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B780: A Cost Analysis of Pruning Procedures in Lowbush Blueberry Production

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Eric J. Hanson, Amr A. Ismail and Homer B. Metzger[1]

SUMMARY

Burning fields with fuel oil is currently the most practical method of pruning blueberries but is costly and destructive to the organic material on the surface of the soil. Fuel oil is a nonrenewable resource that is rapidly increasing in cost and, in the future, may become less readily available for this use. The need to develop alternative means of pruning lowbush bleuberries is evident. This bulletin compares the economics of six pruning procedures on operations of three sizes. The budgets are based on certain assumptions and costs which will change over time. The results will allow blueberry growers to compare procedures to determine which one is most economically feasible for their particular operation and its resources.

A cost analysis was constructed for these pruning procedures: 1) straw burning, spreading straw manually; 2) straw burning, spreading straw mechanically; 3) oil burning using the conventional burner head; 4) oil burning using the economy burner head; 5) oil burning using the Bosse' burner head; and 6) flail mowing. The budgets were constructed for three sizes of blueberry operations: 1) 10 acres; 2) 100 acres; and 3) 1000 acres. Included in the calculations were both fixed costs which are associated with ownership of equipment and are constant over all operations and variable costs which are due to fuel, labor, and replacement parts which vary with the amount of use.

Total costs per acre for straw burning with manual spreading ranged from $109.06 for a 10 acre operation to $87.40 for a 1000 acre operation. No initial investment is required, but labor requirements are high at 11.3 man-hours per acre. This operation would be most attractive to smaller growers with limited capital. Use of mechanical spreading of the straw increases the fixed cost at the 10 acre

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level to give a total cost per acre of $161.27 but at the 1000 acre level it is reduced to $66.05 per acre. The labor requirements of mechanical versus manual are much less at 2.95 man-hours per acre, but the initial investment is higher at $18,275. This procedure would be more attractive to larger growers or a group of smaller growers.

Oil burning costs per acre on a 100 acre operation were reduced from $102.70 to $77.45 to $63.63 using the conventional, economy, or Bosse' burner heads respectively. This reduction in costs is due to an increase in efficiency in the operations of the burner head resulting in less fuel burned and a lower variable cost. Due to the fixed costs, burning is more expensive per acre on the 10 acre operation and lower on the 1000 acre operation, but the burner heads showed the same trend in cost reduction. Initial investment for the equipment is high at approximately $20,000 and labor requirements were constant at 2.43 man-hours per acre.

Flail mowing is the least expensive procedure on all 3 operations at $86.36 per acre for 10 acres, $20.78 per acre for 100 acres and $13.85 per acre for a 1000 acre operation. It had the lowest labor requirement at 1.3 man-hours per acre. The initial investment is $17,000 which is lower than all other alternatives except for manual spreading of straw which has no initial investment. Flail mowing will provide the least expensive means of pruning on relatively smooth blueberry land.

INTRODUCTION

Maine produces an average of 18 million pounds of lowbush blueberries annually (4), representing nearly 50% of the entire North American lowbush blueberry production (3). The industry provides an important source of income for growers, pickers, and processors in some of the most economically depressed rural areas of the state.

Lowbush blueberries are presently pruned biennially by prescribed burning. Burning has a pollarding effect on blueberry plants, stimulating stem proliferation and berry production. "Free burns" were originally employed where natural grasses and brush were sufficiently dense to carry the fire across the field (7). Growers later spread hay or straw over blueberry ground before burning. This served

to fuel the fire, and provided a more uniform and thorough burn (7). The introduction of fuel oil burners in the late 1940s provided growers with a faster, more economical method of pruning blueberries (7). Oil burning is the most commonly practiced pruning procedure, and is employed on an estimated 80% of Maine's commercial blueberry acreage (9). Maine blueberry growers use an estimated 1,000,000 gallons of fuel oil annually to prune approximately 25,000 acres (5).

Recent increases in fuel oil prices have raised some doubt as to the feasibility of oil burning in the future. This has prompted efforts to reduce the amount of fuel consumed in pruning blueberries. Equipment has been modified to improve the efficiency of current burning operations. Two efficient oil burner heads were recently developed (5). The Economy burner head consumes substantially less fuel than the traditional conventional head. The Economy version utilizes two nozzles to more effectively disperse the flame, for greater fuel efficiency. The Bosse' burner head was recently developed in Quebec, and shows considerable promise for a more efficient operation. Its unique design allows for an even greater control of flame dispersal and more complete combustion of fuel (2) than achieved with other heads. The purchase price of both heads is higher than that of the conventional burner head, but the savings in fuel oil could more than compensate for the price differential. It should be pointed out that neither the Economy nor the Bosse' head has been thoroughly evaluated in the field, and the equipment specifications accepted today may be modified in the future.

A flail mowing system has been demonstrated as a practical alternative to burning (6). Blueberry yields from flail mowed plants did not differ significantly from those obtained from fire pruned plants. Mowing eliminates the fuel requirements of burning, and in the long run may also have beneficial effects by periodically returning organic matter to the soil as a mulch. This may gradually reverse the degenerative effect of long-term burning on soil organic matter and field productivity (11).

