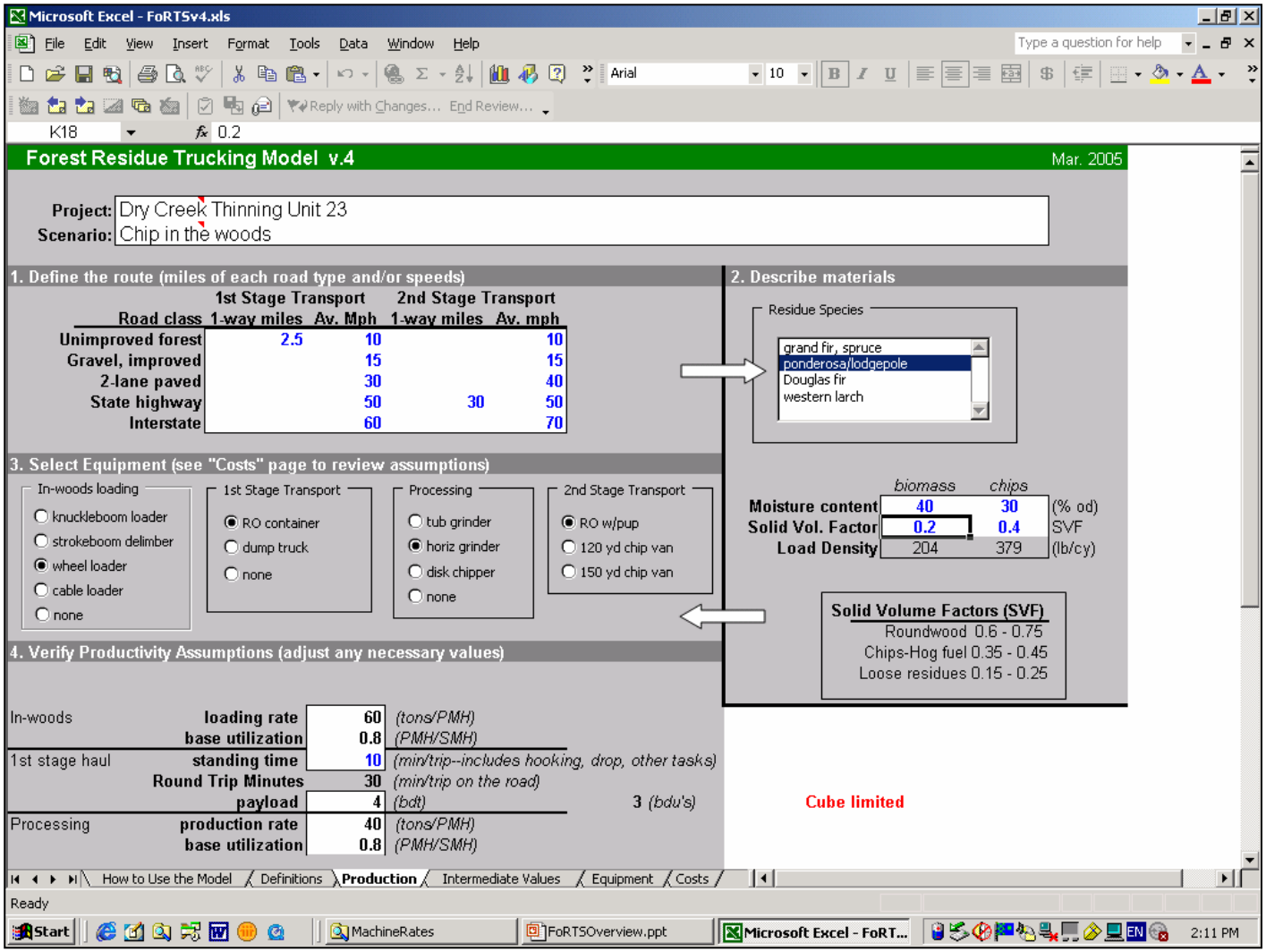
Residue Trucking Model

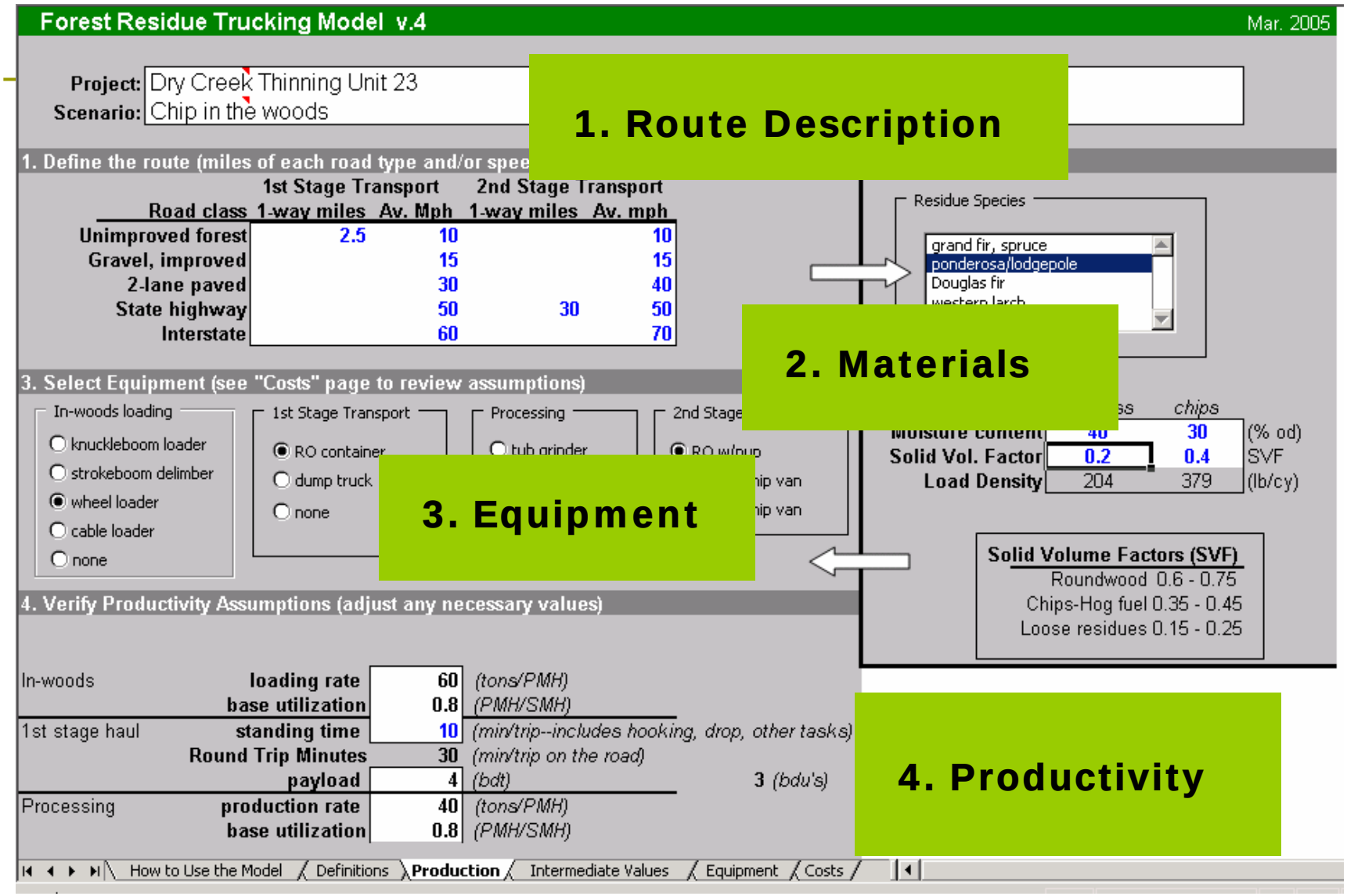


Outline

- Overview of FoRTS
- Review of analysis concepts
- Example scenario

Model objectives

- Estimate transportation costs for biomass
- Evaluate alternative routing
- Understand the impact of system balance
- Determine economic feasibility of 2-stage transport options


Forest Residue Trucking Model v.4
Mar. 2005
Project: Dry Creek Thinning Unit 23
Scenario: Chip in the woods
1. Route Description
1. Define the route (miles of each road type and/or spee
1st Stage Transport
2nd Stage Transport
Road class
1-way miles
Av. Mph
1-way miles
Av. mph
Unimproved forest 2.5 10 10
Gravel, improved 15 15
2-lane paved 30 40
State highway 50 30 50
Interstate 60 70
Residue Species
grand fir, spruce
ponderosa/lodgepole
Douglas fir
2. Materials
3. Select Equipment (see "Costs" page to review assumptions)
In-woods loading
knuckleboom loader
strokeboom delimber
wheel loader
cable loader
none
1st Stage Transport
RO container
dump truck
