PROFIT-PC: A Program for Estimating Maximum Net Revenue from Multiproduct Harvests in Appalachian Hardwoods

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ABSTRACT

PROFIT-PC is a menu driven, interactive PC (personal computer) program that estimates optimum product mix and maximum net harvesting revenue based on projected product yields and stump-to-mill timber harvesting costs. Required inputs include the number of trees/acre by species and 2 inches diameter at breast-height class, delivered product prices by species and product type, and haul distance by road class for each product. The product mix that maximizes net revenue is determined by comparing equivalent unit-product values for each species. The user can specify truck type for hauling and select from 10 yarding or skidding machines to estimate stump-to-mill harvesting costs.

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SYSTEM REQUIREMENTS

PROFIT-PC was written in MS-DOS (ver. 3.2) GW-BASIC (ver. 3.21) for an IBM-compatible AT&T 6300[1] personal computer. It should run on all IBM PC, XT, AT, or PS/2 configurations or any true compatibles that run on the MS-DOS operating system. PROFIT-PC should run on the BASIC, BASICA, or GW-BASIC interpreters supplied by MS-DOS. A printer is optional.

PROGRAM FACTS

Maximum number of tree species: 5

Potential forest products: Large sawlogs (USDA-FS grade 3 or better, scaling diameter >10 inches)

Small sawlogs (USDA-FS grade 3 or better, scaling diameter 8-10 inches)

Sawbolts (sawable roundwood suitable for sound cants, but too small or otherwise unsuitable for sawlogs, scaling diameter $\geq$ 6 in.)

Pulpwood-Fuelwood (low quality bolewood 4.0 in. and larger unsuitable for sawbolts)

Possible units of measurement: International 1/4-inch log scale (Mbf), 100 cubic feet (Ccf), green tons (tons)

Number of truck classes considered: 5

[1] The use of trade, firm, or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an offical endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

Number of road classes considered: 5
Potential yarders/skidders considered:

1. Skylok 78 - cable yarder
2. Appalachian thinner - cable yarder
3. URUS 1000-3 - cable yarder
4. Bitterroot - cable yarder
5. Keller K-300 - cable yarder
6. Ecologer I - cable yarder
7. Radio Horse 9 - skidding winch
8. Clearwater - cable yarder
9. John Deere 540B - rubber-tired skidder
10. Berger SY-25 - cable yarder

Program output — provides detailed product volume appraisal, optimal product mix, and gross revenue by product, by species, and totals. A balance sheet shows revenue and costs based on user's choice of available yarders/skidders. A listing of computed basal areas and costs of all yarding methods suitable to the application is also provided.

Application — product yield estimates are derived from yield equations developed from thinnings in central Appalachian hardwood stands. Therefore, results are most reliable when the program is applied to similar stands, that is most trees harvested 17 in. > dbh ≥ 5 in.

PROFIT-PC TERMINOLOGY

Net Equivalent Unit Value — (NEUV), the value used to compare the relative value of products within a species on an equivalent unit basis. Represents market price ($/Ccf) - haul cost ($/Ccf) when market price for product is $/Mbf, market price ($/Ccf) = ((price/Mbf) (Mbf/acre))/(Ccf/acre); where price equals product price, and Mbf/acre and Ccf/acre are the estimated product yields. A similar procedure is applied if market values are expressed in $/ton.

Potential Product Yield — the weight and volume (Mbf/acre, Ccf/acre, tons/acre) estimated for each product/species combination. This estimate assumes that all wood is allocated to the highest quality product regardless of NEUV. Product ranking in descending order of quality is: large sawlogs, small sawlogs, sawbolts, pulpwood. The estimates are based on product volume and weight equations (Baumgras 1984, 1988). Sawlog and sawbolt yields are estimated in board feet, cubic feet, and tons. Pulpwood yields are estimated in cubic feet and tons. For all products, the cubic-foot estimate includes wood and bark.

Marketed Product Mix — the allocation of wood to product classes that maximizes gross revenue at roadside. Within each species, wood is allocated to the product with the greatest NEUV, constrained only by product dimension and quality criteria. This requires that potential product volumes can only be re-allocated to product classes with lower dimensional or quality requirements. For example, small sawlogs can be allocated to sawbolts or pulpwood if the NEUV of these products is greater than the small sawlog NEUV. However, dimension and quality constraints prevent pulpwood from being allocated to sawbolts or sawlogs, or sawbolts from being allocated to sawlogs. The allocation considers roadside values because of potential differences in hauling cost due to product market locations. The allocation proceeds on a species basis because of differences in product prices between species, especially for sawlogs.

Yarding — the program's delay-free estimate of costs associated with operating the chosen logging equipment to harvest the specified stand. The equations use volume/acre, average slope-yarding distance (SYD), and average tree dbh (LeDoux, 1985). A yarder is disqualified

from consideration if a range of acceptable volumes, SYDs, or average dbh for that particular yarder exceeds the respective cost equation limits.

