

# Logging System Analysis

- ◆ Spreadsheet programs:
  - operate on PC
  - provide a powerful and user-friendly way of estimating costs
- ◆ The PC spreadsheets can:
  - reduce the time spent on making calculations
  - permit rapid examination of costs under several sets of assumptions

# Spreadsheet Programs

- ◆ Three spreadsheet programs:
  - Machine Rate Spreadsheet
  - Auburn Harvesting Analyzer
  - Central Appalachian Harvesting Analyzer

# Machine Rate Spreadsheet

- ◆ This simple spreadsheet:
  - takes input values for a machine rate calculation
  - computes the hourly costs per SMH and per PMH for a single machine
- ◆ The input, assumptions, and calculations follow the method described earlier by Miyata (1980).

# Summary of Machine Rate

$$D (\$ / SMH) = \frac{(P - S)}{N \times (SMH / Year)}$$

$$AVI (\$ / year) = \frac{(P - S) \times (N + 1)}{2 \times N} + S$$

$$IIT (\$ / SMH) = \frac{(\% IIT) \times AVI}{2000 SMH / Year}$$

$$\underline{\text{Fixed Cost (\$/SMH) = D + IIT}}$$

$$M \& R (\$ / PMH) = \frac{(\% M \& R) \times D}{UT}$$

$$F \& L (\$ / PMH) = \text{Consumption Rate} \times \text{Unit Price}$$

$$\underline{\text{Variable Cost (\$/PMH) = M\&R + F\&L}}$$

$$\text{Labor (\$/SMH) = Hourly Rate} \times (1 + \text{Fringe Benefits})$$

$$\underline{\text{Total Cost (\$/PMH) = Fixed Cost + Variable Cost + Labor Cost}}$$

# Machine Rate Spreadsheet

Estimation of Hourly Machine Rate Costs				
by Jingxin Wang				
<b>Machine:</b> Hydro-Ax 611 feller-buncher with circular sawhead				
Purchase Price	\$140,000	Fuel	6.5 gal/PMH@	\$0.75
Salvage Value (%P)	25%	Lube	4 qts/PMH@	\$1.16
Economic Life (year)	4	Maint & Repair (%AVI)		100%
Interest	15%	Labor		\$6.50
Insurance	3%	Fringe		40%
Taxes	2%	Utilization		65%
Weeks/year	50	SMH/Week		40
=====				
Fixed Costs:			\$/SMH	\$/PMH
Depreciation			13.125	20.19231
Interest, Insurance, & Taxes			10.0625	15.48077
<b>Total Fixed Costs</b>			<b>\$23.19</b>	<b>\$35.67</b>
=====				
Variable Costs:				
Maintenance & Repair			13.125	20.19231
Fuel & Lubrication			6.18	9.52
<b>Total Variable Costs</b>			<b>\$19.31</b>	<b>\$29.71</b>
=====				
Labor Costs:				
Wages or Salaries			4.23	6.50
Fringe Benefits			1.69	2.60
<b>Total Labor Costs</b>			<b>\$5.92</b>	<b>\$9.10</b>
=====				
<b>Total Hourly Costs</b>			<b>\$48.41</b>	<b>\$74.48</b>
=====				

# Auburn Harvesting Analyzer

- ◆ A spreadsheet designed to simplify the estimation of logging costs.
- ◆ Originally developed in 1984 at Auburn University, Alabama.
- ◆ With few modifications, the spreadsheet can be used to model nearly any logging systems.
- ◆ Its simplicity and ease of modification to model new systems have made it popular among logging analysts.

# Auburn Harvesting Analyzer

- ◆ The calculations performed in the Auburn Harvesting Analyzer are identical to those performed manually as we described earlier.
- ◆ A stand and stock table and other input variables are used to provide input for production equations.

# Auburn Harvesting Analyzer

- ◆ The production rate and the number of machines in each function are combined to determine:
  - the limiting function of the system, and
  - the actual utilization of of each function
- ◆ Productivity per SMH is then combined with hourly cost to calculate cost per unit volume for each function in the system.



