Economic Returns from Burning Tobosagrass in the Texas Rolling Plains

D.E. ETHRIDGE, R.G. SUDDERTH, AND H.A. WRIGHT

Abstract

Based on 7 prescribed burning trials on tobosagrass (Hilaria mutica) in the Rolling Plains of Texas from 1968 to 1976, burned tobosagrass ranges yielded an additional present value of $36.16/ha ($14.64/ac) over 5 years with calf prices at $1.62/kg ($3.71 lb). Additional costs are $10-12.50/ha ($4–5/ac). These results are based on average precipitation on ranges which had prior chemical treatment on mesquite. The prescribed burns were conducted according to recommended practices.

Tobosagrass (Hilaria mutica (Torr.) Benth.) is a grass which builds up large quantities of litter (Wright 1969). This litter makes tobosagrass less palatable to cattle and decreases both plant and animal production as litter accumulates. Burning removes excess litter and increases the grass palatability and yield for several years. Although cattle will eat tobosagrass after a burn (Heirman and Wright 1973), the investment decisions are affected by soil moisture and economic considerations, including livestock prices and interest rates on borrowed capital.

Prior research on prescribed burning of tobosagrass has been on the physical relationships involved. Wright (1972) studied fire as a management tool in mesquite-tobosagrass communities; 1 location was in the High Plains and 6 were in the Rolling Plains of Texas. His results showed that burned plots reached equilibrium with unburned plots in about 5 years, and reburns could be conducted every 5 to 8 years without forage loss, depending on the site. Tobosagrass is most heavily used in the first and second year after burning. Also, burning improved tobosagrass productivity, controlled broomweed, reduced cactus, removed dead mesquite wood, and killed some honey mesquite (P. glandulosa Torr. var. glandulosa).

Heirman and Wright (1973) measured the effects of burning on the composition and production of a High Plains grass community and on cattle use of tobosagrass. Tobosagrass production increased threefold the first year after the burn. They concluded that in mixed stands of tobosagrass and buffalograss (Buchloe dactyloides (Nutt.) Engelm.), grazing pressure was absorbed primarily by tobosagrass during spring and again in late summer–early fall.

On 5 burned and unburned locations in the Rolling Plains, Wright (1969) concluded that fire could control mesquite without adversely affecting tobosagrass production. Yield of tobosagrass was higher on all burned plots compared to unburned plots. Also, late spring and early summer rainfall most influenced tobosagrass production. Bunting et al. (1978), working on the southwestern edge of the Rolling Plains, found that (1) elimination of excess litter was a major reason for increased tobosagrass production, (2) tobosagrass and other herbs reached equilibrium with control plots by the end of the fifth year after burning, and (3) growing season rainfall following the burn was very important.

Workman (1976) described an economic analysis of prescribed burning which consisted of comparing treatment cost with discounted net annual returns. The identified factors which affected the economic feasibility of a prescribed burn were: (1) herbage increase, (2) percentage of which could be harvested, (3) value of each added unit of forage, (4) life of the treatment, (5) treatment cost, and (6) the interest rate on borrowed capital. He illustrated the procedure with an example on sagebrush burning.

The objective here is to develop a procedure and evaluate the economic feasibility of burning tobosagrass on the Texas Rolling Plains under varying economic circumstances. This will allow decision makers to consider several variables affecting future returns.

Analytical Framework

Prescribed burning of tobosagrass constitutes a capital investment because the major expense occurs at one time and the effects of the burn extend into the future. Since the effects are expected to last several years, there are two risks: (1) physical, such as weather variation, and (2) economic uncertainty, arising mostly from variations in livestock prices. Effectiveness of prescribed burning, in conjunction with certain economic variables, largely determines the feasibility of burning.

The basis for this analysis is a herbage yield response function relating marginal (additional) grass production (yield) resulting from a prescribed burn (MGP) to time (t) and other variables, Xi:

\[ MGP = f(t,Xi) \]  

MGP is expected to decline over time because of litter buildup after the burn. Additional grass production is converted to additional (marginal) livestock production (MLP), or:

\[ MLP = k(MGP) = h(t, Xi) \]

where MLP is additional livestock production per unit of land associated with prescribed burning and k is units of livestock per unit of grass (a conversion factor for converting grass to meat). Equations (1) and (2) are biological relationships. Equation (2) is transformed into the value of additional grass production (VMGP) by multiplying the unit value of livestock produced net of added unit costs of production, PL:

\[ VMGP = (MLP)(PL) = j(t, Xi) \]

Range managers cannot affect the market value of the livestock. VMGP is the additional revenue from prescribing burning, and there is a VMGP each year during which the burn has an impact on grass and livestock production. If all costs of burning occur at the time of the burn, the stream of additional returns must be discounted in order to place them on an equivalent basis with the cost (Witson and Scifres 1980). Thus,

\[ PVMP = \frac{1}{1 + r} [VMGP/(1 + r)^t] \]

where PVMP is present value of added revenue from prescribed burning, VMGP is added revenue from the burn in year t, and r is the discount rate, i.e., the price of capital used for the burn. The longer the life of the burn (t) and the lower the interest rate (r), the greater the present value of the revenue generated from prescribed burning.