none
Processing
tub grinder
2nd Stage
chips
Moisture content 40 30 (% od)
Solid Vol. Factor 0.2 0.4 SVF
Load Density 204 379 (lb/cy)
3. Equipment
Solid Volume Factors (SVF)
Roundwood 0.6 - 0.75
Chips-Hog fuel 0.35 - 0.45
Loose residues 0.15 - 0.25
4. Verify Productivity Assumptions (adjust any necessary values)
In-woods loading rate 60 (tons/PMH)
base utilization 0.8 (PMH/SMH)
1st stage haul standing time 10 (min/trip--includes hooking, drop, other tasks)
Round Trip Minutes 30 (min/trip on the road)
payload 4 (bdt) 3 (bdu's)
Processing production rate 40 (tons/PMH)
base utilization 0.8 (PMH/SMH)
4. Productivity
How to Use the Model
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1st Stage Round Trip Minutes	30	*(min/trip on the road)*
1st Stage Payload	7	*(tons)*
Processing production rate	60	*(tons/PMH)*
Processing base utilization	0.8	*(PMH/SMH)*
2nd Stage Haul Standing Time	20	*(min/trip--includes hooking, drop, other tasks)*
2nd Stage Round Trip Minutes	72	*(min/trip on the road)*
2nd Stage Payload	17	*(tons)*

