An Economic Analysis of Replacing Existing Bermudagrass Stands with Tifton 85 Bermudagrass for Beef Cow-Calf, Stocker and Hay Production

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Introduction[1]

In the southern United States, beef cattle and dairy farms depend on bermudagrass (*Cynodon dactylon*) as a primary grazed forage from early spring until autumn. Although no verified records exist, it is widely-held that thousands of tons of bermudagrass hay are fed to beef and dairy herds during winter and drought periods annually.

Numerous bermudagrass cultivars and selections are grown in the United States, but none are as widely used as Coastal bermudagrass (C). In fact, more than 9 million acres of C are grown in the south. Released in 1943 by Glenn Burton, USDA-ARS, Tifton, GA, C is recognized for its persistence, yield and quality, making it the standard to which selections and hybrids in most of the South are compared.

In 1993, a new hybrid bermuda grass, Tifton-85 (T85), also developed by Dr. Burton, was released. Numerous university experiments have demonstrated the superiority of T85 to C in terms of yield, quality and animal performance. However, producer adoption of T85 has been slow. Although many, if not most, new establishments of bermuda grass in the south are T85, the conversion of C to T85 has been less than desirable.

Although, no formal studies have been conducted to determine the exact reasons for this reluctance to convert C to T85, anecdotal evidence suggests producer satisfaction with C as well as concerns with lost production during the conversion process and longer hay-curing times are considerable impediments to adoption.

Objectives

The overall objective of this paper is to determine the economics of replacing C or T78 with T85 within an expected utility (EU) framework. Specific objectives include:

[1] Much of this introductory section is borrowed from Hill, Gates and West, 2001.

1. Determining the average net present value of converting C or T78 to T85 for beef cow-calf, beef stocker and hay production;
2. Determining the net present value of converting C or T78 to T85 for beef cow-calf, beef stocker and hay production using simulation analysis; and
3. Determining the expected utility for producers converting C or T78 to T85 for beef cow-calf, beef stocker and hay production.

Procedures

To conduct this analysis we incorporate published animal research along with historical input and output prices to develop simulated Net Present Values (NPV). Specific citations and procedures for each scenario will follow the discussion below that addresses the general types of analyses performed as well as information and procedures used in all three scenarios.

The conversion of C or T78 to T85 is a multi-period process that involves destroying the existing stand of C or T78 and establishing T85. As a result, net cash flows will be different for a given period.

Net present value (NPV) analysis is the preferred method for comparing two alternatives with differing net cash flows over a specified period. This is accomplished by taking a future series of cash flows and discounting them to today's dollars. The alternative with the highest value is the most profitable or preferred alternative. NPV can be calculated (modified from Barry, et al.) as:

(1) $$\text{NPV} = \text{-INV} + \sum_{j=1}^{n} \frac{\text{NCF}_j}{(1+i)^j}.$$

Where:

INV = the amount of the investment

i = the discount rate

n = the number of periods

j = the j^{th} period

and NCF_j = the Net Cash flow for the jth period

Based on the published research, three scenarios were considered:

1. Converting Coastal (C) to Tifton-85 (T85) for cow-calf production
2. Converting C to T85 for hay production and
3. Converting Tifton-78 (T78) to T85 for stocker steer production.

To calculate the relative profitability of converting either C or T78 to T85, NPV analysis was conducted using average animal responses and static input and output prices. After this analysis was performed, simulated NPV were calculated using individual animal or hay year production information along with a range of possible input and output values. These values were then considered within an EU framework to determine if producer's level of risk-aversion affected the decision to replace either C or T78 with T85.

The NPV analyses compared the discounted net cash flows of either cow-calf production, hay production or steer production on one acre of land for 10 years. Although bermuda grass stands have documented stand lives of 35 years or more, 10 years was chosen as an initial examination period because most conversions of this type will reach their full potential in about 10 years. The conversion process from C to T85 is at least a two-year process. Using autumn as the beginning period (Y0), the existing stand is terminated with 1-2 applications of glyphosate, followed by establishment of cool-season and warm-season annuals. In Fall of Y1, another winter annual crop is established. In spring of Y1, T85 is planted and if adequate rainfall follows, is completely established by the end (fall) of Y1.

In this analysis, budgets were developed for the conversion process. Because winter and summer annuals are utilized to suppress any residual C, some grazing is available. As a result, the total conversion cost is somewhat reduced by the grazing that is available. To account for this occurrence, estimated grazing days were calculated and a value per grazing day was computed.

