Economics of Clubmoss Control on Saskatchewan Rangelands

In Saskatchewan, according to the 1996 Census of Agriculture, some 12.6 million acres is native rangeland. Lack of proper management practices has reduced desirable forages and grazing capacity on some of this rangeland. The outcome has been replacement of desired species, a decline in forage production, and in some cases an increase in plants such as clubmoss (*Selaginella densa* Rydb.).

Clubmoss forms a mat on the soil surface with up to 80% ground cover on rangeland in southern Saskatchewan. Many producers believe that clubmoss inhibits infiltration of precipitation, and thus reduces soil water and increases plant water stress. Furthermore it is believed that clubmoss reduces growth, productivity, and regeneration of desirable forages. Recent research in Saskatchewan indicated that clubmoss does not reduce soil water or increase plant water stress, and it does not limit growth, productivity, and regeneration of forages.

Some producers have, however, expressed interest in reducing clubmoss with the hope of increasing forage production and grazing capacity.

Low Forage Production has Economic Cost to Producers

Reduced grazing affects the economic costs for producers. These costs may include:

- Increased land costs;
- Reduction in the number of cattle on pastures, thereby reducing the level of net profit from grazing;
- Unreliable forage supply, necessitating purchase of supplemental feed, and;
- Reduction in land values.

Each of these factors could have economic consequences for producers.

Clubmoss can be Reduced

Many mechanical treatments have been developed with the goal of reducing clubmoss cover, increasing herbage production, and changing plant species composition. Commonly used mechanical treatments are cultivation, pitting, furrowing, and ripping. Because mechanical treatment removes ground cover, clubmoss is generally reduced.

Increases in forage production have been the primary criterion used to evaluate success of mechanical disturbances. The longevity of treatment effects on forage production has ranged from 1 to 6 years, depending on location, climate, and treatment. No reliable data from Saskatchewan are available on this subject, but longevity of treatment effects is not expected to exceed 10 years. However, one thing remains certain. Despite increases in forage production following mechanical disturbance, weather is more important in controlling forage productivity than mechanical disturbance or cover of clubmoss.

Many producers are evaluating factors before altering clubmoss through mechanical treatments. Major questions that must be answered include:

- What mechanical treatment options are available?
- What is the cost of applying these treatments?
- Are there other costs associated with undertaking such treatments?
- Will the treatment pay for itself?, and,
- How long is needed to recover the costs of treatments?

Answering these questions requires economic analyses of alternative treatments to reduce clubmoss.

Economic Analysis of Reducing Cover of Clubmoss

Disking and chisel plowing are common treatments used to reduce clubmoss in Saskatchewan. Therefore, we evaluated economic desirability of these treatments.

- In disking, land is cultivated with a heavy-breaking disk. About 45% of the ground surface is covered with overturned sod.
- Chisel plowing involves use of a cultivator first; plowing 5-cm deep followed by chisel plowing at a 10-cm depth at right angles, and finally chisel plowing with 25-cm sweeps at 45^{o} angles to the first treatment.

Information required for economic analyses of treating clubmoss on range included:

- Cost of treatment;
- Change in forage production from that without treatment;
- Value of expected increased forage production per Animal Unit Month (AUM);
- Expected productive life of the improvement;
- Market interest rate or opportunity cost of money, and;
- Grazing deferment requirements.

For these analyses, fair condition, loamy and sandy range sites in dry and moist areas of the Brown soil zone, and the Dark Brown soil zone of Saskatchewan were selected. This selection was based on the fact that these range sites are common in the province, and are likely to be considered for mechanical treatments suggested above.

Data for economic analyses were a combination of Saskatchewan based and those based on experiments conducted in Montana. Forage yields were based on recommended stocking rates on rangelands as suggested by Abouguendia (1990). Economic data for Saskatchewan were also used for estimating costs and returns from treatments.

In all economic analyses, time value of money is an important concept. Money received today is worth more than that received a year from now. For this reason, in economic analyses, benefits and costs are translated into "net present value", the discounted value of the money received in future. The discount rates used in this study were 8% and 10%.