4. System Production and Cost Calculation

	# of each	(tons/SMH)	Act. Util.	$/ton	$/bdu	
Loading	1	20	0.68	$5.73	$6.88	
1st Stage	2	19	0.90	$5.59	$6.71	
Processing	1	48	0.55	$5.33	$6.40	
2nd Stage	3	33	0.90	$5.52	$6.62	
				$22.17	$26.60	TOTAL COST

Production Comments

In-woods loading is limiting

2nd stage haul is limiting

Processing and 2nd stage haul exceed capacity of 1st s

To comment on this tool, please contact:
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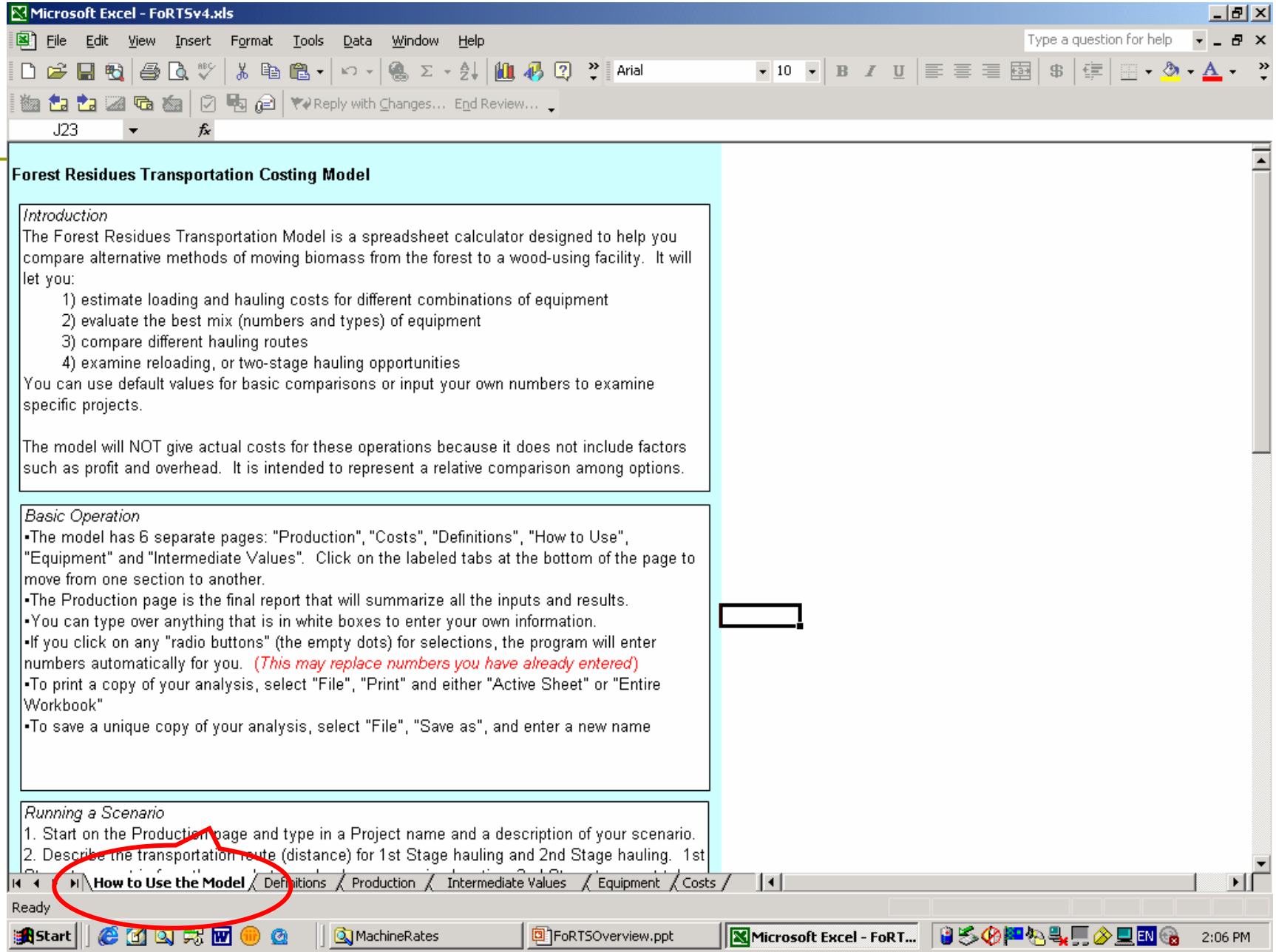
Auburn, Alabama *(334) 826-8700* *rummer@fs.fed.us*

5. System balance and cost

How to Use the Model | Definitions | **Production** | Intermediate Values | Equipment | Costs

