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ECONOMIC ANALYSIS OF CONTROLLING LEAFY SPURGE WITH SHEEP

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Abstract

Leafy spurge (*Euphorbia esula* L.), a widely established exotic, noxious, perennial weed, is a major threat to rangeland and wildland in the Upper Great Plains. Chemical, biological, and cultural control methods have limitations in their applicability and effectiveness in treating leafy spurge. However, many of the constraints prohibiting the use of herbicides, tillage, and biological controls do not apply to sheep grazing. Sheep grazing, while known to be effective in controlling leafy spurge since the 1930s, has lacked widespread adoption as a leafy spurge control.

A deterministic, bioeconomic model, incorporating relationships between sheep grazing and leafy spurge control, grass recovery, and forage use by cattle, was developed to evaluate the economic viability of using sheep to control leafy spurge. Discounted annual control costs were compared to discounted annual control benefits over 5-year, 10-year, and 15-year periods.

Various scenarios were developed depicting likely situations involving adopting a sheep enterprise or leasing sheep for leafy spurge control. Situational factors considered included fencing expenses, debt considerations, grazing values, infestation size, infestation canopy cover, rangeland productivity, and flock performance. Two levels of flock profitability, one based on a level of proficiency achieved by sheep ranches and one substantially lower than typically achieved in the sheep industry, represented best-case and worst-case situations, respectively.

In the best-case situations, using sheep to control leafy spurge was economical in all of the control scenarios examined. However, in the worst-case situations, economics of using sheep to control leafy spurge were mixed across the scenarios examined. Leafy spurge control with poor sheep management, high fence expense, and unproductive rangeland generally was not economical. However, situations with low fencing costs, moderately productive rangeland, and poor sheep management resulted in less economic loss than no treatment.

Although many of the key relationships tying leafy spurge control to grazing benefits remain unquantified, the economics of sheep grazing were positive across many of the scenarios evaluated in this study. Actual returns from leafy spurge control for most ranchers will likely fall between the two extremes examined. As a precaution, careful evaluation using site- and rancher-specific inputs would be recommended before implementing sheep grazing as a leafy spurge control method.

Key Words: Leafy Spurge, Weed Control, Sheep Grazing, Economics

Highlights

Leafy spurge (*Euphorbia esula* L.), a widely established exotic, noxious, perennial weed, is a major threat to rangeland and wildland in the Upper Great Plains. Chemical, biological, and cultural control methods have limitations in their applicability and effectiveness in treating leafy spurge. However, many of the constraints prohibiting herbicides, tillage, and biological controls do not apply to sheep grazing. Sheep grazing, while known to be effective in controlling leafy spurge since the 1930s, has lacked widespread adoption as a control method.

A deterministic, bioeconomic model was developed to evaluate the economics of using sheep to control leafy spurge. Relationships between sheep grazing and leafy spurge control, leafy spurge spread, grass recovery, and grass use by cattle were developed from secondary sources and consultation with weed and range scientists. The model estimates the economic feasibility of using sheep to control leafy spurge using two economic measures: (1) benefit-cost analysis, which compares treatment costs (sheep enterprise returns and fencing expenses) with treatment returns (grazing outputs retained from preventing spread and grazing recovery from within infestations) and (2) least-loss analysis, which compares losses with sheep grazing to losses without control. The economic viability of using sheep to control leafy spurge was evaluated by discounting treatment costs and benefits over 5-year, 10-year, and 15-year periods.

A basic premise of this study was that sheep would be acquired for leafy spurge control through leasing or adding a sheep enterprise to an existing ranch. Seasonal and rotational grazing strategies were considered under a mixed-species approach. Both seasonal and rotational grazing systems would last four months, with rotational grazing consisting of a twice-over approach using alternating 1-month periods per pasture.

Sheep enterprise budgets were developed to accommodate different combinations of flock performance, debt structure, and flock size, reflecting likely situations facing cattle ranchers adopting a sheep enterprise for leafy spurge control. Sheep enterprises were based on lambing in February, with spring lambs retained and sold in the fall as market lambs, and ewes and rams used for grazing leafy spurge. Net returns to unpaid labor, management, and equity for the enterprises initially ranged from $45.21 per ewe (best-case scenario) to ($5.58) per ewe (worst-case scenario). Budgets were generated to accommodate changes in flock size and debt expiration during a 10-year period. Sheep leasing was based on rental rates of $1 and $2 per ewe per month grazed.

Fencing expenses included modifying an existing fence or constructing new fence. Modified fencing was based on adding 2 barb wires to an existing 3- or 4-wire fence. New fence required 6 barb wires, line posts, and corner posts. Fencing costs were estimated for various pasture sizes and were calculated independent of the sheep enterprise budgets.

A number of situations or scenarios were used to evaluate the economics of using sheep to control leafy spurge. However, pasture size was limited to 350 acres, infestation sizes were set at 50 and 250 acres, infestation spread was set at 2 radial feet per year, infestation canopy cover was

assumed to increase by 1.5 percent annually, and AUMs were valued at $15. Infestation cover included 5, 15, and 30 percent, which represented low (17 percent loss), moderate (50 percent loss), and high (100 percent) grazing losses (for cattle) within the leafy spurge infestation, respectively. All situations were evaluated at carrying capacities ranging from 0.20 to 0.90 AUMs per acre.

In the best-case scenarios (i.e., those typified by positive enterprise returns), net returns (treatment benefits less control costs) from leafy spurge control under seasonal grazing strategies were substantial in all periods. In the 5-year period, discounted net returns from leafy spurge control ranged from about $80 to $180 per acre, depending upon infestation size, fencing expenses, infestation cover, and carrying capacity. Over 10 years, discounted net returns ranged from $150 to $270 per acre. In a 15-year time frame, discounted net returns ranged from $170 to $340 per acre.

In the worst-case scenarios, (i.e., those typified by negative enterprise returns), discounted net returns from leafy spurge control under seasonal grazing strategies ranged from about ($50) to $18 per acre in the 5-year period, depending upon infestation size, fencing expenses, infestation cover, and rangeland carrying capacity. Over 10 years, discounted net returns from control ranged from ($75) to $50 per acre. In a 15-year time frame, discounted net returns ranged from ($85) to $80 per acre. The situations where net returns from control were negative included those with low leafy spurge cover, high fencing expenses, low rangeland carrying capacities, and negative enterprise returns.

Over the 5-year period in the worst-case scenarios, only situations with high rangeland productivity and high leafy spurge cover (15 to 30 percent) resulted in less economic loss than with no control. With 5 percent leafy spurge cover, none of the scenarios with negative enterprise returns would be recommended, as economic losses with control exceeded losses without control. Over the 10-year period, most scenarios with high rangeland productivity and high leafy spurge cover resulted in less economic loss than with no control. Many of the worst-case situations with new fence and low leafy spurge cover would not be recommended within the 10-year period. However, with new fence and high leafy spurge cover, both large and small infestations could be recommended for all but the least productive rangeland. Over the 15-year period, many of the scenarios with large infestations or with modified fence would be recommended. However, even within the 15-year period, some new fence scenarios would not be recommended.

The economics of leasing sheep for leafy spurge control were evaluated using $1 and $2 per head per month lease rates with seasonal grazing strategies. In the 5-year period, returns for the $1 lease rate varied from ($32) to $11 per acre. No scenarios produced positive net returns in the 5-year period with the $2 lease rate. In the 10-year and 15-year periods, no scenarios with low levels of leafy spurge cover produced positive net returns with the $1 lease rate. With high levels of leafy spurge cover, the $1 lease rates provided positive net returns only in rangeland with carrying capacities of 0.40 AUMs per acre or higher. With the $2 lease rate, only scenarios with high levels of leafy spurge cover and high rangeland carrying capacities produced positive net returns from leafy spurge control in the 10-year and 15-year periods.

Generally, lease rates of $2 per head per month were not economical in most control situations. However, a lease rate of $1 per head per month was economical in many of the control situations examined.

A multitude of factors can influence the economics of using sheep to control leafy spurge. One of the biggest factors influencing returns from leafy spurge control was enterprise returns, or more fundamentally, flock performance (e.g., lambing rate, weaning weight, death loss). When flock performance approached the level obtained by proven sheep producers, enterprise returns were positive, and subsequently net returns from leafy spurge control were positive.

The economics of using sheep grazing to control leafy spurge appear promising. Although many of the key relationships tying leafy spurge control to grazing benefits remain unquantified, the economics of sheep grazing were positive across many of the scenarios evaluated in this study. A number of factors influenced both the costs and returns from using sheep grazing as a leafy spurge control. General flock performance (e.g., lambing rate, weaning weight, death loss) had the greatest effect on returns from leafy spurge control. Other considerations, such as fencing expenses and enterprise debt, also influenced returns from control. Small flocks (flock size was tied to leafy spurge acreage) were less economical than large flocks. Also, leafy spurge canopy cover, AUM values, and rangeland productivity each directly (proportional to changes in those values) affected returns from control. However, even some of the most pessimistic situations (e.g., poor flock performance, debt overhead, new fence expenses) resulted in less economic loss with grazing controls than without controlling leafy spurge. However, many situations were also not economical.

While using sheep to control leafy spurge could be economical in many situations (based on the limitations in this study), a careful evaluation using site- and rancher-specific inputs would be recommended before implementing sheep grazing as a leafy spurge control method. As with any decision regarding a long-term strategy to control leafy spurge, information in this study should be used in conjunction with other information and with consultation with weed scientists when formulating long-term control strategies.

Economic Analysis of Controlling Leafy Spurge with Sheep

Dean A. Bangsund, Dan J. Nudell, Randall S. Sell, and F. Larry Leistritz*

INTRODUCTION

Leafy spurge (*Euphorbia esula* L.), first introduced in North America in the 19th century, was found in North Dakota in 1909, and was considered a threat to rangeland in the Great Plains as early as 1933 (Hanson and Rudd 1933). The weed currently infests large amounts of untilled land in the Plains and Mountain states. Once established on untilled land, the weed spreads quickly, displacing native vegetation. Leafy spurge has unique characteristics that give it a competitive advantage over most native plants and provide it with natural defenses against cattle grazing. Leafy spurge can create serious economic losses for land owners and ranchers (Leitch et al. 1994).

Current control technologies are ineffective in eradicating established infestations. Although leafy spurge can be controlled through chemical, biological, and cultural methods, each control approach has limitations in its applicability and effectiveness in treating all leafy spurge infestations. Cultivation will control and can eradicate leafy spurge, but this method is not feasible on most rangeland and other untillable land. Herbicides often have economic and environmental restrictions and constraints prohibiting their use (e.g., riparian areas, wooded areas, areas inaccessible to sprayers, uneconomical on large infestations); although they remain the most widely used control method (Sell et al. 1998). Biological controls, while showing promise in becoming an effective tool to control leafy spurge, will not control all leafy spurge infestations (Bangsund et al. 1997; Hansen et al. 1997). Biological agents have been unable to establish on many leafy spurge infestations in the upper Great Plains. Cultural methods such as burning and mowing, by themselves, are generally ineffective in controlling infestations (Lym and Zollinger 1995). Reseeding untillable lands with competitive grasses has many of the same limitations found with using cultivation as a control method. Grazing with sheep and goats, while known to be effective in controlling leafy spurge since the 1930s, has lacked widespread adoption (Sedivec et al. 1995; Sell et al. 1998).

Regardless of the control method employed, many factors affect the economic feasibility of leafy spurge treatments. The long-term economic feasibility of herbicide control of leafy spurge has been examined (Bangsund et al. 1996) but few analyses of the long-term economic feasibility of using sheep and/or goats have been conducted. Williams et al. (1996) showed that adding a sheep enterprise to an existing ranch to control leafy spurge could be profitable. Generally, using a sheep enterprise to utilize lost forage (i.e., lost to cattle) from leafy spurge infestations was economical under a variety of infestation rates and pasture sizes, providing net returns from the sheep enterprise were positive. Williams et al. (1996) did not evaluate the economic feasibility of using sheep to control leafy spurge when enterprise net returns were negative or evaluate the economic feasibility of leasing animals for control purposes. Many questions remain regarding the economic feasibility of using sheep to control leafy spurge.

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A goal of this study is to help determine how sheep grazing could fit into an integrated pest management approach to control leafy spurge by providing economic information for land owners to use in assessing their long-term control strategies. Leafy spurge can be controlled using chemical, cultural, and biological methods. However, the economic feasibility and applicability of leafy spurge controls varies by the size and nature of leafy spurge infestations and by the type of control method. Generally, herbicides appear to be economical on small patches. However, not all small patches are suitable for herbicides (e.g., riparian areas, sprayer accessibility). Herbicides, used in conjunction with tillage and reseeding, have been shown to be effective in leafy spurge control, but tillage techniques are not suitable in most rangeland situations. Where suitable, biological agents may offer an economically attractive solution. But as current research has shown, not all leafy spurge infestations will support biological agents. However, many of the constraints prohibiting herbicides, tillage, and biological controls (i.e., prohibitive expense, unsuitable land, and physiological barriers) do not appear to eliminate sheep grazing as a possible control.

A logical scenario (control approach) in the future may be the use of sheep to control infestations which are not appropriate or feasible for spraying, tillage, or biological agents or use sheep grazing in combination with other controls. Sheep grazing will have a role to play in the control of leafy spurge. However, additional information on the financial and economic constraints on using sheep grazing to control leafy spurge is needed.

OBJECTIVES

The purpose of this report is to evaluate the economic feasibility of using sheep to control leafy spurge in rangeland. Specific objectives include:

1) estimate the benefits of using sheep for leafy spurge control,

2) estimate the costs of using sheep for leafy spurge control,

3) identify factors affecting the economics of using sheep to control leafy spurge, and

4) evaluate the long-term economic viability of using sheep to control leafy spurge.

PROCEDURES

Two major efforts were required to assess the economic feasibility of using sheep to control leafy spurge. First, a model was developed to track the benefits and costs of leafy spurge control. Second, the costs and returns for sheep enterprises, under various conditions, were estimated. The following sections describe these procedures.

Model Design

Leafy spurge control is a long-term management problem since (1) the weed cannot be eradicated economically with current technology,[1] (2) uncontrolled infestations have detrimental long-term consequences for grazing land, and (3) time lags often exist between treatments and returns. The overall framework for the economic analysis was based on evaluating grazing scenarios that would most likely be incurred by ranchers adopting sheep or goat grazing as a control method.

A deterministic, simulation model was developed to evaluate the economics of using sheep and goats[2] to control leafy spurge. The model was also used to determine which variables influence the economic feasibility of various grazing strategies. Economic feasibility compares long-term costs with long-term benefits. Financial feasibility, which generally addresses cash flow issues and financial constraints, was not addressed. From a rangeland management perspective, leafy spurge primarily affects cattle grazing. The basic premise of this study is that sheep or goat grazing (of leafy spurge) will be used by ranchers to improve grazing output for cattle in leafy spurge infested rangeland. General model design was adapted from Bangsund et al. (1996).

Given an initial leafy spurge infestation, the model predicts leafy spurge spread and the corresponding annual losses in grazing output from that infestation (Figure 1). The effects of sheep or goat grazing on infestation canopy cover (i.e., density), spread rates, grazing recovery rates, and grass rejuvenation were incorporated. The dynamics of control (i.e., changes in canopy cover, rate of spread, and grass recovery) were based on secondary information and consultation with weed and range scientists. The economic feasibility of using sheep to control leafy spurge was evaluated using various scenarios which reflect likely situations facing cattle ranchers adopting a sheep enterprise for leafy spurge control.

[1]Leafy spurge has been eradicated using tillage activities in combination with fertilization in cropland (Lym and Messersmith 1993). However, the techniques used are not feasible in most grazing land situations.

[2]The economics of goat grazing were not evaluated in this study; however, the effects of goat grazing of leafy spurge and the capacity to evaluate the economics of goat grazing were incorporated into the model.

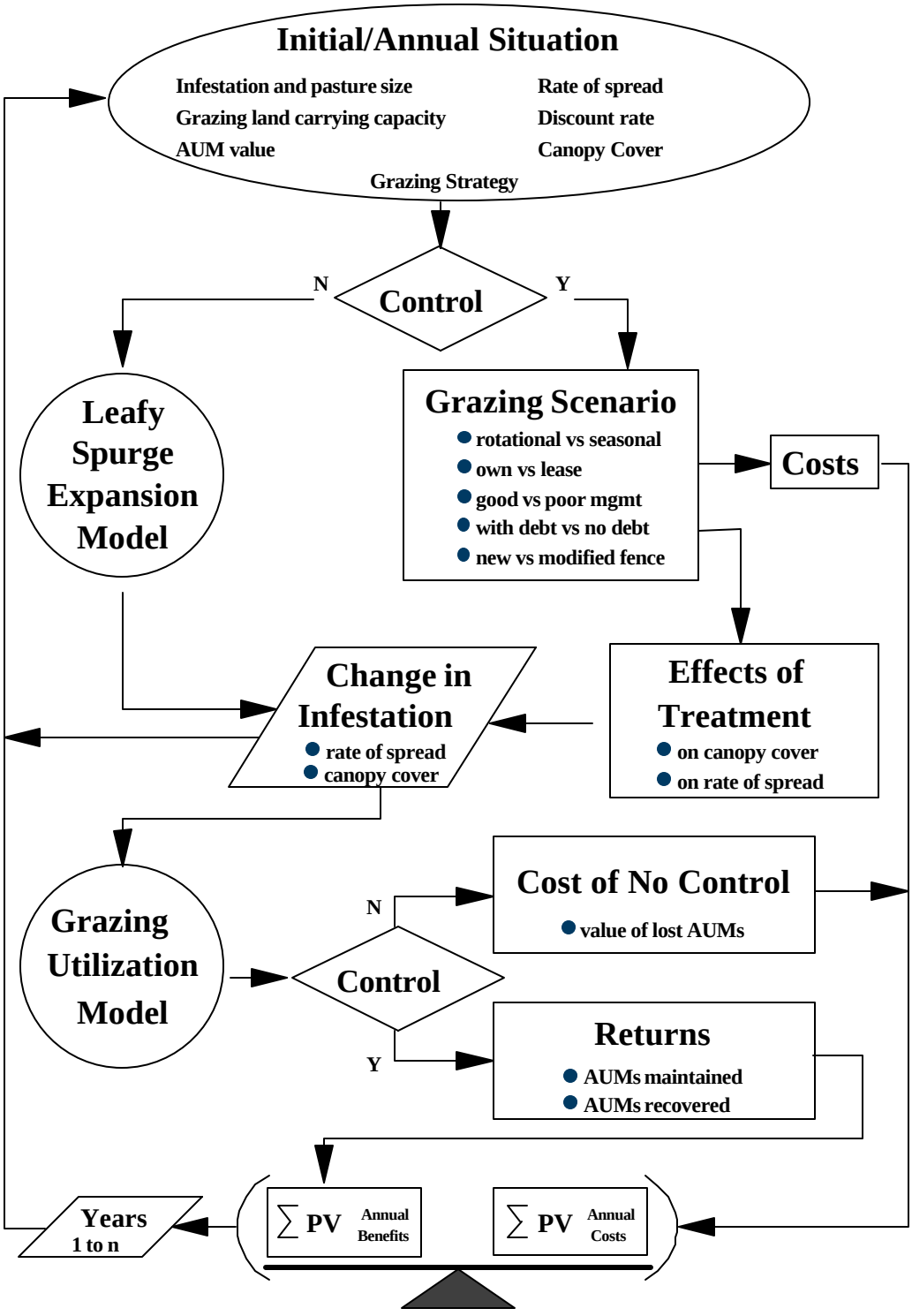

Figure 1. Economic Evaluation Model of the Control of Leafy Spurge Using Sheep and Goat Grazing

The annual difference between treatment expenses and the value of grazing outputs recovered and retained through treatment were discounted over time (up to 15 years) to provide a long-term perspective[3] for various control scenarios. A 4 percent discount rate was used. A lower rate would improve the value of returns relative to the costs of grazing control, conversely a higher rate would reduce the value of returns relative to costs.

Model Components

The key components of the grazing control model included the interaction or relationship between leafy spurge control using sheep or goats and forage recovery by cattle, sheep enterprise budgets, a leafy spurge growth (patch expansion) component, and an economic analysis component.

Leafy Spurge Expansion

Leafy spurge expansion was based on a model adapted from Bangsund et al. (1993). Established leafy spurge infestations in the Upper Midwest expand at a rate of about two radial feet annually. However, the rate of annual spread was allowed to change, accounting for possible variations in growth environments. Unless the growth rate was modified, expansion in this study was assumed uninterrupted without constraints from other weed patches, cropland boundaries, water boundaries, roadways, or other natural or man-made obstacles. The effect that existing infestations may have in the establishment of new patches was not considered. Also, the benefit of reducing or eliminating seed production was not included in the model.

Leafy Spurge Control

Rotational (two 1-month periods) and seasonal (4 months) grazing strategies were considered. In a rotational system, sheep or goats would alternate monthly between two pastures during the grazing season. Each pasture would be grazed a total of two nonconsecutive months, but each pasture would be grazed at a higher stocking rate than the seasonal grazing approach. Sheep or goats were assumed to be on summer pasture for a total of four months. The second strategy would use grazing animals for an entire season in one pasture. Seasonal grazing strategies would use a lower stocking rate than used in the rotational system. Both grazing systems would be expected over time (several grazing seasons) to reduce existing infestation canopy cover and also prevent plant spread.