# Auburn Harvesting Analyzer

- ◆ Production rate for each function is computed within the spreadsheet.
- ◆ The effects on system production and cost can be quickly examined by changing:
  - stand types, or
  - other operating variables

# Auburn Harvesting Analyzer

Logging Cost Analysis Shortcourse										Auburn Harvesting Analyzer					
SYSTEM:															
STAND & STOCK TABLE					GENERAL INFORMATION					Tract Size = 250 Acres					
DBH	Trees/Ac	Tons/Tree	Tons/Acre	Hours/Day =	8	Moving time =	5	Hours	5	Move Distance =	40	Miles	40	Miles	
6	32	0.094	3.00	Days/Week =	5	Distance home =	40	Miles	40	Roads to be Built:					
8	23	0.219	5.05	Weeks/Year =	50	Type		Miles/#	\$/mi	Permanent	0	10000			
10	15	0.417	6.26	Scheduled Hrs/Year =	2000	Temporary	0.6	3000		Push-out	1.5	1500			
12	10	0.524	5.24	Support:		Entrances	2	2000		Mill Quota (Tons/Wk) =	9999				
14	5	0.910	4.55	Pkups	1	0.45 \$/mi.									
16	2	1.204	2.41	Foreman		2,500 \$/mo.									
18	1	1.605	1.61	Overhead		3,000 \$/mo.									
20	1	2.408	2.41	Saws	2	1500 \$ ea.									
22	0		0.00	Pounds/cord =		5350									
24	0		0.00	Pounds/tree =		686									
TOTAL	89		30.51	Quad. Mean DBH =	9.35										
FELLING				SKIDDING				LOADING				HAULING			
BA/accum, sqft=				0.56 Avg Skid Distance (feet) =				Machine Productivity				11.83 Haul Distance (miles) = 40			
DBH	Min/T	Hr/Ac	Avg Turn Volume (tons) =	Prep. Time = 720 Trees/Load =				1 Average Speed (mph) = 40				Load Size (tons) = 26.2			
6	0.37	0.20	0.17	Cord (Y=Yes) = 2.01 Loading Time =				Unloading Time (minutes) = 30				Loading Time (minutes) = 36			
8	0.44	0.12	0.09	Time per Load (minutes) = 5.05				Round Trip Time (hours) = 3.10				8.44			
10	0.50	0.12	0.09					1.0				1.0			
12	0.56	0.12	0.09												
14	0.63	0.05	0.04												
16	0.69	0.02	0.05												
18	2.51	0.04	0.05												
20	2.88	0.05	0.00												
22	3.27	0.00	0.00												
24	3.67	0.00	0.75												
TOTAL			40.71	23.84				64.43				3.10			
Tons/PMH =			1.0	1.0				1.0				8.44			
Oper Effic =												1.0			
Machine Cost															
D (\$/SMH)=	18.56			14.05				12.38 Haul Rate							
I&T (\$/SMH)=	6.56			5.17				4.37 (\$/mile) = \$2.00							
F&L (\$/PMH)=	17.05			9.54				4.53							
M&R (\$/PMH)=	8.90			12.03				8.02							
Labor(\$/SMH)=	10.00			10.00				10.00							
Labor overhead (%)=	40			40				40							
Avail.(%) =	75			70				85				90			
Number =	1			1				1				2.2			
Function	Tons /PMH	Avail%	Tons/SMH	One	All	Utiliz%	Cost per SMH			Cost \$/Ton					
Felling	40.71	75	30.53	30	53	41	25.12	10.64	14.00	49.76	2.98				
Skidding	23.84	70	16.69	16	69	70	19.80	15.10	14.00	48.90	2.93				
Loading	64.43	85	54.76	54	76	26	16.75	3.25	14.00	34.00	2.04				
Hauling	8.44	90	7.60			90					3.05				
Support	Pickups, Chainsaws, Foreman, and Overhead										2.34				
Road Work											1.06				
Moving	5.00 hours spent moving men & equipment to tract										0.10				
System Rate (tons/SMH) =						16.69	Onboard Cost/Ton:				11.44				

**There are five sections:**

- ◆ Stand & Stock Table,
- ◆ System Information,
- ◆ Machine Productivity,
- ◆ Machine Cost, and
- ◆ System Calculation.

# Stand and Stock Table

- ◆ The stand and stock table is found in the upper left corner of the spreadsheet.
- ◆ The user enters:
  - the range of DBH values,
  - stand density in each class, and
  - an appropriate local volume table or equation
- ◆ The input here is used for calculating the felling production per PMH.

