An approach to assessing the financial viability of bush clearing on game ranches in savanna regions

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An approach to assessing the financial viability of bush clearing on game ranches in savanna regions is presented, using data on the rates of change of herbaceous phytomass and tree density following bush clearing. Financial gain is calculated from an increase in grazing capacity with an increase in herbaceous phytomass. The financial gain is offset against the financial loss due to a decrease in browsing capacity with a decrease in bush density. Profitability is calculated by calculating the net present value of the net financial gain over the effective duration of the bush clearing exercise. Shortcomings in the approach are identified and a need for more appropriate long-term data is indicated.

Key words: Bush encroachment, grazing capacity, browsing capacity, bushveld.

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Introduction

Research into the effects of bush clearing in Southern African savannas has not been aimed at relating information to the individual ranch business level, instead it has been *ad hoc*, empirical and limited in nature (Teague & Smit 1992). More research should be aimed at developing models which allow ranchers to predict the ecological and financial consequences of possible management actions via decision support systems (Teague & Smit 1992). To develop models of a predictive nature, data on the rates of change of ecological processes are imperative. In this paper an approach to assessing the financial viability of bush clearing on game ranches in savanna regions is proposed, using data on the rates of change of herbaceous phytomass and tree density following bush clearing. This approach could possibly be incorporated into a decision support system for game ranchers.

To illustrate the approach, the financial viability of bush clearing has been assessed on Ellington Ranch, a 6000-ha game ranch situated approximately 20 km east of Ellisras in the Mixed Bushveld of Northern Province, South Africa (Acocks 1988). Short-term data on changes in herbaceous phytomass with woody plant density were collected on Ellington Ranch (Schmidt *et al.* 1995a). Other data used in the assessment (Berry 1986; Scholes 1990; Van Hoven 1991) were obtained from the literature and do not pertain specifically to the study area. The use of short term data and data not pertaining to the study area, has resulted in certain questionable assumptions being made during the assessment. On completion of the assessment, these assumptions are discussed and possible research priorities suggested.

The main objectives of this paper are therefore to illustrate the approach taken to assessing the financial viability of bush clearing and to identify research priorities which may increase the accuracy of the assessment.

Financial assessment

In the assessment that follows financial gain is calculated from an increase in grazing capacity with an increase in herbaceous phytomass following bush clearing. The financial gain is offset against the financial loss due to a decrease in browsing capacity with a decrease in bush density. Profitability is calculated by calculating the net present value of the net financial gain over the effective duration of the bush clearing exercise. A marginal tax rate of 43 % and a discount rate of 20 % is assumed. All calculations are made for the year 1990. Average animals of a species are taken to be mature, non-lactating females in the tables of Meissner (1982) and their carcass masses are the minimum masses given by Bothma & Van Rooyen (1989) for mature game.

Calculation of ecological and financial gain

There was a significant increase in herbaceous phytomass on plots treated with an arboricide than on adjacent plots not treated with an arboricide on Ellington Ranch in 1990 (Schmidt *et al.* 1995a). The average difference in herbaceous phytomass between cleared and uncleared areas was 125.667 g/m² (or 1 257 kg/ha). The increase in herbaceous phytomass was probably due to competitive release (Smit *et al.* 1996).

In 1991 the average difference between cleared and uncleared plots decreased by 38 % to 77.913 g/m² (or 779 kg/ha). The decrease in the difference between cleared and uncleared areas from 1990 to 1991 was probably mainly due to a loss of *Panicum maximum* with a change in tree density since rainfall and stocking rate remained more or less constant between cleared and uncleared plots (Schmidt *et al.* 1995a). It is also unlikely that the re-establishment of seedlings, and therefore an increase in soil moisture competition, was the cause for the decrease since a granular herbicide with the active ingredient Tebuthiuron was used which tends to achieve complete woody species mortality and retard seedling regrowth in the first few years after treatment (Trollope *et al.* 1989).

Assuming that the average difference between cleared and uncleared areas on Ellington Ranch would continue decreasing by 38 % each year after treatment, then the difference in phytomass between cleared and uncleared areas would become negligible after 12 years, i.e. the effect of bush clearing on grass production would last for approximately 12 years (Table 1). The total gain in phytomass during this 12-year period would be approximately 3 296 kg/ha (Table 1). If the formula of Moore & Odendaal (1987) (Appendix 1) is used to calculate grazing capacity from the gain in phytomass, then the gain in grazing capacity over the 12-year period can be estimated at 0.318 lsu/ha. In terms of game which can utilise long grass, this represents a gain of 0.848 waterbuck/ha (0.318/0.375) since an average waterbuck is equivalent to 0.375 lsu (Meissner 1982). If the average carcass mass of a waterbuck is taken to be 112 kg (Bothma & Van Rooyen 1989) and the net return from game R5.09/kg (Appendix 2), then the gain in grazing capacity due to bush clearing can be estimated in financial terms at approximately R483/ha (0.848 × 112 × 5.09) (Table 1). This figure is the total financial gain over the 29-year period of recovery (ignoring the time value of money). The financial gain for each year of the recovery period is calculated in the same way (Table 1). The above calculations do not take a reduction in browsing capacity and the direct cost of bush clearing into account. These are considered below.