Ready


Microsoft Excel - FoRTSv4.xls
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J23
Forest Residues Transportation Costing Model
Introduction
The Forest Residues Transportation Model is a spreadsheet calculator designed to help you compare alternative methods of moving biomass from the forest to a wood-using facility. It will let you:
1) estimate loading and hauling costs for different combinations of equipment
2) evaluate the best mix (numbers and types) of equipment
3) compare different hauling routes
4) examine reloading, or two-stage hauling opportunities
You can use default values for basic comparisons or input your own numbers to examine specific projects.
The model will NOT give actual costs for these operations because it does not include factors such as profit and overhead. It is intended to represent a relative comparison among options.
Basic Operation
•The model has 6 separate pages: "Production", "Costs", "Definitions", "How to Use", "Equipment" and "Intermediate Values". Click on the labeled tabs at the bottom of the page to move from one section to another.
•The Production page is the final report that will summarize all the inputs and results.
•You can type over anything that is in white boxes to enter your own information.
•If you click on any "radio buttons" (the empty dots) for selections, the program will enter numbers automatically for you. (This may replace numbers you have already entered)
•To print a copy of your analysis, select "File", "Print" and either "Active Sheet" or "Entire Workbook"
•To save a unique copy of your analysis, select "File", "Save as", and enter a new name
Running a Scenario
1. Start on the Production page and type in a Project name and a description of your scenario.
2. Describe the transportation route (distance) for 1st Stage hauling and 2nd Stage hauling. 1st
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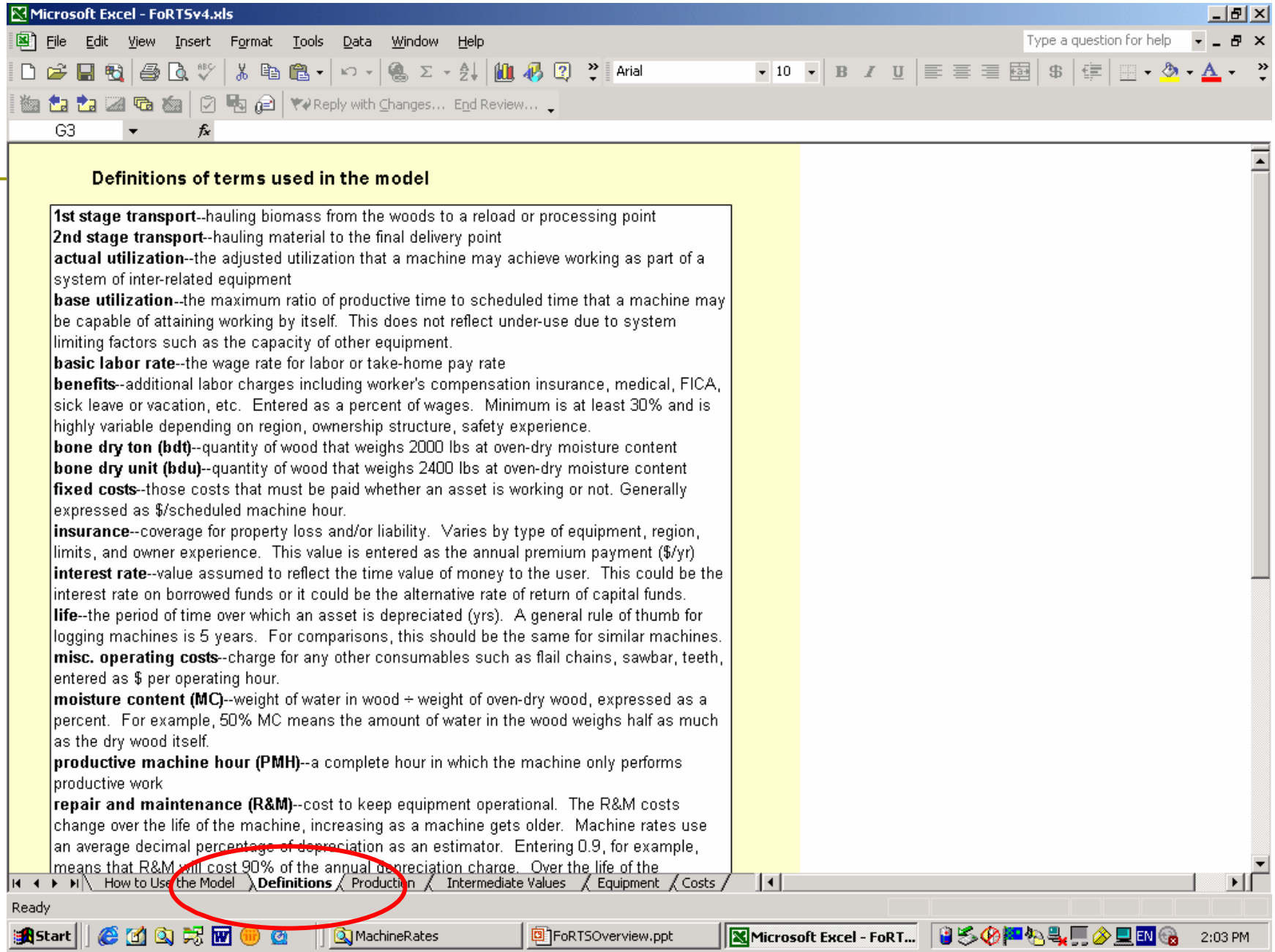