Rising fuel oil costs have rekindled interest in straw burning. The mechanization of straw spreading will greatly facilitate this practice by reducing the cost of spreading straw.

These recent developments in pruning procedures have provided growers with several alternatives. The purpose of this study is to investigate the economic aspects of six pruning methods. The findings will aid growers in choosing a pruning procedure appropriate for their needs.

METHODS

Budgets have been constructed for each of six pruning procedures:

1) Straw burning, spreading straw manually.
2) Straw burning, spreading straw mechanically.
3) Oil burning using the conventional burner head.
4) Oil burning using the Economy burner head.
5) Oil burning using the Bosse' burner head.
6) Flail mowing.

Budgets were constructed for blueberry operations of three different sizes: 10, 100, and 1000 acres. Included were all costs involved in each pruning operation. These have been partitioned into two categories:

1) Fixed costs, which are associated with ownership of equipment.
2) Variable costs of fuel consumption, labor, and replacement parts which are associated with the amount of use.

The costs of another management operation directly affected by the pruning procedure employed has also been considered. Mowing to remove woody weed stems before burning is practiced on most commercial fields (9). Because flail mowing to prune will also effectively accomplish this purpose, weed mowing is included as a cost in all pruning by burning procedures.

All costs are based on certain average or standard conditions. They approximate the conditions facing most growers. All costs are presented on a per acre basis and are based on June, 1980 prices. Calculations are found in Appendices I through VII.

Weed Mowing

The following standard conditions were assumed to calculate the costs of the weed mowing operation:

1) A 6 ft. rotary mower is used, with a 3-point hitch and a

slip clutch, at a field speed of 2 mph. (Price $1275).

2) One man is required for the mowing operation, at a rate of $4.00/hr.

3) The mower is drawn by a 35-49 drawbar HP tractor.

Straw Burning

Cost assessment of straw burning is complicated by the extreme variability in burning techniques, labor circumstances, and field conditions. Various combinations of hay, straw, and oil are commonly used (9). Labor may include family members or hired help. Recognizing these variations, the following conditions were assumed:

1) Price per bale of straw (delivered to the field) = $1.20/bale.

2) Straw requirement = 30 bales/acre.

3) All labor is hired, equipment operator at $4.00/hr. and others at $3.00/hr.

4) Three men are required for the actual burning operation, and the field will be burned at a rate of 10 acres/hr.

5) One water truck is required for fire control at a rate of $10.00/day. Truck is required for 1 day to burn a 10 acre operation, 2 days to burn a 100 acre operation, and 20 days to burn a 1000 acre operation.

6) Straw is spread manually at a rate of 11 man-hours/acre.

7) Straw is spread mechanically by a straw spreader costing $4,000, mounted on a flat-bed trailer costing $1,000 and hydraulically powered off the tractor P.T.O. Three men are required, 1 skilled at $4.00/hr., and 2 unskilled at $3.00/hr. The spreader will cover a swath width of 12 ft., at a field speed of 2 mph.

8) The straw spreader is pulled by a 35-49 drawbar HP tractor, at a price of $12,000. The average annual use (AAU) of the tractor is estimated at 200 hrs. on a 10 acre operation, 300 hrs. on a 100 acre operation, and 400 hrs. on a 1000 acre operation. The tractor fuel consumption is 2.61 gallons/hr (1). These tractor specifications hold for all pruning procedures requiring a tractor.

Figure 1. Straw spreading equipment.

Oil Burning

The standard conditions assumed for each of the three oil burning procedures are identical, with the exception of burner costs and fuel oil consumption. The following standard conditions were assumed:

1) The PBX model Woolery burner is used for conventional oil burning, with a fuel consumption of 150 gal/hr, (price $6500).
2) The PBE model Woolery burner is used for the economy oil burning procedure, with a fuel consumption of 90 gal/hr, (price $6500).
3) The PBE model Woolery burner, with three Bosse' burner heads, is used for the Bosse' burning procedure, with a fuel consumption of 60 gal/hr, (price $7000).
4) Fuel oil price = $1.10/gal.
5) Burners are drawn by a 35-49 drawbar HP tractor, at a field speed of 2 mph, burning a swath of 15 ft.
6) A crew of 3 men is required for the burning operation, 1 skilled at $4.00/hr, and 2 unskilled at $3.00/hr.

7) One water truck and one oil truck are required for the burning operation, each at $10.00/day. Trucks are required for 1 day to burn 10 acres, 2 days to burn 100 acres, and 20 days to burn 1000 acres.