Felling, Bucking and Limbing, and Loading — delay free-cost estimates based on cut-stand parameters.

Hauling — the estimated cost of hauling each product to its respective market destination. Hauling cost is based on the user-specified truck class and mileage for each road class (Table 1).

Delay — a user-supplied cost for harvest-system production delays.

Moving — a user-supplied estimate of the costs for moving in and out and moving initial rig up and down.

PROGRAM OUTLINE

PROFIT-PC has two user phases (Figure 1). In Phase 1, the user is lead through a series of queries to obtain the initial input data. Phase 2 then allows the user to display or print up to 12 output screens and allows for additions, deletions, or editing of individual input items.

Truck Class	Body Type
1	Truck tractor, 6x4, tandem axle with tandem 30-40 foot trailer with additional 15-20 foot trailer
2	Truck tractor, 6x4, tandem axle with tandem trailer
3	Truck tractor, 4x2, single axle with tandem trailer
4	Flat bed, 6x4, tandem axle
5	Flat bed, 4x2, single axle

Road Class	Design Speed(mph)
1	35
2	25
3	16
4	8
5	4

Table 1. Truck and road class specifications.

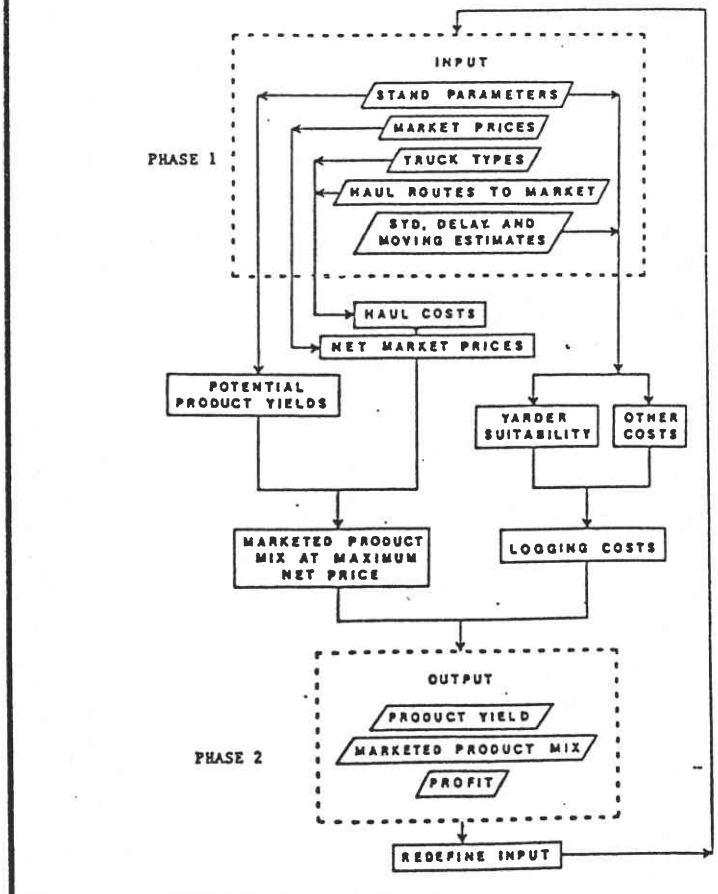

Figure 1. PROFIT-PC information flowchart.

Phase 1

The user will need to supply the following input parameters: number and names of species; number of trees/acre by 2-in. dbh classes and species; market price and unit of measure for each species-product combination; mileage per road and truck classes used for each product; average slope-yarding distance; and moving and delay cost estimates.

The user is queried for this information in a series of displays with brief explanations and variable input limits. There are no more than six queries per display and before progressing to the next display, PROFIT-PC will allow the user to edit the current display. The program also does variable-limit checking and will not allow the user to progress beyond an invalid range. After Phase 1 is completed, a few seconds are allowed for processing the input, then the user control for the main menu is shown.

Phase 2

The user may now choose to view potential product yields, the marketed product mix, and the estimated revenues that consider stump-to-mill costs. As many as five main displays and subdisplays are available, depending on the number of species and products included. A list of available functions and toggle keys is provided on each display. The user may choose to print individual displays using the hardware Print Screen key combination on the computer, or print all output screens by using a special function key provided by PROFIT-PC.

The program also provides submenus, accessible from the main menu, that provide functions to add or delete species or manipulate current input data. The user can experiment with different input combinations.

Application Sample

Consider the following cut-stand table, product-price matrix, and haul routes as shown in Tables 2 - 4.

Tree dbh	Species 1	Species 2	Species 3
--inches--	----------Trees/acre----------		
<= 4.9	0	0	0
5.0 - 6.9	3	2	1
7.0 - 8.9	5	3	3
9.0 - 10.9	7	4	4
11.0 - 12.9	10	10	2
>= 13.0	8	7	3

Table 2. Cut-stand table for sample application.