Table 1

The estimated increase in grazing capacity and corresponding financial gain due to an increase in herbaceous phytomass after bush clearing on Ellington Ranch, Northern Province, South Africa. (The data presented in this table were calculated using a spreadsheet. Data from the manual calculation of this table may therefore differ slightly due to the rounding off of values to two and three decimal places)

Year of effective duration (lsu $ha^{-1}year^{-1}$)	Gain in phytomass (kg/ha)	Gain in grazing capacity	Financial gain before tax (R $ha^{-1}year^{-1}$)
1	1256.670	0.121	183.95
2	779.134	0.075	114.02
3	483.063	0.046	69.93
4	299.499	0.029	44.09
5	185.689	0.018	27.36
6	115.127	0.011	16.72
7	71.379	0.007	10.64
8	44.255	0.004	6.08
9	27.438	0.003	4.56
10	17.012	0.002	3.04
11	10.547	0.001	1.52
12	6.539	0.001	1.52
Total	3296.352	0.318	483.43

Calculation of ecological and financial loss

Van Hoven (1991) found on fenced game ranches in the North West, Northern and Mapumalanga Province that a kudu density of 4 animals/100 ha or less did not result in mortalities. If it is taken that an average kudu is equivalent to 0.397 lsu (Meissner 1982), then the browsing capacity for large game on Ellington Ranch, according to Van Hoven (1991), can be estimated at 1.588 lsu/100 ha (or 0.016 lsu/ha) for uncleared areas (Table 2).

On the cleared areas of Ellington Ranch one can probably expect an initial decrease in the browsing capacity of 87 % since this was the average percentage kill of trees obtained with the chemical Graslan on the entire Ellington Ranch (Schmidt *et al.* 1995a). The trees which were least affected by the poison were *Combretum apiculatum*, *Boscia albitrunca*, *Sclerocarya birrea* and *Commiphora pyracanthoides*. These species are all important browse species, particularly *Boscia albitrunca* which is evergreen and therefore an important winter food source. In accordance with Trollope *et al.* (1989) a reduction of 87 % in the browsing capacity can be expected for approximately five years after application of the poison since bush control chemicals containing the active ingredient Tebuthiuron tend to inhibit seedling reestablishment for a maximum period of five years.

Scholes (1990), in modelling the regrowth of *Colophospermum mopane*, found the recovery time for *Colophospermum mopane* to be about twice the effective duration of the increase in grass production after clearing. At a 90 % tree mortality the recovery period was 22 years. On Ellington Ranch the effective duration of the increase in grass production was estimated to be 12 years, thus following the model of Scholes (1990), the

Table 2

The estimated loss in browsing capacity and corresponding financial loss due to a decrease in woody plant density after bush clearing on Ellington Ranch, Northern Province, South Africa. (The data presented in this table were calculated using a spreadsheet. Data from the manual calculation of this table may therefore differ slightly due to the rounding off of values to two and three decimal places)

Year of effective duration clearing (lsu/ha)	Browsing capacity with no bush clearing (lsu/ha)	Browsing capacity after bush (lsu/100 ha) (col. 2–col. 3)	Loss in browsing capacity	Financial loss before tax (R $ha^{-1}year^{-1}$)
1	0.016	0.002	0.014	15.24
2	0.016	0.002	0.014	15.24
3	0.016	0.002	0.014	15.24
4	0.016	0.002	0.014	15.24
5	0.016	0.002	0.014	15.24
6	0.016	0.003	0.013	14.60
7	0.016	0.003	0.013	13.97
8	0.016	0.004	0.012	13.33
9	0.016	0.004	0.012	12.70
10	0.016	0.005	0.011	12.06
11	0.016	0.006	0.010	11.42
12	0.016	0.006	0.010	10.79
13	0.016	0.007	0.009	10.16
14	0.016	0.007	0.009	9.53
15	0.016	0.008	0.008	8.89
16	0.016	0.008	0.007	8.25
17	0.016	0.009	0.007	7.62
18	0.016	0.010	0.006	6.98
19	0.016	0.010	0.006	6.35
20	0.016	0.011	0.005	5.71
21	0.016	0.011	0.005	5.07
22	0.016	0.012	0.004	4.44
23	0.016	0.012	0.003	4.91
24	0.016	0.013	0.003	3.18
25	0.016	0.014	0.002	2.54
26	0.016	0.014	0.002	1.90
27	0.016	0.015	0.001	1.27
28	0.016	0.015	0.001	0.63
29	0.016	0.016	0.000	0.00
Total	0.461	0.233	0.228	251.38