If PVMP is greater than or equal to the cost of burning, the burn is economically feasible. To estimate costs and returns, several things must be known: (1) the nature of the MGP and/or the MLP relationship, (2) the value of livestock, and (3) the cost of prescribed burning. Value of livestock is difficult to forecast, especially
over a long period. The grass or livestock production response relationship requires identification of factors which affect productivity of the prescribed burn and quantitative estimation of impacts of those factors.

Methods and Procedures

Data on grass yield after prescribed burning were obtained from studies by Neuenschwander (1976) and Wright (1969, 1972). These studies had observations for burns up to 5 years old. All locations were in the Rolling Plains of Texas, and all burns were conducted on range which had prior chemical mesquite control treatment.

Variables having effects on grass yield after a burn in equation (1) included: (a) time, (b) rainfall during the growing season, (c) rainfall during the period preceding the growing season, (d) slope of the terrain, and (e) site where the burn was conducted. The relationship between MGP and each of the independent variables except time was hypothesized to be linear and the relationship with time nonlinear (semi-log) form. The mathematical model formulated was:

\[ MGP = B0 + B1 R1 + B2 R2 + B3 ln t + B4 D1 + B5 D2 + B6 D3 + B7 D4 + B8 D5 \]  

where MGP = added grass production from burning (kg/ha),

\[ R1 = \text{rainfall during the July-Feb. period prior to the growing season (cm)}, \]

\[ R2 = \text{rainfall during the Mar.-June growing season (cm)}, \]

\[ ln t = \text{natural logarithm of year following treatment (1 = year of treatment)}, \]

\[ D1 = \text{site dummy variable; } D1 = 1 \text{ if site is Post, Texas, 0 otherwise}, \]

\[ D2 = \text{site dummy variable; } D2 = 1 \text{ if site is Guthrie, Texas, 0 otherwise}, \]

\[ D3 = \text{site dummy variable; } D3 = 1 \text{ if site is Quanah, Texas, 0 otherwise}, \]

\[ D4 = \text{slope dummy variable; } D4 = 1 \text{ if site is lowland, } 0 \text{ otherwise}, \]

\[ D5 = \text{slope dummy variable; } D5 = 1 \text{ if site is upland, } 0 \text{ otherwise}. \]

If D1, D2, and D3 are all 0, Site is Colorado City, Texas.)

The additional grass yield per year was calculated as the burned plot yield less its respective control plot yield. Data on rainfall were obtained from Climatological Data, Texas (U.S. Department of Commerce 1970). Ordinary least squares was used to estimate parameters of equation (5).

It was assumed that the livestock enterprise would be a cow-calf operation in which an animal unit (AU) would consist of 454 kg (1,000 lb) cow, one 181 kg (400 lb) calf, 5% of a 725 kg (1600 lb) bull, and 14% of a 295 kg (650 lb) replacement heifer (Kennedy 1970). A calving rate of 90% and marketing of calves at 181 kg was assumed. Thus, under these conditions, one AU produces 138 kg (304 lb) of marketable calf. Marketing of calves was determined in terms of net value rather than gross value. If more animal units are placed on the land, there are added costs associated with grazing those livestock. The value of livestock marketed, PL, was calculated as:

\[ PL = PC - VPC \]

where PC is market price of 181 kg calves in $/kg and VPC is variable production costs for 181 kg calves in $/kg. Variable costs consisted of those items shown in Table 1 minus the value of cull cows; land costs and overhead costs were excluded. The value of cull cows was determined using a price relationship between cull cow and calf prices: price of cull cows = .1162 + .4774 (price of calves) where both prices are in $/kg. This regression estimate (\( R^2 = .96; F = 180.9, \text{significant at the .0001 level} \)) was derived from 10 years of price data from the San Angelo market. Weight of cull cow used was 408 kg (900 lb).

Results and Interpretation

Estimation of equation (5) yielded the following relationship:

\[ MGP = -356.31 - 557.69 \ln t + 73.53 R2 - 976.06 D3 \]  

where MGP = added grass production (kg/ha), t = time (logarithm of year), and D3 = site dummy variable for Quanah, Texas. PC and VPC are all 0, Site is Colorado City, Texas.)