# Logging System Information

- ◆ General information about the logging system is found to the right of stand and stock table in Section 2.
- ◆ The user enters:
  - machine hours scheduled per day,
  - tract size,
  - support costs, and
  - road building costs, etc.

# Machine Productivity

- ◆ Potential hourly productivity is computed for each function in the system in Section 3.
- ◆ These production estimates are calculated using
  - stand and stock table, and
  - general information
- ◆ Published production equations or other methods can be used to calculate hourly productivity by each function.

# Machine Productivity

## (Operator Efficiency)

- ◆ The source of production information does not provide a realistic measure of actual production.
- ◆ **The operator efficiency value is used to adjust the production.**
- ◆ Value of 1.0 indicates that the operator in the system being modeled produces at the rate indicated by the equation being used.
- ◆ Using a value of 0.85 would indicate that the operator is 15% less productive.
- ◆ While value of 1.20 would reflect an operator who was 20% more productive.

# Machine Cost Estimates

- ◆ Section 4 contains the machine rate cost estimates provided by the user for each function.
- ◆ **The number of machines in each function and their availability are entered in this section.**
- ◆ Fixed and labor costs are entered on a cost per SMH basis while variable costs are on per PMH basis.

# System Calculation

- ◆ The last section of the spreadsheet:
  - is composed entirely of calculations, and
  - contains no user input
- ◆ Information from other sections of the spreadsheet is combined to determine:
  - the limiting factor of production,
  - actual utilization of each function,
  - hourly costs and cost per unit volume
  - weekly production, and
  - the number of days needed to harvest the tract



# Central Appalachian Harvesting Analyzer



**ESTIMATION OF HOURLY MACHINE COSTS**

Purchase price (\$)	\$90,000	Fuel	6.5 gal/PMH @	\$0.75
Salvage Value (%P)	25%	Lube	4 qts/PMH @	\$1.16
Economic Life (year)	4	Repair and Maint. (%AVL)		100%
Interest	12%	Labor (\$/SMH)		\$12.00
Insurance	5%	Labor fringe (% LR)		40%
Taxes	3%	Mechanical Availability		65%
Weeks/year	50	SMH/Week		40
<b>FIXED COSTS:</b>				
			\$/SMH	\$/PMH
Depreciation			8.44	12.98
Interest, Insurance, & Taxes			6.47	9.95
<b>Total Fixed Costs</b>			<b>14.91</b>	<b>22.93</b>
<b>VARIABLE COSTS:</b>				
Manitenance & Repair			8.44	12.98
Fuel & Lubrication			6.18	9.52
<b>Total Variable Costs</b>			<b>14.62</b>	<b>22.50</b>
<b>LABOR COSTS:</b>				
Wages or Salaries			12.00	18.46
Fringe Benefits			4.80	7.38
<b>Total Labor Costs</b>			<b>16.80</b>	<b>25.85</b>
<b>TOTAL HOURLY COSTS</b>			<b>46.33</b>	<b>71.27</b>

Machine Rate  
Worksheet

- ◆ VBA
- ◆ Two sheets
- ◆ Machine rate and system analysis

OK Reset Cancel

# CAHA

GENERAL INFORMATION									
MHT									
DBH(in.)	(no. of logs)	Trees/Ac	MBF/Tree	MBF/Ac	Hours/Day =	8	Tract Size =	50	Acres
6	1.0	26	0.019	0.50	Days/Week =	5	Moving time =	5	Hours
8	1.5	18	0.036	0.66	Weeks/Year =	50	Move Distance =	50	Miles
10	2.0	21	0.066	1.39	Scheduled Hrs./Year =	2,000	Distance home =	50	Miles
12	2.0	18	0.094	1.68	Support:				
14	2.0	15	0.127	1.91	Pkups	1	0.5 \$/mi.	Roads to be Built:	
16	2.0	14	0.167	2.33	Foreman	1	2,300 \$/mo.	Type	Miles/#
18	2.5	10	0.252	2.52	Overhead	1	2,800 \$/mo.	Permanent	0
20	2.5	7	0.314	2.20	Saws	2	1,300 \$ ea.	Temporary	0.6
22	2.5	4	0.383	1.53				Push-out	1.5
24	2.5	4	0.460	1.84	MBF/tree =	0.12		Entrances	2
TOTAL	137		16.55		Quad. Mean DBH =	13.12		Mill Quota (MBF/Wk) =	9999

