PROFITABILITY OF ESTABLISHING BASIN WILDRYE FOR WINTER GRAZING

By

Gary J. May, Larry W. Van Tassell, Michael A. Smith, James W. Waggoner

Presented at Western Agricultural Economics Association Annual Meeting
July 11-14, 1999
Fargo, ND

Authors are research associate and professor, Department of Agricultural and Applied Economics; professor and associate professor, Department of Renewable Resources, University of Wyoming, Laramie, WY.

This research was funded by Sustainable Agriculture Research and Education Grant 96-063.

ABSTRACT

This study examined the economic viability of establishing basin wildrye for winter grazing. Mixed integer-programming models were developed that minimized cow feed costs. Estimated basin wildrye establishment costs were $154 per acre. Break-even basin wildrye yields were approximately 2.6 and 2.3 AUMs/acre for March and May calving scenarios, respectively.

INTRODUCTION

Replacing hay with grazed forage during the winter has been cited as a way for beef producers to reduce production costs (Adams et al., D'Souza et al.). Advantages of extended grazing include less cash outlay for operating harvesting equipment and fewer resources devoted to storing and feeding hay. Recent studies have estimated the impact winter feeding can have on ranch profitability (Corah and Gutierrez, Adams et al.). Adams et al. concluded that extending grazing in the winter months and grazing earlier in the spring increased returns by $50 to $90 per cow. Simonds found hay costs accounted for up to 70 percent of total ranch costs, and forage costs could be reduced by 48 percent as alternatives to hay were found. D'Souza et al. found late fall and early spring grazing more profitable than harvesting hay, even though total dry matter production was lower.

Most of these studies assume producers have unlimited access to forage resources. Adams et al. concede producers generally face limited grazing land and recognize this may impact the results of their study. Extending grazing into winter may require ranchers to remove land from summer grazing to stockpile forage for winter.

A major risk associated with stockpiling forage for winter grazing in parts of the Intermountain West is that heavy snow often renders grazable forage inaccessible. Winter grazing may not be an option for producers in heavy snowfall regions where rangeland is typically buried during much of the winter. Establishing tall forage species that provide accessible forage through winter may provide an opportunity for producers to extend grazing.

Basin wildrye has been suggested as a possible low-cost winter-feed source

(Majerus 1991, Majerus 1992, USDA-SCS, Jarecki, Lesperance et al.). Basin wildrye is a tall, thick stemmed plant that stands upright and remains accessible after other winter grazing alternatives are covered with snow. Other benefits include protection from the wind and elements, and a natural dry bedding source (USDA-SCS, Jarecki). Basin wildrye is described as an early, rapid developing, long lived, perennial bunchgrass. Stems are normally 3 to 5 feet tall and stand stiff and erect.

The objective of this study was to evaluate the profitability of replacing native range forage with basin wildrye for winter grazing. Conditions where basin wildrye establishment was profitable under a fixed forage resource situation were identified.

METHODS AND MATERIALS

Shifting rangeland utilization from summer to winter may alter the overall feeding regime by affecting hay demand and total carrying capacity when a fixed land base is assumed. This study was accomplished by examining the total feeding capacity and regime of a representative ranching operation to account for the change in livestock numbers when switching resources to winter grazing.

The reduction in feed costs associated with winter grazing would likely depend on the timing of the reproductive cycle. Low quality standing winter forage would better satisfy nutritional requirements of cows that calve in late spring/early summer relative to cows calving in early spring/late winter. The winter feeding system was evaluated under nutritional requirements for both a March and a May calving scenario.

The potential benefit of winter grazing may not be fully captured without allowing cows to store energy in fat reserves during the summer and mobilize these reserves during the winter. Morrison and Castle found allowing body condition to fluctuate throughout the year did not adversely affect calf production, provided the cow's body condition score (BCS) was at least 5 (1 to 9 scale) at calving. The ability of cows to change body condition each month was incorporated as a decision variable.

Model

The viability of grazing basin wildrye during winter depends largely on its ability to meet cow nutritional requirements. Nutritional quality of standing forage declines with maturity and subsequent weathering. Total wintering costs could increase if supplements are required to offset nutrient deficiencies introduced by replacing hay with lower quality forage. To incorporate forage quality and account for the trade-off between lower production costs and reduced nutrient yields, the ration was balanced each month of the year on an as-fed basis. Mixed integer programming models (MIP) were constructed for a March and May calving system with an objective function that maximized profit while adjusting cow numbers to fit the optimal feeding system. Nutritional requirements were dependent on the interaction between the reproductive cycle and environmental conditions. Nutrients were available depending on the forage production cycle.