A mixed-species grazing approach was assumed. Research has indicated that one ewe can be added per cow without affecting cattle production (Umberger et al. 1984; Glimp 1988; Nelson et al. 1992; Sedivec 1995). The acreage of leafy spurge was used to determine the number of sheep required for control. Adding sheep at a rate of one ewe per acre of leafy spurge was assumed to not

[3]The model was designed to evaluate the economics of grazing scenarios over various time periods; however, many of the model parameters for leafy spurge control, grass use, forage recovery, etc. were only estimated over a 10-year period. Even within the 10-year time horizon, many of those relationships represent "best estimates" of range and weed scientists. Thus, for analyses using the 15-year time horizon, model parameters were held constant at the rate or level incurred in year 10. For example, leafy spurge control in year 13 would equal the level of control prescribed in year 10.

violate the rule of adding one ewe per cow to a given pasture. The type of grazing strategy influenced the stocking rate for sheep in the pasture (Appendix A). The stocking rate for cattle was assumed to remain unchanged the first year of sheep grazing and assumed to increase over time as the carrying capacity (for cattle) increased with improved levels of leafy spurge control. [Note: the model valued the change in grass production (in AUMs) and assumed (1) ranchers adjusted cattle stocking rates or grazing duration to accommodate the increase in grazing output, (2) initial cattle stocking rates were appropriate for the land prior to leafy spurge treatment, and (3) reductions in sheep stocking rates were implemented over time].

Leafy spurge control using sheep or goat grazing was based on information obtained from secondary sources and consultation with weed and range scientists. Control of leafy spurge was modeled as a function of time (i.e., years grazed), assuming the same flock is used to graze leafy spurge each year and that proper stocking rates are maintained (Figure 2). In a seasonal grazing strategy, leafy spurge control remains relatively low during the first three years; however, control increases substantially in subsequent years. In a rotational grazing strategy, leafy spurge density was modeled to actually increase after the first season. However, after the third year of a rotational grazing strategy, leafy spurge control begins to parallel control found with a seasonal strategy. After 10 years of sheep grazing, annual control in both strategies is maximized; however, the amount of annual reduction in canopy cover with rotational grazing remains less than seasonal grazing. Control in years 4 through 10 are based on "best estimates" by weed and range scientists, since sufficient information from range and grazing trials was not available. Control was defined as a percentage of the previous year's density or canopy cover {e.g., density(year 2)-[density(year 2) x control(year 2)] = density(year 3)}.

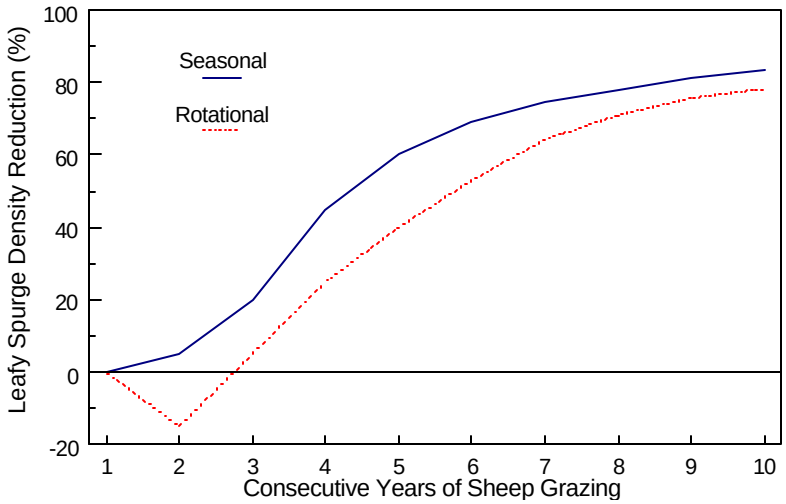

Figure 2. Leafy Spurge Control with Sheep Grazing, Seasonal and Rotational Strategies

The rate of leafy spurge spread under sheep and goat grazing was modeled as a function of the number of years of grazing. Since the model can accommodate various rates of expansion, reduction in the rate of spread was estimated as a percentage of actual spread (Figure 3). In a seasonal grazing strategy, leafy spurge expansion is halted in the fourth year of sheep grazing. In a rotational grazing strategy, five years of sheep grazing would be required to halt leafy spurge expansion.

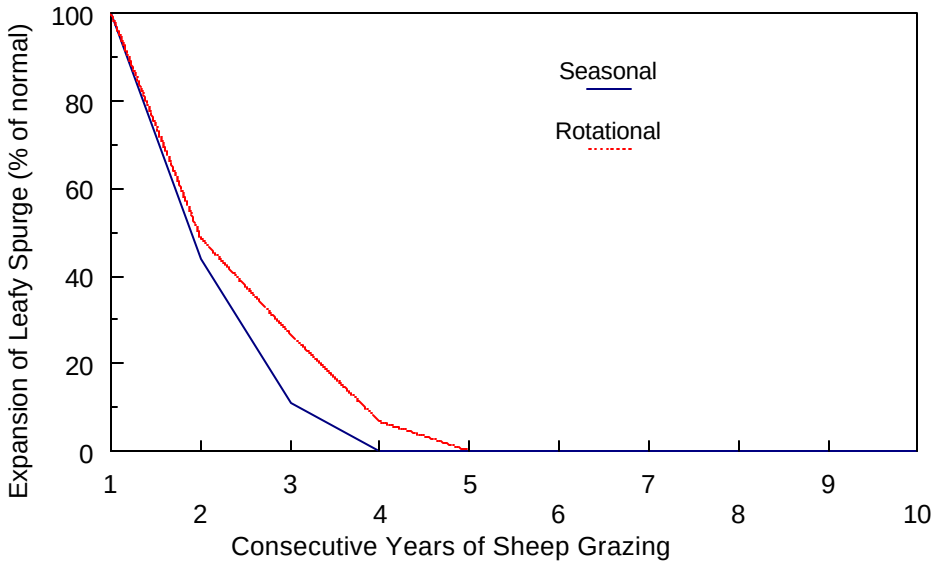

Figure 3. Rate of Leafy Spurge Expansion with Sheep Grazing, Seasonal and Rotational Strategies

Grazing Reduction Model

One of the key components in the model is the relationship between infestation density or canopy cover and lost grazing capacity (for cattle). In order to estimate the losses from leafy spurge infestations, the analysis of the economics of sheep grazing required estimating the amount of forage lost to cattle that results from various leafy spurge infestations. The interaction between lost grazing capacity (cattle) and infestation canopy cover was estimated from consultation with range scientists (Appendix A). The degree of lost grazing capacity within a leafy spurge infestation was estimated as linear function of canopy cover (Figure 4). Cattle avoid grazing within leafy spurge infestations, and this avoidance becomes acute with modest infestation densities. Once a leafy spurge infestation represents about one-third of the canopy cover (top growth) within the patch, grazing consumption by cattle within the infestation has been eliminated (assuming the stocking rate for cattle is proper for the carrying capacity of the land). The model assumes that a 30 percent canopy cover would roughly translate to about 80 to 130 stems/M^2.

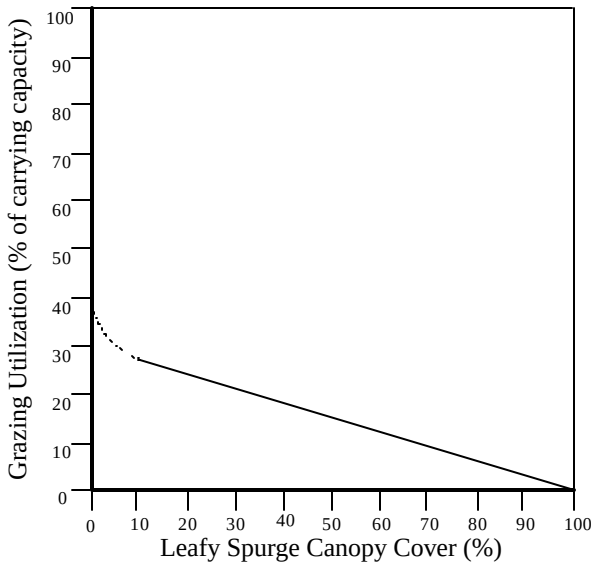

Figure 4. Reduction in Cattle Grazing within Leafy Spurge Infestations
Source: Kirby (1999).

Forage Recovery

The relationships between canopy cover reduction, grass utilization (cattle), and grass production over time were estimated from secondary sources (Lym et al. 1997; Sedivec et al. 1995) and from consultation with weed and range scientists (Appendix A).

The basic approach to estimating the amount of forage consumed by cattle was based on two factors: (1) the amount of grass available within leafy spurge infestations and (2) the amount of available grass that cattle would graze. The model assumes that as leafy spurge infestations increase in density, grass production within those infestations decreases (Figure 5). The relationship between leafy spurge density and grass production was based on the ability of leafy spurge to out compete native vegetation and create near monocultures (Watson 1985; Messersmith et al. 1985).

Since sheep will not eradicate leafy spurge, the model assumes that sheep will not eliminate enough leafy spurge to overcome cattle avoidance to grazing within leafy spurge infestations. Since control was based on a function of time, the rate of grass consumption by cattle was also modeled as a function of the number of years of sheep grazing (Figure 6). Thus, even after 10 years of control with sheep or goats, forage consumption by cattle within leafy spurge infestations was assumed to remain below that of uninfested rangeland, since some avoidance to grazing within the infestation would remain and grass production within the infestation would likely remain below that of uninfested rangeland, due to competition by leafy spurge roots. Grass production within the infestation was modeled to increase over time as infestation density was reduced; however, constraints on the increase in grass production were incorporated into the model to prevent forage production from equaling uninfested rangeland productivity (Appendix A).

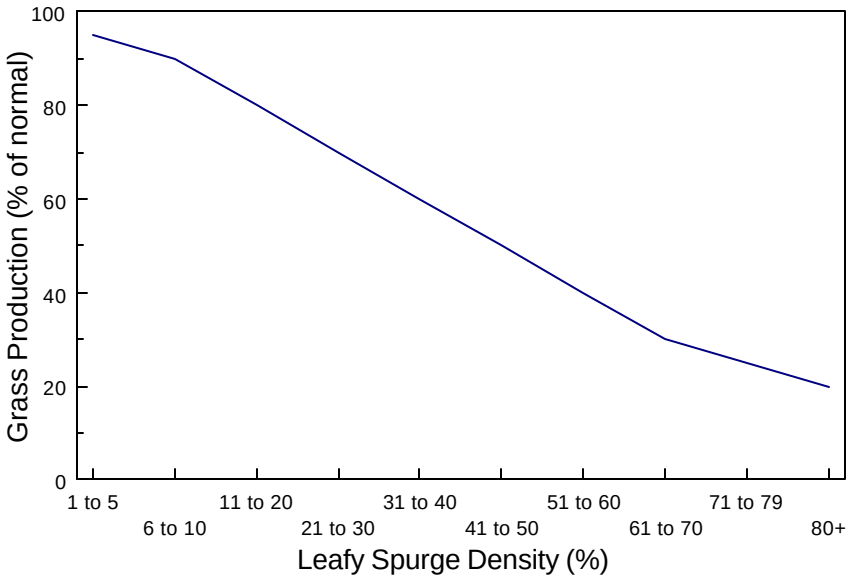

Figure 5. Relationship between Grass Production and Leafy Spurge Infestation Density

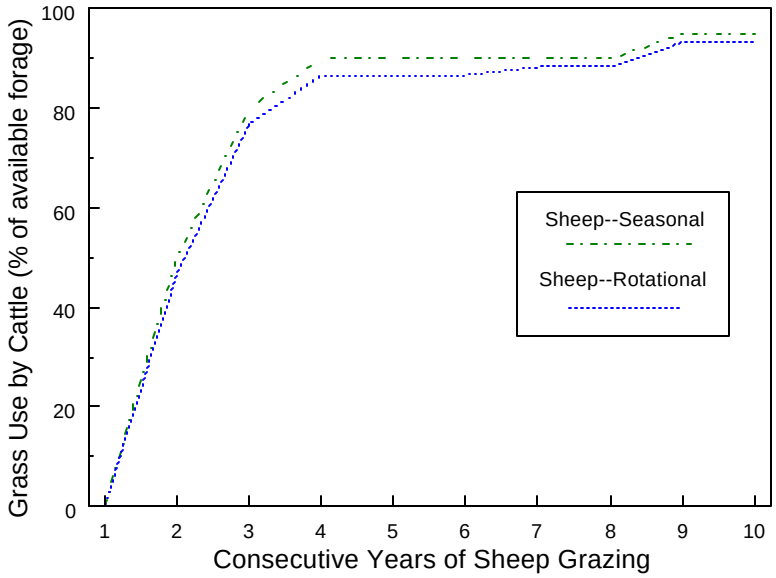

Figure 6. Grass Consumption by Cattle within Leafy Spurge Infestations Controlled with Sheep Grazing

Sheep Enterprise Budgets

A basic premise in this study was that sheep would be added to leafy spurge infested rangeland either through (1) adoption of a sheep enterprise by an existing ranch or (2) leasing sheep during the grazing season.

All budget scenarios, with the exception of the wether flock, represent typical sheep operations in western North Dakota. Breeding stock was commercial Western White-faced ewes and black-faced rams. Replacements were raised with spring lambs fed during the summer and marketed in the fall as slaughter lambs. Ewes were assumed to lamb in February. Only ewes and rams were assumed to be used for grazing leafy spurge.

Several possible sheep enterprise scenarios were budgeted. Flock performance will likely vary depending upon the management ability and animal husbandry of ranchers and producers. Some ranchers may be able to obtain higher flock performance or efficiency than others. Also, some ranchers or producers may be more willing or able to put the required time and effort into obtaining greater flock performance. Thus, budgets for good and poor flock performance were developed (Appendix B).

Financial capabilities and resources of ranchers and producers vary. Some ranchers may be able to readily adopt a sheep enterprise without financial difficulty; however, others may not have the necessary capital or funds for such a venture. Thus, budgets with no debt and partial debt (i.e., breeding stock and equipment) were developed (Appendix B).

Budgets for small and large flocks were developed to accommodate different levels of enterprise size. Small flocks were based on 60 ewes and large flocks were based on 200 ewes. Thus, budgets for eight combinations of flock performance, size, and debt for breeding flocks were developed (Appendix B).

Some ranchers and producers may wish to use sheep for leafy spurge control, but do not have the desire or ability to maintain a breeding flock. Thus, large, small, debt, and no debt budgets were developed for wether flocks (Appendix B).

After the first three or four years of a grazing control program, the number of sheep needed for leafy spurge control generally decreases (Sedivec et al. 1995). Initial stocking rates for sheep were based on geographic location within the state and the number of months grazed (Appendix A). Stocking rate reductions were estimated as a percentage of the initial stocking rate, based on species grazed and grazing system (Appendix A). Budgets for each production scenario were estimated for each year of a 10-year period to accommodate changing flock size and corresponding changes in debt (Appendix B). Production coefficients, selling prices, and variable expenses were fixed over the 10-year period. The amount of fixed expense, excluding debt costs, remained unchanged over the 10-year period; however, expenses per ewe changed with reductions in flock size (Appendix B).

In addition to estimating budgets for a variety of production scenarios, fencing costs were estimated separately for a variety of infestation and pasture sizes. Costs were developed for new fence construction and for modifying existing fence (Appendix C). Fence expenses (i.e., new or modified fence, debt or no debt) in the model were based on pasture size. In the scenarios that evaluated debt considerations, debt costs for a portion of the fencing expenses were also estimated (Appendix C). The model treated fencing costs separately (i.e., those costs were not specifically estimated in the initial budget analysis), instead, fencing costs were added to the overhead portion of the enterprise budgets after fencing expenses were estimated.

Model Outputs and Assumptions

The model starts with initial values describing the physical and economic characteristics of an infestation (e.g., infestation size, spread rate, grazing values). The opportunity cost of no control is measured by estimating the loss of grazing from the initial infestation and the subsequent losses from expansion. The benefits of control include (1) recapturing grazing outputs from current infestations and (2) maintaining existing grazing outputs by preventing infestation expansion. The costs of control included either (1) material, equipment, and rental expenses in the scenarios examining lease arrangements or (2) net returns from sheep enterprises. Net returns (revenues less expenses) from sheep enterprises could be positive or negative.

Grazing land output is typically measured by livestock carrying capacity. Carrying capacity was assumed to be the highest sustainable stocking rate possible without incurring damage to vegetation or related resources. Carrying capacities are generally measured in animal unit months (AUMs). An AUM is an average amount of forage needed to feed one animal unit (AU) for one month. An AU is typically considered a mature cow weighing approximately 1,000 pounds or an equivalent grazing animal(s) based on an average feed consumption of 26 pounds of dry matter per day (Shaver 1977). Carrying capacities of uninfested land were assumed to remain unchanged during the treatment period.

Grazing values were based on a reasonable range of AUM values varying from $12 per AUM to $18 per AUM. The range of AUM values used was based on grazing land rental rates and county-wide carrying capacities in North Dakota (Bangsund et al. 1996). Cash rents represent an analytically attractive measure of the value of grazing since (1) they should closely approximate the contribution of a unit of grazing to a rancher's income under conditions of a competitive market and (2) variations among rental rates for land tracts or areas should reflect differences in productivity.

A Grazing Reduction Model (GRM) (see Figure 4) was used to estimate grazing loss by cattle within leafy spurge infestations based upon infestation canopy cover. The GRM, carrying capacities, and infestation size were used to estimate the number of lost AUMs. The increase in available AUMs resulting from reductions in infestation densities and canopy cover were estimated using the relationships discussed in previous sections. Additional benefits of control were estimated from the difference in infestation spread following grazing treatment and infestation spread without control. The difference in infestation areas was used with carrying capacity rates and AUM values to estimate the benefit from preventing infestation expansion. The values of AUM retention (preventing spread) and AUM recovery (gain in grazing from reducing infestation density) were summed annually to estimate total

returns from control. Benefits less control costs were estimated annually and discounted back to the present to assess the economic viability of a control program.

The model was structured to assess grazing situations by (1) comparing only control costs with control returns (i.e., classic economic cost/returns approach) and (2) determining potential overall losses with control (using sheep) versus losses without control (i.e., least-loss or cost-effective approach). The first economic analysis considers only control benefits and costs. Grazing situations where cumulative discounted annual returns are greater than cumulative discounted annual costs are economically feasible. In the second approach, grazing situations that are not economical (i.e., discounted costs greater than discounted returns) may still result in less economic loss than incurred without control. Under those conditions, using grazing controls would be economically advisable, provided more economical control options were not available. In the event that existing grazing controls (regardless of the grazing strategy) result in more loss than without control, a "do nothing" strategy or one employing other methods (herbicides, biological, combined controls) might be optimal.

Sheep graze leafy spurge, but do not completely remove the influence of leafy spurge on cattle grazing. Thus, even with effective grazing control some grazing capacity likely would remain lost. The difference between uninfested grazing capacity (i.e., 100 percent of the highest sustainable rate) and grazing use after treatment of leafy spurge infested rangeland, represented the loss of grazing output with control. The value of this lost grazing capacity was combined with the costs of treatment and compared to the loss of grazing under no control. If the combination of grazing losses/gains from control and uncontrollable losses during treatment were greater than losses under no control, the use of that treatment option would result in greater loss than if no control was adopted.

Many of the components (e.g., forage recovery, leafy spurge control) in the model are based on “best estimates” of range and weed scientists, especially for periods that extend beyond current scientific data. The model was designed to accommodate changes in parameters as scientists quantify some of these relationships through trials and experiments. Thus, the usefulness and accuracy of the model can be increased as additional information becomes available.

RESULTS

The factors involved in leafy spurge control strategies are complex. A host of economic and environmental variables are involved with control decisions. The grazing strategies analyzed were based on either adopting a sheep enterprise or leasing sheep for purposes of control. Other options to using grazing controls may exist, but were not addressed in this study. Results are based on following prescribed guidelines for the length of grazing, timing of grazing, and use of proper stocking rates for control animals, and assume that provisions have been provided for acclimating grazing animals to leafy spurge. Not only will actual control and treatment conditions differ from the simulations used in this study, but economic variables (e.g., sheep costs and revenues, AUM values, fencing costs) and control applications (e.g., mixed rotational and grazing approaches, time of year that grazing animals are put on pasture) are likely to vary as well. Thus, economic evaluation of grazing options was conducted across a wide range of environmental and economic conditions.

Potential Returns to Control

The first step in evaluating the economic feasibility of long-term grazing controls was to estimate the potential returns from leafy spurge controls (foregone benefits of no treatment). The cost of no control includes lost grazing outputs from the current infestation plus lost outputs from infestation expansion. Losses from decreased land values were not included.

Grazing losses were measured using AUMs. Grazing losses from various infestation sizes were estimated for demonstration purposes (Table 1). For example, a 25-acre leafy spurge infestation, with a 30 percent canopy cover, over 10 years with normal expansion rates, would eliminate between 51 to 256 AUMs of grazing on rangeland with carrying capacities ranging from 0.20 to 1.0 AUM/acre, respectively (Table 1). Infestations with less canopy cover also result in substantial losses of grazing output. A 25-acre infestation with a 10 percent canopy cover, increasing in canopy cover by 1.5 percent annually, spreading at a normal rate would still result in grazing losses ranging from 27 to 135 AUMs for rangeland carrying capacities of 0.20 to 1.0 AUM/acre, respectively (Table 1). Grazing losses for infestations with more than 30 percent canopy cover were not evaluated since cattle grazing within the infestations was assumed to be eliminated at 30 percent (see Figure 4).