recovery period would be 24 years. This implies a constant rate of recovery of 0.058 lsu/year from year 6 to year 29 if it is assumed that no seedling re-establishment took place during the first 5 years after the application of Graslan. Over the 29 year recovery period this represents a loss of 0.228 lsu/ha (Table 2) or 0.574 kudu/ha (0.228/0.397) if it is taken that an average kudu is equivalent to 0.397 lsu (Meissner 1982). If the carcass mass of an average kudu is taken to be 86 kg (Bothma & Van Rooyen 1989), and the net return from game R5.09/kg (Appendix 2), then the loss in browsing capacity due to bush clearing can be estimated in financial terms at approximately R251/ha (0.574 × 86 × 5.09) (Table 2). This figure is the total estimate of the financial loss over the 29-year period of recovery (ignoring the time value of money). The financial loss for each year of the recovery period is calculated in the same way

(Table 2). The above calculations do not take the direct cost of bush clearing on Ellington Ranch into account. This was R180/ha for the year 1990.

Calculation of profitability

The profitability of the bush clearing operation cannot be calculated by merely subtracting the total financial loss (R251/ha) and the direct cost of bush clearing (R180/ha) from the total financial gain (R483). These figures do not take the time value of money into account and first need to be discounted at an acceptable rate. In order to do this it is necessary to calculate the net present value of the annual net return over the 29-year duration of the bush clearing operation.

The annual net return (Table 3) was calculated by subtracting the financial loss for each year of the 29 year duration of the bush clearing operation (Table 2) from the financial gain for each year (Table 1). The annual net return, including the initial cost of bush clearing (Table 3, year 0), was then adjusted to reflect an after tax net annual return, assuming a marginal tax rate of 43 %. The adjustment of the initial cost of bush clearing to an after tax value assumes that the bush clearing cost can be offset against income derived in the rest of the business. The after tax net return for each year was then discounted at a rate of 20 % (Table 3). This rate is based on the average cost of capital principle and was purposefully taken as high to ensure a stringent test of financial viability. A positive net present value of R38.87/ha was realised (equivalent to an internal rate of return of 49 %) (Table 3). It therefore appears as if the bush clearing program on Ellington Ranch could have been profitable assuming the increase in grass production was effectively utilised. It is also apparent from Table 3 that negative financial gains are only realised after six years. This implies that it would pay to repeat the bush clearing exercise in year seven.

Discussion

It is generally accepted that total (or near total) bush clearing is an ecologically unacceptable practice and not financially viable. Selective thinning of trees is usually advocated (Scholes 1990; Smit & Van Romburgh 1993). The above result, of a profit after near total bush clearing, is therefore questionable. One major shortcoming in the above assessment, which may go some way to explaining the above result, relates to the problem of estimating browsing capacity in savanna regions. There is a lack of information on this topic in the literature and this is probably due to the complexity of carrying out such an assessment. The only available estimate of browsing capacity that could be obtained for the study area was that of Van Hoven (1991) which relates kudu mortalities to animal density. In this study no other browsing species were directly taken into account. It is therefore likely that a conservative estimate of browsing capacity was used in the above financial assessment. A conservative estimate of browsing capacity would lead to an underestimation of the financial loss due to clearing which would result in a greater financial gain.

Two other major shortcomings in the above assessment are (1) the assumption of a constant rate of decrease in herbaceous phytomass following the initial increase in phytomass after clearing; and (2) the constant rate of increase in tree density after the effects of the arboricide have worn off. Inherent sporadic changes in environmental conditions in savannas would ensure variable rates of change in herbaceous phytomass and tree density over time (Teague & Smit 1992; Smit *et al.* 1996). Variable rates of change in these parameters could influence the effective duration of the bush clearing exercise and thus the profitability of the

Table 3

The estimated net present value of the net financial gain over the effective duration of the bush clearing exercise on Ellington Ranch, Northern Province, South Africa. (The data presented in this table were calculated using a spreadsheet. Data from the manual calculation of this table may therefore differ slightly due to the rounding off of values to two and three decimal places)