Conversion of C to T85 for Cow-calf Production

In the only published research comparing cow-calf performance on C and T85, Corriher, et al found that tester calves on T85 had adjusted-205d weights of 558 pounds while tester calves on C had adjusted-205d weights of 530 pounds, a difference of 28 pounds ($p<.01$). Additionally, cow-stocking rate was increased by 1.04 cows per acre ($p<.01$) for the T85 compared to C. These findings are confirmed by producers who report stocking rates of 2-4 cow-calf pairs per acre on T85 during summers with adequate rainfall or under irrigation.

Average NPV analysis was conducted by taking a base scenario of 1.0 cow-calf pairs per acre for C (which is typical for this region) and producing a weaned calf weighing 530 pounds and comparing it to 2.04 cows per acre weaning calves weighing 558 pounds. The C scenario has cow-calf income from Y0-Y10, while the T85 scenario does not begin having cow-calf income until Y2.

UGA beef cow-calf budgets for 2008 were utilized to provide costs for annual cow costs other than pasture expense ($280.97 per cow) and pasture maintenance ($184.06 per acre). It should be noted that once established, annual maintenance costs for C and T85 are identical. Sales prices for weaned calves were the Georgia average monthly prices of August-October for 2003-2007 for 500-550 pound steers and 550-600 pound steers (USDA-AMS).

Conversion of T78 to T85 for Stocker Production

Many cow-calf producers utilize permanent warm-season grasses in their replacement heifer development program. Additionally, with the increased demand and expanding market for grass-fed beef, there is a need for lower cost warm-season forages for growing beef steers.

Although there has been no published work relating to T85 and these specific scenarios, Hill, Gates and Burton (Hill, Gates and Burton 1993) found that when compared to T78, T85 had 38% more grazing days and 46% higher bodyweight gains when grazed by stocker steers. T78 had previously been found to produce about 25% more forage and 38% more bodyweight gains than C. By inference then, if it is profitable to replace T78 with T85 based on the stocker steer performance, it would make economic sense to replace C with T85 for the same reasons. If it is not profitable to replace T78 with T85, the conclusion would be indeterminate concerning replacing C with T85 for stocker production.

Even though there is very little warm-season stocker production in the south, if T85 has a relatively higher NPV than T78 (and C), the results can be used to make some inferences regarding relative cost of production for developing heifers or beef growing steers.

To account for the analytical difficulties imposed by the “put and take” method utilized in the physical experiment, it was assumed that differences in total bodyweight gain (BG) per acre could be represented by increasing stocking rates by the percentage of the difference in BW. Pasture establishment and maintenance costs used were the same as those in the cow-calf analysis.

The net cash flow per acre from stockering can be expressed as:

(2) $$NCF_j = \left(SRx(EndWt \text{ x } EndPrice) - SRx(BegWt \text{ x } BegPrice)\right) - PastureCost/acre$$

Where:

SR is the stocking rate of steers per acre,

EndWt is the weight of steers after the stockering period,

EndPrice is the ending price ($/Cwt.) for the steers,

BegWt is the weight of the steers at the beginning of the stockering period (SP),

BegPrice is the price ($/Cwt.) for the steers at the beginning of the stockering period, and

PastureCost/acre is pasture cost per acre.

Ending weight (EndWt) of the steers was calculated as:

(3) $\text{EndWt} = \text{BegWt} + \text{ADG} * \text{SP}.$

Initial SR for steers was set at 2.19, the rate utilized in the physical experiment. To account for the higher yields of T85 as reflected in total bodyweight gain (BG), stocking rates for T85 were increased by 38.13%, the amount of the reported differences in BG ($P<.01$). Values for average daily gain (ADG) are the reported results from Hill, Gates and Burton (.65 pounds per day, $P>.10$).

BegWT was assumed to be 500 pounds (the weight at which most stockering programs begin) and the stockering period (SP) was set at 169 days, the average length of the experiment. This time period also corresponds to the time of year when cattle, either stockers or replacements, would be moving off summer pastures.

Prices for beginning and ending weights are Georgia prices for medium frame number one and two steers for 2003-2007 (USDA-AMS). The prices are reported in 50 pound increments (500-550, 550-600, etc). Prices for beginning weights were calculated as the average price of 500-550 pound steers for April from 2003-2007 and prices for ending weights were calculated as the average price of steers in the respective weight classes from September-October from 2003-2007.