The present value (PV) of lost grazing outputs from an initial infestation and subsequent expansion was estimated for various carrying capacities, AUM values, and expansion rates for demonstration purposes (Table 2). The value of lost grazing outputs from leafy spurge infestations increases with more productive land, higher AUM values, and greater rates of spread. The PV of grazing losses from a 25-acre infestation spreading at 2 radial feet/year for 10 years on grazing land with a carrying capacity of 0.50 AUMs/acre and a $15/AUM value is $1,917 (Table 2). When examining grazing losses, spread rates have less of an effect with larger infestations (e.g., over 5 acres) than with smaller infestations (e.g., 1-acre patches). For example, the PV of lost grazing outputs from a 25-acre infestation increases from $1,917 to $1,960 when spread changes from 2 to 4 radial feet/year, given a carrying capacity of 0.50 AUMs/acre and $15/AUM. However, the PV of lost grazing outputs increases proportionally when AUM values and carrying capacities change. Grazing losses increase 50 percent when AUM values increase from $12 to $18. Similarly, if carrying capacity increases from 0.50 to 0.75 AUMs/acre, other factors remaining constant, the PV of lost grazing outputs increases by 50 percent. Even with a modest infestation of 25 acres, economic losses from foregone grazing over a 10-year period can be substantial.

Table 1. Estimated Grazing Loss Over 10 Years, by Size and Density of Various Leafy Spurge Infestations[a]

Uninfested Carrying Capacity	25-acre Infestation Canopy Cover[b]		50-acre Infestation Canopy Cover		100-acre Infestation Canopy Cover	
	10%	30%	5%	20%	15%	25%
AUMs/acre	---------- Lost AUMs ----------					
0.20	27	51	37	86	140	192
0.25	34	64	46	107	175	240
0.30	40	77	55	128	210	288
0.35	47	89	64	150	245	336
0.40	54	102	73	171	280	384
0.45	61	115	82	193	315	432
0.50	67	128	92	214	350	480
0.55	74	141	101	235	385	528
0.60	81	153	110	257	420	576
0.65	88	166	119	278	455	624
0.70	94	179	128	300	490	673
0.75	101	192	137	321	525	721
0.80	108	204	146	342	560	769
0.85	115	217	156	364	595	817
0.90	121	230	165	385	630	865
0.95	128	243	174	407	666	913
1.0	135	256	183	428	701	961

[a] Infestations spreading at 2 radial feet/year and canopy cover increasing by 1.5 percent annually.
[b] A 30 percent canopy cover equates roughly to 80 to 130 stems/M^2.

Sheep Enterprises

All budget scenarios, with the exception of the wether flock, were developed based on costs and revenues that could be expected from typical sheep operations in western North Dakota. Several possible sheep enterprise scenarios were budgeted to accommodate differences in flock performance, debt structure, and flock size. Wether flocks were also included to evaluate the economic feasibility of using a nonbreeding flock for leafy spurge control.

Net Returns

Budgets were generated to accommodate changes in flock size and debt expiration during the 10-year period (Appendix B). Net returns, excluding fence costs and taxes, for the various sheep enterprises ranged from ($5.82) to $45.14 per ewe in year 1 of the 10-year budgeting period (Table 3). Net returns from the wether flocks varied from ($20.08) to ($15.38) in year 1 (Table 3). Net returns decreased in year 3 due to a flock reduction. Net returns decreased because breeding stock was sold as cull animals, which were valued less than their value as breeding stock. Also, debt and other fixed expenses, on a per ewe basis, increase with reduced flock size. Net returns, under the debt scenarios, generally improved from year 3 to year 4, as debt on breeding stock expired. Year 6 also

resulted in a change in net returns as debt on equipment and buildings expired. Net returns in year 7 reflect another flock reduction. Years 8 through 10 reflect higher fixed costs per ewe (due to a flock reduction at the end of year 7), which equates to lower net returns. Net returns in years 8 through 10 remain unchanged since no additional flock reductions were modeled. Net returns in year 10 were used in years 11 through 15.

Table 2. Present Value of Lost Grazing Outputs From a 25-Acre Leafy Spurge Infestation Expanding at Various Rates Over 10 Years

	$12 per AUM		$15 per AUM		$18 per AUM	
Carrying Capacity	Radial Spread ft/yr 2	4	Radial Spread ft/yr 2	4	Radial Spread ft/yr 2	4
AUMs/acre	---------- dollars[a] ----------					
0.20	613	627	767	784	920	941
0.25	767	784	958	980	1,150	1,176
0.30	920	941	1,150	1,176	1,380	1,411
0.35	1,073	1,097	1,342	1,372	1,610	1,646
0.40	1,227	1,254	1,534	1,568	1,840	1,881
0.45	1,380	1,411	1,725	1,764	2,070	2,117
0.50	1,534	1,568	1,917	1,960	2,300	2,352
0.55	1,687	1,725	2,109	2,156	2,530	2,587
0.60	1,840	1,881	2,300	2,352	2,760	2,822
0.65	1,994	2,038	2,492	2,548	2,990	3,057
0.70	2,147	2,195	2,684	2,744	3,220	3,292
0.75	2,300	2,352	2,875	2,940	3,451	3,528
0.80	2,454	2,509	3,067	3,136	3,681	3,763
0.85	2,607	2,665	3,259	3,332	3,911	3,998
0.90	2,760	2,822	3,451	3,528	4,141	4,233
0.95	2,914	2,979	3,642	3,724	4,371	4,468
1.0	3,067	3,136	3,834	3,920	4,601	4,703

[a] Present value of lost grazing (lost AUMs times value per AUM) discounted at 4 percent.

Fencing Costs

Fencing costs were estimated separately from the sheep enterprise budgets. By estimating fencing costs independent of the sheep budgets, flexibility was added to accommodate various combinations of pasture size and leafy spurge infestations for all sheep enterprise scenarios. Thus, fencing costs would reflect the appropriate expense for multiple combinations of pasture size, new or modified fence, and infestation size. Material costs for constructing new fence or modifying existing fence were based on August, 1998 retail prices for wire and posts in Hettinger, North Dakota. Labor expense in constructing or modifying fences was not included.

Table 3. Returns to Unpaid Labor, Management, and Equity for Various Sheep Enterprise Scenarios, Western North Dakota[a]

	Conventional Sheep Enterprise								Wether Flock			
	Good Management[b]				Poor Management[c]							
	Debt[d]		No Debt		Debt		No Debt		Debt		No Debt	
Year	Small[e]	Large[e]	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
	dollars per ewe											
1 & 2	30.09	41.25	34.56	45.21	(5.58)	(3.25)	(1.23)	0.62	(19.84)	(17.97)	(17.00)	(15.31)
3	22.02	32.88	26.48	36.85	(16.45)	(14.40)	(12.09)	(10.54)	(38.85)	(37.73)	(36.00)	(35.07)
4 & 5	30.26	32.46	31.59	32.99	(3.79)	(0.78)	(2.46)	(0.25)	(24.61)	(20.53)	(22.78)	(20.40)
6	31.59	32.99	31.59	32.99	(2.46)	(0.25)	(2.46)	(0.25)	(22.78)	(20.40)	(22.78)	(20.40)
7	26.18	27.99	26.18	27.99	(10.57)	(8.04)	(10.57)	(8.04)	(33.34)	(31.71)	(33.34)	(31.71)
8 - 10	24.54	31.67	24.54	31.67	(6.90)	(1.64)	(6.90)	(1.64)	(22.96)	(20.73)	(22.96)	(20.73)

[a] Net returns do not include fencing costs or taxes. For a complete listing of revenues and costs, see Appendixes B anc C.

[b] Good management based on flock performance obtained by proven sheep producers in North Dakota (Hettinger Research Extension Center 1999).

[c] Poor management represents a low level of flock efficiency and productivity (Hettinger Research Extension Center 1999).

[d] Debt included financing one-half of the breeding flock for three years and one-half of equipment and building expenses for five years at 10 percent interest.

[e] Small flocks based on 60 ewes and large flocks based on 200 ewes. Flock reductions occurred in years 4 and 8.

Fencing costs for constructing new fence and modifying existing fence assumed a relatively square and flat pasture. Water development costs were not included as existing pastures were assumed to have adequate water sources which would require minimal effort to modify for their use by sheep. Fencing costs for modifying an existing fence were based on adding 2 barb wires to an existing 3- or 4-wire fence without using additional posts. Fencing costs for new fence were based on 6 wires, posts every 20 feet, and 5 wood posts per corner. An additional 1 percent of wire expense was budgeted for miscellaneous fence costs (e.g., tying or fastening). Fence costs for an existing fence (the portion of an existing fence that would not be modified) were assumed to be part of the existing ranch expenses (i.e., those costs would be charged to a cow-calf or other similar operation).

Within the range of fencing costs presented, annualized fencing expense ranged from $0.10 to $8.49 per ewe with seasonal grazing (Table 4). Five percent of the estimated total fence cost was charged to the sheep enterprise annually for fence depreciation, repairs, and insurance. In the scenarios including debt, 50 percent of total fencing costs was assumed to be financed for 5 years at 10 percent interest. The interest expense in financing fencing debt was included as an additional fencing expense. Fencing costs per ewe for new fence were generally over 5 times higher than costs of modifying an existing fence. Fencing costs per acre decreased as pasture size increased. Fencing costs per ewe decreased as the size of the infestation increased within a given pasture (Table 4). Expenses for constructing new fence were about 22 percent higher in rotational grazing systems than in seasonal grazing systems. Expenses for modifying existing fence were about 25 percent higher in rotational grazing scenarios than in seasonal grazing systems (Appendix C).

Feasibility of Long-term Control--Sheep Enterprises

Long-term control was approached using rotational or seasonal grazing strategies. Sheep were assumed to be either leased or added as an additional enterprise to an existing ranch. Benefit-cost and least-loss analyses were used to evaluate long-term economic feasibility.[4] The economic feasibility of using sheep to control leafy spurge was evaluated using various likely scenarios facing cattle ranchers adopting a sheep enterprise for leafy spurge control.

Although a number of scenarios were used to evaluate the economics of using sheep to control leafy spurge over a wide range of possibilities, several variables were held constant across all analyses. Pasture size was limited to 350 acres. Infestation spread was limited to 2 radial feet per year and infestations were assumed to increase in canopy cover by 1.5 percent annually. Scenarios with grazing outputs valued at $15 per AUM are presented in the following sections; however, additional scenarios with $12 and $18 were included in Appendix D. All analyses, including those in Appendix D, were evaluated using 5, 15, and 30 percent canopy cover for the leafy spurge infestation. The canopy cover rates of 5, 15, and 30 percent represented low (17 percent loss), moderate (50 percent loss), and high (100 percent) grazing losses within the leafy spurge infestation, respectively.

[4]The concept of financial feasibility (i.e., constraints on or availability of resources needed for flock, equipment, building, and fencing purchases) was not examined. Analysis of the cash flow of the sheep enterprises was not addressed. Other constraints, such as labor, were not addressed.

Table 4. Estimated Fencing Costs for New and Modified Fence for Various Pasture and Infestation Sizes, With and Without Debt, Seasonal Grazing[a]

Pasture Size (acres)	Fence Type	Debt vs No Debt	Total Fence Costs ($)	Leafy Spurge Infestation (acres) 50	100	150	200	250	300	350	400	450
				annual fence costs per ewe								
100	New	no debt	2,197	2.20	1.10	na	na	na	na	na	na	na
		debt		3.60	1.80	na	na	na	na	na	na	na
	Modify	no debt	405	0.40	0.20	na	na	na	na	na	na	na
		debt		0.66	0.33	na	na	na	na	na	na	na
200	New	no debt	3,051	3.05	1.53	1.02	0.76	na	na	na	na	na
		debt		5.00	2.50	1.67	1.25	na	na	na	na	na
	Modify	no debt	572	0.57	0.29	0.19	0.14	na	na	na	na	na
		debt		0.94	0.47	0.31	0.23	na	na	na	na	na
300	New	no debt	3,706	3.71	1.85	1.24	0.93	0.74	0.62	na	na	na
		debt		6.07	3.04	2.02	1.52	1.21	1.01	na	na	na
	Modify	no debt	701	0.70	0.35	0.23	0.18	0.14	0.12	na	na	na
		debt		1.15	0.57	0.38	0.29	0.23	0.19	na	na	na
400	New	no debt	4,259	4.26	2.13	1.42	1.06	0.85	0.71	0.61	0.53	na
		debt		6.98	3.49	2.33	1.74	1.40	1.16	1.00	0.87	na
	Modify	no debt	810	0.81	0.40	0.27	0.20	0.16	0.13	0.12	0.10	na
		debt		1.33	0.66	0.44	0.33	0.27	0.22	0.19	0.17	na
500	New	no debt	4,745	4.75	2.37	1.58	1.19	0.95	0.79	0.68	0.59	0.53
		debt		7.77	3.89	2.59	1.94	1.55	1.30	1.11	0.97	0.86
	Modify	no debt	905	0.91	0.45	0.30	0.23	0.18	0.15	0.13	0.11	0.10
		debt		1.48	0.75	0.49	0.37	0.30	0.25	0.21	0.19	0.16
600	New	no debt	5,185	5.19	2.59	1.73	1.30	1.04	0.86	0.74	0.65	0.58
		debt		8.49	4.25	2.83	2.12	1.70	1.42	1.21	1.06	0.94
	Modify	no debt	991	0.99	0.50	0.33	0.25	0.20	0.17	0.14	0.12	0.11
		debt		1.62	0.81	0.54	0.41	0.32	0.27	0.23	0.20	0.18

na--not applicable.

[a] Fencing costs based on one ewe per acre of leafy spurge. Five percent of total fencing costs charged to sheep enterprise annually. Debt based on 50 percent of total fencing costs financed for 5 years at 10 percent interest. Fence expenses per ewe will change as flock size is reduced and debt expires over a 10-year treatment period.

Seasonal Grazing

Seasonal grazing strategies were based on grazing sheep for four months, with grazing initiated in May. Seasonal grazing periods longer than four months were not evaluated; however, the capacity to evaluate alternative grazing periods was incorporated into the model.

Four of the eight scenarios evaluated had positive net returns for the sheep enterprise (see Table 3). Under those circumstances, even with modest levels of leafy spurge control, sheep grazing will be economical. However, with negative enterprise returns, the cost of control (i.e., money lost maintaining the sheep enterprise) must be balanced with the benefits of control (i.e., value of leafy spurge control and grazing output for cattle).

Benefit-Cost Analysis

Benefit-cost analyses of the four scenarios with good flock management revealed substantial positive returns from leafy spurge control (Tables 5 and 6). The good management scenarios (with and without debt and small and large flocks) exhibited positive net returns over 5-year, 10-year, and 15-year periods. With low levels of leafy spurge infestation (5 percent canopy cover), total net returns varied from $83 per acre of leafy spurge at 0.20 AUMs per acre carrying capacity over a 5-year period for the good management, with debt, small flock, new fence scenario to $154 per acre with the good management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity. Over the 5-year period, average total net returns from leafy spurge control, in the scenarios with positive enterprise returns, increased about 11 to 13 percent when leafy spurge canopy cover increased from 5 to 30 percent.

With the good flock management scenarios, total net returns from leafy spurge control improved by about 49 percent when switching from a 5-year to a 10-year period, averaged across various carrying capacities and leafy spurge infestation rates. Over a 15-year period with low levels of initial leafy spurge infestation (5 percent cover), total net returns varied from $148 per acre of leafy spurge at 0.20 AUMs per acre carrying capacity for the good management, with debt, small flock, new fence scenario to $290 per acre for the good management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity (Tables 5 and 6).

Benefit-cost analysis of the four scenarios with poor flock management revealed that net returns from leafy spurge control were sensitive to the time period, rangeland productivity, leafy spurge canopy cover, and AUM value (Tables 7 and 8). Over the 5-year period, only scenarios with high rangeland productivity and high leafy spurge cover produced positive net returns. With low levels of leafy spurge infestation (5 percent canopy cover) over the same period, total net returns varied from ($52) per acre of leafy spurge at 0.20 AUMs per acre carrying capacity for the poor management, with debt, small flock, new fence scenario to $18 per acre with the poor management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity. Over the 5-year period, total net returns from leafy spurge control, averaged over various carrying capacities, in the scenarios with poor flock management, increased about $15 per acre when leafy spurge canopy cover increased from 5 percent to 30 percent.

Table 5. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Good Management, Seasonal Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	118.5	120.0	123.8	106.5	108.0	111.8	151.1	152.7	156.4	147.5	149.1	152.8
0.30	118.9	121.2	126.8	106.8	109.2	114.8	151.5	153.9	159.4	147.9	150.3	155.8
0.40	119.2	122.4	129.8	107.2	110.4	117.8	151.9	155.0	162.5	148.3	151.4	158.9
0.50	119.6	123.6	132.8	107.6	111.6	120.8	152.3	156.2	165.5	148.7	152.6	161.9
0.60	120.0	124.7	135.9	108.0	112.7	123.9	152.7	157.4	168.5	149.1	153.8	164.9
0.70	120.4	125.9	138.9	108.4	113.9	126.9	153.0	158.5	171.5	149.4	154.9	167.9
0.80	120.8	127.1	141.9	108.8	115.1	129.9	153.4	159.7	174.5	149.8	156.1	170.9
0.90	121.2	128.3	145.0	109.2	116.3	133.0	153.8	160.9	177.6	150.2	157.3	174.0
	---------- 10-year Period ----------											
0.20	167.8	171.6	177.4	145.9	149.7	155.5	209.5	213.3	219.0	202.9	206.7	212.5
0.30	170.2	175.9	184.6	148.3	154.0	162.7	211.8	217.5	226.1	205.3	210.9	219.6
0.40	172.6	180.2	191.8	150.7	158.3	169.9	214.2	221.7	233.2	207.6	215.2	226.7
0.50	175.0	184.5	199.0	153.1	162.6	177.1	216.5	225.9	240.3	210.0	219.4	233.8
0.60	177.4	188.8	206.2	155.5	166.9	184.3	218.9	230.2	247.5	212.3	223.6	240.9
0.70	179.7	193.1	213.4	157.9	171.2	191.5	221.2	234.4	254.6	214.7	227.8	248.0
0.80	182.1	197.4	220.6	160.3	175.5	198.7	223.6	238.6	261.7	217.0	232.1	255.1
0.90	184.5	201.7	227.8	162.7	179.8	205.9	226.0	242.9	268.8	219.4	236.3	262.2
	---------- 15-year Period ----------											
0.20	201.5	206.4	212.4	171.5	176.4	182.4	252.9	257.7	263.6	243.9	248.7	254.6
0.30	206.9	214.3	223.2	176.9	184.3	193.3	258.2	265.4	274.3	249.2	256.4	265.3
0.40	212.3	222.2	234.1	182.3	192.2	204.1	263.5	273.1	284.9	254.5	264.1	275.9
0.50	217.7	230.0	245.0	187.8	200.1	215.0	268.7	280.7	295.5	259.7	271.7	286.6
0.60	223.2	237.9	255.8	193.2	207.9	225.9	274.0	288.4	306.2	265.0	279.4	297.2
0.70	228.6	245.8	266.7	198.6	215.8	236.7	279.3	296.1	316.8	270.3	287.1	307.8
0.80	234.0	253.7	277.6	204.0	223.7	247.6	284.6	303.8	327.5	275.6	294.8	318.5
0.90	239.4	261.6	288.4	209.4	231.6	258.4	289.9	311.5	338.1	280.9	302.5	329.1

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 6. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Good Management, Seasonal Grazing Scenario[a]

Carrying Capacity	50-acre Infestation						250-acre Infestation					
	Infestation Canopy Cover						Infestation Canopy Cover					
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	102.9	104.5	108.2	83.3	84.9	88.6	139.1	140.6	144.3	133.2	134.7	138.4
0.30	103.3	105.7	111.3	83.7	86.0	91.6	139.4	141.8	147.4	133.5	135.9	141.5
0.40	103.7	106.9	114.3	84.1	87.2	94.6	139.8	143.0	150.4	133.9	137.1	144.5
0.50	104.1	108.0	117.3	84.4	88.4	97.7	140.2	144.1	153.4	134.3	138.2	147.5
0.60	104.5	109.2	120.4	84.8	89.6	100.7	140.6	145.3	156.4	134.7	139.4	150.5
0.70	104.9	110.4	123.4	85.2	90.7	103.7	141.0	146.5	159.4	135.1	140.6	153.5
0.80	105.2	111.6	126.4	85.6	91.9	106.8	141.4	147.6	162.5	135.5	141.7	156.6
0.90	105.6	112.7	129.4	86.0	93.1	109.8	141.7	148.8	165.5	135.8	142.9	159.6
	---------- 10-year Period ----------											
0.20	152.3	156.1	161.9	122.7	126.6	132.4	197.4	201.2	206.9	188.6	192.3	198.1
0.30	154.7	160.4	169.1	125.1	130.9	139.6	199.8	205.4	214.0	190.9	196.6	205.2
0.40	157.0	164.7	176.3	127.5	135.2	146.8	202.1	209.6	221.2	193.3	200.8	212.3
0.50	159.4	169.0	183.5	129.9	139.5	154.0	204.5	213.9	228.3	195.6	205.0	219.4
0.60	161.8	173.3	190.7	132.3	143.8	161.2	206.8	218.1	235.4	198.0	209.2	226.5
0.70	164.2	177.6	197.9	134.7	148.1	168.4	209.2	222.3	242.5	200.3	213.5	233.6
0.80	166.6	181.9	205.1	137.1	152.4	175.5	211.5	226.6	249.6	202.7	217.7	240.7
0.90	169.0	186.2	212.3	139.5	156.7	182.7	213.9	230.8	256.7	205.0	221.9	247.8
	---------- 15-year Period ----------											
0.20	186.0	190.9	196.8	148.3	153.2	159.2	240.8	245.6	251.5	229.5	234.3	240.3
0.30	191.4	198.8	207.7	153.7	161.1	170.1	246.1	253.3	262.2	234.8	242.0	250.9
0.40	196.8	206.6	218.6	159.2	169.0	180.9	251.4	261.0	272.8	240.1	249.7	261.5
0.50	202.2	214.5	229.4	164.6	176.9	191.8	256.7	268.7	283.5	245.4	257.4	272.2
0.60	207.6	222.4	240.3	170.0	184.8	202.7	261.9	276.3	294.1	250.7	265.1	282.8
0.70	213.1	230.3	251.2	175.4	192.7	213.5	267.2	284.0	304.8	255.9	272.7	293.5
0.80	218.5	238.2	262.0	180.8	200.5	224.4	272.5	291.7	315.4	261.2	280.4	304.1
0.90	223.9	246.0	272.9	186.3	208.4	235.3	277.8	299.4	326.0	266.5	288.1	314.8