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G3
Definitions of terms used in the model
1st stage transport--hauling biomass from the woods to a reload or processing point
2nd stage transport--hauling material to the final delivery point
actual utilization--the adjusted utilization that a machine may achieve working as part of a system of inter-related equipment
base utilization--the maximum ratio of productive time to scheduled time that a machine may be capable of attaining working by itself. This does not reflect under-use due to system limiting factors such as the capacity of other equipment.
basic labor rate--the wage rate for labor or take-home pay rate
benefits--additional labor charges including worker's compensation insurance, medical, FICA, sick leave or vacation, etc. Entered as a percent of wages. Minimum is at least 30% and is highly variable depending on region, ownership structure, safety experience.
bone dry ton (bdt)--quantity of wood that weighs 2000 lbs at oven-dry moisture content
bone dry unit (bdu)--quantity of wood that weighs 2400 lbs at oven-dry moisture content
fixed costs--those costs that must be paid whether an asset is working or not. Generally expressed as $/scheduled machine hour.
insurance--coverage for property loss and/or liability. Varies by type of equipment, region, limits, and owner experience. This value is entered as the annual premium payment ($/yr)
interest rate--value assumed to reflect the time value of money to the user. This could be the interest rate on borrowed funds or it could be the alternative rate of return of capital funds.
life--the period of time over which an asset is depreciated (yrs). A general rule of thumb for logging machines is 5 years. For comparisons, this should be the same for similar machines.
misc. operating costs--charge for any other consumables such as flail chains, sawbar, teeth, entered as $ per operating hour.
