THE ECONOMICS OF STAND LIFE IN THE PRODUCTION OF ALFALFA

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Alfalfa is a crop which once established, can provide production of hay for several years thereafter. The productive years of the established crop are often referred to as the stand life. The life of an alfalfa stand is variable depending on many factors including variety grown, soil, weather conditions during the production period, insect and weed pressures, and of course the management skills of the producer in timely harvesting and other production jobs.

Oftentimes, yield level has been promoted as an important factor in reducing the costs of producing alfalfa. The higher the yield the lower the cost per ton. This idea has merit because alfalfa is more expensive to produce compared to other forages which a farmer might consider as viable alternatives to alfalfa in a ration. Important also in determining the cost of producing alfalfa, is the life of the alfalfa stand, i.e. how many years will the present stand remain productive before it must be replaced. This issue has not received the attention it deserves, in so much as producers may be able to exercise some control over factors that effect stand life as well as yield level.

In this paper, comparisons will be made of operating costs during the year of establishment and in subsequent years of the stand. The issue of alfalfa yield variation during the stand life will also be discussed and operating cost per ton estimated for each year of the stand for varying lengths of stand. This information will be used to estimate differences in operating cost per ton for varying yield levels and stand life. The cost estimates will also consider the time value of money to adjust for differences in the cost stream during alfalfa stands of varying length.

Operating Costs in Alfalfa Production

In order to fully analyze this issue, it is first necessary to be able to identify the differences in costs during each year of the alfalfa stand. This is difficult. The basic premise is that there are costs associated with establishing the crop which are not incurred in other years and that there is also a tendency for certain costs to change during the life of the stand - costs associated with yield level or with insect and weed problems which might be dependent on the age of the crop.

In Table 1, an attempt is made to compare operating cost for the first year of an alfalfa stand with operating costs in all subsequent years of the stand. These estimates are based on several

assumptions: (1) fertilizer rates are the same each year, (2) the need to use herbicides will increase during the stand life, (3) insecticide use will be the same each year, and (4) the crop will be harvested less times the first year. Based on these assumptions, operating costs are approximately 30 percent higher the first year than in all other years during the stand life.

Table 1. Estimated Operating Costs Per Acre During the Year of Establishment and in Subsequent Years of the Stand for Production of Alfalfa, Kentucky, 1984.

Cost Item	First Year	Other Years
Fertilizer	$ 49.20	$ 49.20
Seed	37.50	
Herbicides	12.75	16.25
Insecticides	11.25	11.25
Fuel and Repairs	22.20	25.75
Operating Interest	7.97	6.15
Total	$140.87	$108.60

Adapted from Field Crop and Forage Budget Estimates for Kentucky for 1984, Extension No. 55, Dept. of Agricultural Economics, University of Kentucky, April 1984.

Alfalfa Yields During The Stand Life

In viewing several variety tests results conducted by the University of Kentucky, it is difficult to establish what the expected life of an alfalfa stand could be. Variety trials are conducted for a given test, a maximum of 6 years. At the end of 6 years, however, many varieties still yield as well as they did several years earlier and the percentage of plants per acre still exceeds accepted levels. Another data problem is that the yields during the first year have not been recorded with exception of tests seeded in 1977 and 1980. For these two tests, yields during the year of establishment averaged 70 percent of alfalfa's yield potential during the remaining years of the test.

Assuming that this is a realistic exception, and if we assume that as the stand weakens the yield would decline to this same level in the last year of the stand before replacement, the following relationship shown in Figure 1 would represent alfalfa yields during a six year stand life. The graph shows yields as a percentage of yield potential during a normal year of the stand.

For example, if stand life is six years and yield is expected to be 6 tons per acre then yields would be 4.2 tons per acre the first and last years of the stand and 6 tons per acre during the 4 years of full production potential. Average yield per acre during the six year period would be 5.4 tons. If only a four year stand life is expected and yield expected to be 5 tons per acre, then yields would be 3.5 tons per acre the first and last years and 5 tons per acre during the two years of full production potential- averaging 4.25 tons per acre.