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 7. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Seasonal Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-17.6	-16.0	-12.3	-29.6	-28.0	-24.3	-8.5	-7.0	-3.3	-12.1	-10.6	-6.9
0.30	-17.2	-14.8	-9.3	-29.2	-26.8	-21.3	-8.2	-5.8	-0.2	-11.8	-9.4	-3.8
0.40	-16.8	-13.7	-6.2	-28.8	-25.7	-18.2	-7.8	-4.6	2.8	-11.4	-8.2	-0.8
0.50	-16.4	-12.5	-3.2	-28.4	-24.5	-15.2	-7.4	-3.5	5.8	-11.0	-7.1	2.2
0.60	-16.0	-11.3	-0.2	-28.0	-23.3	-12.2	-7.0	-2.3	8.8	-10.6	-5.9	5.2
0.70	-15.7	-10.1	2.9	.27.7	-22.1	-9.1	-6.6	-1.1	11.8	-10.2	-4.7	8.2
0.80	-15.3	-9.0	5.9	-27.3	-21.0	-6.1	-6.2	0.0	14.9	-9.8	-3.6	11.3
0.90	-14.9	-7.8	8.9	-26.9	-19.8	-3.1	-5.9	1.2	17.9	-9.5	-2.4	14.3
	---------- 10-year Period ----------											
0.20	-27.7	-23.9	-18.1	-49.5	-45.7	-39.9	-10.5	-6.7	-0.9	-17.0	-13.3	-7.5
0.30	-25.3	-19.6	-10.9	-47.2	-41.4	-32.7	-8.1	-2.5	6.2	-14.7	-9.0	-0.4
0.40	-22.9	-15.3	-3.7	-44.8	-37.1	-25.5	-5.8	1.8	13.3	-12.3	-4.8	6.7
0.50	-20.5	-11.0	3.5	-42.4	-32.8	-18.3	-3.4	6.0	20.4	-10.0	-0.6	13.8
0.60	-18.1	-6.7	10.7	-40.0	-28.5	-11.1	-1.1	10.2	27.5	-7.6	3.7	20.9
0.70	-15.7	-2.4	17.9	-37.6	-24.2	-3.9	1.3	14.4	34.6	-5.3	7.9	28.0
0.80	-13.3	1.9	25.1	-35.2	-19.9	3.3	3.6	18.7	41.7	-2.9	12.1	35.2
0.90	-10.9	6.2	32.3	-32.8	-15.6	10.5	6.0	22.9	48.8	-0.6	16.3	42.3
	---------- 15-year Period ----------											
0.20	-31.8	-26.9	-20.9	-61.8	-56.9	-50.9	-7.0	-2.1	3.8	-16.1	-11.3	-5.4
0.30	-26.4	-19.0	-10.1	-56.4	-49.0	-40.0	-1.7	5.6	14.5	-10.8	-3.6	5.2
0.40	-21.0	-11.1	0.8	-51.0	-41.1	-29.2	3.7	13.4	25.3	-5.6	4.0	15.9
0.50	-15.6	-3.3	11.7	-45.5	-33.2	-18.3	9.0	21.2	36.0	-0.3	11.7	26.5
0.60	-10.1	4.6	22.5	-40.1	-25.3	-7.4	14.4	29.0	46.8	5.0	19.4	37.2
0.70	-4.7	12.5	33.4	-34.7	-17.5	3.4	19.7	36.7	57.5	10.3	27.1	47.8
0.80	0.7	20.4	44.3	-29.3	-9.6	14.3	25.1	44.5	68.3	15.6	34.8	58.5
0.90	6.1	28.3	55.1	-23.9	-1.7	25.2	30.4	52.3	79.0	20.8	42.4	69.1

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 8. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Seasonal Grazing Scenario[a]

Carrying Capacity	50-acre Infestation Infestation Canopy Cover						250-acre Infestation Infestation Canopy Cover					
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-32.8	-31.2	-27.5	-52.4	-50.9	-47.2	-20.3	-18.8	-15.0	-26.2	-24.6	-20.9
0.30	-32.4	-30.0	-24.5	-52.1	-49.7	-44.1	-19.9	-17.6	-12.0	-25.8	-23.5	-17.9
0.40	-32.0	-28.9	-21.4	-51.7	-48.5	-41.1	-19.6	-16.4	-9.0	-25.5	-22.3	-14.9
0.50	-31.6	-27.7	-18.4	-51.3	-47.3	-38.1	-19.2	-15.2	-6.0	-25.1	-21.1	-11.9
0.60	-31.2	-26.5	-15.4	-50.9	-46.2	-35.0	-18.8	-14.1	-3.0	-24.7	-20.0	-8.9
0.70	-30.9	-25.3	-12.3	-50.5	-45.0	-32.0	-18.4	-12.9	0.1	-24.3	-18.8	-5.8
0.80	-30.5	-24.2	-9.3	-50.1	-43.8	-29.0	-18.0	-11.7	3.1	-23.9	-17.6	-2.8
0.90	-30.1	-23.0	-6.3	-49.8	-42.7	-25.9	-17.6	-10.6	6.1	-23.5	-16.5	0.2
	---------- 10-year Period ----------											
0.20	-42.9	-39.1	-33.3	-72.4	-68.6	-62.8	-22.2	-18.5	-12.7	-31.1	-27.3	-21.6
0.30	-40.5	-34.8	-26.1	-70.0	-64.3	-55.6	-19.9	-14.3	-5.6	-28.8	-23.1	-14.5
0.40	-38.1	-30.5	-18.9	-67.6	-60.0	-48.4	-17.5	-10.0	1.5	-26.4	-18.9	-7.4
0.50	-35.7	-26.2	-11.7	-65.2	-55.7	-41.2	-15.2	-5.8	8.6	-24.1	-14.7	-0.3
0.60	-33.3	-21.9	-4.5	-62.8	-51.4	-34.0	-12.8	-1.6	15.7	-21.7	-10.4	6.9
0.70	-30.9	-17.6	2.7	-60.4	-47.1	-26.8	-10.5	2.7	22.8	-19.4	-6.2	14.0
0.80	-28.5	-13.3	9.9	-58.1	-42.8	-19.6	-8.1	6.9	29.9	-17.0	-2.0	21.1
0.90	-26.1	-9.0	17.1	-55.7	-38.5	-12.4	-5.8	11.1	37.0	-14.6	2.3	28.2
	---------- 15-year Period ----------											
0.20	-47.0	-42.1	-36.1	-84.6	-79.7	-73.8	-18.9	-14.1	-8.2	-30.2	-25.4	-19.5
0.30	-41.6	-31.2	-25.3	-79.2	-71.8	-62.9	-13.6	-6.4	2.4	-24.9	-17.7	-8.8
0.40	-36.2	-26.3	-14.4	-73.8	-64.0	-52.0	-8.4	1.2	13.1	-19.6	-10.0	1.8
0.50	-30.8	-18.5	-.35	-68.4	-56.1	-41.2	-3.1	8.9	23.7	-14.4	-2.4	12.4
0.60	-25.3	-10.6	7.3	-63.0	-48.2	-30.3	2.2	16.6	34.4	-9.1	5.3	23.1
0.70	-19.9	-2.7	18.2	-57.5	-40.3	-19.4	7.5	24.3	45.0	-3.8	13.0	33.7
0.80	-14.5	5.2	29.1	-52.1	-32.4	-8.6	12.8	32.0	55.7	1.5	20.7	44.4
0.90	-9.1	13.1	39.9	-46.7	-24.6	2.3	18.1	39.6	66.3	6.8	28.4	55.0

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

With the poor flock management scenarios, total net returns from leafy spurge control varied from an average decrease of about $7 per acre (0.20 AUMs/acre) to an average increase of about $15 per acre (0.90 AUMs/acre) when switching from a 5-year to a 10-year period, averaged across various carrying capacities and leafy spurge infestation rates (Tables 7 and 8). Total net returns over a 10-year period for all of the poor management scenarios remained negative with low rangeland carrying capacities (i.e., 0.20 to 0.25 AUMs/acre). However, in one scenario, net returns were positive down to 0.30 AUMs per acre carrying capacity.

With the poor flock management scenarios, over a 15-year period with low levels of initial leafy spurge infestation (5 percent cover), total net returns from control varied from ($85) per acre of leafy spurge at 0.20 AUMs per acre carrying capacity for the with debt, small flock, new fence scenario to $79 per acre for the no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity (Tables 7 and 8). Thus, with the poor management scenarios over the 15-year period, net returns from control varied substantially depending upon the combination of infestation canopy cover, rangeland carrying capacity, and infestation size.

Generally, over all periods (5-year, 10-year, and 15-year), net returns from leafy spurge control were about $12 to $23 per acre higher for scenarios having no debt versus those with debt (e.g., good management without debt compared to good management with debt) (Tables 5, 6, 7, and 8). Because debt was structured to expire in year 5, the effects of debt on net returns from control were constant across the three time periods. In the 5-year period, the additional expense for new fence versus modified fence reduced net returns from leafy spurge control by an average of $16 per acre across all management scenarios with small infestations and reduced net returns by $5 per acre across all management scenarios with large infestations. Over the 10-year period, net returns from leafy spurge control were $26 per acre less for scenarios with new fence versus modified fence across all management scenarios with small infestations and net returns from leafy spurge control were $8 per acre less with large infestations. Similarly, net returns from leafy spurge control over the 15-year period were $34 per acre less for scenarios with new fence versus modified fence for small infestations, and net returns were $10 per acre less across all management scenarios with large infestations.

Net returns per acre from leafy spurge control were higher with large infestations (250-acre) versus small infestations (50-acre) across all scenarios in each period (Tables 5, 6, 7, and 8). In the 5-year period, net returns from large infestations compared to small infestations improved by $9 to $36 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, net returns from leafy spurge control improved by $17 to $50 per acre when comparing large to small infestations. In the 10-year period, net returns from large infestations compared to small infestations improved by $17 to $45 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, net returns from leafy spurge control improved by $33 to $66 per acre when comparing large to small infestations. In the 15-year period, net returns from large infestations compared to small infestations improved by $25 to $55 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, net returns from leafy spurge control improved by $46 to $81 per acre when comparing large to small infestations.

Least-loss Analysis

Least-loss analysis compares the economic losses that would occur if a leafy spurge infestation was left uncontrolled to the losses incurred with control. In the situations where the economic loss sustained with control (i.e., benefits of control are less than control costs) is less than the economic loss without control, the treatment program or method would be recommended, provided more economical treatment programs were not available. In situations where economic losses with treatment are more than the economic losses incurred with no control, the treatment program or method would not be recommended.

The good management scenarios had positive enterprise returns, which resulted in positive returns from control. Thus, least-loss analyses were not conducted for those scenarios. Least-loss scenarios were conducted for the poor management scenarios.

Over the 5-year period, only scenarios with high rangeland productivity and high leafy spurge cover resulted in less economic loss than with no control (Tables 9 and 10). With low levels of leafy spurge infestation (5 percent canopy cover) over the same period, none of the scenarios with poor management (i.e., with or without debt, small or large infestations, new or modified fence) would be recommended, as economic losses with control exceeded losses without control.

Over the 10-year period, most scenarios with high rangeland productivity and high leafy spurge cover resulted in less economic loss than with no control (Tables 9 and 10). Many of the scenarios with new fence and low leafy spurge cover would not be recommended within the 10-year period. However, with new fence and high leafy spurge cover, both large and small infestations could be recommended for all but the least productive rangeland. In the 10-year period, none of the small flock scenarios would be recommended at rangeland carrying capacities of 0.20 AUMs per acre.

Over the 15-year period, many of the scenarios with large infestations or with modified fence would be recommended. However, even within the 15-year period, some new fence scenarios would not be recommended. Thus, using sheep to control leafy spurge is not economical in all situations evaluated in the seasonal grazing approach, given the budgets used in this study.

Rotational Grazing

Rotational (two 1-month periods) grazing strategies were evaluated. In a rotational system, sheep would graze the infestation for one month periods at a higher stocking rate than used in seasonal grazing. Sheep grazing would be initiated in May. Sheep would graze the same pasture a total of two nonconsecutive months during the grazing season. Other rotational grazing programs were not evaluated; however, the capacity to evaluate alternative rotational grazing programs was incorporated into the model.

Four of the eight scenarios evaluated had positive net returns for the sheep enterprise (see Table 3). Under those circumstances, even with modest levels of leafy spurge control, sheep grazing will be economical. Thus, with positive enterprise returns, returns from leafy spurge control will be positive regardless of the specific grazing system (rotational or seasonal).

Table 9. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Seasonal Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.60	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.30	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.40	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled. A "yes" implies that the scenario will result in less economic loss than no treatment. A "no" implies that the scenario will result in more economic loss than no treatment.

Table 10. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Seasonal Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	yes	no	no	no
0.50	no	no	no	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.90	no	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled. A "yes" implies that the scenario will result in less economic loss than no treatment. A "no" implies that the scenario will result in more economic loss than no treatment.

Benefit-cost Analysis

Benefit-cost analyses of the four scenarios with positive enterprise net returns revealed substantial positive returns from leafy spurge control in rotational grazing strategies (Tables 11 and 12). The good management scenarios (with and without debt and small and large flocks) exhibited positive net returns over 5-year, 10-year, and 15-year periods. With low levels of leafy spurge infestation (5 percent canopy cover), total net returns from control varied from $78 per acre of leafy spurge at 0.20 AUMs per acre carrying capacity over a 5-year period for the good management, with debt, small flock, new fence scenario to $153 per acre with the good management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity. Over the 5-year period, total net returns from leafy spurge control, in the rotational grazing scenarios with positive enterprise returns, increased about 11 to 13 percent when leafy spurge canopy cover increased from 5 to 30 percent.

With the good flock management scenarios in rotational grazing strategies, total net returns from leafy spurge control improved by about 48 percent when switching from a 5-year to a 10-year period, averaged across various carrying capacities and leafy spurge infestation rates (Tables 11 and 12). Over a 15-year period with low levels of initial leafy spurge infestation (5 percent cover), total net returns varied from $137 per acre of leafy spurge at 0.20 AUMs per acre carrying capacity for the good management, with debt, small flock, new fence scenario to $287 per acre for the good management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity (Tables 11 and 12).

Benefit-cost analysis of the four scenarios with negative enterprise net returns revealed that returns from leafy spurge control were sensitive to the time period, rangeland productivity, leafy spurge canopy cover, and AUM value. The pattern of net returns from control using rotational grazing strategies were similar to those with seasonal grazing strategies for all periods. Over the 5-year period, only scenarios with high rangeland productivity and high leafy spurge cover produced positive net returns (Tables 13 and 14). With low levels of leafy spurge infestation (5 percent canopy cover) over the 5-year period, total net returns varied from ($58) per acre of leafy spurge at 0.20 AUMs per acre carrying capacity for the poor management, with debt, small flock, new fence scenario to $16 per acre with the poor management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity. Over the 5-year period, total net returns from leafy spurge control, averaged over various carrying capacities, increased about $14 per acre when leafy spurge canopy cover increased from 5 percent to 30 percent.

When enterprise net returns were negative, total returns from leafy spurge control varied from an average decrease of about $10 per acre (0.20 AUMs/acre) to an average increase of about $16 per acre (0.90 AUMs/acre) when switching from a 5-year to a 10-year period, averaged across various carrying capacities and leafy spurge infestation rates (Tables 13 and 14). Total returns over a 10-year period for all of the poor management, rotational grazing scenarios with low leafy spurge canopy cover remained negative with moderate to high rangeland carrying capacities (i.e., less than 0.80 AUMs/acre). However, in one scenario with high leafy spurge canopy cover, net returns over a 10-year period were positive down to 0.30 AUMs per acre carrying capacity.

Table 11. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Good Management, Rotational Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	117.6	119.1	122.7	103.0	104.5	108.1	150.7	152.3	155.8	146.4	147.9	151.5
0.30	117.9	120.2	125.5	103.3	105.6	110.9	151.0	153.4	158.7	146.7	149.0	154.3
0.40	118.2	121.3	128.4	103.6	106.7	113.8	151.3	154.4	161.5	146.9	150.0	157.1
0.50	118.5	122.3	131.2	103.9	107.8	116.6	151.6	155.5	164.3	147.2	151.1	160.0
0.60	118.7	123.4	134.1	104.1	108.8	119.5	151.9	156.6	167.2	147.5	152.2	162.8
0.70	119.0	124.5	136.9	104.4	109.9	122.3	152.2	157.6	170.0	147.8	153.2	165.6
0.80	119.3	125.6	139.8	104.7	111.0	125.2	152.5	158.7	172.9	148.1	154.3	168.5
0.90	119.6	126.6	142.6	105.0	112.0	128.0	152.8	159.7	175.7	148.4	155.4	171.3
	---------- 10-year Period ----------											
0.20	166.1	169.9	175.6	139.5	143.4	149.0	208.7	212.5	218.1	200.7	204.5	210.1
0.30	168.3	174.0	182.5	141.7	147.5	155.9	210.9	216.5	225.0	202.9	208.6	217.0
0.40	170.5	178.2	189.5	143.9	151.6	162.9	213.0	220.6	231.8	205.0	212.6	223.8
0.50	172.7	182.3	196.4	146.1	155.7	169.8	215.2	224.6	238.6	207.2	216.6	230.7
0.60	174.9	186.4	203.3	148.3	159.8	176.8	217.3	228.6	245.5	209.3	220.7	237.5
0.70	177.1	190.5	210.3	150.5	163.9	183.7	219.5	232.7	252.3	211.5	224.7	244.4
0.80	179.3	194.6	217.2	152.7	168.0	190.6	221.6	236.7	259.2	213.6	228.7	251.2
0.90	181.5	198.7	224.2	154.9	172.1	197.6	223.8	240.8	266.0	215.8	232.8	258.1
	---------- 15-year Period ----------											
0.20	199.2	204.1	210.0	162.7	167.7	173.5	251.8	256.7	262.4	240.9	245.7	251.5
0.30	204.3	211.8	220.5	167.9	175.3	184.1	256.8	264.1	272.8	245.9	253.2	261.8
0.40	209.5	219.4	231.0	173.0	182.9	194.6	261.8	271.5	283.1	250.9	260.6	272.2
0.50	214.6	227.0	241.6	178.2	190.6	205.1	266.9	278.9	293.4	255.9	268.0	282.5
0.60	219.8	234.6	252.1	183.3	198.2	215.7	271.9	286.4	303.7	260.9	275.4	292.8
0.70	224.9	242.3	262.7	188.5	205.8	226.2	276.9	293.8	314.0	265.9	282.9	303.1
0.80	230.1	249.9	273.2	193.6	213.5	236.8	281.9	301.2	324.4	271.0	290.3	313.4
0.90	235.2	257.5	283.8	198.8	221.1	247.3	286.9	308.7	334.7	276.0	297.7	323.8

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 12. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Good Management, Rotational Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	101.6	103.2	106.7	77.7	79.3	82.8	138.5	140.1	143.6	131.4	132.9	136.5
0.30	101.9	104.2	109.6	78.0	80.3	85.7	138.8	141.1	146.5	131.6	134.0	139.3
0.40	102.2	105.3	112.4	78.3	81.4	88.5	139.1	142.2	149.3	131.9	135.0	142.1
0.50	102.5	106.4	115.3	78.6	82.5	91.3	139.4	143.3	152.1	132.2	136.1	145.0
0.60	102.8	107.4	118.1	78.9	83.5	94.2	139.7	144.3	155.0	132.5	137.2	147.8
0.70	103.1	108.5	120.9	79.2	84.6	97.0	140.0	145.4	157.8	132.8	138.2	150.6
0.80	103.4	109.6	123.8	79.5	85.7	99.9	140.3	146.5	160.6	133.1	139.3	153.5
0.90	103.6	110.7	126.6	79.7	86.8	102.7	140.6	147.5	163.5	133.4	140.4	156.3
	---------- 10-year Period ----------											
0.20	150.1	154.0	159.6	114.2	118.1	123.7	196.5	200.3	205.9	185.7	189.5	195.1
0.30	152.3	158.1	166.6	116.4	122.2	130.7	198.7	204.3	212.7	187.9	193.5	202.0
0.40	154.5	162.2	173.5	118.6	126.3	137.6	200.8	208.4	219.6	190.0	197.6	208.8
0.50	156.7	166.3	180.4	120.8	130.4	144.5	203.0	212.4	226.4	192.2	201.6	215.7
0.60	158.9	170.4	187.4	123.0	134.5	151.5	205.1	216.4	233.3	194.3	205.7	222.5
0.70	161.1	174.5	194.3	125.2	138.6	158.4	207.3	220.5	240.1	196.5	209.7	229.4
0.80	163.3	178.6	201.2	127.4	142.7	165.3	209.4	224.5	247.0	198.6	213.7	236.2
0.90	165.5	182.7	208.2	129.6	146.8	172.3	211.6	228.5	253.8	200.8	217.8	243.1
	---------- 15-year Period ----------											
0.20	183.2	188.2	194.0	137.5	142.4	148.2	239.6	244.5	250.2	225.9	230.7	236.5
0.30	188.4	195.8	204.5	142.6	150.0	158.8	244.6	251.9	260.6	230.9	238.2	246.8
0.40	193.5	203.4	215.1	147.8	157.7	169.3	249.6	259.3	270.9	235.9	245.6	257.1
0.50	198.7	211.1	225.6	152.9	165.3	179.9	254.6	266.7	281.2	240.9	253.0	267.5
0.60	203.8	218.7	236.2	158.0	172.9	190.4	259.7	274.2	291.5	245.9	260.4	277.8
0.70	209.0	226.3	246.7	163.2	180.6	200.9	264.7	281.6	301.8	250.9	267.9	288.1
0.80	214.1	233.9	257.2	168.3	188.2	211.5	269.7	289.0	312.2	256.0	275.3	298.4
0.90	219.3	241.6	267.8	173.5	195.8	222.0	274.7	296.5	322.5	261.0	282.7	308.8