The model was solved including, and excluding, basin wildrye as alternative forage. The expected annual benefit of winter grazing basin wildrye was derived by comparing the objective function of each model. The estimated increase in profitability associated with grazing basin wildrye was compared against the annualized establishment costs to determine if expected benefits exceeded total expected costs.

The integer-programming model is stated mathematically as:

(1) Maximize Profit = $nd - Sw_jb_j$; Objective function.

Subject to:

(2) $\Sigma e_{ij}b_j \geq k_i n$; Energy requirement constraint.

(3) $\Sigma c_{ij}b_j \geq p_i n$; Protein requirement constraint.

(4) $\Sigma t_{ij}b_j \leq r_i n$; Dry matter intake capacity constraint.

(5) $\Sigma y_j b_j \leq f$; Forage availability constraint.

Equation (1) represents the objective function of maximizing the profitability of operating a cowherd. The first term of equation (1) represents revenue per cow, where d denotes returns per cow excluding feed costs and n is a decision variable representing the number of cows. The second term of equation (1) denotes feed costs, where w_j represents the cost of the j^{th} feeding activity and b_j is the level the j^{th} feeding activity enters the solution. Grazing native range and basin wildrye was mutually exclusive within each period.

Energy and protein constraints are represented by equations (2) and (3) where e_{ij} and c_{ij} represent the net energy and crude protein contribution (as-fed basis) of the j^{th} feed alternative during the i^{th} month since calving. Energy was measured in mega calories (Mcals) of net energy for maintenance (NE_m), while crude protein was measured in pounds. The right-hand-side of equations (2) and (3) denote minimum monthly per cow energy (k_i) and protein (p_i) requirements in the i^{th} month, multiplied by the number of cows (n) entering the solution. Slack and surplus variables were added to each energy constraint to allow storage or depletion of energy reserves. Each Mcal mobilized to meet maintenance requirements required 1.25 dietary Mcals to return to the original body condition (NRC). Condition scores at calving were constrained to be 5 or higher (Morrison and Castle, Wickse et al., Odde).

Dry matter intake constraints were represented by equation (4), where t_{ij} denotes the dry matter content of the j^{th} feedstuff in the i^{th} month. The right-hand-side term is composed of per cow monthly dry matter intake capacity (r_i) multiplied by the number of cows (n) entering the solution. Limited intake capacity forced cows to consume forage sufficiently rich in nutrients to satisfy requirements. Low cost, low quality forages may require additional supplementation, potentially increasing the cost of the total ration.

The model was based on the assumption of limited grazable forage, with constraints represented by equation (5). Hay and supplement were assumed available in unlimited quantities. The symbol y_j represents the yield (AUMs/acre) of the j^{th} forage alternative and f represents the acreage limit imposed on the model. Total rangeland available was 20,000 acres, of which 10 percent (2,000 acres) was suitable for basin wildrye establishment. Limited grazing resources required the model to choose between winter and non-winter grazing and determine the number of animals supported by the resources and management system. This provided the framework to model the trade-off between lower feed costs and reduced carrying capacity as grazable forage was shifted from summer to winter consumption.

Defining a model ranch that represents all operations in a given region is difficult because each has a unique resource endowment. Parametric analysis was conducted to assess the sensitivity of the results to changes in forage resource assumptions.

Cost and Return Estimates

Returns per cow were obtained from USDA-ERS cow/calf cost and return estimates for the Western United States for the period 1988 to 1997. Values were inflated to 1997 dollars using the GDP implicit price deflator. After feed and grazing costs were subtracted from the budgets, an average of $268 per cow was obtained. Revenue estimates included a weighted average weaned and yearling calf, fed steer, and cull cow price. Non-feed variable costs included bulls, marketing, trucking, fuel, repairs, and miscellaneous charges. Fixed costs, including taxes, insurance, depreciation, and utilities, were not included in the model, as these costs do not vary with cattle numbers. Returns per cow represent d in equation (1) and are interpreted as returns to feed, fixed costs, and management.

Forage alternatives were valued at their estimated opportunity cost reflected by market prices (AAEA Task Force). Valuing forages at their opportunity cost implies they can be shifted to alternative uses if not employed in the feeding program. Basin wildrye and native range forage were assigned equivalent opportunity costs per AUM (animal unit month) in the model. Alfalfa and grass hay were valued using an eight-year average Wyoming price of $77 and $71/ton, respectively (Wyoming Department of Agriculture). An $8/ton feeding charge and a 10 percent hay waste adjustment were assumed. Protein supplement (20 percent) was priced at $210/ton. Basin wildrye establishment costs were annualized using the cost recovery method with a 7 percent discount rate (AAEA Task Force) over a 15-year period. Total annual basin wildrye establishment costs were estimated at $13/acre. Grazing costs were adapted from Van Tassell et al..