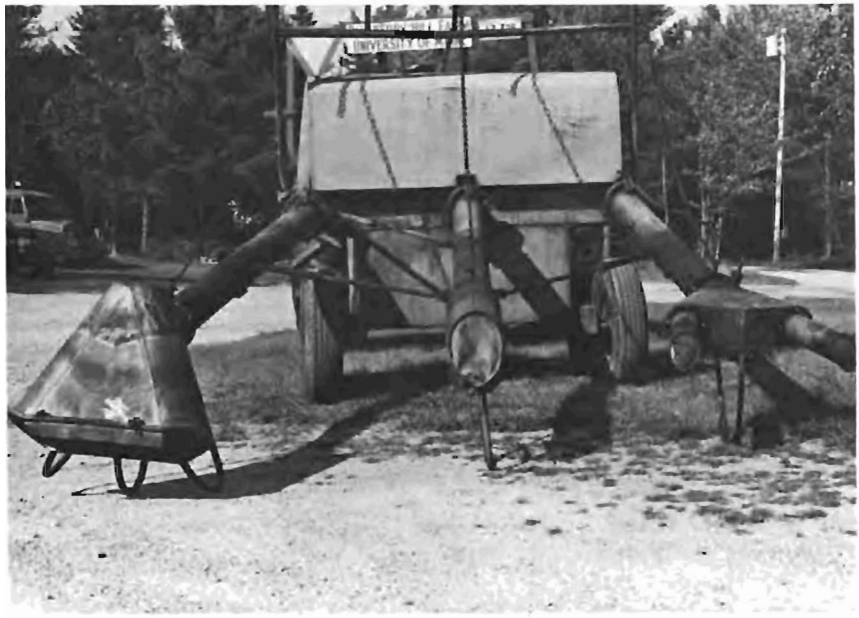

Figure 2. Oil burner with Bosse', Conventional and Economy heads respectively.

Flail Mowing

The following conditions were assumed for the flail mowing procedure:

1) A gang of three 38 inch flail mower heads, powered by individually mounted hydraulic motors, with a swath width of 9 ft., drawn at a field speed of 2 mph, will be used (price $5000).
2) Two men are required for the mowing operation, one at $4.00/hr, and one at $3.00/hr.
3) A set of 72 knife blades will be replaced after mowing 50 acres, (cost $25.00/set).
4) Mowers will be drawn by a 35-49 drawbar HP tractor.

Figure 3. Flail Mower.

RESULTS

Costs of Burning With Straw Spread Manually, (Table 1).

Most apparent were the high total variable costs accompanied by relatively low total fixed costs. The variable operation costs remain constant, and were unaffected by the operation size. In contrast, the fixed costs of equipment ownership were spread over a greater number of acres as the operation size increases. Accordingly, the total fixed costs declined as the operation size increased, from $24.59/A on a 10 acre operation, to $2.93/A on a 1000 acre operation. Nearly all of these fixed costs were attributed to equipment required for the weed mowing operation. The labor cost of spreading straw manually, at $33.00/A, accounted for 39% of the total variable costs. The total costs of burning with straw spread manually was $109.06/A, $89.91/A and $87.40/A on the 10, 100, and 1000 acre operations respectively.

Table 1. Costs Per Acre of Straw Burning, Spreading Straw Manually.*

	Operation size		
	10 A	100 A	1000 A
Variable costs			
Straw	$ 36.00	$36.00	$36.00
Labor - spreading straw	33.00	33.00	33.00
Labor - burning operation	0.90	0.90	0.90
Labor - weed mowing	4.72	4.72	4.72
Tractor - weed mowing	9.10	9.10	9.10
Rotary mower	0.75	0.75	0.75
Total variable costs	$ 84.47	$84.47	$34.47
Fixed costs			
Water truck	$ 1.00	$ 0.20	$ 0.20
Tractor - weed mowing	5.08	3.39	2.54
Rotary mower	18.51	1.85	0.19
Total fixed costs	24.59	5.44	2.93
Total cost/A	$109.06	$89.91	$87.40

*Cost calculations are in Appendices I and II.

Costs of Burning With Straw Spread Mechanically, (Table 2).

Variable costs totaled $61.34/A on all operation sizes. Nearly 60% of this, or $36.00/A, was the cost of the straw. The total fixed costs were very high on the 10 acre operation, at $99.93/A, but declined to $14.17/A on the 100 acre operation, and to $4.71/A on the 1000 acre operation. The total cost per acre of burning straw spread mechanically was $161.27/A on a 10 acre operation, $75.51/A on a 100 acre operation, and $66.05/A on a 1000 acre operation.

Costs of Oil Burning With Conventional Burner Heads, (Table 3).

Total variable costs were high, at $86.53/A. Seventy-five percent of this total, or $64.51/A, is attributed to fuel oil consumption alone. Total fixed costs were very high on the 10 acre operation, at $120.65/A. As the operation size increases, these fixed costs were spread over a greater number of acres and were reduced

substantially. The total cost was $207.18/A on a 10 acre operation, $102.70/A on a 100 acre operation, and $92.21/A on a 1000 acre operation.

Table 2. Costs Per Acre of Straw Burning Spreading Straw Mechanically*.