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 13. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Rotational Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-18.5	-16.9	-13.4	-33.1	-31.5	-28.0	-8.9	-7.4	-3.8	-13.3	-11.8	-8.2
0.30	-18.2	-15.8	-10.5	-32.8	-30.4	-25.1	-8.6	-6.3	-1.0	-13.0	-10.7	-5.4
0.40	-17.9	-14.8	-7.7	-32.5	-29.4	-22.3	-8.4	-5.3	1.8	-12.7	-9.6	-2.5
0.50	-17.6	-13.7	-4.8	-32.2	-28.3	-19.4	-8.1	-4.2	4.7	-12.4	-8.6	0.3
0.60	-17.3	-12.6	-2.0	-31.9	-27.2	-16.6	-7.8	-3.1	7.5	-12.2	-7.5	3.1
0.70	-17.0	-11.6	0.9	-31.6	-26.2	-13.7	-7.5	-2.1	10.3	-11.9	-6.4	6.0
0.80	-16.7	-10.5	3.7	-31.3	-25.1	-10.9	-7.2	-1.0	13.2	-11.6	-5.4	8.8
0.90	-16.4	-9.4	6.6	-31.0	-24.0	-8.0	-6.9	0.1	16.0	-11.3	-4.3	11.6
	---------- 10-year Period ----------											
0.20	-29.4	-25.5	-19.9	-55.9	-52.1	-46.5	-11.2	-7.5	-1.8	-19.2	-15.4	-9.8
0.30	-27.2	-21.4	-12.9	-53.8	-48.0	-39.5	-9.1	-3.4	5.0	-17.1	-11.4	-3.0
0.40	-25.0	-17.3	-6.0	-51.6	-43.9	-32.6	-6.9	0.6	11.8	-14.9	-7.4	3.9
0.50	-22.8	-13.2	0.9	-49.4	-39.8	-25.7	-4.8	4.6	18.7	-12.8	-3.3	10.7
0.60	-20.6	-9.1	7.9	-47.2	-35.7	-18.7	-2.6	8.7	25.5	-10.6	0.7	17.6
0.70	-18.4	-5.0	14.8	-45.0	-31.6	-11.8	-0.5	12.7	32.4	-8.5	4.7	24.4
0.80	-16.2	-0.9	21.7	-42.8	-27.5	-4.8	1.7	16.8	39.2	-6.3	8.8	31.3
0.90	-14.0	3.2	28.7	-40.6	-23.4	2.1	3.8	20.8	46.1	-4.2	12.8	38.1
	---------- 15-year Period ----------											
0.20	-34.1	-29.2	-23.3	-70.6	-65.6	-59.8	-8.2	-3.4	2.4	-19.1	-14.3	-8.5
0.30	-29.0	-21.5	-12.8	-65.4	-58.0	-49.2	-3.2	4.1	12.7	-14.1	-6.9	1.8
0.40	-23.8	-13.9	-2.2	-60.3	-50.3	-38.7	1.8	11.5	23.1	-9.1	0.6	12.1
0.50	-18.7	-6.3	8.3	-55.1	-42.7	-28.1	6.8	18.9	33.4	-4.1	8.0	22.4
0.60	-13.5	1.4	18.8	-50.0	-35.1	-17.6	11.8	26.3	43.7	0.9	15.4	32.8
0.70	-8.4	9.0	29.4	-44.8	-27.5	-7.1	16.9	33.8	54.0	5.9	22.8	43.1
0.80	-3.2	16.6	39.9	-39.7	-19.8	3.5	21.9	41.2	64.3	10.9	30.3	53.4
0.90	1.9	24.2	50.5	-34.5	-12.2	14.0	26.9	48.6	74.7	15.9	37.7	63.7

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 14. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Rotational Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-34.1	-32.6	-29.0	-58.0	-56.5	-52.9	-20.9	-19.3	-15.8	-28.0	-26.5	-22.9
0.30	-33.8	-31.5	-26.2	-57.7	-55.4	-50.1	-20.6	-18.2	-12.9	-27.7	-25.4	-20.1
0.40	-33.5	-30.4	-23.3	-57.4	-54.3	-47.2	-20.3	-17.2	-10.1	-27.4	-24.3	-17.3
0.50	-33.2	-29.4	-20.5	-57.2	-53.3	-44.4	-20.0	-16.1	-7.2	-27.2	-23.3	-14.4
0.60	-33.0	-28.3	-17.6	-56.9	-52.2	-41.5	-19.7	-15.0	-4.4	-26.9	-22.2	-11.6
0.70	-32.7	-27.2	-14.8	-56.6	-51.1	-38.7	-19.4	-14.0	-1.6	-26.6	-21.1	-8.7
0.80	-32.4	-26.1	-11.9	-56.3	-50.0	-35.8	-19.1	-12.9	1.3	-26.3	-20.1	-5.9
0.90	-32.1	-25.1	-9.1	-56.0	-49.0	-33.0	-18.8	-11.8	4.1	-26.0	-19.0	-3.1
	---------- 10-year Period ----------											
0.20	-45.0	-41.2	-35.5	-80.9	-77.1	-71.4	-23.2	-19.4	-13.8	-33.9	-30.2	-24.5
0.30	-42.8	-37.1	-28.6	-78.7	-73.0	-64.5	-21.0	-15.4	-6.9	-31.8	-26.1	-17.7
0.40	-40.6	-33.0	-21.6	-76.5	-68.9	-57.5	-18.9	-11.3	-0.1	-29.6	-22.1	-10.8
0.50	-38.4	-28.9	-14.7	-74.3	-64.8	-50.6	-16.7	-7.3	6.8	-27.5	-18.0	-4.0
0.60	-36.2	-24.8	-7.8	-72.1	-60.7	-43.7	-14.6	-3.2	13.6	-25.3	-14.0	2.8
0.70	-34.0	-20.6	-0.8	-69.9	-56.5	-36.7	-12.4	0.8	20.5	-23.2	-10.0	9.7
0.80	-31.9	-16.5	6.1	-67.8	-52.4	-29.8	-10.3	4.8	27.3	-21.0	-5.9	16.5
0.90	-29.7	-12.4	13.0	-65.6	-48.3	-22.9	-8.1	8.9	34.2	-18.9	-1.9	23.4
	---------- 15-year Period ----------											
0.20	-49.8	-44.8	-39.0	-95.5	-90.6	-84.7	-20.1	-15.3	-9.5	-33.8	-29.0	-23.2
0.30	-44.6	-37.2	-28.4	-90.4	-82.9	-74.2	-15.1	-7.9	0.8	-28.8	-21.6	-12.9
0.40	-39.5	-29.5	-17.9	-85.2	-75.3	-63.6	-10.1	-0.4	11.1	-23.8	-14.2	-2.6
0.50	-34.3	-21.9	-7.4	-80.1	-67.7	-53.1	-5.1	7.0	21.5	-18.8	-6.7	7.7
0.60	-29.2	-14.3	3.2	-74.9	-60.1	-42.6	-0.1	14.4	31.8	-13.8	0.7	18.1
0.70	-24.0	-6.7	13.7	-69.8	-52.4	-32.0	4.9	21.9	42.1	-8.8	8.1	28.4
0.80	-18.9	1.0	24.3	-64.6	-44.8	-21.5	9.9	29.3	52.4	-3.8	15.6	38.7
0.90	-13.7	8.6	34.8	-59.5	-37.2	-10.9	15.0	36.7	62.7	1.2	23.0	49.0

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Over a 15-year period with low levels of initial leafy spurge infestation (5 percent cover), total returns varied from ($95) per acre of leafy spurge at 0.20 AUMs per acre carrying capacity for the poor management, with debt, small flock, new fence scenario to $75 per acre for the poor management, no debt, large flock, modified fence scenario at 0.90 AUMs per acre carrying capacity (Tables 13 and 14). Thus, with the poor management, rotational grazing scenarios over the 15-year period, returns from control varied substantially depending upon the combination of the infestation canopy cover, rangeland carrying capacity, and infestation size.

Generally, over all periods (5-year, 10-year, and 15-year), returns from leafy spurge control in rotational grazing scenarios were about $12 to $25 per acre higher for scenarios having no debt versus those with debt (Tables 11, 12, 13, and 14). In the 5-year period under the rotational grazing strategies, the additional expense for new fence versus modified fence reduced returns from leafy spurge control by an average of $19 per acre across all management scenarios with small infestations. Over the same period, the additional expense for new fence versus modified fence reduced returns from leafy spurge control by $6 per acre across all management scenarios with large infestations. Over the 10-year period, returns from leafy spurge control were $31 per acre less for scenarios with new fence versus modified fence across all management scenarios with small infestations, and $9 per acre less with large infestations. Similarly, returns from leafy spurge control over the 15-year period were $41 per acre less for scenarios with new fence versus modified fence for small infestations, and $12 per acre less with large infestations.

Returns per acre from leafy spurge control were higher with large infestations (250-acre) versus small infestations (50-acre) across all scenarios in each period (Tables 11, 12, 13, and 14). In the 5-year period, returns from large infestations compared to small infestations improved by $9 to $37 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, returns from leafy spurge control improved by $20 to $54 per acre when comparing large to small infestations. In the 10-year period, returns from large infestations compared to small infestations improved by $18 to $46 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, returns from leafy spurge control improved by $37 to $71 per acre when comparing large to small infestations. In the 15-year period, returns from large infestations compared to small infestations improved by $26 to $56 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, returns from leafy spurge control improved by $51 to $88 per acre when comparing small to large infestations.

Least-loss Analysis

The good management scenarios in the rotational grazing systems had positive enterprise returns, which result in positive returns from control. Thus, least-loss analyses were not conducted for those scenarios. However, least-loss scenarios were conducted for the poor management scenarios.

Over the 5-year period, only scenarios with high rangeland productivity and high leafy spurge cover resulted in less economic loss than with no control (Tables 15 and 16). With low levels of leafy spurge infestation (5 percent canopy cover) over the same period, no poor management scenarios would be recommended, as economic losses with control exceeded losses without control. With high

levels of leafy spurge infestation (30 percent canopy cover) over the same period, poor management scenarios with large infestations would be recommended, as economic losses with control were less than losses without control

Over the 10-year period, most scenarios with high rangeland productivity and high leafy spurge cover with large infestations resulted in less economic loss than with no control. Many of the scenarios with new fence and low leafy spurge cover would not be recommended over the 10-year period. However, with new fence and high leafy spurge cover, both large and small flock scenarios could be recommended for all but the least productive rangeland. No small flock scenarios would be recommended at rangeland carrying capacities of 0.20 AUMs per acre (Tables 15 and 16).

Over the 15-year period, nearly all of the scenarios with modified fence and large infestations would be recommended. However, even within the 15-year period, some new fence scenarios and many of the small infestation scenarios would not be recommended. Thus, using sheep to control leafy spurge is not economical in all the situations evaluated in the rotational grazing approach, given the budgets used in this study.

Feasibility of Long-term Control--Sheep Leasing

An alternative to adopting a sheep enterprise would be to lease sheep for leafy spurge control. Leasing sheep for leafy spurge control would have some advantages over adding a sheep enterprise to an existing ranch. Many financial and operational constraints (e.g., capital, labor, facilities) inherent with adding another enterprise to an existing ranch operation would be eliminated with sheep leasing. However, leasing sheep would likely eliminate the potential net revenue generated from an additional enterprise. Expenses for leasing sheep would be similar in context to annual treatment expenses associated with herbicides (i.e., a rancher would be expected to pay some charge per acre per year for leafy spurge control). The lease arrangements between the sheep owner and individual desiring leafy spurge control could be numerous. The arrangement used for this study was that the animals would be leased on a monthly basis for only the time required for leafy spurge control. The lessee would not be responsible for death loss, health, or other flock maintenance duties during summer grazing. The lessee would be responsible for providing adequate fencing and water, along with sufficient forage for the period leased. Transportation was assumed the responsibility of the lessor. The only expenses for the lessee would be the monthly lease rate and fencing costs.

A critical assumption in the evaluation of leasing sheep for purposes of leafy spurge control was that the same flock would be leased over several years. The relationship between sheep grazing and leafy spurge control, in this study, was based on sheep becoming acclimated to eating leafy spurge. If, in a leasing arrangement, a rancher used sheep each year that were not acclimated to eating leafy spurge, control of leafy spurge would likely be less than the amount estimated in this analysis.

Table 15. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Rotational Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.60	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.70	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	no	no	no	no	yes	yes	yes	no	yes	yes
0.30	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.40	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled. A "yes" implies that the scenario will result in less economic loss than no treatment. A "no" implies that the scenario will result in more economic loss than no treatment.

Table 16. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Rotational Grazing Scenario[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	yes	no	no	no
0.50	no	no	no	no	no	no	no	no	yes	no	no	no
0.60	no	no	no	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	no	no	no	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	no	no	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	no
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.
Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled. A "yes" implies that the scenario will result in less economic loss than no treatment. A "no" implies that the scenario will result in more economic loss than no treatment.

The economics of leasing sheep for leafy spurge control were evaluated using $1 per head per month and $2 per head per month lease rates. Each lease rate was evaluated according to the same format used in the sheep enterprise analyses, except debt was not considered (debt considerations in sheep leasing scenarios would only affect fence expenses). Seasonal grazing strategies were based on grazing sheep for four months, with grazing initiated in May. Seasonal grazing periods longer than four months were not evaluated. Also, rotational grazing strategies were not evaluated with sheep leasing for sake of brevity.

Benefit-cost Analysis

Benefit-cost analysis of the two lease rates revealed that returns from leafy spurge control were sensitive to infestation size, infestation canopy cover, fencing costs, and lease rate (Tables 17 and 18). In the 5-year period, returns for the $1 lease rate varied from ($32) per acre for the small flock, low cover infestation, new fence scenario at 0.20 AUMs per acre carrying capacity to $11 per acre for the large infestation, modified fence, high cover infestation scenario at 0.90 AUMs per acre carrying capacity. Over the same period, returns for the $2 lease rate varied from ($47) per acre for the small flock, low cover infestation, new fence scenario at 0.20 AUMs per acre carrying capacity to ($4) per acre for the large infestation, modified fence, high cover infestation scenario at 0.90 AUMs per acre carrying capacity. No scenarios produced positive net returns in the 5-year period with the $2 lease rate (Table 18).

In the 10-year period, net returns for the $1 lease rate varied from ($50) per acre for the small flock, low cover infestation, new fence scenario at 0.20 AUMs per acre carrying capacity to $40 per acre for the large infestation, modified fence, high cover infestation scenario at 0.90 AUMs per acre carrying capacity (Tables 17 and 18). Over the same period, returns for the $2 lease rate varied from ($72) per acre for the small flock, low cover infestation, new fence scenario at 0.20 AUMs per acre carrying capacity to $18 per acre for the large infestation, modified fence, high cover infestation scenario at 0.90 AUMs per acre carrying capacity. With the $1 lease rate, no scenarios with low levels of leafy spurge cover produced positive net returns. With high levels of leafy spurge cover, the $1 lease rates provided positive net returns only in rangeland with carrying capacities of 0.40 AUMs per acre or higher. With the $2 lease rate, only scenarios with high levels of leafy spurge cover and high rangeland carrying capacities produced positive net returns from leafy spurge control (Tables 17 and 18).

In the 15-year period, returns for the $1 lease rate varied from ($61) per acre for the small flock, low cover infestation, new fence scenario at 0.20 AUMs per acre carrying capacity to $67 per acre for the large infestation, modified fence, high cover infestation scenario at 0.90 AUMs per acre carrying capacity (Table 17). Over the same period, returns for the $2 lease rate varied from ($88) per acre for the small flock, low cover infestation, new fence scenario at 0.20 AUMs per acre carrying capacity to $40 per acre for the large infestation, modified fence, high cover infestation scenario at 0.90 AUMs per acre carrying capacity. With the $1 lease rate, scenarios with low levels of leafy spurge cover only produced positive net returns with rangeland carrying capacities of 0.60 AUMs per acre or higher. With high levels of leafy spurge cover, the $1 lease rates provided positive returns in some scenarios with rangeland carrying capacities down to 0.40 AUMs per acre. In the 15-year period with the $2 lease rate, only scenarios with high levels of leafy spurge cover and high rangeland carrying capacities produced positive returns from leafy spurge control (Table 18).

Table 17. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($1.00 per head per month), Seasonal Grazing[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-17.7	-16.2	-12.4	-32.1	-30.6	-26.8	-15.0	-13.5	-9.8	-17.9	-16.3	-12.6
0.30	-17.3	-15.0	-9.4	-31.7	-29.4	-23.8	-14.7	-12.3	-6.7	-17.5	-15.2	-9.6
0.40	-17.0	-13.8	-6.4	-31.4	-28.2	-20.8	-14.3	-11.1	-3.7	-17.2	-14.0	-6.6
0.50	-16.6	-12.6	-3.3	-31.0	-27.0	-17.8	-13.9	-10.0	-0.7	-16.8	-12.8	-3.6
0.60	-16.2	-11.5	-0.3	-30.6	-25.9	-14.7	-13.5	-8.8	2.3	-16.4	-11.7	-0.6
0.70	-15.8	-10.3	2.7	-30.2	-24.7	-11.7	-13.1	-7.6	5.3	-16.0	-10.5	2.5
0.80	-15.4	-9.1	5.7	-29.8	-23.5	-8.7	-12.7	-6.5	8.4	-15.6	-9.3	5.5
0.90	-15.0	-7.9	8.8	-29.4	-22.3	-5.6	-12.4	-5.3	11.4	-15.2	-8.2	8.5
	---------- 10-year Period ----------											
0.20	-23.6	-19.8	-14.0	-49.8	-46.0	-40.2	-18.7	-15.0	-9.2	-24.0	-20.2	-14.5
0.30	-21.2	-15.5	-6.8	-47.4	-41.7	-33.0	-16.4	-10.8	-2.1	-21.6	-16.0	-7.4
0.40	-18.8	-11.2	0.4	-45.0	-37.4	-25.8	-14.0	-6.5	5.0	-19.3	-11.8	-0.3
0.50	-16.4	-6.9	7.6	-42.6	-33.1	-18.6	-11.7	-2.3	12.1	-16.9	-7.5	6.8
0.60	-14.0	-2.6	14.8	-40.3	-28.8	-11.4	-9.3	1.9	19.2	-14.6	-3.3	14.0
0.70	-11.6	1.7	22.0	-37.9	-24.5	-4.2	-7.0	6.2	26.3	-12.2	0.9	21.1
0.80	-9.2	6.0	29.2	-35.5	-20.2	3.0	-4.6	10.4	33.4	-9.9	5.1	28.2
0.90	-6.8	10.3	36.4	-33.1	-15.9	10.2	-2.3	14.6	40.5	-7.5	9.4	35.3
	---------- 15-year Period ----------											
0.20	-24.6	-19.7	-13.7	-60.6	-55.7	-49.7	-18.2	-13.4	-7.4	-25.3	-20.5	-14.6
0.30	-19.2	-11.8	-2.9	-55.2	-47.8	-38.8	-12.9	-5.7	3.2	-20.1	-12.9	-4.0
0.40	-13.8	-3.9	8.0	-49.7	-39.9	-28.0	-7.6	2.0	13.9	-14.8	-5.2	6.7
0.50	-8.3	4.0	18.9	-44.3	-32.0	-17.1	-2.3	9.7	24.5	-9.5	2.5	17.3
0.60	-2.9	11.8	29.7	-38.9	-24.1	-6.2	3.0	17.4	35.1	-4.2	10.2	27.9
0.70	2.5	19.7	40.6	-33.5	-16.3	4.6	8.3	25.1	45.8	1.1	17.9	38.6
0.80	7.9	27.6	51.5	-28.1	-8.4	15.5	13.5	32.7	56.4	6.3	25.5	49.2
0.90	13.3	35.5	62.3	-22.6	-0.5	26.4	18.8	40.4	67.1	11.6	33.2	59.9