Results of these analyses are presented in terms of two criteria, both of which are commonly used to evaluate similar investment projects. These criteria are:

- Net present worth of the treatment, the value in current dollars (today's value), and

- Internal rate of return, the return on an investment if the treatment were applied.

Estimation of Costs and Benefits of Treating Clubmoss

In developing economic analyses it is assumed that producers would value forage for feeding beef cattle. If forage availability were limited, producers would have to reduce the size of the herd or expand the land base. Both of these are costly propositions.

Two direct costs are associated with treatment of clubmoss. One of these is the cost of applying the treatment. Experiences elsewhere suggest it is advisable to allow the plants to grow and seedlings establish before grazing. Thus, it is recommended that range is rested for two years after treatment. Grazing deferment is the second part of the cost of treatment.

In this section how we estimated these factors is discussed.

Project Cost: Cost of Treatment

Disking or chisel plowing requires the use of farm machinery. A heavy breaking disk, costing $32.00 per hectare (ha) was used in this analysis. Chisel plowing was undertaken using a cultivator. Researchers in Montana recommended chisel plowing three times. Its cost using Saskatchewan Agriculture and Food data was estimated at $28.01 per ha, which decreases to $9.71 per ha for the second and third cultivation treatments. The total cost of this treatment is $47.40 per ha.

Project Cost: Cost of Deferring Grazing

For each treatment, grazing was deferred for two years. This is a cost to the producer in reduced beef production, and therefore it must be taken into account. The basis for this calculation is explained below with the benefits.

Project Benefits: Increased Forage Yields

Based on experiments conducted in Montana, and using Saskatchewan conditions, the projected improvement in herbage yields under the two treatments for clubmoss control in Table 1. For example, if untreated, fair condition range would produce 254 kg per ha, and under disking, the yield would increase to 401 kg per ha, an increase of 147 kg per ha.

Project Benefits: Increased Stocking Rates

Increase forage production can lead to increased stocking rates (Table 2). The increases implicit in Table 1 are used here. We assumed that 55% of the forage is available for grazing. Increases in stocking rates are measures in terms of animal unit months. Disking a loamy range site in the Dry Brown soil zone would lead to adequate forage to feed 23.4 animal unit months per 100 ha. Using a 3.5 month grazing period, this would translate into 9 animal units per 100 ha. The number of additional animal unit months would be between 14.7 on loamy range sites in the Dark Brown soil zone and 4.3 animals per

100 ha on sandy range sites in the Dry Brown soil zone.

Project Benefits: Increased Gross Revenue from Cattle Sales

The additional stocking rate translates into increased gross sales for producers as shown (Table 3). The level varies directly in proportion to the number of animals.

Results of Analysis

Two indicators of economic desirability of treatment for clubmoss control are shown in Tables 4 and 5. In general, lower discount rates give higher economic returns from these treatments. Overall, disking is economically more favorable than chisel plowing. If money is available at another rate of interest than the 8 or 10% used in the analysis, one should look at Table 5. Here you will find the rate of return on the investment. The rate of return is further conditioned by the effective life of the treatment. At 4% interest rate, it would be economical to use disking in the Moist Brown and Dark Brown soil zones provided that treatment effects on forage production lasts for at least 10 years. If this life is longer, it may even be economical at 6-8% rate of interest. However, it is likely that the effect of the treatment may not extend beyond the 10-year period.

Management Implications

- Under best case scenarios, disking of rangeland to reduce clubmoss is economically feasible, but the feasibility varies by soil zones and range sites. To be economically feasible, treatment effects must persist more than 10 years or money must be borrowed at rates lower than 8 or 10%. It is very questionable whether forage yields will be increased more than 10 years.
- Chisel plowing is not economically feasible.
- Producers must make decisions based on expected longevity of treatment effects and the rate of interest for borrowing money.
- Availability of cheaper money makes such decisions more economically viable as do longer treatment effects.
- Each producer should translate these results for their own situation before making decisions to treat clubmoss on rangeland.

Table 1. Herbage yield before treatment and projected herbage yield after treatment by soil zones and range sites in Saskatchewan.