Conversion of C to T85 for Hay Production

In addition to improved animal performance, T85 has been shown to consistently yield more high quality forage than C or T78. In two different three-year small-plot experiments (Hill, Gates and Burton, 1993), T85 produced 11% more DM yield than other cultivars in the experiment. In one experiment it produced 20% more DM yield than C and in another experiment it produced 34% and 30% more DM than C or T78, respectively. Moreover, variety trial data gathered at the Coastal Plain Experiment Station (CPES) in Tifton, GA from 2002-2005 shows that T85 yielded an average of 21% more DM yield than C.

To analyze the profitability of converting from C to T85 for hay production, differences in NPV were calculated using costs from 2008 UGA Hybrid Bermuda Budgets, mean yields from the two experiments adjusted to 85% DM (6.9 t/ac for C and 8.68 t/ac for T85). Hay prices used were the average of monthly hay prices for good-quality bermuda hay in the Southeastern U.S. (USDA-AMS) from January 2003-October 2007 ($60.70 per ton).

Results

NPV analysis based on mean values (Table 1) indicates that is profitable for producers to renovate their existing stands of C and replace them with T85. Cow-calf producers have the most to gain by switching to T85 while hay producers have the least to gain. It bears noting that the NPV should be compared only in a relative sense and not absolute dollars as there are numerous profit-determining factors omitted from these analyses such as calf crop percentage, death loss, etc.

It is for these reasons and others that many producers have been reluctant to convert C to T85. Uncertainty of rainfall (and stand establishment), volatile sales and input prices are all factors affecting adoption of this promising technology.

To account for uncertainty and the resulting risk, stochastic simulations were conducted for all scenarios utilizing an expected utility (EU) framework. Following Anderson, et al, the model for calculating NPV within an EU framework with imperfect capital markets can be generally expressed as:

(4)
$$E\left[U\{u_1(r_1),\ldots u_t(r_t)\}\right];$$
$$E\left[NPV\{u_1(r_1),\ldots u_t(r_t)\}\right]$$

Where:

NPV = Net Present Value,

i=time preference rate,

r_t is stage return for stage t,

U is a total utility function,

$u_t(r_t)$ is the t-th stage utility function,

and E is the Expectation operator.

Provided U is a monotone of NPV, as is likely (Hardaker, Huirne, and Anderson).

Assuming Constant Relative Risk Aversion (CRRA), the model can further be specified as:

(5)
$$E(U)_r = \sum_{i=1}^{n} \omega_i \frac{W_i^{1-r}}{1-r}, r \neq 1$$

or

(6)
$$E(U)_r = \sum_{i=1}^{n} \omega_i \ln(W_i), r = 1.$$

where $W_i = W_0 + NPV_i$, r is a risk aversion coefficient, and ω_i is the weight associated with each observation i. Simulated ending wealth is represented by W_i, and initial wealth is represented by W_0. Since the analysis is on a per acre basis, initial wealth is assumed to be zero. Utility values are calculated for risk aversion coefficients 1, 2, and 3, with r=1 representing slightly risk averse and r=3 representing extremely risk averse.

By solving equation 6 for NPV, certainty equivalents (CE) can be calculated for each level of risk aversion. The CE represents the lowest sure price for which a decision maker would be willing to sell a risky prospect (Hardaker, Huirne, and Anderson). For any two alternatives i and j, if $CE_i > CE_j$, then alternative i is preferred to j.

Output prices were treated as stochastic variables in all scenarios as were various production factors. In the cow-calf analysis, risk was introduced by using individual adjusted 205d calf weaning weights instead of mean reported weights. Cow stocking rate was held constant.

In the stocker scenario, individual performance data was not available at time of paper submission. However, because steer purchase and output prices are treated as stochastic, there is some level of risk accounted for in the model.

In the hay comparison, risk is incorporated by using the yearly yield values for the different cultivars as well as yield data collected at the CPES in 2002-3005. Annual differences in yield between C and T85 were calculated for each year. Simulated yields for C are randomly drawn observations from these years while yields for T85 are calculated as:

(7) $T85_i = C_i + \delta_i$

Where $T85_i$= is the yield for T85 in a given year,

C_i = the yield for C in a given year and

δ_i = the reported difference in T85 and C for a given year.