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Table 18. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($2.00 per head per month), Seasonal Grazing[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-32.9	-32.9	-27.6	-47.3	-45.7	-42.0	-30.2	-28.6	-24.9	-33.0	-31.5	-27.8
0.30	-32.5	-32.5	-24.5	-46.9	-44.5	-38.9	-29.8	-27.4	-21.9	-32.7	-30.3	-24.7
0.40	-32.1	-32.1	-21.5	-46.5	-43.3	-35.9	-29.4	-26.3	-18.8	-32.3	-29.1	-21.7
0.50	-31.7	-31.7	-18.5	-46.1	-42.2	-32.9	-29.0	-25.1	-15.8	-31.9	-28.0	-18.7
0.60	-31.3	-31.3	-15.4	-45.7	-41.0	-29.8	-28.6	-23.9	-12.8	-31.5	-26.8	-15.7
0.70	-30.9	-30.9	-12.4	-45.3	-39.8	-26.8	-28.2	-22.8	-9.8	-31.1	-25.6	-12.7
0.80	-30.5	-30.5	-9.4	-44.9	-38.6	-23.8	-27.9	-21.6	-6.8	-30.7	-24.5	-9.6
0.90	-30.2	-30.2	-6.4	-44.6	-37.5	-20.8	-27.5	-20.4	-3.7	-30.4	-23.3	-6.6
	---------- 10-year Period ----------											
0.20	-45.8	-42.0	-36.2	-72.0	-68.2	-62.4	-41.0	-37.2	-31.4	-46.2	-42.5	-36.7
0.30	-43.4	-37.7	-29.0	-69.6	-63.9	-55.2	-38.6	-33.0	-24.3	-43.9	-38.2	-29.6
0.40	-41.0	-33.4	-21.8	-67.3	-59.6	-48.0	-36.3	-28.7	-17.2	-41.5	-34.0	-22.5
0.50	-38.6	-29.1	-14.6	-64.9	-55.3	-40.8	-33.9	-24.5	-10.1	-39.2	-29.8	-15.4
0.60	-36.2	-24.8	-7.4	-62.5	-51.0	-33.6	-31.6	-20.3	-3.0	-36.8	-25.5	-8.3
0.70	-33.8	-20.5	-0.2	-60.1	-46.7	-26.4	-29.2	-16.1	4.1	-34.5	-21.3	-1.2
0.80	-31.5	-16.2	7.0	-57.7	-42.4	-19.2	-26.9	-11.8	11.2	-32.1	-17.1	6.0
0.90	-29.1	-11.9	14.2	-55.3	-38.1	-12.0	-24.5	-7.6	18.3	-29.8	-12.8	13.1
	---------- 15-year Period ----------											
0.20	-51.6	-46.7	-40.8	-87.6	-82.7	-76.7	-45.2	-40.4	-34.5	-52.4	-47.6	-41.7
0.30	-46.2	-38.8	-29.9	-82.2	-74.8	-65.9	-39.9	-32.7	-23.8	-47.1	-39.9	-31.0
0.40	-40.8	-31.0	-19.0	-76.8	-66.9	-55.0	-34.6	-25.0	-13.2	-41.8	-32.2	-20.4
0.50	-35.4	-23.1	-8.2	-71.3	-59.0	-44.1	-29.3	-17.3	-2.5	-36.5	-24.5	-9.7
0.60	-30.0	-15.2	2.7	-65.9	-51.2	-33.3	-24.1	-9.7	8.1	-31.2	-16.9	0.9
0.70	-24.5	-7.3	13.6	-60.5	-43.3	-22.4	-18.8	-2.0	18.8	-26.0	-9.2	11.6
0.80	-19.1	0.6	24.4	-55.1	-35.4	-11.5	-13.5	5.7	29.4	-20.7	-1.5	22.2
0.90	-13.7	8.4	35.3	-49.7	-27.5	-0.7	-8.2	13.4	40.0	-15.4	6.2	32.8

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Over the 5-year period, total returns from leafy spurge control with $1 and $2 lease rates, averaged over various carrying capacities, increased about $15 per acre when leafy spurge canopy cover increased from 5 percent to 30 percent. Over the 10-year period, returns from leafy spurge control with $1 and $2 lease rates, averaged over various carrying capacities, increased about $26 per acre when leafy spurge canopy cover increased from 5 percent to 30 percent. Similarly, over the 15-year period, returns from control improved about $30 per acre when leafy spurge canopy cover increased from 5 percent to 30 percent (Tables 17 and 18).

In the 5-year period, the additional expense for new fence versus modified fence reduced returns from leafy spurge control by an average of $14 per acre across all scenarios with small infestations, and $3 per acre less with large infestations. Over the 10-year period, net returns from leafy spurge control were $26 per acre less for scenarios with new fence versus modified fence across all scenarios with small infestations, and $5 per acre less with large infestations. Similarly, net returns from leafy spurge control over the 15-year period were $36 per acre less for scenarios with new fence versus modified fence for small infestations, and $7 per acre less with large infestations (Tables 17 and 18).

Net returns per acre from leafy spurge control were higher with large infestations (250-acre) versus small infestations (50-acre) across all scenarios in each period. In the 5-year period, net returns from large infestations compared to small infestations improved by $3 per acre for $1 and $2 lease rates. For all scenarios with new fence over the same period, net returns from leafy spurge control improved by $14 per acre when comparing large to small infestations. In the 10-year period, net returns from large infestations compared to small infestations improved by $5 per acre for $1 and $2 lease rates. For all scenarios with new fence over the same period, net returns from leafy spurge control improved by $26 per acre when comparing large to small infestations. In the 15-year period, net returns from large infestations compared to small infestations improved by $6 per acre for all scenarios with modified fence. For all scenarios with new fence over the same period, net returns from leafy spurge control improved by $35 per acre when comparing large to small infestations (Tables 17 and 18).

Least-loss Analysis

Least-loss analysis determines if the losses from control exceed the losses from no control. Most of scenarios evaluated in the 5-year, 10-year, and 15-year periods had negative net returns from leafy spurge control with the lease rates evaluated.

Over the 5-year period with the $1 lease rate, only scenarios with high rangeland productivity and high leafy spurge cover resulted in less economic loss than with no control (Tables 19 and 20). With low levels of leafy spurge infestation (5 percent canopy cover) over the same period, none of the lease scenarios examined would be recommended, as economic losses with control exceeded losses without control. With high levels of leafy spurge infestation (30 percent canopy cover), scenarios with modified fence would be recommended based on the least-loss criteria for small and large infestations with rangeland carrying capacities down to 0.40 AUMs per acre. With high levels of leafy spurge cover, scenarios with new fence would be recommended for small infestations with rangeland carrying

capacities down to 0.60 AUMs per acre. With high levels of leafy spurge infestation, scenarios with new fence would be recommended based on the least-loss criteria for large infestations with rangeland carrying capacities down to 0.40 AUMs per acre.

Over the 5-year period with the $2 lease rate, only scenarios with high leafy spurge cover and those with rangeland carrying capacities of 0.60 AUMs per acre or higher resulted in less economic loss than with no control (Tables 19 and 20). All other scenarios evaluated in the 5-year period with the $2 lease rate would not be recommended.

Over the 10-year period with the $1 lease rate, nearly all scenarios with high rangeland productivity (0.60 AUMs per acre or higher) and high leafy spurge cover (30 percent canopy cover) resulted in less economic loss than with no control (Tables 19 and 20). Some of the scenarios with new fence and low leafy spurge cover would not be recommended over the 10-year period. However, with new fence and high leafy spurge cover, both large and small infestations could be recommended for all but the least productive rangeland. In the 10-year period, the small infestation scenario with low leafy spurge cover and new fence would not be recommended, regardless of rangeland carrying capacity.

Over the 10-year period with the $2 lease rate, no scenarios with low leafy spurge cover would be recommended, regardless of rangeland productivity (Tables 19 and 20). Some of the scenarios with modified fence and high leafy spurge cover would be recommended down to rangeland carrying capacities of 0.40 AUMs per acre. Most of the new fence, small infestation scenarios would not be recommend with the $2 lease rate over the 10-year period. Similarly, in the new fence, large infestation scenarios, only those with productive rangeland would be recommended.

In the 15-year period, most of the modified fence scenarios, both small and large infestations, would be recommended with $1 lease rate. However, with small infestations and new fence, recommendations would be sensitive to rangeland carrying capacities. The new fence, large infestation scenarios would be recommended with the $1 lease rate for carrying capacities down to 0.30 AUMs per acre.

Many scenarios, in the 15-year period, with high infestation cover, high rangeland productivity, and modified fencing would be recommended at the $2 lease rate. Conversely, most scenarios with low infestation cover, low rangeland productivity, and new fencing would not be recommended (Tables 19 and 20). No scenarios would be recommended with the $2 lease rate in the 15-year period for rangeland carrying capacities of 0.20 AUMs per acre.

Table 19. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($1.00 per head per month), Seasonal Grazing[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	no
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.80	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
	10-year Period											
0.20	no	no	yes	no	no	no	no	no	yes	no	no	no
0.30	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	yes	yes	no	no	yes	no	yes	yes	yes	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.30	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled. A "yes" implies that the scenario will result in less economic loss than no treatment. A "no" implies that the scenario will result in more economic loss than no treatment.

Table 20. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($2.00 per head per month), Seasonal Grazing[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	no	no	no	no
0.50	no	no	no	no	no	no	no	no	no	no	no	no
0.60	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	no	yes	no	no	yes
	---------- 10-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	yes	yes	no	yes	yes	no	yes	yes
	---------- 15-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.40	no	yes	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.60	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $15.
Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled. A "yes" implies that the scenario will result in less economic loss than no treatment. A "no" implies that the scenario will result in more economic loss than no treatment.

DISCUSSION

The following section identifies data and method shortcomings present in this study. Also, a general discussion of the factors influencing the economics of using sheep to control leafy spurge has been included.

Data and Method Shortcomings

A number of data and method shortcomings were present in this analysis. First, some key components of the model were based on "best estimates" of range and weed scientists. The first three to four years of leafy spurge control using sheep was based on range research; however, control in the remaining years was largely extrapolated from existing research data. The exact nature of leafy spurge control using sheep in years 5 through 10 has not been fully quantified. Also, the exact relationship between leafy spurge control and grass recovery is unknown.

A number of additional analyses could be used to show the sensitivity of net returns from leafy spurge control with different sets of model parameters (e.g., adjust model for less or more control, increase or decrease the amount of grass availability, use various rates of grass recovery). However, for sake of brevity, and since most of the existing relationships used in the model have not be been fully researched, additional scenarios showing the effects of different model parameters were not included. Little value exists in showing the sensitivity to returns from subjective adjustments to parameters that are already somewhat subjective (based on best estimates). Sensitivity of returns to changes in model parameters would best be addressed in further research.

All analyses were evaluated based on leafy spurge canopy cover levels of 5, 15, and 30 percent. These percentages were used to evaluate low, moderate, and high levels of grazing loss to cattle within leafy spurge infestations. Higher canopy cover percentages would not affect the amount of lost grazing to cattle, but would have implications for grass recovery and potential returns to control. However, analyses of leafy spurge infestations with greater than 30 percent canopy cover were not evaluated for sake of brevity. Additional analyses of the net returns from grazing controls using higher leafy spurge densities and levels of canopy cover would be warranted in further research.

Sheep prices, enterprise proficiency, production costs, debt levels, and grazing values were fixed over the analysis periods. Their values will likely fluctuate over time or vary for individual ranchers. The effects of changes in those values were not addressed in this study. Analyzing the effects of changing economic values for key components of a sheep enterprise would best be completed in future work. A stochastic approach (i.e., a range of values allowed to change over time) to incorporating changing economic values would represent an improvement over the deterministic approach (i.e., values fixed over the analysis period) used in this study.

Fencing costs were amortized over 20 years. However, the longest analysis period was 15 years. Net returns in each of the three periods analyzed did not include all of the fencing expenses. Net returns from leafy spurge control would decrease if total fencing costs were allocated to any particular period. However, since the salvage value of the additional fencing materials were not

incorporated into the annual amortization of fencing costs, fencing expenses approximated fence depreciation, since the portion of fencing costs that was not allocated would approximate the remaining value of the fencing materials. From that perspective, the results closely captured the net costs of fencing in each time period.

The effects of changing the values of some initial situation inputs were not included in the analysis. For example, all analyses were conducted using one spread rate for leafy spurge infestations. Also, the annual rate of increase in leafy spurge canopy cover was fixed across all analyses. Other fixed inputs included the overall size of the pasture (all analyses used a 350-acre pasture) and fixed sizes of leafy spurge infestations (only a 50-acre and 250-acre infestation). The sensitivity of net returns to changes in those values was not addressed, and the study results could be improved by including these additional analyses. However, these additional analyses would be best conducted when other model parameters are improved or refined.

Multiple species grazing has been shown to improve range health and increase grazing output on rangeland, assuming proper stocking rates. Any additional benefits obtained from multiple species grazing were not included in the analysis. Sheep may also help control other weeds on rangeland, in addition to controlling leafy spurge. Potential benefits from additional weed control and improvements in range productivity stemming from multiple species grazing were not included in this study. Future analyses, incorporating those benefits, would enhance the value of using sheep for weed control and provide a broader look at using grazing controls for range improvements.

Labor costs were not included in the sheep enterprise budgets or in the fencing expenses. Thus, even though returns may be positive for many control situations, returns from control may not be sufficient to adequately compensate a rancher for labor inputs. What a rancher would consider adequate compensation for time and labor inputs is a question best resolved by individual ranchers. Labor requirements for a sheep enterprise would be required annually; whereas, labor requirements for fence construction and modification would be incurred once (not including requirements for annual fence maintenance). Returns from leafy spurge control would be reduced if specific charges were included for labor inputs, as labor charges would reduce enterprise returns and increase fencing costs.

This study examined the economics of using sheep grazing to control leafy spurge; however, the issue of the economics of control may be irrelevant if a ranch operation has other constraints to adopting a sheep enterprise. Other issues, which should be examined, include financial and operational constraints to using sheep as a control tool for leafy spurge. These constraints may include the financial feasibility of adding a sheep enterprise to an existing ranch. Financial feasibility would address the availability of capital, cash flow, and other financial characteristics of a ranch operation that may prohibit adoption of an additional enterprise. Operational constraints, such as labor availability and seasonal labor demands, may also pose restrictions on adopting an additional enterprise. Financial and operational constraints need to be addressed; however, those issues would be best resolved in additional research.

Factors Influencing Returns from Control

A multitude of factors can influence the economics of using sheep to control leafy spurge. One of the biggest factors influencing returns from leafy spurge control would be enterprise returns. When enterprise returns were positive, net returns from leafy spurge control were positive in all of the treatment situations examined. In some cases, returns from leafy spurge control were substantial. However, when sheep are leased or enterprise returns were negative, a number of other factors influence the economics of control.

Large infestations were more economical to treat than small infestations, based on the fundamental assumptions used in this study. Fencing costs were modeled to be less with larger infestations, since overall pasture size was fixed across infestation sizes. In reality, per acre fencing costs for a 200-acre infestation could be the same for a 50-acre infestation. Also, because some efficiencies in sheep production occur when moving from small flocks (e.g., 50 ewes) to large flocks (e.g., 200 ewes), enterprise returns (i.e., $ per ewe) improved with flock size. Thus, lower per ewe fencing costs and more favorable enterprise returns were major reasons for returns from control being more favorable with larger infestations.

With good flock management, returns from control were positive with both rotational and seasonal grazing strategies. However, rotational grazing scenarios were less economical than seasonal controls, due to reduced leafy spurge control and higher fencing costs associated with rotational grazing systems. However, differences in leafy spurge control between the two grazing systems for any particular situation may not match those used in this report. Fencing costs were higher with rotational grazing because of the additional materials for internal fences. Over the 10-year and 15-year periods, the difference between returns from rotational and seasonal grazing strategies, in most situations analyzed in this study, did not substantially influence the economics of using sheep to control leafy spurge.

Returns from control improved as leafy spurge canopy cover increased. As grazing losses for cattle increased, returns from leafy spurge control also increased. This relationship directly influenced the amount of grazing recovery that could be expected from leafy spurge control. Returns from leafy spurge control improved proportionally to changes in grazing recovery. Also, since sheep grazing was only evaluated using relatively large infestations, the value of grazing retention (i.e., grazing output retained by preventing infestation spread) was a small component of overall returns. The effects of much higher leafy spurge densities and levels of canopy cover would affect net returns from leafy spurge control if grass recovery and forage available within the infestations differed from the levels/relationships assumed in this study.

Returns from control were directly proportional to the productivity of rangeland. Returns also improved proportionally with increases in AUM values. As the two components increased, returns increased proportionally with changes in rangeland productivity and grazing output values. Thus, holding all other factors constant, returns were greater on more productive rangeland. Similarly, holding all factors constant, returns improved as AUM values increased.

The level of debt used in this study did affect returns from leafy spurge control. The level of debt used in this study had sufficient influence on returns from control (about $12 to $23 per acre) to affect decisions regarding the economics of using sheep to control leafy spurge. The effects of debt were most influential in the poor management scenarios. Debt expenses reduced enterprise returns and increased fencing expenses. If enterprise returns are positive after debt expenses, returns from control will still be positive. However, when enterprise returns were negative, debt expenses were sufficient in some situations to make sheep grazing of leafy spurge uneconomical. The effects of various debt levels and debt expenses were not included in this study. A broader examination of the effects of debt expenses on the economics of using sheep to control leafy spurge would improve this research.

The added expense for new fence had a much greater effect on returns from small infestations (expense was divided among fewer acres). For example, in the 5-year period, returns from control improved by $15 per acre with modified fence compared to new fence with small infestations; however, returns from control only increased by $5 per acre with modified fence compared to new fence with large infestations. The difference in net returns with modified versus new fence increased with both the small and large infestations over the three periods. For example, with small infestations, returns from control improved about $15 per acre in the 5-year period, but over the 10-year period, returns improved by $26 per acre and improved by $34 per acre over the 15-year period. Similarly, with large infestations, returns from control improved by $5 per acre in the 5-year period, $7.5 per acre in the 10-year period, and $10 per acre in the 15-year period.

The difference in net returns between new fence and modified fence scenarios for rotational grazing were greater than the differences with the seasonal grazing strategies. The increased fencing expense assumed in the rotational grazing systems accounted for the difference.

Lease rates of $2 per head per month were not economical in most control situations. However, a lease rate of $1 per head per month was economical in many of the control situations.

Returns from using wethers to control leafy spurge were not provided because none of the wether enterprise scenarios developed in this study were economical for leafy spurge control. Little data exists to accurately estimate annual production costs for wether flocks. Wether flocks may be economical to use for leafy spurge control in some situations, providing actual production costs are less than those developed in this study.

To recap, the factors influencing returns from using sheep to control leafy spurge have been highlighted:

AUM values--returns from control changed proportionally with changes in AUM values.

Rangeland productivity--returns from control changed proportionally with changes in rangeland productivity.

Enterprise returns--the level of management, or financial performance, of the sheep enterprise had substantial effects on returns. Labor costs were not included in either the sheep budgets or fencing expenses.

Sheep leasing--leasing sheep for leafy spurge control may be an attractive alternative to adding a sheep enterprise to an existing operation. However, lease rates above $1 per head per month were not economical in many situations.

Infestation size--returns from control increase as infestation size increased across constant pasture sizes. Between the two infestation sizes evaluated, large infestations substantially increased net returns per acre over smaller infestations.

Fence expenses--modified fence was more economical than new fence, although the additional cost of new fence was not as prevalent in large infestations, assuming fixed pasture size. Expenses for new fence had more effect on returns from control in rotational grazing systems.

Debt costs--returns from control were less in the enterprise scenarios with debt; however, debt costs alone did not greatly influence overall returns from leafy spurge control

Grazing system--seasonal grazing was more economical than rotational grazing, largely because rotational grazing had lower leafy spurge control rates and higher fencing costs.

Infestation canopy cover--as infestation canopy cover increased (ability of cattle to graze within the infestation decreased), returns from control increased. The range of canopy cover evaluated only ranged from 5 to 30 percent. Returns from control of much denser leafy spurge infestations would likely differ from the results presented in this study.

Time period--returns per acre of leafy spurge improved for most scenarios as the analysis period increased from 5-years to 10- and 15-year periods. Returns in the various periods would be sensitive to changes in the discount rate.

CONCLUSIONS

Very little economic information is available regarding the economics of using sheep to control leafy spurge. The primary goal of this research was to evaluate the economics of using sheep to control leafy spurge over a wide range of situations. Although a wide range of situations was evaluated, many of the key relationships between sheep grazing and forage recovery (cattle) have not be quantified. These relationships were estimated, for purposes of this study, based on assumptions and "best estimates" of weed and range scientists. Thus, until these relationships can be further refined, much of the economic analysis provided by this research remains sensitive to those key assumptions and relationships. However, the results from this preliminary research do provide important insights into the economics of using sheep to control leafy spurge.

The basic premise for this study was that sheep would be added to leafy spurge infested rangeland either through (1) adoption of a sheep enterprise by an existing ranch or (2) leasing sheep during the grazing season. Several possible sheep enterprise scenarios were developed, which would represent a reasonable range of flock performance and financial conditions which could be expected from cattle ranchers. Sheep grazing as a leafy spurge control method was economical across many of

enterprise scenarios developed. However, a number of other factors, such as additional labor requirements and financial constraints, need to be considered before implementing a grazing control strategy. Labor costs were not included in the sheep enterprise budgets or in the fencing expenses. Thus, even though returns may be positive for many control situations, returns from control may not be sufficient to adequately compensate a rancher for labor inputs. Providing these constraints do not prohibit adding a sheep enterprise to an existing ranch, the economics of using sheep grazing to control leafy spurge appear favorable. In many of the scenarios with negative sheep enterprise returns, the benefits of leafy spurge control outweighed the costs of control (enterprise returns). Thus, controlling leafy spurge with sheep grazing can be economical even if the sheep enterprise had negative enterprise returns.