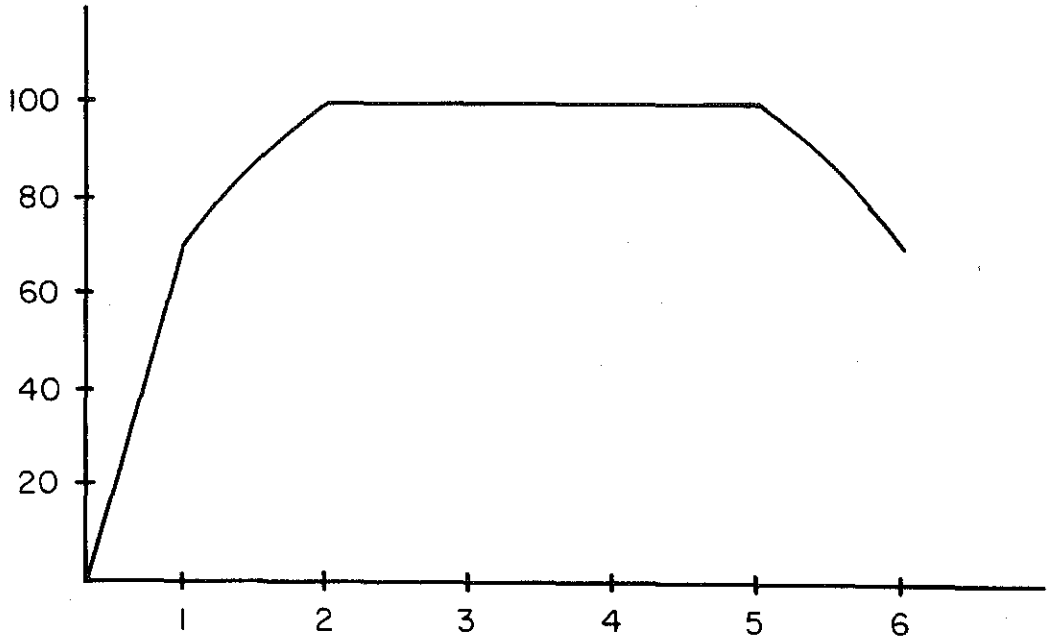

Figure 1. Alfalfa Yields During a Six-Year Stand as a Percent of Yield Potential In Years Excluding the First and Last Years of the Stand.

Effect of Stand Life on Costs Over Time

Given the previous discussion, the life of an alfalfa stand can potentially effect both yields and production costs over time. Table 2 shows the tandem effect of changes in costs and yields over time on the operating cost per ton of producing alfalfa given a 4-year stand and a 6-year stand. In order to accurately compare the two, a common time period must be used. A six year period was chosen.

Table 2. Example of Cost Stream and Yields Over the Life of the Stand and for a Six Year Period Given a Four and Six Year Stand Life and Yield Potential of Six Tons Per Acre in a Normal Year of the Stand.

	4-Year Stand Life			6-Year Stand Life		
Year	$/Acre	Yield	$/Ton	$/Acre	Yield	$/Ton
1	140.87	4.2	33.54	140.87	4.2	33.54
2	108.60	6.0	18.10	108.60	6.0	18.10
3	108.60	6.0	18.10	108.60	6.0	18.10
4	108.60	4.2	25.86	108.60	6.0	18.10
5	140.87	4.2	33.54	108.60	6.0	18.10
6	108.60	6.0	18.10	108.60	4.2	25.86
Total	716.16			683.87		
Cumulative Yield		30.6			32.4	
Average Yield		5.1			5.4	

Yield potential is six tons per acre. With a 4-year stand, total operating costs during a six year period would be $716.16 or $23.40 per ton. Yields would average 5.1 tons per acre annually. Comparatively, with a six year stand operating costs would total $683.87 or $21.11 per ton. Yields would average 5.4 tons per acre per year.

Time Value of Money Principles

To be completely correct, the cost streams in Table 2 must be adjusted to reflect values in todays dollars. This is called the Present Value of the cost stream expensed over a period of time. The reasoning for doing this is that a dollar today is worth more than a dollar in the future, thus future dollars must be "discounted" to reflect what that same dollar is worth, for example, in 1985. The rate at which money is adjusted from the future is called the discount rate. Consider the following information from the cost stream in Table 2. In year 3 of a 4-year stand, the cost outlay per ton is expected to be $18.10. Ask yourself the question "How much is $18.10 three years from now equivalent to today?" In other words, what amount today would be equivalent to $18.10 in three years.

Since the $18.10 in three years was really calculated using costs for 1984, these costs are calculated using todays dollars or what is called "real" dollars- not adjusted for inflation. To discount the future cost stream, therefore, it is appropriate to use a "real" rate of interest or the inflation free interest rate. For this analysis, 5 percent was used.

So what amount today is equivalent to $18.10 in three years if discounted at 5 percent? The answer is $15.64. In other words, $15.64 if earning 5 percent would equal $18.10 in three years.

Table 3 shows the time value of money applied to the cost stream for 6 years given a 4-year stand life and a six ton yield potential (from Table 2). The Present Value is the sum of the discounted cost stream over the six year period. In other words, during the 6-year period a total of $125.06 per ton operating costs will be spend in present dollars.

Table 3. Example Calculation of the Present Value of Costs for a Six Year Period Given a Four Year Stand Life and a Six Ton Yield Potential During a Normal Year of the Stand.