MACHINES											
Felling	Feller-buncher		Extraction	Grapple skidder		Loading	Loader		Hauling	Long log truck	
Machine Productivity											
dist/Tree, ft=	32.44		Avg Extraction Dist (feet) =	1000.00		Prep. Time =	11.83		Haul Distance (miles) =	50	
DBH (in.)	MHT	Min/Tree	Hr/Ac	Avg Turn Volume (MBF) =	0.53	Loading MBF/hr	9.59		Average Speed (mph) =	40	
6	1.0	1.15	0.50			Loading Time =	24.40		Load Size (MBF) =	3.90	
8	1.5	1.17	0.35					Unloading Time (minutes) =	30.00		
10	2.0	1.20	0.42					Loading Time (minutes) =	36.23		
12	2.0	1.23	0.37								
14	2.0	1.27	0.32								
16	2.0	1.32	0.31								
18	2.5	1.37	0.23								
20	2.5	1.43	0.17								
22	2.5	1.49	0.10								
24	2.5	1.56	0.10								
TOTAL	2.87							Round Trip Time (hours) =	3.60		
MBF/PMH =	5.77			5.17		6.46			1.08		
Oper Effy =	1.0			1.0		1.0			1.0		
Machine Cost											
	Felling Cost		Extraction Cost		Loading Cost		System Balance		Reset		
Depreciation (\$/SMH)=	\$16.88		\$11.96		\$9.94		Haul Rate (\$/mile) =		\$4.00		
Interest insur.&taxes (\$/SMH)=	\$11.79		\$8.22		\$6.83						
<b>Total Fixed Cost (\$/SMH)=</b>	<b>\$28.67</b>		<b>\$20.18</b>		<b>\$16.77</b>						
Fuel&Lube (\$/PMH)=	\$5.28		\$11.06		\$1.39						
Maint. &Repair (\$/PMH)=	\$16.88		\$18.40		\$16.26						
<b>Total Variable cost (\$/SMH)</b>	<b>\$15.51</b>		<b>\$19.15</b>		<b>\$9.71</b>						
Labor(\$/SMH)=	\$12.00		\$12.00		\$12.00						
Labor fringe (%)=	40%		40%		40%						
Mechanical Availability(%)=	70%		65%		55%				90%		
No. of machine =	1		1		1						

SYSTEM									
Function	MBF/PMH	Mech Avail%	MBF/SMH		Utiliz%	Cost per SMH			Cost \$/MBF
			One	All		Fixed	Oper	Labor	Total
Felling	5.77	70%	4.04	4.04	58%	28.67	12.89	16.80	58.36
Extraction	5.17	65%	3.36	3.36	65%	20.18	19.15	16.80	56.13
Loading	6.46	55%	3.55	3.55	52%	16.77	9.18	16.80	42.75
Hauling	1.08	90%	0.97						51.28
Support	Pickups, Chainsaws, Foreman, and Overhead								11.36
Road Work									9.87
Moving	5.00 hours spent moving men & equipment to tract								1.43
System Rate (MBF/SMH) =			3.36			Onboard Cost/MBF:			\$89
Daily production (MBF, truck loads) =			27 (MBF)		7 (truck loads)	Cut & haul Cost/MBF:			\$121
Days required to harvest tract =			32						

Save Sheet

# Class Exercises

## (1) Machine Rate

### Timberjack 520 grapple skidder

Purchase price:	\$165,000
Salvage value:	20%
Economic life:	5 years
Interest:	10%
Insurance:	3%
Taxes:	0%
Fuel usage:	4.4 gal/PMH
Lube usage:	1.0 qt/PMH
Fuel cost:	0.88/gal
Lube cost:	1.30/qt
M&R:	90%
Wages:	10.00/SMH
Fringes:	35% of wages
Utilization:	75%

<http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/MachRate.xls>

# Class Exercises

## (2) Auburn Harvesting Analyzer

[http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/aha\\_tons.xls](http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/aha_tons.xls)

## (3) Central Appalachian Harvesting Analyzer

<http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/CAHA.xls>