The economics of using sheep grazing to control leafy spurge appear promising. Although many of the key relationships tying leafy spurge control to grazing benefits remain unquantified, the economics of sheep grazing were positive across many of the scenarios evaluated in this study. A number of factors, more so than perhaps in other leafy spurge controls, can influence both the costs and returns from using sheep grazing as a leafy spurge control. General flock performance (e.g., lambing rate, weaning weight, death loss) had the greatest effect on returns from leafy spurge control. Other considerations, such as fencing expenses and enterprise debt, also influenced returns from control. Obviously, modifying an existing fence to contain sheep was more economical than constructing new fence. Similarly, enterprise scenarios that were debt free were more economical than those with debt. Small flocks (flock size was tied to leafy spurge acreage) were less economical than large flocks. Also, leafy spurge canopy cover, AUM values, and rangeland productivity each directly (proportional to changes in those values) affected returns from control. However, even some of the most pessimistic situations (e.g., poor flock performance, debt overhead, new fence expenses) resulted in less economic loss with grazing controls than without controlling leafy spurge. However, many situations were also not economical.

While using sheep to control leafy spurge could be economical in many situations (based on the limitations in this study), a careful evaluation using site- and rancher-specific inputs would be recommended before implementing sheep grazing as a leafy spurge control method. As with any decision regarding a long-term strategy to control leafy spurge, information in this study should be used in conjunction with other information and with consultation with weed scientists when formulating long-term control strategies.

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APPENDIX A

Model Parameters

This section presents model parameters and explanations of how the physical relationships between infestation canopy cover, rate of spread, grass production, and grass utilization (beef) are handled in the model. Sheep stocking rates were parameters in the model (Appendix Table A1). Reduction in leafy spurge density also was a model parameter (Appendix Table A2).

Grazing Loss

Loss of grazing capacity in AUMs (beef) is based on infestation size, carrying capacity, infestation canopy cover percentage, and the percentage grazing loss resulting from various levels of leafy spurge canopy cover. Carrying capacity, size of infestation, initial infestation canopy cover, initial rate of spread (lateral feet per year), and annual increase in leafy spurge canopy cover (if uncontrolled) are inputs to the model. The amount of grazing loss from various levels of infestation canopy cover is a model parameter (see Figure 4). The model calculates the amount of lost grazing that would occur without control by estimating the change in infestation size and canopy cover over time.

Grass Utilization

The model first determines the dynamics of infestation size and the influences of grazing control on the rate of infestation spread. Infestation size in year 1 is matched with the expected change in infestation spread rate to arrive at expected size of the infestation in year 2. Subsequent years are handled in the same manner. Rate of spread is a function of control, which is determined by the type of grazing system and number of years of grazing (Appendix Table A3).

The model then determines the effects of sheep grazing on infestation canopy cover. In year 1, the model starts with initial infestation cover and the expected change in cover with the specific level of control (sheep-seasonal, sheep-rotational). The model then estimates the change in cover for year 2. In subsequent years, the model has (built in) constraints on the minimum infestation density obtainable through sheep control in any given year. (Infestation canopy cover can only drop to a certain point regardless of control--a minimum density was mandated in each year as percentage of starting density, because mathematically, the amount of leafy spurge control, as defined in this study (see Figure 4), would eventually produce near zero levels of canopy cover. However, sheep grazing will not eradicate leafy spurge).

The amount of forage available to cattle in the infestation is then estimated based on the canopy cover of the infestation (Appendix Table A4). Maximum (percentage of carrying capacity) levels of forage production were built into the model to limit the upper capacity of grass production within the infestation. The change in grass production was also limited to 40 percent of the change in density in any given year (e.g., if infestation density goes from 60 to 50 percent, grass production increases by 4 percent from levels in the previous year). Grass used by cattle is then a function of grass available and the amount used by cattle based on year of grazing control (Appendix Table A5). Thus, cattle can only use a portion of the amount of grass available, and the amount of grass available was regulated by changes in canopy cover. Over time the stocking rate for sheep was assumed to be reduced (Appendix Table A6).

Appendix Table A1. Recommended Sheep and Goat Stocking Rates for Leafy Spurge Control

Months Grazed	Western ND Animals Per Acre		Eastern ND Animals Per Acre	
	Sheep	Goats	Sheep	Goats
1	4	12	8	16
2	2	6	4	8
3	1.5	4.5	3	6
4	1	3	2	4
5	0.875	2.625	1.75	3.5
6	0.75	2.25	1.5	3
7	0.625	1.875	1.25	2.5
8	0.5	1.5	1	2

Appendix Table A2. Leafy Spurge Density Reduction, Sheep and Goat Grazing

Year	Goats		Sheep	
	Seasonal	Rotational	Seasonal	Rotational
1	0%	0%	0%	0%
2	8%	-10%	5%	-15%
3	25%	10%	20%	5%
4	55%	28%	45%	25%
5	70%	50%	60%	40%
6	79%	71%	69%	53%
7	83%	77%	75%	64%
8	87%	80%	78%	71%
9	87%	80%	81%	76%
10	87%	80%	83%	78%

Appendix Table A3. Rate of Expansion of Leafy Spurge Infestation, under Goat and Sheep Grazing

Year	Goats		Sheep	
	Seasonal	Rotational	Seasonal	Rotational
	---------- % of normal expansion ----------			
1	100%	100%	100%	100%
2	44%	49%	44%	49%
3	11%	27%	11%	27%
4	0%	7%	0%	7%
5	0%	0%	0%	0%
6	0%	0%	0%	0%
7	0%	0%	0%	0%
8	0%	0%	0%	0%
9	0%	0%	0%	0%
10	0%	0%	0%	0%

Appendix Table A4. Relationship between Infestation Density and Forage Available to Cattle, Initial Conditions

Infestation Density	Forage Available as a Percent of Carrying Capacity
1 to 5%	95%
6 to 10%	90%
11 to 20%	80%
21 to 30%	70%
31 to 40%	60%
41 to 50%	50%
51 to 60%	40%
61 to 70%	30%
71 to 79%	25%
80+%	20%

Appendix Table A5. Grass Utilization of Available Forage within Leafy Spurge Infestations, Cattle

Year	Goats		Sheep	
	Seasonal	Rotational	Seasonal	Rotational
1	0%	0%	0%	0%
2	50%	47%	50%	47%
3	80%	77%	80%	77%
4	90%	88%	90%	87%
5	90%	88%	90%	87%
6	90%	88%	90%	87%
7	90%	88%	90%	88%
8	90%	88%	90%	88%
9	95%	93%	95%	93%
10	95%	93%	95%	9,3%

Appendix Table A6. Stocking Rate Reduction for Sheep and Goat Grazing of Leafy Spurge

Year	Goats		Sheep	
	Seasonal	Rotational	Seasonal	Rotational
	---------- % of normal rate ----------			
1	100%	100%	100%	100%
2	100%	100%	100%	100%
3	100%	100%	100%	100%
4	50%	100%	60%	60%
5	50%	60%	60%	60%
6	50%	60%	60%	60%
7	50%	60%	60%	60%
8	25%	25%	40%	40%
9	25%	25%	40%	40%
10	25%	25%	40%	40%

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APPENDIX B

Sheep Enterprise Coefficients and Budgets

All scenarios with the exception of the wether flock,[5] describe operations typical in western North Dakota farm flock operations. The sheep enterprises were based on spring lambing prior to spring calving, so as to not interfere with a ranch's normal operations. Only breeding stock were used for leafy spurge control. Lambs were assumed to be weaned before summer grazing and retained in feedlots after weaning. Sheep budgets were prepared using *SheepBud*, a computer enterprise analysis program for sheep producers (Hughes et al. 1997). Ewes were assumed to be commercial western white faced ewes and rams were black faced sires. All replacements were assumed raised and remaining lambs were marketed for slaughter.

Small flocks had 60 ewes and 2 rams and large flocks had 200 ewes and 6 rams. Facility and equipment requirements for all flocks were modest. The small flock was budgeted at $1500 for building renovation and equipment purchase and the large flock was budgeted at $2000, assuming the sheep enterprises were placed into an existing ranch operation and would be able share or reuse existing facilities.

Flocks were further categorized by those with debt and those without debt. Half of the sheep enterprises had no debt, meaning that livestock, facilities, and equipment were either already available or purchased without financing. The enterprises with debt were assumed to have 50 percent of the equipment and facility requirements financed for 5 years and 50 percent of the breeding stock purchases financed for 3 years. Loan interest rate was set at 10 percent.

Poor management flocks were assumed to have a lambing rate of 100 percent and a 10 percent death loss up to weaning. An additional death loss post-weaning of about 20 percent was assumed for the poor management flocks. Actual lambs sold per ewe exposed was assumed to be 0.7 for the poor management flocks. The level of proficiency in the poor performing scenarios was below that of unassisted lambing flocks on the Hettinger Research Station (Hettinger Research Extension Center 1999). In contrast, the good management flocks were assumed to wean 1.35 lambs per ewe exposed and to market 1.15 lambs per ewe exposed. The good management scenarios represent average results for North Dakota sheep producers. Thus, the proficiency of enterprises in this study ranged from levels achieved by proven sheep producers to levels below that of unassisted flocks.

Feed expense for all flocks was based on market prices for feed inputs (Appendix Table B1). Pasture charges were not included the budgets, as sheep would primarily be grazing forage unavailable to cattle (i.e., leafy spurge). Good management scenarios used slightly more feed per ewe. Lamb feed, on a per head basis from weaning to market, was assumed equal for all flocks. Lambs were assumed to gain 1 pound for every 7 pounds of feed fed. Lamb ration was 25 percent roughage and 75 percent grain. Ewe rations varied according to specific reproductive periods.

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[5]There are no known wether flocks in the northern Great Plains. Wethers have been used for grazing research in the past, but not in recent years.

Other variable costs, such as shearing, utilities, fuel, etc., were assumed equal (i.e., per ewe) among all enterprises. Selling prices for lamb, cull ewes, and wool represented average 5-year North Dakota prices (North Dakota Agricultural Statistics *various years*).

Several other key assumptions were made in the preparation of the sheep budgets. Economic charges (depreciation) were not included for machinery and equipment that overlap with cattle production. Thus, expenses for stock trailers, loader tractor, pickup, and other overlapping equipment were not included in the budgets. All pastures were assumed to have water present in sufficient quantities and available to sheep. Water maintenance expenses were not included in the budgets.

A number of annual budgets were estimated for the various enterprise scenarios due to changes in debt expense and reductions in flock size over time. In the enterprise scenarios with debt, separate budgets were estimated for years 1 and 2, 3, 4 and 5, 6, 7, and 8 through 10. Years 1 and 2 represented initial conditions. Year 3 had extra sale of lambs since no replacement lambs were needed for the following year. Year 4 and 5 represented a reduction in flock size from year 3 and debt on breeding stock was expired. Year 6 had the same flock size as years 4 and 5; however, debt on fixed assets was expired. Year 7 had extra sale of lambs since no replacement lambs were needed for the following year. Years 8 through 10 represented a new flock size.

In the enterprise scenarios with no debt, separate budgets were estimated for years 1 and 2, 3, 4 through 6, 7, and 8 through 10. Years 1 and 2 represented initial conditions. Year 3 had extra sale of lambs since no replacement lambs were needed for the following year. Years 4 through 6 represented a reduction in flock size from previous years. Year 7 had extra sale of lambs since no replacement lambs were needed for the following year. Years 8 through 10 represented a new flock size.

Appendix Table B1. Sheep Enterprise Coefficients and Characteristics

Characteristics/Coefficients	Level of Enterprise Proficiency: Good Management		Poor Management	
Selling Characteristics				
Market Lamb Selling Price (per cwt)	$75.00		$75.00	
Cull Ewe Selling Price (per cwt)	$35.00		$35.00	
Cull Ram Selling Price (per hd)	$50.00		$50.00	
Wool Selling Price (per lb)	$0.50		$0.50	
Market Lamb Selling Weight (lbs/hd)	120		105	
Lamb Weaning Weight (lbs/hd)	50		45	
Cull Ewe Selling Weight (lbs/hd)	150		150	
Wool Production (lbs/ewe/year)	10		10	
Flock Performance				
Conception Rate	100.0%		100.0%	
Lambing Rate	150.0%		100.0%	
Lamb Death Loss	10.0%		12.0%	
Ewe Death Loss	5.0%		5.5%	
Replacement Rate (raised)	20.0%		20.0%	
Ewes per Ram	33		30	
Feed Use				
Lamb:				
Lbs of feed/lb of gain	7		7	
Roughage (% of ration)	25		25	
Grain (% of ration)	75		75	
Ewe:	grain	hay	grain	hay
First 17 weeks (119 days) (lbs/ewe/day)	0	4	0	4
Last 4 weeks (28 days) (lbs/ewe/day)	1	5	1	5
Lactation (56 days) (lbs/ewe/day)	2	6	1	5
Maintenance/Flushing (161 days)	0	4	0	4
Hay waste (lb/ewe/day)	----	0.25	----	0.35
Mineral (lbs/ewe)	10		10	
Creep (lbs/ewe)	----		45	

- continued -

Appendix Table B1. Continued

Characteristics/Coefficients	Level of Enterprise Proficiency Good Management	 Poor Management
Feed Prices		
Hay (per ton)	$50.00	$50.00
Grain (per bu)	$2.00	$2.00
Grain (lbs/bu)	48	48
Pasture (per AUM)	no charge	no charge
Mineral (per cwt)	$12.00	$12.00
Creep (per cwt)	----	$12.00
Livestock Expenses (per ewe)		
Bedding	$0.45	$0.45
Vet and Medicine	$4.00	$2.00
Power and Fuel	$1.00	$1.00
Utilities and General Farm Expense	$1.00	$1.00
Supplies	$3.00	$2.00
Shearing	$2.00	$2.00
Marketing Expenses (per hd sold)	$1.80	$1.80
Fixed Expenses per year)		
Buildings (7% of $500 per year for small flock and 7% of $1000 per year for large flock)		
Equipment (13% of $1000 per year for large and small flocks)		
Ewes (1 % of $1 00/ewe per year)		
Replace Ewes (1 % of $80/head per year)		
Rams (33% of $100 per ram for poor mgnt, 33% of $200 per ram for good mgnt)		
Fencing (estimated seperately, based on new or modified fence for various-sized pastures)		
Land	no charge	no charge

Appendix Table B2. Sheep Enterprise Size, Over 10 Years of Leafy Spurge Control, Good Enterprise Management

Animal Types	Flock Parameter	Years of Leafy Spurge Control 1	2	3	4	5	6	7	8	9	10
Large Flock											
Ewes in Flock		200	200	200	120	120	120	120	80	80	80
Lambs produced	150%	300	300	300	180	180	180	180	120	120	120
Lambs die before selling	10%	30	30	30	18	18	18	18	12	12	12
Lambs available in fall		270	270	270	162	162	162	162	108	108	108
Ewe death loss	5%	10	10	10	6	6	6	6	4	4	4
Repl. lambs needed	20%	40	40	0	24	24	24	0	16	16	16
Ewes culled and sold	*	30	30	70	18	18	18	34	12	12	12
Lambs sold	**	230	230	270	138	138	138	162	92	92	92
Rams need	30	6.7	6.7	6.7	4.0	4.0	4.0	4.0	2.7	2.7	2.7
Small Flock											
Ewes in Flock		60	60	60	36	36	36	36	24	24	24
Lambs produced	150%	90	90	90	54	54	54	54	36	36	36
Lambs die before selling	10%	9	9	9	5	5	5	5	4	4	4
Lambs available in fall		81	81	81	49	49	49	49	32	32	32
Ewe death loss	5%	3	3	3	2	2	2	2	1	1	1
Replacement lambs nee	20%	12	12	0	7	7	7	0	5	5	5
Ewes culled and sold	*	9	9	21	5	5	5	10	4	4	4
Lambs sold	**	69	69	81	42	42	42	49	27	27	27
Rams needed	30	2	2	2	1	1	1	1	1	1	1

*Replacement lambs less ewe death loss.
**Lambs available less replacement lambs.

Appendix Table B3. Sheep Enterprise Size, Over 10 Years of Leafy Spurge Control, Poor Enterprise Management

Animal Types	Flock Parameter	Years of Leafy Spurge Control 1	2	3	4	5	6	7	8	9	10
Large Flock											
Ewes in Flock		200	200	200	120	120	120	120	80	80	80
Lambs produced	100%	200	200	200	120	120	120	120	80	80	80
Lambs die before selling	12%	24	24	24	14	14	14	14	10	10	10
Lambs available in fall		176	176	176	106	106	106	106	70	70	70
Ewe death loss	6%	11	11	11	7	7	7	7	4	4	4
Repl. lambs needed	20%	40	40	0	24	24	24	0	16	16	16
Ewes culled and sold	*	29	29	69	17	17	17	33	12	12	12
Lambs sold	**	136	136	176	82	82	82	106	54	54	54
Rams needed		6.7	6.7	6.7	4.0	4.0	4.0	4.0	2.7	2.7	2.7
Small Flock											
Ewes in Flock		60	60	60	36	36	36	36	24	24	24
Lambs produced	100%	60	60	60	36	36	36	36	24	24	24
Lambs die before selling	12%	7	7	7	4	4	4	4	3	3	3
Lambs available in fall		53	53	53	32	32	32	32	21	21	21
Ewe death loss	6%	3	3	3	2	2	2	2	1	1	1
Repl. lambs needed	20%	12	12	0	7	7	7	0	5	5	5
Ewes culled and sold	*	9	9	21	5	5	5	10	4	4	4
Lambs sold	**	41	41	53	25	25	25	32	16	16	16
Rams needed		2	2	2	1	1	1	1	1	1	1

*Replacement lambs less ewe death loss.
**Lambs available less replacement lambs.

Appendix Table B4. Sheep Enterprise Size, Over 10 Years of Leafy Spurge Control, Wether Flock

Animal Types	Flock Parameter	Years of Leafy Spurge Control 1	2	3	4	5	6	7	8	9	10
Large Flock											
Wethers in Flock		200	200	200	120	120	120	120	80	80	80
Wethers death loss	5%	10	10	10	6	6	6	6	4	4	4
Replacements needed	12.5%	10	10	0	15	15	15	0	10	10	10
Repl. purchased	*	10	10	0	15	15	15	0	10	10	10
Wethers sold		0	0	70	9	9	9	34	6	6	6
Small Flock											
Wethers in Flock		60	60	60	36	36	36	36	24	24	24
Wethers death loss	5%	3	3	3	2	2	2	2	1	1	1
Replacements needed	12.5%	3	3	0	5	5	5	0	3	3	3
Repl. purchased	*	3	3	0	5	5	5	0	3	3	3
Wethers sold		0	0	21	3	3	3	10	2	2	2

*Replacements needed less death loss

Appendix Table B5. Sheep Enterprise Budgets, Years 1 and 2

	No Debt				With Debt							
	Small Operations I Large Operations				Small Operations I Large Operations				Wether Flock			
	Management Level				Management				No Debt		With Debt	
	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Small	Large	Small	Large
Number of Ewes	60	60	200	200	60	60	200	200	60	200	60	200
Revenues												
Lambs Sold	3,229	6,210	10,710	20,700	3,229	6,210	10,710	20,700	0	0	0	0
Cull Ewes	473	473	1,523	1,575	473	473	1,523	1,575	0	0	0	0
Shorn Wool	300	300	1,000	1,000	300	300	1,000	1,000	600	2,000	600	2,000
Ram Sales	33	33	100	100	33	33	100	100	0	0	0	0
Total Revenue	4,035	7,016	13,333	23,375	4,035	7,016	13,333	23,375	600	2,000	600	2,000
Variable Expenses												
Feed												
Hay	1,587	1,732	5,257	5,476	1,587	1,732	5,257	5,476	790	2,633	790	2,633
Grain	1,160	1,877	3,836	4,851	1,160	1,877	3,836	4,851	85	284	85	284
Stubble	48	48	160	161	48	48	160	161	83	276	83	276
Comm Feed	396	72	1,320	240	396	72	1,320	240	72	240	72	240
Total Feed	3,192	3,729	10,574	10,728	3,191	3,729	10,574	10,728	1,030	3,432	1,030	3,432
Livestock												
Bedding	30	30	90	90	30	30	90	90	0	0	0	0
Marketing	106	157	316	487	106	157	316	487	15	15	15	15
Vat and Medicine	120	240	400	800	120	240	400	800	0	0	0	0
Power and Fuel	60	60	200	200	60	60	200	200	60	200	60	200
Util and Gen Farm	60	60	200	200	60	60	200	200	60	200	60	200
Supplies	120	180	400	600	120	180	400	600	0	0	0	0
Shearing	120	120	400	400	120	120	400	400	120	400	120	400
Total Livestock	616	847	2,006	2,777	616	847	2,006	2,777	255	815	255	815
Total Variable	3,808	4,576	12,579	13,505	3,808	4,576	12,579	13,505	1,285	4,247	1,285	4,247
Fixed Expenses												
Depreciation. Repairs, and Insurance												
Buildings	35	35	70	70	35	35	70	70	0	0	0	0
Equipment	130	130	130	130	130	130	130	130	65	65	65	65
Ewes	60	60	200	200	60	60	200	200	45	0	45	0
Repl. Ewes	10	10	32	32	10	10	32	32	225	750	225	750
Rams	66	132	198	396	66	132	198	396	0	0	0	0
sub-total	301	367	630	828	301	367	630	828	335	815	335	815
Interest on Debt												
Buildings	0	0	0	0	16	16	32	32	0	0	0	0
Equipment	0	0	0	0	32	32	32	32	0	0	16	16
Ewes	0	0	0	0	206	206	688	688	0	0	155	516
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	7	14	21	41	0	0	0	0
sub-total	0	0	0	0	261	268	772	793	0	0	171	532
Total Fixed	301	367	630	828	562	635	1,402	1,621	335	815	506	1,347
Net Return	(74)	2,074	123	9,042	(335)	1,806	(649)	8,250	(1,020)	(3,062)	(1,190)	(3,594)
Per Animal												
Gross Revenues	67.24	116.93	66.66	116.88	67.24	116.93	66.66	116.88	10.00	10.00	10.00	10.00
Variable Expenses	63.46	76.26	62.90	67.52	63.46	76.26	62.90	67.52	21.41	21.24	21.41	21.24
Fixed Expenses	5.01	6.11	3.15	4.14	9.36	10.58	7.01	8.10	5.58	4.08	8.43	6.73
Net Returns	(1.23)	34.56	0.62	45.21	(5.58)	30.09	(3.25)	41.25	(17.00)	(15.31)	(19.84)	(17.97)

Notes: Net returns represent returns to unpaid labor, management, and equity. Fencing costs were not included in the budgets.

