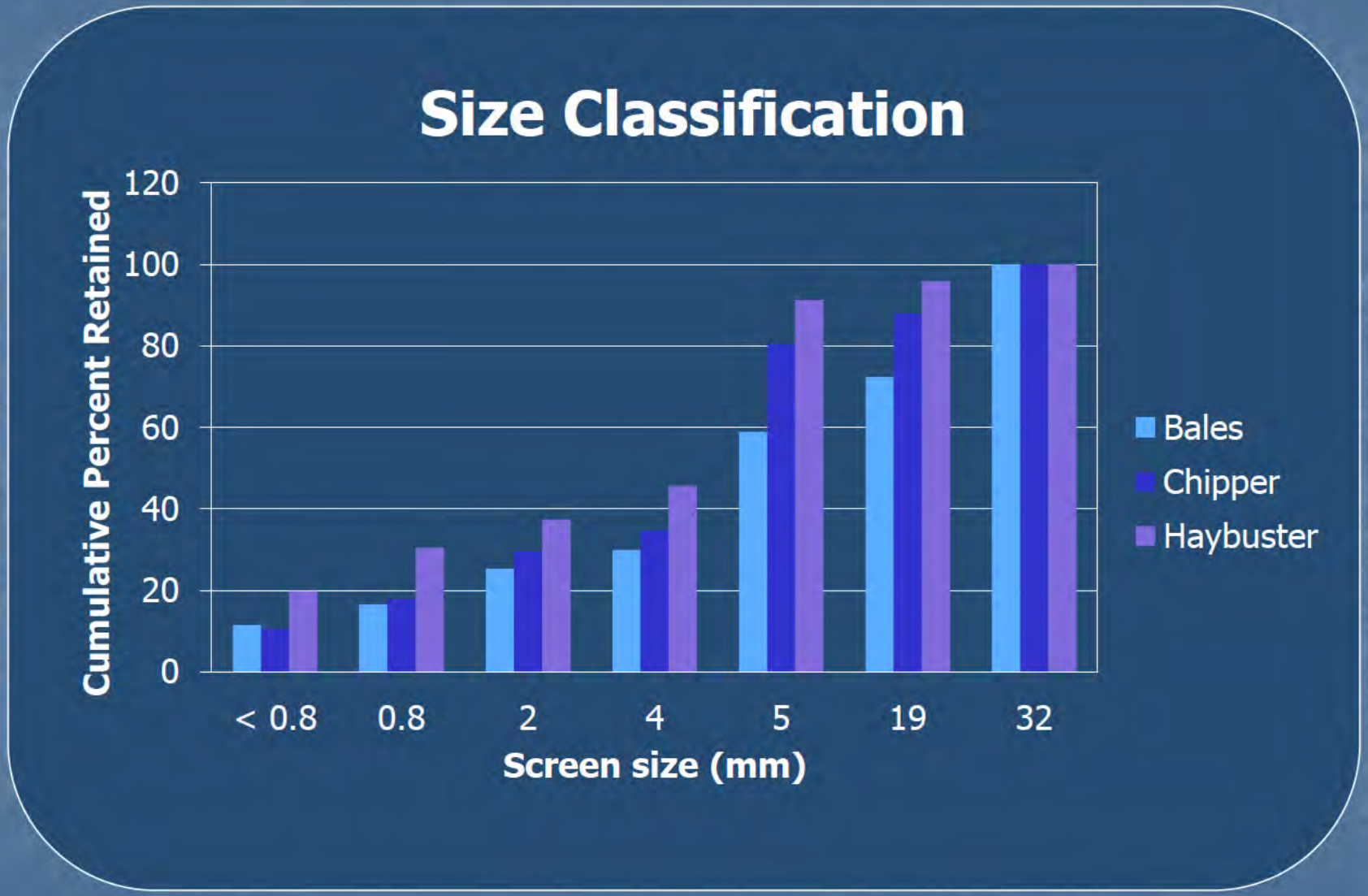
Payload = 13.42 tons

Payload = 19.07 tons
40 bales/hr

Bale

Chipper

Haybuster


Size Classification
Cumulative Percent Retained
120
100
80
60
40
20
0
< 0.8
0.8
2
4
5
19
32
Screen size (mm)
Bales
Chipper
Haybuster