	Operation size		
	10 A	100 A	1000 A
Variable costs			
Straw	$36.00	$36.00	$36.00
Straw spreader	0.98	0.98	0.98
Trailer for spreader	0.20	0.20	0.20
Tractor - straw spreading	3.79	3.79	3.79
Tractor - weed mowing	9.10	9.10	9.10
Rotary mower	0.75	0.75	0.75
Labor - spreading operation	4.90	4.90	4.90
Labor - burning operation	0.90	0.90	0.90
Labor - weed mowing	4.72	4.72	4.72
Total variable costs	$61.34	$61.34	$61.34
Fixed costs			
Water truck	$ 1.00	$ 0.20	$ 0.20
Straw spreader	57.39	5.74	0.57
Trailer	15.84	1.58	0.16
Tractor - straw spreading	2.11	1.41	1.05
Tractor - weed mowing	5.08	3.39	2.54
Rotary mower	18.51	1.85	0.19
Total fixed costs	99.93	14.17	4.71
Total cost/A	$161.27	$75.51	$66.05

*Cost calculations are in Appendices I and IV.

Costs of Oil Burning With Economy Burner Heads, (Table 4).

All costs were identical with those calculated for conventional oil burning, with one exception. The greater fuel efficiency of the Economy burner heads resulted in variable burner costs of $39.26/A. The total costs per acre of burning with Economy heads were $181.93/A on a 10 acre operation, $77.45/A on a 100 acre operation, and $66.96/A on a 1000 acre operation.

Table 3. Costs Per Acre of Oil Burnings With Conventional Heads*.

	Operation size		
	10 A	100 A	1000 A
Variable costs			
Tractor - burning operation	$ 3.25	$ 3.25	$ 3.25
Tractor - weed mowing	9.10	9.10	9.10
Burner	64.51	64.51	64.51
Rotary weed mower	0.75	0.75	0.75
Labor - burning	4.20	4.20	4.20
Labor - weed mowing	4.72	4.72	4.72
Total variable costs	$86.53	$86.53	$86.53
Fixed costs			
Tractor - burning	$ 1.80	$ 1.20	$ 0.90
Tractor - weed mowing	5.08	3.39	2.54
Burner	93.26	9.33	0.93
Rotary mower	18.51	1.85	0.91
Water truck	1.00	0.20	0.20
Oil truck	1.00	0.20	0.20
Total fixed costs	120.65	16.17	5.68
Total costs/A	$207.18	$102.70	$92.21

*Cost calculations are in Appendices I and IV.

Costs of Oil Burning With Bosse' Burner Heads, (Table 5).

The fuel efficiency of the Bosse' equipment lowered the variable burner cost to $26.73/A. The total fixed costs were high on the 10 acre operation, at $26.73/A, but declined as the number of acres increased, to $5.75/A on the 1000 acre operation. The total costs were $176.54/A, $65.63/A, and $54.50/A, on the 10, 100, and 1000 acre operations respectively.

Table 4. Costs Per Acre of Oil Burning With Economy Heads.*

	Operation size		
	10 A	100 A	1000 A
Variable costs			
Tractor - burning	$ 3.25	$ 3.25	$ 3.25
Tractor - weed mowing	9.10	9.10	9.10
Burner	39.26	39.26	39.26
Rotary weed mower	0.75	0.75	0.75
Labor - burning	4.20	4.20	4.20
Labor - weed mowing	4.72	4.72	4.72
Total variable costs	$61.28	$61.28	$61.28
Fixed costs			
Tractor - burning	$ 1.80	$ 1.20	$ 0.90
Tractor - weed mowing	5.08	3.39	2.54
Burner	93.26	9.33	0.93
Rotary mower	18.51	1.85	0.91
Water truck	1.00	0.20	0.20
Oil truck	1.00	0.20	0.20
Total fixed costs	120.65	16.17	5.68
Total cost/A	$181.93	$77.45	$66.96

*Cost calculations are in Appendices I and V.

Table 5. Costs Per Acre of Oil Burning With Bosse' Heads*.

	Operation size		
	10 A	100 A	1000 A
Variable costs			
Tractor - burning	$ 3.25	$ 3.25	$ 3.25
Tractor - weed mowing	9.10	9.10	9.10
Burner	26.73	26.73	26.73
Rotary weed mower	0.75	0.75	0.75
Labor - burning	4.20	4.20	4.20
Labor - weed mowing	4.72	4.72	4.72
Total variable costs	$48.75	$48.75	$48.75
Fixed costs			
Tractor - burning	$ 1.80	$ 1.20	$ 0.90
Tractor - weed mowing	5.08	3.39	2.54
Burner	100.40	10.04	1.00
Rotary mower	18.51	1.85	0.91
Water truck	1.00	0.20	0.20
Oil truck	1.00	0.20	0.20
Total fixed costs	127.79	16.88	5.75
Total cost/A	$176.54	$65.63	$54.50

*Cost calculations are in Appendices I and VI.

Costs of Pruning by Flail Mowing, (Table 6).

Flail mowing did not require the straw or oil of burning procedures, which resulted in a lower total variable cost at $11.73/A. Total fixed costs were highest on the 10 acre operation, at $74.63/A, but substantially lower as the operation size increased. Total costs range from $86.36/A on the 10 acre operation, to $20.78/A on the 100 acre size, and to $13.85/A on the 1000 acre operation.