Year	Cost/Acre	Yield	Cost/Ton	Discount Factor*	Discounted Cost
1	$ 140.87	4.2	$ 33.54	.95238	$ 31.94
2	108.60	6.0	18.10	.90703	16.42
3	108.60	6.0	18.10	.86384	15.64
4	108.60	4.2	25.86	.82270	21.27
5	140.87	4.2	33.54	.78353	26.28
6	108.60	6.0	18.10	.74622	13.51
Present Value					125.06

*The discount factor is calculated by the formula $1/(1+r)^n$ where r is the discount rate and n is the year. For example, with a discount rate of 5 percent, in year 3 the discount factor would be calculated as $1/(1.05)^3 = .86384$

This present value can be converted to an annualized cost by multiplying by an appropriate "amortization" factor. This factor is simply the percentage of the total cost stream which would have to be invested each year during the period to equal the Present Value at the end of the period. For the example in Table 3, what amount would have to be invested annually at 5 percent to equal $125.06 at the end of six years? That amount is $24.64. The amortization factor is .19702 for a six year period and a 5 percent rate of interest.

Stand Life and Yield Level Combined Effects on Cost

Both length of life of the alfalfa stand and alfalfa yield level have significant impacts on a producers cost of production. Fixed or overhead costs have not been considered because these amounts would not change with differences in stand life. Only the total amount of operating cost would vary with stand life and are thus the only costs which need to be compared.

Given a five ton yield level, a producer can reduce production cost by $3.00 per ton if managing to increase stand life from 4 years to 6 years (Table 4). Also, given a five year stand life, increasing yields from 4 tons per acre to 6 tons per acre would reduce operating cost by $4.89 per ton. Note that the effect of yield increases is slightly more when expected stand life is less.

Table 4. Annualized Operating Cost Per Ton Over a Six Year Period Given Various Lengths of Stand Life and at Various Yield Levels.

Tons/Acre	Stand Life 3	4	5	6
4	$ 38.94	$ 36.96	$ 36.70	$ 33.21
5	31.15	29.57	29.36	26.57
6	25.96	24.64*	24.46	22.14
7	22.25	21.12	20.97	18.98

*The annualized cost is the Present Value of the cost stream multiplied by the amortization factor. The amortization factor is found by the formula $r(1+r)^n/(1+r)^n-1$ where r is the discount rate and n is the number of years. For example, with a 5 percent discount rate and 6 years, the amortization factor is $.01(1.05)^6 / (1.05)^6 - 1$. This equals .19702. The annualized cost of $125.06 from Table 3 is calculated as (.19702 x $125.06) which equals $24.64.

The most obvious result should be the combined effect that both higher yield and improved stand life can have on reducing the cost of production. From Table 4, improving stand life from 4 years to 6 years while improving yields from 4 tons per acre to 6 tons per acre would lower operating cost per ton by $14.82!

Summary

Both yield level and length of stand life are important management goals in alfalfa production. Improvements can significantly reduce production costs over time. Alfalfa is a relatively expensive forage crop to produce, but under proper management may actually have a lower cash cost requirement per ton compared to alternative forages- especially when considering alfalfa's nutrient value relative to other feeds and the total cash expense of balancing a given ration with alternative forages and other feeds. This was not directly addressed in this paper, however, and needs further study- but is noteworthy nevertheless.

Length of stand gives rise to yield changes and cost changes over time. Factors which influence stand life include site selection or soil, weather, herbicide and insecticide programs to control pests, variety grown, and harvesting management. Management practices designed to cut corners and save cost may reduce cash requirements in the short term, but may increase the actual cost per ton both in the short term and over the longer term.

REFERENCES

Bauer, Larry L., James Rathwell, and G. Ansel King. The Arithmetic of Time Analysis Applied to Peaches, AE-410, Dept. of Agricultural Economics, Clemson University, November 1979.

Bradford, Garnett L., Fundamentals of Time-Money Relationships. Unpublished manuscript, Department of Agricultural Economics, University of Kentucky, November 1984.

Shurley, W. Donald. "An Economic Examination of Kentucky's Potential for Alfalfa Production", Proceedings of the III Annual Kentucky Alfalfa Conference, February 1983.

Shurley, W. Donald., Field Crop and Forage Budget Estimates for Kentucky for 1984, Extension No. 55, Dept. of Agricultural Economics, University of Kentucky, April 1984.

Sigafus, Roy E., and N. E. Taylor. Kentucky Forage Variety Trials-1981, Progress Report 260, Dept. of Agronomy, University of Kentucky.

Sigafus, R. E., et al. "Alfalfa Variety Trials Through 1982", Agronomy Notes, Vol. 15, No. 7, Dept. of Agronomy, University of Kentucky, December 1982.

Sigafus, Roy E. "Summary of Alfalfa Variety Trials in Kentucky (1971-1983)", Agronomy Notes, Vol. 17, No. 2, Dept. of Agronomy, University of Kentucky, April 1984.