moisture content (MC)--weight of water in wood ÷ weight of oven-dry wood, expressed as a percent. For example, 50% MC means the amount of water in the wood weighs half as much as the dry wood itself.
productive machine hour (PMH)--a complete hour in which the machine only performs productive work
repair and maintenance (R&M)--cost to keep equipment operational. The R&M costs change over the life of the machine, increasing as a machine gets older. Machine rates use an average decimal percentage of depreciation as an estimator. Entering 0.9, for example, means that R&M will cost 90% of the annual depreciation charge. Over the life of the
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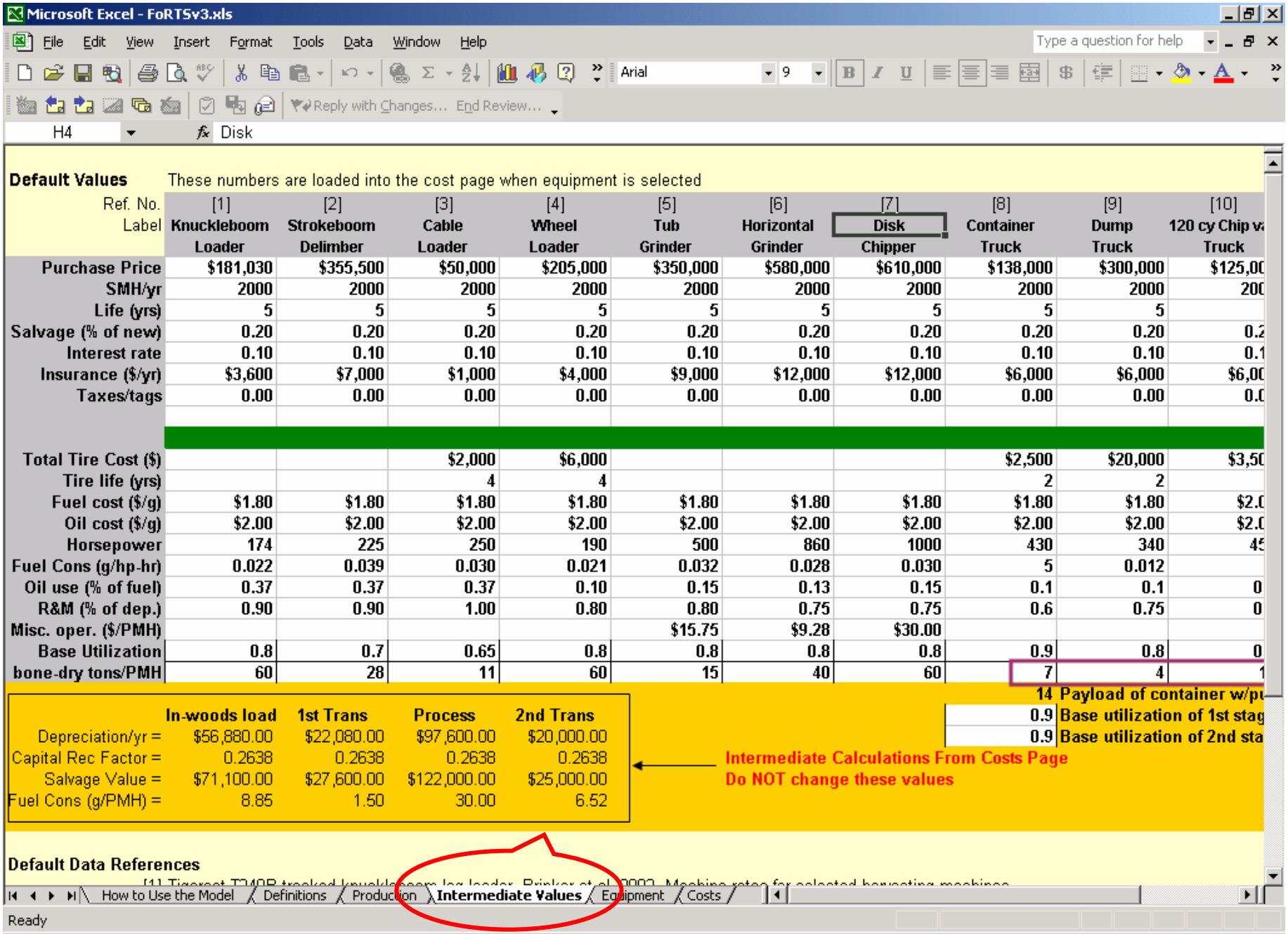
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H4
Disk
Default Values
These numbers are loaded into the cost page when equipment is selected
Ref. No. [1] [2] [3] [4] [5] [6] [7] [8] [9] [10]
Label Knuckleboom Loader | Strokeboom Delimber | Cable Loader | Wheel Loader | Tub Grinder | Horizontal Grinder | Disk Chipper | Container Truck | Dump Truck | 120 cy Chip v
Purchase Price $181,030 $355,500 $50,000 $205,000 $350,000 $580,000 $610,000 $138,000 $300,000 $125,0
SMH/yr 2000 2000 2000 2000 2000 2000 2000 2000 2000 200
Life (yrs) 5 5 5 5 5 5 5 5 5
Salvage (% of new) 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.2
Interest rate 0.10 0.10 0.10 0.10 0.10 0.10 0.10 0.10 0.10 0.1
Insurance ($/yr) $3,600 $7,000 $1,000 $4,000 $9,000 $12,000 $12,000 $6,000 $6,000 $6,0
Taxes/tags 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0
Total Tire Cost ($) $2,000 $6,000 $2,500 $20,000 $3,5
Tire life (yrs) 4 4 2 2
Fuel cost ($/g) $1.80 $1.80 $1.80 $1.80 $1.80 $1.80 $1.80 $1.80 $1.80 $2.0
Oil cost ($/g) $2.00 $2.00 $2.00 $2.00 $2.00 $2.00 $2.00 $2.00 $2.00 $2.0
Horsepower 174 225 250 190 500 860 1000 430 340 4
Fuel Cons (g/hp-hr) 0.022 0.039 0.030 0.021 0.032 0.028 0.030 5 0.012
Oil use (% of fuel) 0.37 0.37 0.37 0.10 0.15 0.13 0.15 0.1 0.1 0