Treatment	Soil zone					
	Dry Brown		Moist Brown		Dark Brown	
	Range site					
	Loamy	Sandy	Loamy	Sandy	Loamy	Sandy
	Herbage yield (kg per ha)					
Untreated	254	206	349	302	460	413
Disking	401	325	551	477	727	653
Chisel plowing	340	276	468	405	616	553

Table 2. Projected increases in stocking rates on treated range sites in Saskatchewan.

Treatment	Soil Zone					
	Dry Brown		Moist Brown		Dark Brown	
	Range site					
	Loamy	Sandy	Loamy	Sandy	Loamy	Sandy
	Stocking rate (Animal Unit Months per 100 ha)					
Disking	23.4	18.9	32.2	27.9	42.6	38.3
Chisel plowing	13.7	11.2	19.0	16.4	24.9	22.3

Table 3. Revenues and costs of deferring grazing after mechanical treatment of rangeland by soil zone and range sites in Saskatchewan.

Treatment	Soil zone					
	Dry Brown		Moist Brown		Dark Brown	
	Range site					
	Loamy	Sandy	Loamy	Sandy	Loamy	Sandy
	Additional gross revenue ($ per 100 ha per year)					
Disking	$1,297	$1,045	$1,781	$1,548	$2,361	$2,109
Chisel plowing	$755	$619	$1,045	$948	$1,374	$1,238
	Cost of grazing deferment ($ per 100 ha per year)					
Disking	$1,406	$1,130	$1,926	$2,537	$2,268	$3,063

Chisel plowing	$1,387	$1,083	$1,845	$1,613	$2,401	$2,172

Table 4. Net present worth of mechanical treatment by soil zones and range sites in Saskatchewan.

Treatment	Discount Rate (%)	Treatment Life (Years)	Soil zone					
			Dry Brown		Moist Brown		Dark Brown	
			Range site					
			Loamy	Sandy	Loamy	Sandy	Loamy	Sandy
			Net present worth ($ per 100 ha)					
Disking	8	5	(3,636)[1]	(3,478)	(3,826)	(3,685)	(4,080)	(3,980)
		10	(1,380)	(1,632)	(664)	(962)	(603)	(257)
		15	155	(376)	1,487	898	2,964	2,277
	10	5	(3,673)	(3,475)	(3,860)	(3,717)	(4,143)	(4,029)
		10	(1,689)	(1,876)	(1,121)	(1,350)	(621)	(804)
		15	(471)	(883)	580	(120)	1,742	1,198
Chisel plowing	8	5	(5,784)	(5,531)	(6,304)	(5,972)	(6,946)	(6,669)
		10	(4,457)	(4,538)	(4,457)	(4,308)	(4,492)	(4,465)
		15	(3,554)	(3,858)	(3,201)	(3,176)	(2,822)	(2,967)
	10	5	(5,714)	(5,456)	(6,237)	(5,907)	(6,884)	(6,604)
		10	(4,564)	(4,593)	(4,638)	(4,466)	(4,758)	(4,696)
		15	(3,850)	(4,058)	(3,645)	(3,572)	(3,439)	(3,512)

[1] ( ) Negative returns

Table 5. Rate of return on investment for mechanical treatment of range by soil zones and range sites in Saskatchewan.

Treatment	Life of treatment (Years)	Soil zone					
		Dry Brown		Moist Brown		Dark Brown	
		Range site					
		Loamy	Sandy	Loamy	Sandy	Loamy	Sandy
		Rate of return (%)					
Disking	5	-[1]	-	-	-	-	-
	10	2	0	6	4	8	7
	15	8	7	12	10	14	13
	20	11	9	13	12	16	15
Chisel plowing	5	-	-	-	-	-	-
	10	-	-	-	-	-	-
	15	-	-	0	0	2	2
	20	4	3	6	5	7	7

[1] -indicates rate of return is negative.

Reference

Abouguendia, Z. M. 1990. A practical guide for management and improvement of Saskatchewan rangeland: Range plan development. New Pasture and Grazing Technologies Project. Regina, SK.

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