Moisture, Heat Value & Ash Content

Moisture, Heat Value & Ash Content

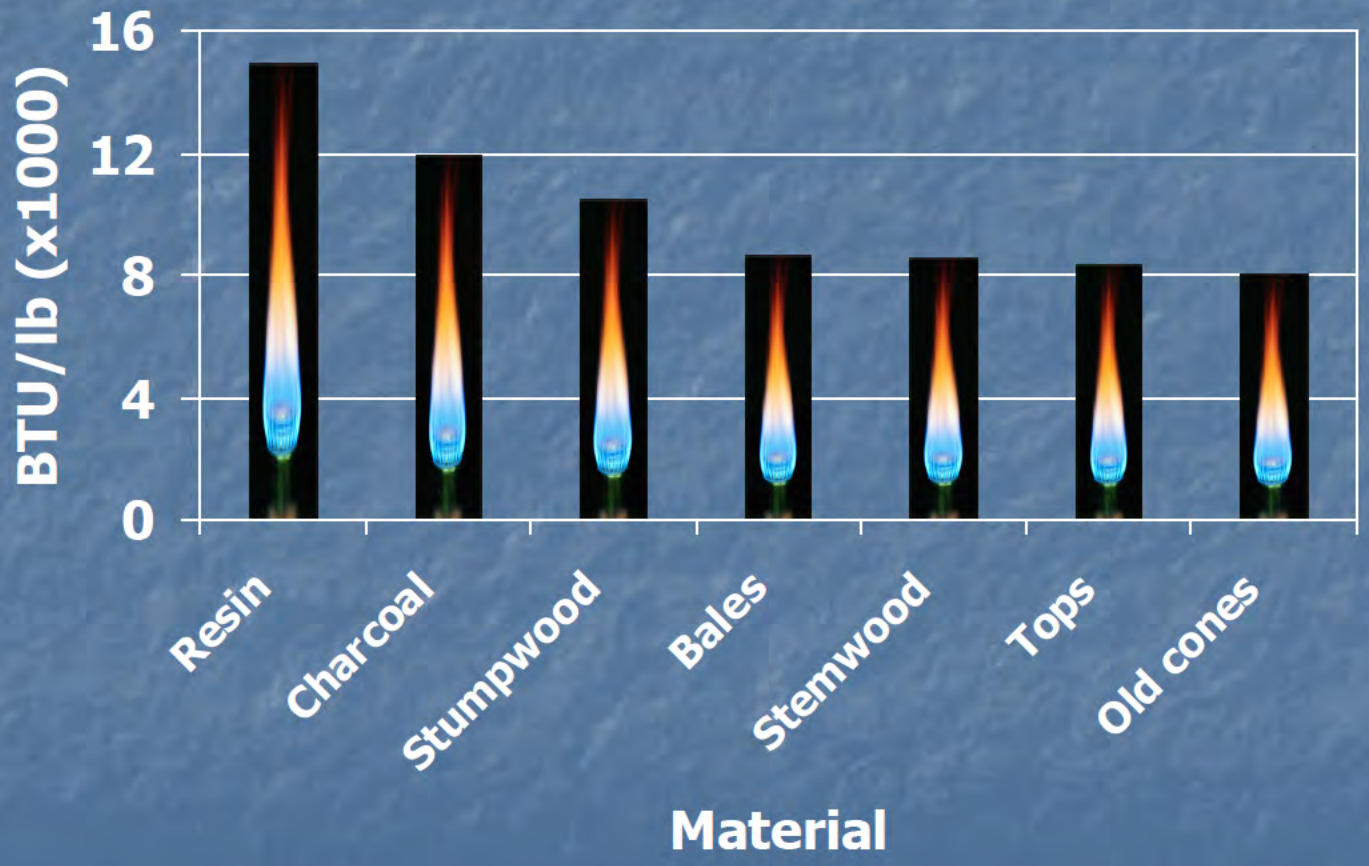
Moisture, Heat Value & Ash Content

8500 – 8700 Btu/lb dry

Moisture, Heat Value & Ash Content

Variable	N	Mean	Std. Dev.	Min.	Max.
Heat of Combustion (BTU/lb)	10	8629	90.4	8506	8751
Field MC (% wet basis)	10	35.0	3.49	30.5	41.2
MMBtu's/bale (field)	10	3.0	0.29	2.6	3.5
MMBtu's/bale (dry)	10	5.5	0.41	4.9	6.1
Ash content (%)	10	1.8	0.54	1.0	2.5

Heat Values



(Source: Utilization of Southern Pines, Peter Koch, 1972)

Heat Content

5.5 MMBtu's/dry bale

5.8 MMBtu's/barrel

Costs – Fendt 818 Tractor/ WB-55 Biobaler

	Fendt 818 Tractor	WB-55 Biobaler
Purchase price ($)	150,000	125,000
Depreciation ($/yr)	20,000	23,438
Interest ($/yr)	8,000	7,188
Insurance ($/yr)	3,500	1,797
Total Owning ($/SMH)	15.75	16.21
Fuel & lube ($/PMH)	12.00	1.61
R & M ($/PMH)	14.29	25.11
Teeth ($/PMH)		4.00
Bale twine ($/PMH)		3.53
Total Operating ($/PMH)	48.57	34.26
Labor & benefits ($/SMH)	15.60	
Total Cost ($/SMH)	49.75	40.19