Table 6. Costs Per Acre of Flail Mowing.*

	Operation size		
	10 A	100 A	1000 A
Variable costs			
Tractor - flail mowing	$ 5.05	$ 5.05	$ 5.05
Mower	1.63	1.63	1.63
Labor	4.55	4.55	4.55
Replacement blades	0.50	0.50	0.50
Total variable costs	$11.73	$11.73	$11.73
Fixed costs			
Tractor	$ 2.80	$ 1.87	$ 1.40
Mower	71.83	7.18	0.72
Total fixed costs	74.63	9.05	2.12
Total cost/A	$86.36	$20.78	$13.85

*Cost calculations are in Appendices I and VII.

DISCUSSION

Each grower is confronted with different financial, labor and field conditions under which he must operate. Selection of the most appropriate pruning technique must be an individual decision for each grower, based on the size of his operation and resources. The six pruning procedures may be compared based on total costs presented in Table 7. The labor requirements and initial investments reported in Table 8 will also help in evaluating pruning procedures for a particular operation. Initial investment costs include the price of all equipment required to implement a pruning procedure.

Table 7. Comparison of Total Costs of Pruning.

Pruning technique	Operation size 10 A	100 A	1000 A
Straw burning - manual spreading	$109.06	$ 89.91	$ 87.40
Straw burning - mechanical spreading	161.27	75.51	66.05
Oil burning - conventional heads	207.18	102.70	92.21
Oil burning - economy heads	181.93	77.45	66.96
Oil burning - Bosse' heads	176.54	65.63	54.50
Flail mowing	86.36	20.78	13.85

Table 8. Labor Requirements and Initial Investments.

Pruning procedure	Labor requirements (man-hours/acre)	Initial Investment
Burning straw - spread manually	11.30	$0.00
Burning straw - spread mechanically	2.95	$18,275.00
Oil burning - conventional heads	2.43	$19,775.00
Oil burning - economy heads	2.43	$19,775.00
Oil burning - Bosse' heads	2.43	$20,275.00
Flail mowing	1.30	$17,000.00

Small growers with less than 50 acres are faced with the problem of justifying the purchase of expensive equipment for use on relatively few acres. Purchase of oil burning equipment would not be feasible. Flail mowing is the least expensive, at $86.36/acre, as well as the least time consuming, at 1.30 man-hours/acre, of any pruning technique considered. If sufficient capital is available to cover the initial investment of $17,000.00, and the field terrain is smooth enough to accomodate flail mowing, a small grower may find this a feasible pruning technique.

At $109.06/acre, burning straw spread manually may also be feasible on a small operation of 10 acres. The equipment requirement to burn straw spread manually is small and initial investment and annual fixed costs are consequently minimal. This is encouraging to the small grower, because available capital is often limited

on a small enterprise, making initial investments and annual costs of prime concern. The large 11.3 man-hours/acre labor requirement of burning straw spread manually should not be limiting on a small operation, where often family help may reduce labor expenditures. Contracting services from larger growers may still be the most economical means of pruning on a small enterprise. The information provided here will hopefully allow growers to evaluate all possible alternatives in light of contracting costs.

Growers managing larger operations may find it easier to justify purchase of pruning equipment. On the 100 acre operation size, fixed equipment costs are spread over a greater number of acres, and total costs of implementing mechanized pruning procedures are considerably lower than on a 10 acre operation. The mechanical straw spreader reduced the manual straw spreading cost by 18%, for a savings of $14.40/A. Oil burning with the Bosse' head is the least expensive burning technique, at $65.63/acre. Flail mowing, at $20.78/A, is the least expensive of all procedures and would be economically justified on any intermediate size operation where field conditions will permit its use.

Growers managing larger acreages of relatively smooth blueberry land are in a position to take full advantage of flail mowing. At a total cost of $13.85/acre, flail mowing is the least expensive procedure. The initial capital investment of flail mowing should be less restricting on a large enterprise, and the low labor requirement may facilitate more efficient personnel scheduling and management. The two least expensive burning techniques on a 1,000 acre operation are oil burning with the Bosse' heads, at $54.50/acre, and burning straw spread mechanically, at $66.04/acre. Both of these are substantially less costly than oil burning with conventional equipment. Straw burning may have the advantage of adding nutrients contained in the straw to the soil (10).

No attempt has been made here to compare expected yields under these pruning procedures. Predicting yields based on experimental results is difficult, as productivity varies enormously from year to year, from field to field, and among different locations within a field.