R&M (% of dep.) 0.90 0.90 1.00 0.80 0.80 0.75 0.75 0.6 0.75 0
Misc. oper. ($/PMH) $15.75 $9.28 $30.00
Base Utilization 0.8 0.7 0.65 0.8 0.8 0.8 0.8 0.9 0.8 0
bone-dry tons/PMH 60 28 11 60 15 40 60 7 4 1
14 Payload of container w/p
0.9 Base utilization of 1st stag
0.9 Base utilization of 2nd sta
In-woods load 1st Trans Process 2nd Trans
Depreciation/yr = $56,880.00 $22,080.00 $97,600.00 $20,000.00
Capital Rec Factor = 0.2638 0.2638 0.2638 0.2638
Salvage Value = $71,100.00 $27,600.00 $122,000.00 $25,000.00
Fuel Cons (g/PMH) = 8.85 1.50 30.00 6.52
Intermediate Calculations From Costs Page
Do NOT change these values
Default Data References
How to Use the Model Definitions Production Intermediate Values Equipment Costs
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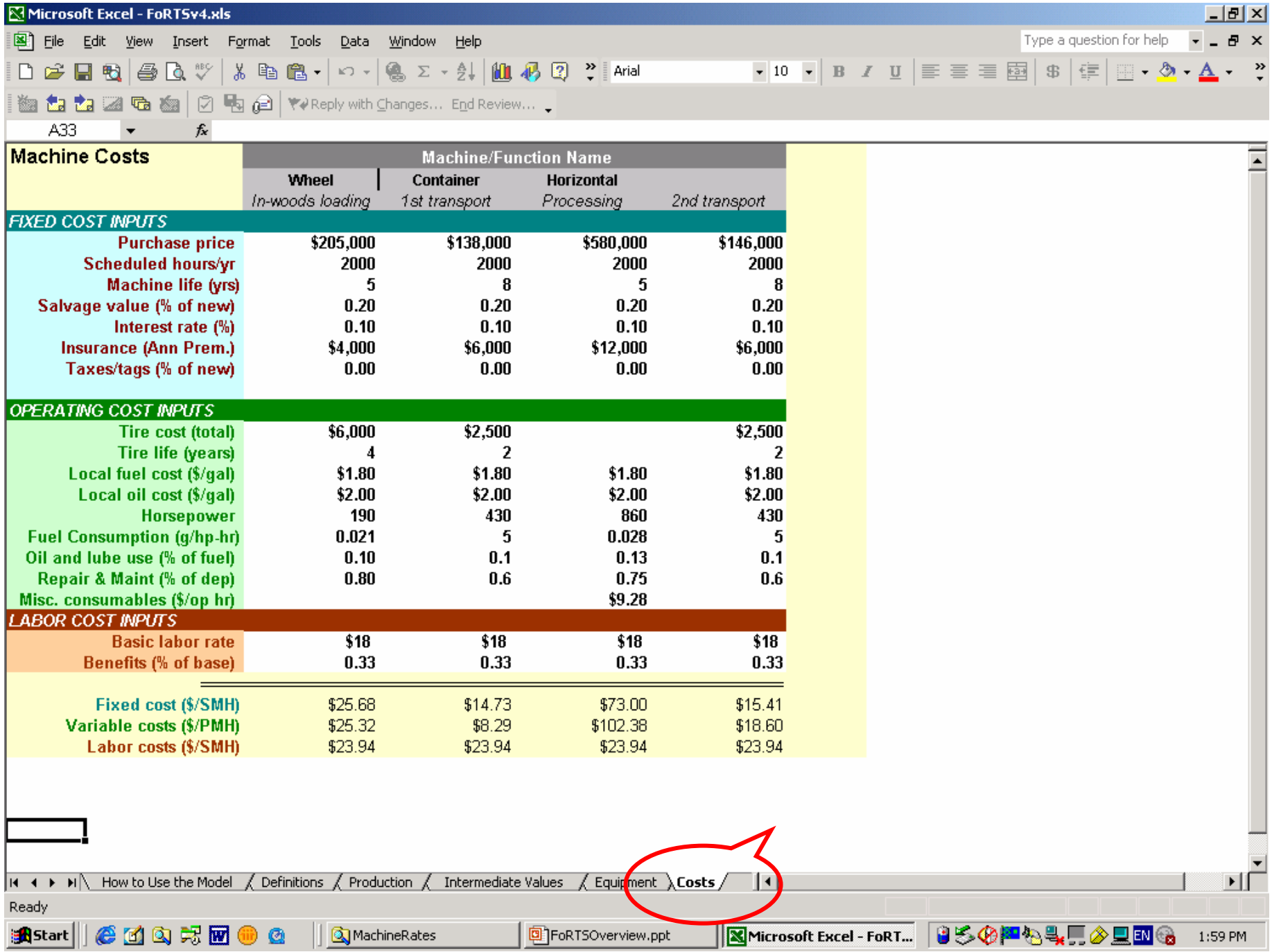
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A33
Machine Costs
Machine/Function Name
Wheel
In-woods loading
Container
1st transport
Horizontal
Processing
2nd transport
FIXED COST INPUTS
Purchase price $205,000 $138,000 $580,000 $146,000
Scheduled hours/yr 2000 2000 2000 2000
Machine life (yrs) 5 8 5 8
Salvage value (% of new) 0.20 0.20 0.20 0.20
Interest rate (%) 0.10 0.10 0.10 0.10
Insurance (Ann Prem.) $4,000 $6,000 $12,000 $6,000
Taxes/tags (% of new) 0.00 0.00 0.00 0.00
OPERATING COST INPUTS
Tire cost (total) $6,000 $2,500 $2,500
Tire life (years) 4 2 2
Local fuel cost ($/gal) $1.80 $1.80 $1.80 $1.80
Local oil cost ($/gal) $2.00 $2.00 $2.00 $2.00
Horsepower 190 430 860 430
Fuel Consumption (g/hp-hr) 0.021 5 0.028 5
Oil and lube use (% of fuel) 0.10 0.1 0.13 0.1
Repair & Maint (% of dep) 0.80 0.6 0.75 0.6
Misc. consumables ($/op hr) $9.28
LABOR COST INPUTS
Basic labor rate $18 $18 $18 $18
Benefits (% of base) 0.33 0.33 0.33 0.33
Fixed cost ($/SMH) $25.68 $14.73 $73.00 $15.41
Variable costs ($/PMH) $25.32 $8.29 $102.38 $18.60
Labor costs ($/SMH) $23.94 $23.94 $23.94 $23.94
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A1 Equipment Selection