Year of effective duration	Net financial gain before tax from bush clearing* ($R\ ha^{-1}year^{-1}$)	Net financial gain after tax from bush clearing** ($R\ ha^{-1}year^{-1}$)	Discount rate (20 %)	Present value ($R\ ha^{-1}year^{-1}$)
0	-180.00	-102.60	1.000	-102.60
1	168.71	96.16	0.833	80.14
2	98.78	56.30	0.694	39.10
3	54.69	31.17	0.579	18.04
4	28.85	16.44	0.482	7.93
5	12.13	6.91	0.402	2.78
6	2.12	1.21	0.335	0.41
7	-3.33	-1.90	0.279	-0.53
8	-7.25	-4.13	0.233	-0.96
9	-8.14	-4.64	0.194	-0.90
10	-9.02	-5.14	0.162	-0.83
11	-9.90	-5.64	0.135	-0.76
12	-9.27	-5.29	0.112	-0.59
13	-10.16	-5.79	0.093	-0.54
14	-9.53	-5.43	0.078	-0.42
15	-8.89	-5.07	0.065	-0.33
16	-8.25	-4.70	0.054	-0.25
17	-7.62	-4.34	0.045	-0.20
18	-6.98	-3.98	0.038	-0.15
19	-6.35	-3.62	0.031	-0.11
20	-5.71	-3.26	0.026	-0.08
21	-5.07	-2.89	0.022	-0.06
22	-4.44	-2.53	0.018	-0.05
23	-3.80	-2.17	0.015	-0.03
24	-3.18	-1.81	0.013	-0.02
25	-2.54	-1.45	0.010	-0.01
26	-1.90	-1.08	0.009	-0.01
27	-1.27	-0.72	0.007	-0.01
28	-0.63	-0.36	0.006	-0.01
29	0.00	0.00	0.005	0.00
Net Present Value				38.87***

* Except for row 1 (year 0), this column was calculated by subtracting column 5 (Table 2) from column 4 (Table 1). Row 1 (year 0) represents the initial cost of bush clearing.

** A marginal tax rate of 43 % is assumed.

*** The Internal Rate of Return = 49 %.

entire operation. It is therefore imperative that the variable effects of environmental events (such as rainfall) be taken into account when attempting to assess the financial viability of bush clearing.

Another shortcoming in the above assessment includes the use of data not collected at the study site, or at least in the region of the study site. For example the data of Berry (1986) that were used to calculate the expected net return from various wildlife production enterprises (Appendix 2) were collected in the Northern Cape Province and some years prior to the present study. The data of

Scholes (1990) were collected in Mapumalanga Province and that of Van Hoven (1991) were collected over a wide region covering North West, Northern and Mapumalanga Provinces.

The outcome of the financial assessment would also be affected by the discount rate used, as the average cost of capital or required rate of return may vary from game ranching enterprise to game ranching enterprise. For example, the net present value would increase from R29.65/ha to R38.87/ha as the discount rate increased from zero to 20 percent.

Conclusion

To improve the sensitivity of financial assessments of bush clearing in savanna regions it is imperative that wide spread and long-term data be collected on the rates of change of herbaceous phytomass and tree density following bush clearing experiments so as to take environmental variability into account. More work also needs to be done in the field of assessing browsing capacity for game. There is also a need for continuous financial comparisons between different wildlife production enterprises in as many game ranch regions as possible.

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Appendix 1

The increase in grazing capacity due to an increase in herbaceous phytomass was calculated using the following formula of Moore & Odendaal (1987):

Grazing capacity (lsu/ha/year) = phytomass (kg/ha) × 0.35*/10** × 365***

* Utilisation factor: Only 35 % of the herbaceous material is grazed while 40 % remains as tufts and stubbles and 25 % is lost to environmental factors
** 10 kg feed/day is required per lsu
*** Days in a year

This formula has been successfully used to estimate grazing capacity in the study area (Schmidt *et al.* 1995b).

Appendix 2

A net return of R5/kg for game is calculated in Table 4 below using data from Berry (1986). Berry (1986) did a financial comparison between six wildlife utilisation enterprises of which self operated trophy hunting, live game sales and large animal venison production are practised on Ellington Ranch. Trophy hunting showed the best net return in terms of Rand/kg meat, followed by live game sales and venison production. Trophy hunting, however, is limited to a small portion of the adult male population. Probably only about 5 % of most multi-species game populations are suitable trophies (Du Toit & Van Rooyen 1989). For this reason only 5 % of the cropping quota in the calculation in Table 4 is assigned to trophy hunting. Eighty five percent of the cropping quota is assigned to live game sales and only 10 % to venison production since venison is only produced for the staff on Ellington Ranch.

Table 4
The expected net return in 1990 from three wildlife utilisation enterprises

Enterprise	Expected net return In 1985* (R/kg)	Expected net return in 1990** (R/kg)	Fraction of cropping quota	Expected net return in 1990 per croppingquota (R/kg)
Trophy hunting	5.47	10.53	0.05	0.53
Live game sales	2.63	5.06	0.85	4.30
Venison production	1.34	2.58	0.10	0.26
Total	–	–	1.00	5.09

* Data from Berry (1986)
** Calculated from the data of Berry (1986) assuming a mean inflation rate of 14 % for the years 1985 through to 1990.