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APPENDIX I

Weed Mowing

Variable Costs

1. Tractor - (FC)(FP) + (OC)(OP) + (RMF)(NP) = cost/hr
   (2.61gal/hr)($1.10/gal) + (0.012gal/hr)
   ($4.40/gal) + (0.0004) ($12,000.00) = $7.72/hr

   FC = fuel consumption = 2.61 gal/hr (1)
   FP = fuel price $1.10/gal.
   OC = oil consumption = 0.012 gal/hr.
   OP = oil price - $4.40/gal.
   RMF = repairs and maintenance factor = 0.0004 (1)
   NP = new price = $12,000.00

   Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
   = ($7.72/hr)(8.25)/(2mph)(5 ft)(0.7) = $9.10/A

   8.25 = conversion factor
   FS = field speed = 2 mph
   SW = swath width = 12 feet
   FE = field efficiency, estimate of maneuverability
   = 0.7

2. Rotary mower - Cost/hr = (FC)(FP) + (OC)(OP) + (RMF)(NP)
   = (0)($1.10/gal) + (0)($4.40/gal)
   + (0.0005)($1275) = (0.64/hr

   Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
   = ($0.64/hr)(8.25)/(2mph)(5 ft)(0.7) = $0.75/A

3. Labor - (1 man)($4.00/hr)(1.18hr/A) = $4.72/A

Fixed Costs

1. Tractor - (NP-SV)/(L) + (0.097)(A) + (RIT)(AI) + (I)(AI) =
   annual cost
   ($12,000 - 1200)/(10 years) + (0.097)(92 sq.ft)
   + (1.75%)($5,400) + (10%)($5,400) = $1723.42/year

   NP = new price = $12,000
   SV = salvage value = 10% of new price
   L = life expectancy = 10 years
   0.097 = cost per sq.ft. of shelter space (1)
   A = shelter space required = 92 sq.ft.
   RIT = rate of insurance and taxes = 1.75% (1)
   AI = average investment = (NP - SV)/(2)
   I = interest rate = 10%

2. Rotary mower - (NP - SV)/(L) + (0.097)(A) + (RIT)(AI) + (I)(AI) = annual cost
($1275 - $127.50)/(10 years) + (0.097)(30ft) + (1.75%)($573.75) + (10%)($573.75) = $185.07/year

Cost/A = (annual cost)/(acres in operation)

10 acre operation - ($185/yr)/(10 acres) = $18.51/A
100 acre operation - ($185/yr)/(100 acres) = $1.85/A
1000 acre operation - ($185/yr)/(1000 acres) = $0.19/A

APPENDIX II

Cost Calculations - Burning Straw Spread Manually

Variable Costs

1. Straw costs - (30 bales/A)($1.20/bale) = $36.00/A
2. Labor costs to spread straw - ($3.00/hr)(11 hr/A) = $33.00/A.
3. Labor costs to burn - (3 men)($3.00/hr)/(10 A/hr) = $0.90/A.

Fixed Costs

1. Water truck: 10 acre operation - ($10.00/day)(1 day)/(10 acres) = $1.00/A.
100 acre operation - ($10.00/day)(2 days)/(100 acres) = $0.20/A.
1000 acre operation - ($10.00/day)(20 days)/(1000 acres) = $0.20/A.

APPENDIX III

Cost Calculations - Burning Straw Spread Mechanically

Variable Costs

1. Straw cost - Identical to the straw costs calculated in Appendix II.

2. Straw spreader - (FC)(FP) + (OC)(OP) + (RMF)(NP) = cost/hr.
(0)($1.10/gal.) + (0)($4.40/gal) + (0.0005)($4,000.00) = $2.00/hr.

FC = fuel consumption = 0
FP = fuel price = $1.10/gal.
OC = oil consumption = 0
OP = oil price = $4.40/gal.
RMF = repairs and maintenance factor = 0.0005
NP = new price = $4,000.00

Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
= ($2.00/hr)(8.25)/(2mph)(12 feet)(0.7) = $0.98/A.

8.25 = conversion factor
FS = field speed = 2 mph
SW = swath width = 12 feet
FE = field efficiency, estimate of maneuverability
= 0.7

3. Trailer - (FC)(FP) + (OC)(OP) + (RMF)(NP) = cost/hr
(0)($1.10/gal) + (0)($4.40/gal)
+ (0.004)($1,000.00) = $0.40/hr.

FC = fuel consumption = 0
FP = fuel price = $1.10/gal
OC = oil consumption = 0
OP = oil price = $4.40/gal
RMF = repairs and maintenance factor = 0.0004
NP = new price = $1,000.00

Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
= ($0.40/hr)(8.25)/(2mph)(12 feet)(0.7) = $0.20/A

8.25 = conversion factor
FS = field speed = 2 mph
SW = swath width = 12 feet
FE = field efficiency, estimate of maneuverability
= 0.7

4. Tractor - (FC)(FP) + (OC)(OP) + (RMF)(NP) = cost/hr
(2.61gal/hr)($1.10/gal) + (0.012 gal/hr)
($4.40/gal) + (0.0004)($12,000.00) = $7.72/hr

FC = fuel consumption = 2.61 gal/hr (1)
FP = fuel price - $1.10/gal
OC = oil consumption = 0.012 gal/hr (1)
OP = oil price = $4.40/gal
RMF = repairs and maintenance factor = 0.0004 (1)
NP = new price = $12,000

Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
= ($7.72/hr)(8.25)/(2mph)(12 feet)(0.7) = $3.79/A

8.25 = conversion factor
FS = field speed = 2 mph
SW = swath width = 12 feet
FE = field efficiency = 0.7