Site guides developed by the USDA-SCS along with data collected by Sedivec and Murphy were used to estimate relative yields between basin wildrye and native forage. Suggested stocking rates are 0.5 to 0.6 AUMs/acre on native range sites in excellent condition and 0.2 to 0.3 AUMs/acre on sites in fair condition (USDA-SCS). Basin wildrye dry matter yields range from 0.5 to 2.5 tons per acre depending on precipitation and location (Sedivec, Murphy). These results suggest basin wildrye yield may vary from 0.25 to 3.3 AUMs/acre.

Protein and energy requirements were obtained from the National Research Council. Energy requirements in NRC tables were developed for cattle under thermo-neutral conditions. Range cattle are typically exposed to wind and bitter temperatures during the winter. Additional energy is required to maintain a cow under these conditions. An adjustment factor, therefore, was estimated to account for additional energy requirements imposed by cold stress (Ames).

Nutritional quality of native range was taken from Younglove. The values for alfalfa and grass hay were obtained from the NRC feed library. Nutritional quality of dormant season basin wildrye was taken from Jensen (unpublished data) and Sedivec. These studies did not estimate NE_m/lb of forage for basin wildrye. A subjective assessment, therefore, was made based on the correlation between TDN and NE_m/lb of native range found in the NRC Feed Library.

Sensitivity Analysis

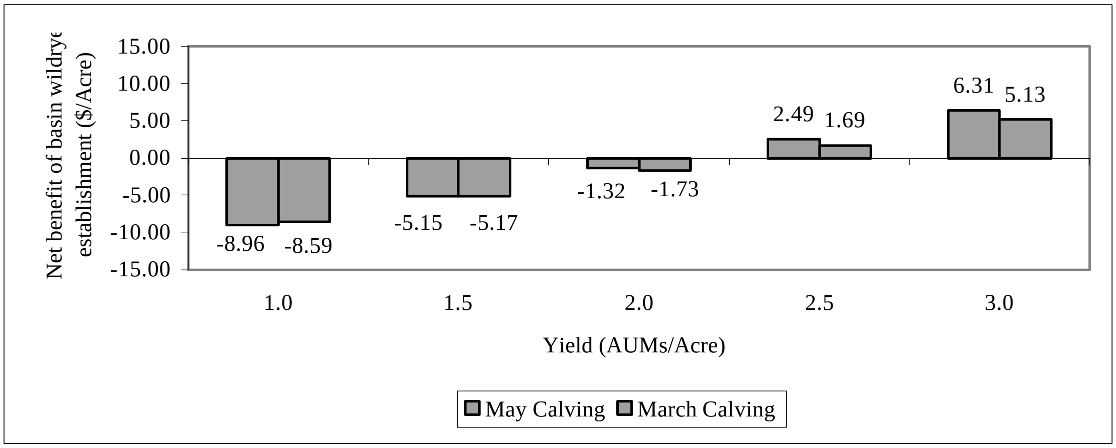
Mathematical programming assumes parameter and constraint values in the model are known with certainty. This model required specifically defined values to represent costs, forage nutritional quality, and biological interactions. Many of these values are not well documented and may change depending on location and type of operation. Sensitivity analysis was conducted to test the robustness of the results to changes in input values. Probability distributions were assigned to input variables such as costs and nutritional values. Simulation software (Palisade) was used to randomly select values of these inputs based on the specified distributions. The MIP model was solved after each random selection. This process was repeated for 500 iterations. A Spearman rank correlation coefficient (Groebner and Shannon) between the profitability of grazing basin wildrye and the random input values was calculated. The absolute magnitude of these correlation coefficients identified which input variables influenced the value of basin wildrye establishment.

RESULTS AND DISCUSSION

Figure 1 shows the estimated net benefit of basin wildrye establishment for winter grazing under various yield scenarios. A yield of 0.4 AUMs/acre on rangeland suitable for basin wildrye was assumed. The expected benefit of grazing basin wildrye did not offset the cost of establishment until the yield approached 2.5 AUMs/acre in the May calving scenario and 3.0 AUMs/acre in the March calving scenario. A yield less than the estimated break-even implied it was more profitable to graze forage in the summer and feed hay during the winter than incur the cost of establishing basin wildrye for winter grazing.

Table 1 shows results assuming a May calving season and break-even combination of basin wildrye and native range forage yields. The optimal herd size when winter grazing was not available (December through March) was 758 cows. Approximately 1.4 tons of

Figure 1. Net benefit of basin wildrye establishment under May and March calving, along with various basin wildrye yield scenarios.



hay was consumed annually per head. Winter grazing decreased per cow hay consumption to 0.6 tons annually. Basin wildrye was utilized November through March. The average ration consisted of 18.5 lbs. of basin wildrye and 6.8 lbs. of hay. An estimated outlay of $132,000 in establishment costs (annualized cost of $21,700 amortized over 15 years) was required to establish the 1,859 acres of basin wildrye required to support winter grazing.