The additional grass produced can be utilized, the number of kilograms of grass required to support an animal unit for years 1 through 5 is found by 5715.3 + 816.5 t. Therefore, the conversion factor for converting kg of grass to kg of marketable calf becomes:

\[ k = \frac{138}{(5715.3 + 816.5 t)} \]  

The value of the calves was determined in terms of net value rather than gross value. If more animal units are placed on the land, there are added costs associated with grazing those livestock. The value of livestock marketed, PL, was calculated as:

\[ PL = PC - VPC \]

where PC is market price of 181 kg calves in $/kg and VPC is variable production costs for 181 kg calves in $/kg. Variable costs consisted of those items shown in Table 1 minus the value of cull cows. The value of the calves was determined in terms of net value rather than gross value. If more animal units are placed on the land, there are added costs associated with grazing those livestock. The value of livestock marketed, PL, was calculated as:

\[ PL = PC - VPC \]

where PC is market price of 181 kg calves in $/kg and VPC is variable production costs for 181 kg calves in $/kg. Variable costs consisted of those items shown in Table 1 minus the value of cull cows.
To facilitate interpretation, the R2 and D3 variables in equation (8) were assigned fixed values to produce a grass yield function with added grass yield as a function of time. If D3 is set at 0 and the mean value for growing season rainfall (Table 2) is substituted into equation (8),

\[ MGP = 922.38 - 557.69 \ln t \quad (9) \]

This relationship indicated that with normal rainfall conditions prescribed burning would produce 922 kg/ha (820 lb/ac) more grass the first year after the burn, 536 kg/ha (477 lb/ac) the second year after the burn, 310 kg the third year, 149 kg the fourth year, and 25 kg the fifth year (Table 3). After year 5, the effects of the burn are negligible. In practice, implementation of the system might involve rotational burning with say, 5 tracts and 1 tract burned each year. This would allow stability in livestock numbers rather than annual adjustment of stocking rates.

To convert the added grass yield to added beef production, the appropriate conversion factor was obtained by using equation (6).

\[ \text{Added grass prod.} = 922.38 \times 0.211 = 194.19 \text{ kg/ha} \]

\[ \text{Conversion factor} = 0.211 \]

\[ \text{Added beef prod.} = 194.19 \times 0.8458 = 163.64 \text{ kg/ha} \]

\[ \text{Value of grass prod.} = 163.64 \times 1.62 = 265.35 \text{ $/ha} \]

\[ \text{Discounted value of added prod.} = \frac{265.35}{1.05} = 252.14 \text{ $/ha} \]

As with changes in physical conditions, changes in economic conditions likewise affect the economic feasibility. Economic factors which affect beef prices, costs of producing beef, and interest rates may have a substantial effect on the returns from and feasibility of prescribed burning. Magnitudes of these effects are shown in Table 4. The value of prescribed burning in the Texas Rolling Plains increases as beef prices increase and decreases as interest rates increase.

### Table 4. Present value of prescribed burning ($/ha) at different calf prices and discount rates.

<table>
<thead>
<tr>
<th>Calf Price ($/kg)</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.43</td>
<td>10%</td>
</tr>
<tr>
<td>1.54</td>
<td>15%</td>
</tr>
<tr>
<td>1.65</td>
<td>10%</td>
</tr>
<tr>
<td>1.76</td>
<td>15%</td>
</tr>
<tr>
<td>1.81</td>
<td></td>
</tr>
</tbody>
</table>

As with changes in physical conditions, changes in economic conditions likewise affect the economic feasibility. Economic factors which affect beef prices, costs of producing beef, and interest rates may have a substantial effect on the returns from and feasibility of prescribed burning. Magnitudes of these effects are shown in Table 4. The value of prescribed burning in the Texas Rolling Plains increases as beef prices increase and decreases as interest rates increase.

### Conclusions

The economic feasibility of prescribed burning of tobobagrass in the Rolling Plains of Texas depends on many variables, some are environmental, some are economic, and some may be influenced or manipulated by managers. The main environmental variable which affects added grass and beef production, and therefore economic feasibility associated with prescribed burning, is growing season rainfall. An additional consideration is that in a year when a prescribed burn is done and growing season rainfall is less than 5 inches during the first year there will be a decrease in production instead of an increase. This type of situation can be avoided by burning in late March when a better assessment of adequate soil moisture can be made (Wright 1969).

Among the economic variables which affect economic feasibility are livestock prices, costs of production, and interest rates. While an individual ranch manager is quite limited on the degree to which he may influence these variables, some impact on them through livestock production management, financial management, and marketing strategies may occur. This analysis shows the relative magnitudes of effects from the various factors on the economic returns from prescribed burning of tobobagrass. Based on 7 burns conducted and followed from 1968 to 1976, burned tobobagrass ranged were estimated to yield an additional $36/ha over a 5-year time span. To determine economic feasibility, the discounted added returns from burning must be compared to the added costs of burning. Economic feasibility may, therefore, vary with time, among ranches, and among pastures within ranches. The added forage production relationship estimated in this study is believed to be generally reliable for the Rolling Plains region.
appropriate values of the variables within the relationship, the appropriate factors to convert to marketable product, and the appropriate values for the economic variables will vary from one situation to another. The analytical framework, along with the MGP relationships, should be applicable to individual decision situations.

Literature Cited


Texas Department of Agriculture. 1982. Texas livestock market news, published weekly.