5. Labor to spread straw - (1 man)($4.00/hr)(0.49 hr/A) + (2 men)($3.00/hr)(0.49 hr/A) = ($4.90/A)

6. Labor to burn = (3 men)($3.00/hr)/(10 A/hr) = $0.90/A

Fixed Costs

1. Water truck - Identical to the water truck cost calculated in Appendix II.

2. Straw spreader - (NP - SV)/(L) + (0.097)/(A) + (RIT)(AI) + (I)(AI) = annual cost
($4,000 - $400)/(10 years) + (0.097)(25) + (1.75%)($1,800) + (10%)($1,800) = $573.92/year

NP = new price = $4,000
SV = salvage value = 10% of new price
L = life expectancy of equipment = 10 years
0.097 = cost per sq. ft. of shelter space (1)
A = shelter space required = 25 sq. ft.
RIT = rate of insurance and taxes = 1.75% (1)
AI = average investment = (NP - SV)/(2)
I = interest rate = 10%

Cost/A = (annual cost)/(acres in operation)

10 acre operation - ($573.92)/(10 acres) = $57.39/A
100 acre operation - ($573.92)/(100 acres) = $5.74/A
1000 acre operation - ($573.92)/(1000 acres) = $0.57/A

3. Trailer - (NP - SV)/(L) + (0.097)(A) + (RIT)(AI) + (I)(AI) = annual cost
($1,000 - $100)/(10 years) + (0.097)(160 sq.ft.) + (1.75%)($450) + (10%)($450) = $158.39/year

NP = new price = $1,000
SV = salvage value = 10% of new price
L = life expectancy of equipment = 10 years
0.097 = cost per sq. ft. of shelter space (1)
A = shelter space required = 160 sq. ft.
RIT = rate of insurance and taxes = 1.75% (1)
AI = average investment = (NP - SV)/(2)
I = interest rate = 10%

Cost/A = (annual cost)/(acres in operation)

10 acre operation - ($158.39)/(10 acres) = $15.84/A
100 acre operation - ($158.39)/(100 acres) = $1.58/A
1000 acre operation - ($158.39)/(1000 acres) = $0.16/A

4. Tractor - (NP - SV)/(L) + (0.097)(A) + (RIT)(AI)
+ (I)(AI) = annual cost
($12,000 - $1200)/(10 years) + (0.097)(92 sq.ft.)
+ (1.75%)($5,400) + (10%)($5,400) = $1723.42/year

NP = new price = $12,000
SV = salvage value = 10% of new price
L = life expectancy = 10 years
0.097 = cost per sq. ft. of shelter space (1)
A = shelter space required = 92 sq. ft.
RIT = rate of insurance and taxes = 1.75% (1)
AI = average investment = (NP - SV)/(2)
I = interest rate = 10%

Cost/A = (annual cost)(hr/A)/(average annual use)
(2 year burn cycle)

10 acre operation - ($1723.42)(0.49hr/A)/(200/hr)
(2) = $2.11/A
100 acre operation - ($1723.42)(0.49hr/A)/(300 hr)
(2) = $1.41/A
1000 acre operation - ($1723.42)(0.49 hr/A)/(400 hr)
(2) = $1.05/A

APPENDIX IV

Cost Calculations of Oil Burning - Conventional Burner Heads

Variable Costs

1. Tractor - Cost/hr = $7.72/hr, from Appendix III

Cost/A = (cost/hr)(8.25)(FS)(SW)(FE)
= ($7.72/hr)(8.25)/(2 mph)(14 feet)(0.7) = $3.25/A

8.25 = conversion factor
FS = field speed = 2 mph
SW = swath width = 14 feet
FE = field efficiency, estimate of maneuverability
= 0.7

2. Burner - Cost/hr = (FC)(FP) = (OC)(OP) + (RMF)(NP)
= (150 gal/hr)($1.00/gal) + (0)
+ (0.0005)($6500) = $153.25/hr

Cost/A = (Cost/hr)(8.25)/(FS)(SW)(FE)
= ($153.25)(8.25)/(2 mph)(14ft)(0.7) = $64.51/A

3. Labor - (1 man)($4.00/hr)(0.42hr/A) + (2 men)($3.00/hr)
(0.42hr/A) = $4.20/A

Fixed Costs

1. Tractor - annual cost = $1723.42/year, from Appendix III.

Cost/A = (annual cost)(hr/A)/(average annual use)
(2 year cycle)

10 acre operation - ($1723.42)(0.42hr/A)/(200hr)
(2) = $1.80/A
100 acre operation - ($1723.42)(0.42hr/A)/(300hr)
(2) = $1.20/A
1000 acre operation - ($1723.42)(0.42hr/A)/(400hr)
(2) = $0.90/A

2. Burner - (NP - SV)/(L) + (0.097)(A) + (RIT)(A) + (I)(AI)
= annual cost
($6500 - $650)/(10yr) + (0.097)(40 sq.ft.)
+ (1.75%)($2925) + (10%)($2925) = $932.57/year