Output prices are treated as stochastic by randomly selecting hay prices taken from a normal distribution with a mean and standard deviation calculated from annual average hay prices from 2003-2005.

Results from Simulations

Results from the simulation analyses are presented in Tables 2-5. For a 10-year planning horizon, risk neutral cow-calf and stocker producers could economically justify converting C to T85 while hay producers could not (Table 2). For cow-calf producers, the additional stocking rates and higher production far outweigh any short-term losses in production. For stocker or replacement heifer producers the costs savings ($/pound of gain) are considerable; $0.55/pound of gain for T85 versus $0.78/pound of gain for C.

For hay producers, the additional production from T85 is not enough to offset the lost income from the two year transition. However, if the planning horizon is extended to 12 years, it becomes economically rational to convert C to T85.

When differing levels of risk-aversion are considered (Tables 3-5), the results and implications change slightly. Cow-calf producers regardless of the level of risk-aversion should consider adopting T85 (Table 3) as should stocker producers regardless of the level of risk-aversion. It should be noted that for the stocker analysis, W_0 was set at $3,000 per acre to avoid the transformation issue that arises when trying to calculate negative NPV. Once the CE calculations were performed, the NPV were reduced by $3,000 to arrive at CE that would be comparable between, cow-calf, stocker and hay production.

Hay producers who are only slightly risk averse would be indifferent toward adopting T85, while moderately or extremely risk-averse hay producers should consider adopting T85. On the surface, this sounds counter-intuitive. However, the additional yield provided by T85, especially in normal to above-normal growing conditions, more than compensates for the lost production during the transition period. Furthermore, a review of the individual observations generated in the simulation analysis shows that the yield-price combinations that make adopting T85 economically feasible are high-yields and high prices. Grass hay prices in the southeast have increased by 40-50% just in the past two years. Also increasing numbers of producers are installing irrigation to manage their risk on the production side. The implication then is that if hay prices remain high as they are expected, it will behoove many hay producers, especially those with irrigation to consider adopting T85.

Summary and Conclusions

Comparisons of simulated NPV for C and T85 bermuda-grass using experimental data, current input prices and historical hay and feeder cattle prices indicates that many producers would benefit by adopting this new cultivar. Cow-calf producers would benefit the most followed by stocker/replacement heifer producers and finally hay producers. When risk-aversion is introduced into the model, all cow-calf and stocker producers regardless of the level of risk-aversion should consider adopting T85. Moderately or extremely risk-averse hay producers would consider adopting T85, while those that are slightly risk-averse would be indifferent.

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Table 1. Comparison of Calculated NPV for C and T85 Using Mean Values

Scenario	NPV T85 ($/acre)	NPV C/T78 ($/acre)	$/Acre Difference	Percentage Difference
Cow-calf	4,357.53	872.87	3,484.66	399.22
Stocker	387.01	136.53	523.53	284.02
Hay	531.13	368.23	162.90	44.24

Table 2. Comparison of Simulated NPV for C and T85, n=100

Scenario	Mean NPV Advantage for T85 ($/acre)	Max Advantage for T85 ($/acre)	Min Advantage for T85 ($/acre)	Std. Dev
Cow-calf	3,563.44	4,386.33	2,774.41	301.44
Stocker	526.53	4,500.64	(2,449.39)	917.63
Hay	(6.27)	599.08	(712.08)	283.87

Table 3. Simulated Net Certainty Equivalents from Replacing C with T85 for Cow-calf Production, n=100

r	CE for C ($/acre)	CE for T85 ($/acre)	Difference ($/acre)
1	861.40	4,439.56	3,578.16
2	853.40	4,430.14	3,576.75
3	846.52	4,421.69	3,575.17

Table 4. Simulated Net Certainty Equivalents from Replacing C with T85 for Stocker Production, n=100

r	CE for C ($/acre)	CE for T85 ($/acre)	Difference ($/acre)
1	(293.10)	378.23	671.33
2	(581.88)	367.82	949.70
3	(1,210.07)	358.33	1,568.70

Table 5. Simulated Net Certainty Equivalents from Replacing C with T85 for Hay Production, n=100

r	CE for C ($/acre)	CE for T85 ($/acre)	Difference ($/acre)
1	1464.48	1463.78	(0.70)
2	1416.30	1428.42	12.12
3	1355.30	1394.06	38.42