Basin wildrye establishment was less favorable in the March calving than the May calving scenario. When winter grazing was not available, the optimal size of a March calving herd was 873 cows and annual hay consumption was 1.7 tons per head. Allowing grazing through the winter months shifted 814 acres of rangeland from summer to winter grazing and reduced hay feeding to 1.1 tons per cow. The higher basin wildrye forage yields relative to native range increased carrying capacity and herd size to 903 cows. The importance of fat reserves as a winter energy source was less than anticipated. Energy deficiencies in both calving scenarios occurred in early fall before basin wildrye was

Table 1.Comparison of the mixed integer-programming model results including and excluding winter grazing for a cowherd under May and March calving scenarios.

		Calving month			
		May		March	
	Units	Excluding	Including	Excluding	Including
Basin wildrye	AUMs	0	2132	0	2016
Basin wildrye	Acres	0	859	0	814
Hay per cow	Tons/Cow	1.5	0.6	1.7	1.1
Supplement	Lbs/Cow	0	18	1631	0
Cows	Head	758	755	873	903
Returns	$	37091	50337	24509	36436
Annual BW cost	$	0	13237	0	12544

available as a feed. Protein was primarily the limiting nutrient during winter months in the May calving model. Energy requirements, therefore, were exceeded as protein requirements were met. Mobilization of fat reserves was constrained between January and May for the March calving scenario. Consequently, energy reserves did not have a significant impact on the profitability of basin wildrye establishment under either calving scenario.

Changing the amount of rangeland available did not affect per acre profitability of basin wildrye establishment. The model simply increased or decreased range cow numbers in response to a proportional change in rangeland. The assumption regarding the proportion of rangeland available to basin wildrye establishment did not effect the results, as the 2,000 acres available for establishment was non-binding in the model.

May and March calving scenarios achieved a profitability level of $0.00 or less in approximately 70 and 72 percent, respectively, of the observations. Thus, under the assumptions specified in the stochastic sensitivity analysis, replacing good quality range forage with basin wildrye would not likely be a recommended strategy to increase winter grazing. The March calving scenario experienced a wider range of profitability than the May calving scenario, which suggests basin wildrye establishment may be a riskier investment for a March calving operation.

Spearman rank correlation coefficients were calculated from the stochastic simulation analysis to test the impact each random input variable had on the profitability of basin wildrye. Five input variables had a significant impact ($P = 0.05$) on the results of the May calving scenario, while six variables were significant in the March calving scenario. Basin wildrye yield had the highest impact on profitability in the May calving scenario (correlation = 0.33), followed by the nutritional value of basin wildrye (correlation = 0.13) and hay (correlation = -0.12). The input variables having a significant ($P = 0.05$) impact on basin wildrye profitability in the March calving scenario include basin wildrye yield (correlation = 0.21), the nutritional quality of basin wildrye (correlation =0.196), and the nutritional value of alfalfa hay (correlation = -0.141). The cost of grass and alfalfa hay also carried a significant positive correlation with basin wildrye profitability in the March calving scenario, with correlation coefficients of 0.201 and 0.226, respectively.

CONCLUSIONS

Results from the MIP and simulation analysis suggest that replacing good quality forage with basin wildrye for winter grazing would likely have a negative impact on profitability, even when existing forage is inaccessible during the winter. Available data suggest yields are not likely to be consistently high enough to offset establishment costs, and feeding hay would be a less expensive alternative. Profitability may be increased by substituting grazing for hay, consistent with the conclusions of Adams et al. and D'Souza et al., if a less expensive source of winter forage is available. Sensitivity results show relative yields between native range and existing forage carry the highest impact the decision to establish basin wildrye. Further research in this area is suggested to establish a more conclusive evaluation of basin wildrye introduction.

These results are based on a comparison between the cost of establishing basin wildrye and utilizing existing forage lands that are in good condition. Other conditions exist that may lead to basin wildrye establishment being profitable, including the relative yield and nutritional quality of basin wildrye, native rangeland forage, and hay. The decision to establish basin wildrye depends on the management objectives and climatic conditions of the ranch operation. If the decision to undertake a reclamation project has previously been made, basin wildrye may be a good choice if winter grazing is a management objective. The needs of the operation should be carefully assessed, however, before proceeding. For example, basin wildrye provides forage and protection from the elements in areas that typically experience deep snow and bitter winter weather. Conversely, several wheatgrass varieties appear to possess superior nutrient retention qualities during the dormant season relative to basin wildrye (Jensen, personal communication) and may be a better choice if snow cover is not a factor.

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