NP = new price = $6500
SV = salvage value = 10% of new price
L = life expectancy of equipment = 10 years
0.097 = cost per sq.ft. of shelter space (1)
A = shelter space required = 40 sq.ft.
RIT = rate of insurance and taxes = 1.75% (1)
AI = average investment = (NP - SV)/(2)
I = interest rate = 10%

Cost/A = (annual cost)/(acres in operation)

10 acre operation - ($932.57/year)/(10 acres) = $93.26/A
100 acre operation - ($932.57/year)/(100 acres) = $9.33/A
1000 acre operation - ($932.57/year)/(1000 acres) = $0.93/A

3. Water truck - Identical to the water truck cost calculated
in Appendix II.

4. Oil truck - identical to the water truck cost calculated in
Appendix II.

APPENDIX V

Cost Calculations for Oil Burning - Economy Burner Heads

Variable Costs

1. Tractor - Identical to the tractor cost calculated in Appendix IV.

2. Burner - Cost/hr = (FC)(FP) + (OC)(OP) + (RMF)(NP)
   = (90 gal/hr)($1.00/gal) + (0)($4.40/gal)
   + (0.0005)($6500) = $93.25/hr

   Cost/A = (Cost/hr)(8.25)/(FS)(SW)(FE)
   = ($93.25/hr)(8.25)/(2mph)(14ft)(0.7) = $39.26/A

3. Labor - Identical to the labor cost calculated in Appendix IV.

Fixed Costs

1. Tractor - Identical to the tractor cost calculated in Appendix IV.

2. Burner - Identical to the burner cost calculated in Appendix IV.

3. Water Truck - Identical to water truck cost calculated in Appendix II.

4. Oil truck - Identical to the water truck cost calculated in Appendix II.

APPENDIX VI

Cost Calculation for Oil Burning - Bosse' Burner Heads

Variable Costs

1. Tractor - Identical to the tractor cost calculated in Appendix IV.

2. Burner - Cost/hr = (FC)(FP) + (OC)(OP) + (RMF)(NP)
   = (60 gal/hr)($1.00/gal) + (0)($4.40/gal)
   + (0.0005)($7000) = $63.50/hr

   Cost/A = (Cost/hr)(8.25)/(2mph)(14 ft)(0.7) = $26.73/A

3. Labor - Identical to the labor cost calculated in Appendix IV.

Fixed Costs

1. Tractor - Identical to the tractor cost calculated in Appendix IV.

2. Burner - (NP - SV)/(L) + (0.097)(A) + (RIT)(A) + (I)(AI)
= annual cost
($7000 - $700)/(10 years) + (0.097)(40 sq.ft.)
+ (1.75%)($3150) + (10%)($3150) = $1004.01/year.

Cost/A = (annual cost)/(acres in operation)

10 acre operation - ($1004)/(10 acres) = $100.40/A
100 acre operation - ($1004)/(100 acres) = $10.04/A
1000 acre operation - ($1004)/(1000 acres) = $1.00/A

3. Water truck - Identical to the water truck cost calculated in Appendix II.

4. Oil truck - Identical to the water truck cost calculated in Appendix II.

APPENDIX VII

Cost Calculations - Flail Mowing

Variable Costs

1. Tractor - Cost/hr = $7.72/hr, from Appendix III.

Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
= ($7.72/hr)(8.25)/(2mph)(9ft)(0.7) = $5.05/A

2. Mower - Cost/hr = (FC)(FP) + (OC)(OP) + (RMF)(NP)
= (0)($1.00/gal) + (0)($4.40/gal)
+ (0.0005)($5000) = $2.50/hr

Cost/A = (cost/hr)(8.25)/(FS)(SW)(FE)
= ($2.50/hr)(8.25)/(2mph)(9ft)(0.7) = $1.63/A

3. Labor - (1 man)($4.00/hr)(0.65hr/A) + (1 man)($3.00/hr)
(0.65hr/A) = $4.55/A

4. Replacement mower blades - ($25/set)(0.02 sets/A)
= $0.50/A

Fixed Costs

1. Tractor - annual cost = $1723.42/year, from Appendix III.

   Cost/A = (annual cost)(hr/A)/(average annual use)
   (2 year cycle)

   10 acre operation - ($1723.42/yr)(0.65hr/A)/(200hr/yr)(2) = $2.80/A
   100 acre operation - ($1723.42/yr)(0.65hr/A)/(300hr/yr)(2) = $1.87/A
   1000 acre operation - ($1723.42/yr)(0.65hr/A)/(400hr/yr)(2) = $1.40/A

2. Mower - (NP - SV)/(L) + (0.097)(A) + (RIT)(A) + (I)(AI)
   = annual cost
   ($5000 - $500)/(10 years) + (0.097)(40ft)
   + (1.75%)($2250) + (10%)($2250) = $718.26/year

   Cost/A = (annual cost)/(acres in operation)

   10 acre operation - ($718.26/yr)/(10 A) = $71.83/A
   100 acre operation - ($718.26/yr)/(100 A) = $7.18/A
   1000 acre operation - ($718.26/yr)/(1000 A) = $0.72/A