(Source: Machine Rates for Selected Harvesting Machines, Brinker and others, 2002)

Extraction

Extraction

4-wheel Forwarder

- 20 min/turn
- 10 bales/turn
- ~1000 lbs/bale
- 15 tons/hr

Costs – Forwarder Extraction

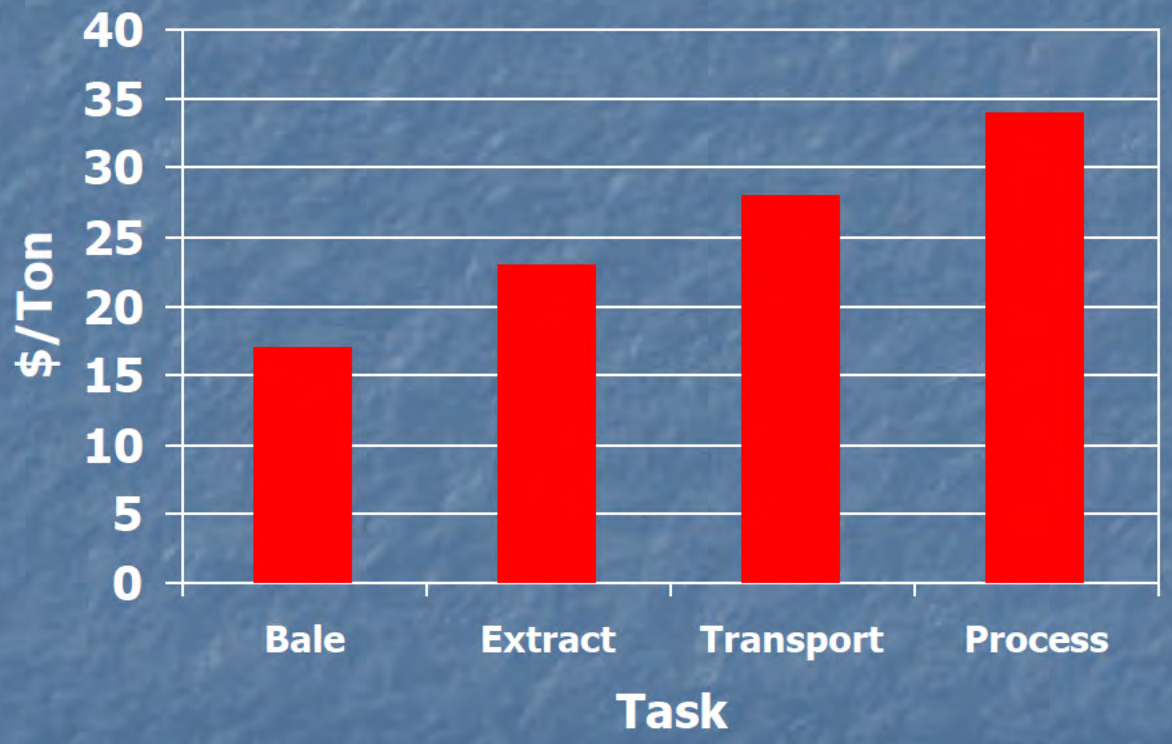
	4-wheel Forwarder
Purchase price ($)	200,000
Depreciation ($/yr)	32,000
Interest ($/yr)	10,880
Insurance ($/yr)	4,760
Total Owning ($/SMH)	23.82
Fuel & lube ($/PMH)	9.58
R & M ($/PMH)	22.86
Total Operating ($/PMH)	54.72
Labor & benefits ($/SMH)	15.60
Total Cost ($/SMH)	62.12

(Source: Machine Rates for Selected Harvesting Machines, Brinker and others, 2002)

Woods-to-Landing Costs

Machine	# for Balance	Machine (tons/SMH)	System			
			$/SMH	$/ton	$/bale	$/MMBtu
Tractor/ Baler	2	10.22	241.30	23.61	11.72	2.13
4-wheel Forwarder	1	10.54				

Cost Breakdown



Conclusions

- Modifications made enhanced production and reduced cost
- Extraction methods need improvement and studied to more confidently estimate production and cost of this phase
- Material derived from bales appears to be a suitable fuel source
- Value of energy in bales isn't enough to cover harvest and transport cost
- Ease of maintenance
- Forestry tires

Thank you!