Equipment Selection

1st Stage Loading

knuckleboom loader

wheel loader

cable loader

1st Stage Transport

RO container

Off-highway Dump Truck

Processing

Horizontal Grinder with loader

Chipper with loader

Tub Grinder with loader

2nd Stage Transport

RO container w/pup

Chip van 120 cy

Chip van 148 cy

How to Use the Model | Definitions | Production | Intermediate Values | **Equipment** | Costs

Ready

Start | MachineRates | FoRTSOverview.ppt | Microsoft Excel - FoRT... | 2:08 PM

Production and Utilization

- Productive Machine Hours vs. Scheduled Machine Hours

Utilization = PMH/SMH

.75 = 6 PMH/8 SMH

Single axle

Tandem axle

Tri-axle

Tractor-trailer

Chip van

Container Double

Container payloads

- 50 yd bin—tare 8,500#
- Pup trailer—tare 10,000#
- Tractor with hooklift—tare 28,200#

- Legal payload as a single—10,000#
- Legal payload as a double—46,000#

Cubed or Grossed?

- User defines moisture content and SVF, the model calculates green wt/cubic yd
- User defines transport volume capacity and legal payload
- The model checks:
  - If volume * density > legal load (grossed out)
  - If volume * density < legal load (cubed out)

Machine Costing

- Machine Rate—average unit costs over the ownership life of the asset
- Fixed costs accrue on SMH; Variable costs accrue on PMH
- Capital recovery
- Big assumptions: Repair & maint
- Doesn’t include all costs (P&O)

Costs

- Ownership costs: (5 yr, 20% salv)
  - Annual depreciation, IIT

Effect of machine life

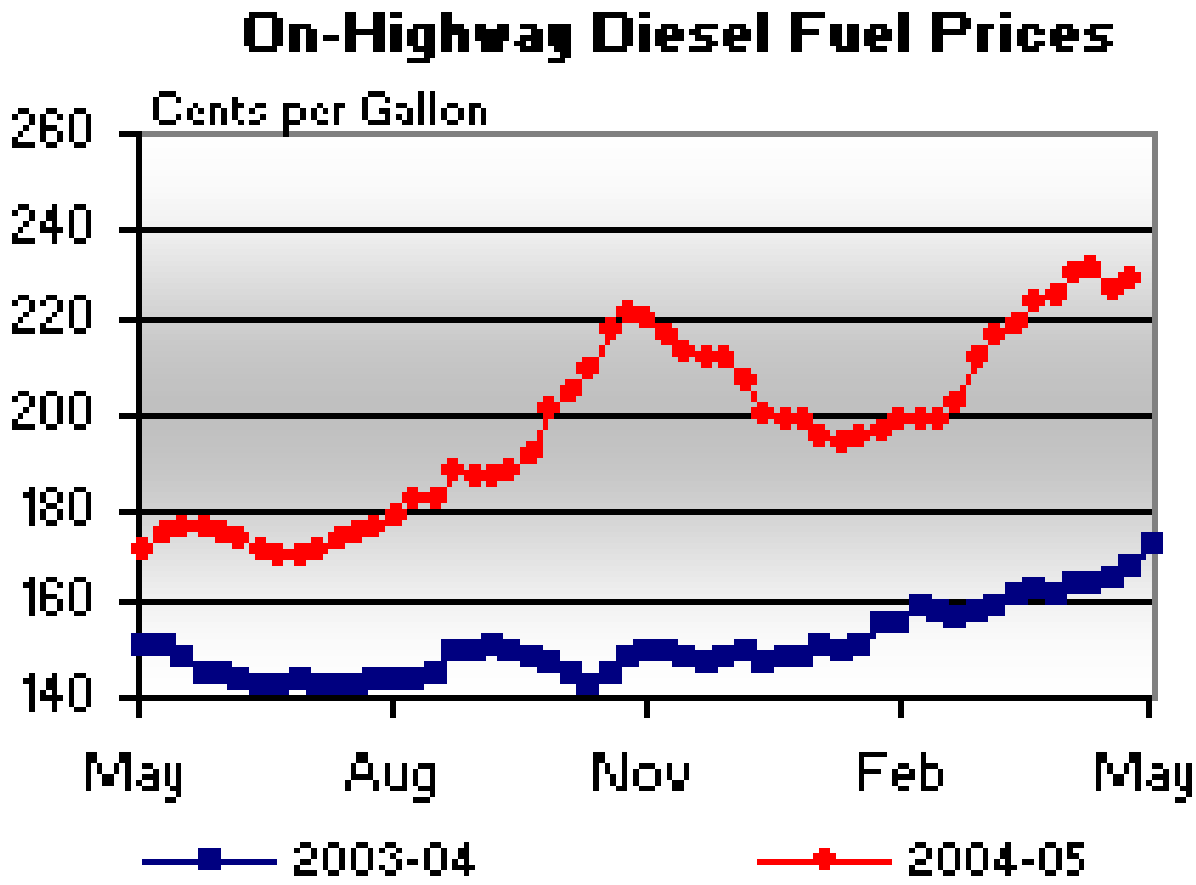
Fuel and Lube

- Fuel consumption for logging machines is based on gal/hp-hr

$$\frac{14 \text{ gal/hr}}{500 \text{ hp}} = 0.028 \text{ gal/hp-hr}$$

- Fuel consumption for trucks is in miles/gal

Petroleum products pricing



System Balancing

- The production of connected pieces is limited by the slowest operation in the system

Loader: 40 tons/PMH

Grinder: 80 tons/PMH

Loader: 36 tons/SMH (90% ut)

Grinder: 36 tons/PMH (50% ut)

www.srs.fs.usda.gov/forestops

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