Product	Prices		
	Species 1	Species 2	Species 3
Large sawlogs	$220/Mbf	$180/Mbf	$150/Mbf
Small sawlogs	$150/Mbf	$120/Mbf	$115/Mbf
Sawbolts	$55/Ccf	$55/Ccf	$55/Ccf
Pulpwood-fuelwood	$12/ton	$12/ton	$12/ton

Table 3. Product price matrix for sample application.

Product	Haul distance by road class				
	1	2	3	4	5
	----------Miles----------				
Large sawlogs	10	12	1	0	1
Small sawlogs	10	12	1	0	1
Sawbolts	22	19	1	0	1
Pulpwood-fuelwood	15	0	1	0	1

Table 4. Haul routes for sample application.

This information is entered in Phase 1, where Truck Class 1 and the average slope-yarding distance (800) feet is also specified. This sample application does not include delay or moving costs.

PROFIT-PC then projects the income from harvesting the sample acre with the Clearwater yarder (Figure 2).

Total revenue	$1,168.93
Total hauling	165.37
Clearwater yarding	251.48
Felling, bucking, limbing	293.33
Loading	86.96
Delay	0.00
Moving	0.00
Projected profit	$ 348.77

Figure 2. Income-from-harvesting screen.

Product	Potential product yields - all species		
	Mbf/acre	Ccf/acre	Tons/acre
Large sawlogs	3.19	6.34	18.75
Small sawlogs	1.25	2.78	8.22
Sawbolts	1.56	3.90	11.53
Pulpwood-fuelwood	NA	4.84	14.31
Total	5.99	17.84	52.81

Figure 3. Potential product-yield screen.

Product	Product Mix			Gross Revenue	Haul Cost	Gross Revenue at Roadside
	Mbf/ acre	Ccf/ acre	Tons/ acre	$/acre	$/acre	$/acre
Large sawlog	3.19	6.34	18.75	617.13	61.07	556.05
Small sawlogs	1.25	2.78	8.22	165.56	26.83	138.73
Sawbolts	1.56	3.90	11.53	214.69	56.73	157.95
Pulpwood-fuelwood	NA	4.84	14.30	171.56	20.73	150.83
Total	5.99	17.89	52.81	$1,168.93	$165.37	$1,003.57

Figure 4. Marketed product-mix screen (marketed product mix, gross revenue, haul cost, and gross roadside revenue). Gross revenue = volume x delivered price. Gross roadside revenue = gross revenue - haul cost.

The potential product-yield screen (Figure 3) shows the product yields with all wood allocated to the highest quality products. The marketed product-mix screen (Figure4) shows the product mix that maximizes gross value at roadside and gross profits. The maximizing of gross profit is based only on net, or delivered prices minus haulcosts. Other harvesting costs are unaffected by product mix, being a function of cutstand parameters, yarding distance, and the selected yarder. Projected profit equals value at roadside minus stump-to-truck harvesting costs, and can be viewed in other output screens. In this case, prices and hauling costs are such that the available product mix equals the marketed mix.

Suppose the user chooses the Alter Study Data menu option and alters the variables shown in Table 5 for the preceding application.

With these new modified values, potential product yields remain unchanged, but all saw-

	Old Value	New Value
Haul miles on road		
Class 1 - small sawlogs	10	25
Market price for pulpwood-fuelwood in all species	$12/ton	$16/ton

Table 5. Modified program variables for sample application.

bolt-quality material is allocated to pulpwood-fuelwood due to the increase in pulpwood prices (Figure 5). Most small sawlog volume is also allocated to pulpwood-fuelwood as a combined result of the price increase for pulpwood-fuelwood, and the added haul distance and haul cost for small sawlogs. The only small sawlogs marketed are those in Species 1, which are priced high enough that the net price exceeds the pulpwood-fuelwood NEUV.

FUTURE VERSIONS

Future versions of PROFIT-PC, already in planning, will provide graphic capabilities and explore ways to describe the sample acre. The use of higher level programming languages will improve execution speed and versatility of the program.

CONTACT

PROFIT-PC is available on request with the understanding that the Forest Service, U.S. Department of Agriculture, cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program. For further information, write: Chris B. LeDoux, USDA Forest Service, Northeastern Forest Experiment Station, P.O. Box 4360, Morgantown, WV 26505. Send a blank double-sided, double density 5.25 inch floppy disk. Comments and suggestions are welcome.

Product	Product Mix			Gross Revenue	Haul Cost	Gross Revenue at Roadside
	Mbf/ acre	Ccf/ acre	Tons/ acre	$/acre	$/acre	$/acre
Large sawlog	3.19	6.34	18.75	617.13	61.07	556.05
Small sawlogs	0.57	1.27	3.77	85.28	14.51	70.77
Sawbolts	0.00	0.00	0.00	0.00	0.00	0.00
Pulpwood-fuelwood	NA	10.26	30.28	484.49	43.94	440.55
Total	3.76	17.86	52.81	$1,186.89	$119.52	$1,067.37

Figure 5. Marketed product-mix and gross revenues for modified conditions for the sample application.

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