Appendix Table B6. Sheep Enterprise Budgets, Year 3

	No Debt				With Debt							
	Small Operations | Large Operations				Small Operations | Large Operations				Wether Flock			
	Management Level				Management Level				No Debt | With Debt			
	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Small	Large	Small	Large
Number of Ewes	60	60	200	200	60	60	200	200	60	200	60	200
Revenues												
Lambs Sold	4,174	7,290	13,860	24,300	4,174	7,290	13,860	24,300	0	0	0	0
Cull Ewes	1,103	1,103	3,623	3,675	1,103	1,103	3,623	3,675	473	1,575	473	1,575
Shorn Wool	300	300	1,000	1,000	300	300	1,000	1,000	600	2,000	600	2,000
Ram Sales	50	50	100	100	50	50	100	100	0	0	0	0
Total Revenue	5,626	8,743	18,583	29,075	5,626	8,743	18,583	29,075	1,073	3,575	1,073	3,575
Variable Expenses												
Feed												
Hay	1,555	1,695	5,152	5,353	1,555	1,695	5,152	5,353	790	2,633	790	2,633
Grain	1,001	1,692	3,310	4,236	1,001	1,692	3,310	4,236	85	284	85	284
Stubble	48	48	160	161	48	48	160	161	83	276	83	276
Comm Feed	396	72	1,320	240	396	72	1,320	240	72	240	72	240
Total Feed	3,001	3,507	9,942	9,989	3,001	3,507	9,942	9,989	1,030	3,432	1,030	3,432
Livestock												
Bedding	30	30	90	90	30	30	90	90	0	0	0	0
Marketing	150	200	460	631	150	200	460	631	53	141	53	141
Vet and Medicine	120	240	400	800	120	240	400	800	0	0	0	0
Power and Fuel	60	60	200	200	60	60	200	200	60	200	60	200
Util and Gen Farm	60	60	200	200	60	60	200	200	60	200	60	200
Supplies	120	180	400	600	120	180	400	600	0	0	0	0
Shearing	120	120	400	400	120	120	400	400	120	400	120	400
Total Livestock	660	890	2,150	2,921	660	890	2,150	2,921	293	941	293	941
Total Variable	3,661	4,397	12,092	12,910	3,661	4,397	12,092	12,910	1,323	4,373	1,323	4,373
Fixed Expenses												
Depreciation Repairs. and Insurance												
Buildings	35	35	70	70	35	35	70	70	0	0	0	0
Equipment	130	130	130	130	130	130	130	130	65	65	65	65
Ewes	60	60	200	200	60	60	200	200	45	150	45	150
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	66	132	198	396	66	132	198	396	0	0	0	0
sub-total	291	357	598	796	291	357	598	796	110	215	110	215
Interest on Debt												
Buildings	0	0	0	0	16	16	32	32	0	0	0	0
Equipment	0	0	0	0	32	32	32	32	0	0	16	16
Ewes	0	0	0	0	206	206	688	688	0	0	155	516
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	7	14	21	41	0	0	0	0
sub-total	0	0	0	0	261	268	772	793	0	0	171	532
Value of Inventory Loss	2,400	2,400	8,000	8,000	2,400	2,400	8,000	8,000	1,800	6,000	1,800	6,000
Total Fixed	2,691	2,757	8,598	8,796	2,952	3,025	9,370	9,589	1,910	6,215	2,081	6,747
Net Returns	(726)	1,589	(2,107)	7,369	(987)	1,321	(2,880)	6,576	(2,160)	(7,013)	(2,331)	(7,545)
Per Animal												
Gross Revenue	93.77	145.71	92.91	145.38	93.77	145.71	92.91	145.38	17.88	17.88	17.88	17.88
Variable Expenses	61.01	73.28	60.46	64.55	61.01	73.28	60.46	64.55	22.04	21.87	22.04	21.87
Fixed Expenses	44.85	45.95	42.99	43.98	49.20	50.42	46.85	47.94	31.83	31.08	34.68	33.73
Net Returns	(12.09)	26.48	(10.54)	36.85	(16.45)	22.02	(14.40)	32.88	(36.00)	(35.07)	(38.85)	(37.73)

Notes: Net returns represent returns to unpaid labor, management, and equity. Fencing costs were not included in the budgets.

Appendix Table B7. Sheep Enterprise Budgets, Years 4 and 5

	No Debt				With Debt							
	Small Operations | Large Operations				Small Operations | Large Operations				Wether Flock			
	Management Level				Management Level				No Debt | With Debt			
	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Small	Large	Small	Large
Number of Ewes	36	36	120	120	36	36	120	120	36	120	36	120
Revenues												
Lambs Sold	1,969	3,780	6,458	12,420	1,969	3,780	6,458	12,420	0	0	0	0
Cull Ewes	263	263	893	945	263	263	893	945	68	203	68	203
Shorn Wool	180	180	600	600	180	180	600	600	360	1,200	360	1,200
Ram Sales	17	17	67	67	17	17	67	67	0	0	0	0
Total Revenue	2,428	4,239	8,017	14,032	2,428	4,239	8,017	14,032	428	1,403	428	1,403
Variable Expenses												
Feed												
Hay	944	1,046	3,161	3,519	944	1,046	3,161	3,519	473	1,580	473	1,580
Grain	690	1,197	2,311	4,032	690	1,197	2,311	4,032	51	171	51	171
Stubble	29	29	96	97	29	29	96	97	49	165	49	165
Comm Feed	238	43	792	144	238	43	792	144	43	144	43	144
Total Feed	1,901	2,315	6,360	7,792	1,901	2,315	6,360	7,792	616	2,059	616	2,059
Livestock												
Bedding	18	18	60	60	18	18	60	60	0	0	0	0
Marketing	70	100	196	298	70	100	196	298	20	31	20	31
Vet and Medicine	72	144	240	480	72	144	240	480	0	0	0	0
Power and Fuel	36	36	120	120	36	36	120	120	36	120	36	120
Util and Gen Farm	36	36	120	120	36	36	120	120	36	120	36	120
Supplies	72	108	240	360	72	108	240	360	0	0	0	0
Shearing	72	72	240	240	72	72	240	240	72	240	72	240
Total Livestock	376	514	1,216	1,678	376	514	1,216	1,678	164	511	164	511
Total Variable	2,277	2,829	7,575	9,470	2,277	2,829	7,575	9,470	781	2,571	781	2,571
Fixed Expenses												
Depreciation, Repairs. and Insurance												
Buildings	35	35	70	70	35	35	70	70	0	0	0	0
Equipment	130	130	130	130	130	130	130	130	65	65	65	65
Ewes	36	36	120	120	36	36	120	120	27	90	27	90
Repl. Ewes	6	6	19	19	6	6	19	19	375	1,125	375	1,125
Rams	33	66	132	264	33	66	132	264	0	0	0	0
sub-total	240	273	471	603	240	273	471	603	467	1,280	467	1,280
Interest on Debt												
Buildings	0	0	0	0	16	16	32	32	0	0	0	0
Equipment	0	0	0	0	32	32	32	32	0	0	66	16
Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	48	48	64	64	0	0	66	16
Total Fixed	240	273	471	603	287	320	535	667	467	1,280	533	1,296
Net Returns	(88)	1,137	(30)	3,958	(136)	1,089	(94)	3,895	(820)	(2,448)	(886)	(2,464)
Per Animal												
Gross Revenue	67.44	117.75	66.81	116.93	67.44	117.75	66.81	116.93	11.88	11.69	11.88	11.69
Variable Expenses	63.24	78.59	63.13	78.92	63.24	78.59	63.13	78.92	21.68	21.42	21.68	21.42
Fixed Expenses	6.66	7.57	3.93	5.03	7.98	8.90	4.46	5.56	12.97	10.67	14.80	10.80
Net Returns	(2.46)	31.59	(0.25)	32.99	(3.79)	30.26	(0.78)	32.46	(22.78)	(20.40)	(24.61)	(20.53)

Notes: Net returns represent returns to unpaid labor, management, and equity. Fencing costs were not included in the budgets.

Appendix Table B8. Sheep Enterprise Budgets, Year 6

	No Debt				With Debt							
	Small Operations I Large Operations				Small Operations I Large Operations				Wether Flock			
	Management Level				Management Level				No Debt I With Debt			
	Poor	Good	Poor	Good	Poor	Good	Poor Good		Small	Large	Small	Large
Number of Ewes	36	36	120	120	36	36	120	120	36	120	36	120
Revenues												
Lambs Sold	1,969	3,780	6,458	12,420	1,969	3,780	6,458	12,420	0	0	0	0
Cull Ewes	263	263	893	945	263	263	893	945	68	203	68	203
Shorn Wool	180	180	600	600	180	180	600	600	360	1,200	360	1,200
Ram Sales	17	17	67	67	17	17	67	67	0	0	0	0
Total Revenue	2,428	4,239	8,017	14,032	2,428	4,239	8,017	14,032	428	1,403	428	1,403
Variable Expenses												
Feed												
Hay	944	1,046	3,161	3,519	944	1,046	3,161	3,519	473	1,580	473	1,580
Grain	690	1,197	2,311	4,032	690	1,197	2,311	4,032	51	171	51	171
Stubble	29	29	96	97	29	29	96	97	49	165	49	165
Comm Feed	238	43	792	144	238	43	792	144	43	144	43	144
Total Feed	1,901	2,315	6,360	7,792	1,901	2,315	6,360	7,792	616	2,059	616	2,059
Livestock												
Bedding	18	18	60	60	18	18	60	60	0	0	0	0
Marketing	70	100	196	298	70	100	196	298	20	31	20	31
Vet and Medicine	72	144	240	480	72	144	240	480	0	0	0	0
Power and Fuel	36	36	120	120	36	36	120	120	36	120	36	120
Util and Gen Farm	36	36	120	120	36	36	120	120	36	120	36	120
Supplies	72	108	240	360	72	108	240	360	0	0	0	0
Shearing	72	72	240	240	72	72	240	240	72	240	72	240
Total Livestock	376	514	1,216	1,678	376	514	1,216	1,678	164	511	164	511
Total Variable	2,277	2,829	7,575	9,470	2,277	2,829	7,575	9,470	781	2,571	781	2,571
Fixed Expenses												
Depreciation, Repairs, and Insurance												
Buildings	35	35	70	70	35	35	70	70	0	0	0	0
Equipment	130	130	130	130	130	130	130	130	65	65	65	65
Ewes	36	36	120	120	36	36	120	120	27	90	27	90
Repl. Ewes	6	6	19	19	6	6	19	19	375	1,125	375	1,125
Rams	33	66	132	264	33	66	132	264	0	0	0	0
sub-total	240	273	471	603	240	273	471	603	467	1,280	467	1,280
Interest on Debt												
Buildings	0	0	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0	0	0
Total Fixed	240	273	471	603	240	73	471	603	467	1,2K ---~6-7		1,280
Net Returns	(88)	1,137	(30)	3,958	(88)	1,137	(30)	3,958	(820)	(2,448)	(820)	(2,448)
Per Animal												
Gross Revenue	67.44	117.75	66.81	116.93	67.44	117.75	66.81	116.93	11.88	11.69	11.88	11.69
Variable Expenses	63.24	78.59	63.13	78.92	63.24	78.59	63.13	78.92	21.68	21.42	21.68	21.42
Fixed Expenses	6.66	7.57	3.93	5.03	6.66	7.57	3.93	5.03	12.97	10.67	12.97	10.67
Net Returns	(2.46)	31.59	(0.25)		32.99	(2.46)	(0.25)		32.99	(22.78)	(20.40)	(22.78)

Notes: Net returns represent returns to unpaid labor, management, and equity. Fencing costs were not included in the budgets.

Appendix Table B9. Sheep Enterprise Budgets, Year 7

	No Debt				With Debt				Wether Flock			
	Small Operations		Large Operations		Small Operations		Large Operations		No Debt		With Debt	
	Management Level				Management Level							
	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Small	Large	Small	Large
Number of Ewes	36	36	120	120	36	36	120	120	36	120	36	120
Revenues												
Lambs Sold	2,520	4,410	8,348	14,580	2,520	4,410	8,348	14,580	0	0	0	0
Cull Ewes	525	525	1,733	1,785	525	525	1,733	1,785	225	765	225	765
Shorn Wool	180	180	600	600	180	180	600	600	360	1,200	360	1,200
Ram Sales	17	17	75	75	17	17	75	75	0	0	0	0
Total Revenue	3,242	5,132	10,755	17,040	3,242	5,132	10,755	17,040	585	1,965	585	1,965
Variable Expenses												
Feed												
Hay	926	1,025	3,097	3,445	926	1,025	3,097	3,445	473	1,580	473	1,580
Grain	599	1,089	1,995	3,662	599	1,089	1,995	3,662	51	171	51	171
Stubble	29	29	96	97	29	29	96	97	49	165	49	165
Comm Feed	238	43	792	144	238	43	792	144	43	144	43	144
Total Feed	1,791	2,186	5,980	7,347	1,791	2,186	5,980	7,347	616	2,059	616	2,059
Livestock												
Bedding	18	18	60	60	18	18	60	60	0	0	0	0
Marketing	91	122	268	371	91	122	268	371	33	76	33	76
Vet and Medicine	72	144	240	480	72	144	240	480	0	0	0	0
Power and Fuel	36	36	120	120	36	36	120	120	36	120	36	120
Util and Gen Farm	36	36	120	120	36	36	120	120	36	120	36	120
Supplies	72	108	240	360	72	108	240	360	0	0	0	0
Shearing	72	72	240	240	72	72	240	240	72	240	72	240
Total Livestock	397	536	1,288	1,751	397	536	1,288	1,751	177	556	177	556
Total Variable	2,188	2,722	7,268	9,098	2,188	2,722	7,268	9,098	793	2,616	793	2,616
Fixed Expenses												
Depreciation Repairs. and Insurance												
Buildings	35	35	70	70	35	35	70	70	0	0	0	0
Equipment	130	130	130	130	130	130	130	130	65	65	65	65
Ewes	36	36	120	120	36	36	120	120	27	90	27	90
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	33	66	132	264	33	66	132	264	0	0	0	0
sub-total	234	267	452	584	234	267	452	584	92	155	92	155
Interest on Debt:												
Buildings	0	0	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0	0	0
Value of Inventory Loss	1,200	1,200	4,000	4,000	1,200	1,200	4,000	4,000	900	3,000	900	3,000
Total Fixed	1,434	1,467	4,452	4,584	1,434	1,467	4,452	4,584	992	3,155	992	3,155
Net Returns	(380)	942	(965)	3,358	(380)	942	(965)	3,358	(1,200)	(3,806)	(1,200)	(3,806)
Per Animal												
Gross Revenue	90.04	142.54	89.63	142.00	90.04	142.54	89.63	142.00	16.25	16.38	16.25	16.38
Variable Expenses	60.78	75.61	60.57	75.81	60.78	75.61	60.57	75.81	22.03	21.80	22.03	21.80
Fixed Expenses	39.83	40.75	37.10	38.20	39.83	40.75	37.10	38.20	27.56	26.29	27.56	26.29
Net Returns	(10.57)	26.18	(8.04)	27.99	(10.57)	26.18	(8.04)	27.99	(33.34)	(31.71)	(33.34)	(31.71)

Notes: Net returns represent returns to unpaid labor, management, and equity. Fencing costs were not included in the budgets.

Appendix Table B10. Sheep Enterprise Budgets, Years 8 Through 10

	No Debt				With Debt							
	Small Operations		Large 0perations		Small Operations		Large Operations		Wether-Flock			
	Management Level				Management Level				No Debt		With Debt	
	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Small	Large	Small	Large
Number of Ewes	24	24	80	80	24	24	80	80	24	80	24	80
Revenues												
Lambs Sold	1,260	2,430	4,253	8,280	1,260	2,430	4,253	8,280	0	0	0	0
Cull Ewes	210	210	630	630	210	210	630	630	45	135	45	135
Shorn Wool	120	120	400	400	120	120	400	400	240	800	240	800
Ram Sales	17	17	50	50	17	17	50	50	0	0	0	0
Total Revenue	1,607	2,777	5,333	9,360	1,607	2,777	5,333	9,360	285	935	285	935
Variable Expenses												
Feed												
Hay	643	713	2,123	2,356	643	713	2,123	2,356	317	1,053	317	1,053
Grain	470	820	1,544	2,699	470	820	1,544	2,699	34	114	34	114
Stubble	20	20	65	65	20	20	65	65	33	110	33	110
Comm Feed	158	29	528	96	158	29	528	96	29	96	29	96
Total Feed	1,290	1,581	4,260	5,216	1,290	1,581	4,260	5,216	414	1,373	414	1,373
Livestock												
Bedding	12	12	36	36	12	12	36	36	0	0	0	0
Marketing	52	71	136	204	52	71	136	204	19	26	19	26
Vet and Medicine	48	96	160	320	48	96	160	320	0	0	0	0
Power and Fuel	24	24	80	80	24	24	80	80	24	80	24	80
Util and Gen Farm	24	24	80	80	24	24	80	80	24	80	24	80
Supplies	48	72	160	240	48	72	160	240	0	0	0	0
Shearing	48	48	160	160	48	48	160	160	48	160	48	160
Total Livestock	256	347	812	1,120	256	347	812	1,120	115	346	115	346
Total Variable	1,546	1,928	5,072	6,336	1,546	1,928	5,072	6,336	528	1,719	528	1,719
Fixed Expenses												
Depreciation. Repairs and Insurance												
Buildings	35	35	70	70	35	35	70	70	0	0	0	0
Equipment	130	130	130	130	130	130	130	130	65	65	65	65
Ewes	24	24	80	80	24	24	80	80	18	60	18	60
Repl. Ewes	4	4	13	13	4	4	13	13	225	750	225	750
Rams	33	66	99	198	33	66	99	198	0	0	0	0
sub-total	226	259	392	491	226	259	392	491	308	875	308	875
Interest on Debt												
Buildings	0	0	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0	0	0
Total Fixed	226	259	392	491	226	259	392	491	308	875	308	875
Net Returns	(166)	589	(131)	2,534	(166)	589	(131)	2,534	(551)	(1,659)	(551)	(1,659)
Per Animal												
Gross Revenue	66.94	115.69	66.66	117.00	66.94	115.69	66.66	117.00	11.88	11.69	11.88	11.69
Variable Expenses	64.42	80.35	63.40	79.19	64.42	80.35	63.40	79.19	22.01	21.48	22.01	21.48
Fixed Expenses	9.42	10.79	4.90	6.14	9.42	10.79	4.90	6.14	12.83	10.94	12.83	10.94
Net Returns	(6.90)	24.54	(1.64)	31.67	(6.90)	24.54	(1.64)	31.67	(22.96)	(20.73)	(22.96)	(20.73)

Notes: Net returns represent returns to unpaid labor, management, and equity. Fencing costs were not included in the budgets.

Appendix Table B11. Budgets, Small Flock, No Debt, Good Management Flock, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	6,210	6,210	7,290	3,780	3,780	3,780	4,410	2,430	2,430	2,430
Cull Ewes	473	473	1,103	263	263	263	525	210	210	210
Shorn Wool	300	300	300	180	180	180	180	120	120	120
Ram Sales	33	33	50	17	17	17	17	17	17	17
Total	7,016	7,016	8,743	4,239	4,239	4, 39	5,132	2,777	2,777	2,777
Variable Expenses										
Feed										
Hay	1,732	1,732	1,695	1,046	1,046	1,046	1,025	713	713	713
Grain	1,877	1,877	1,692	1,197	1,197	1,197	1,089	820	820	820
Stubble	48	48	48	29	29	29	29	20	20	20
Comm Feed	72	72	72	43	43	43	43	29	29	29
Total Feed	3,729	3,729	3,507	2,315	2,315	2,315	2,186	1,581	1,581	1,581
Livestock										
Bedding	30	30	30	18	18	18	18	12	12	12
Marketing	157	157	200	100	100	100	122	71	71	71
Vet and Medicine	240	240	240	144	144	144	144	96	96	96
Power and Fuel	60	60	60	36	36	36	36	24	24	24
Util and Gen Farm	60	60	60	36	36	36	36	24	24	24
Supplies	180	180	180	108	108	108	108	72	72	72
Shearing	120	120	120	72	72	72	72	48	48	48
Total Livestock	847	847	890	514	514	514	536	347	347	347
Total Variable	4,576	4,576	4,397	2,829	2,829	2,829	2,722	1,928	1,928	1,928
Fixed Expenses										
Depreciation, Repairs, and Insurance										
Buildings	35	35	35	35	35	35	35	35	35	35
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	60	60	60	36	36	36	36	24	24	24
Repl. Ewes	10	10	0	6	6	6	0	4	4	4
Rams	132	132	132	66	66	66	66	66	66	66
sub-total	367	367	357	273	273	273	267	259	259	259
Interest on Debt										
Buildings	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0
Value of Inventory Loss			2,400				1,200			
Total Fixed	367	367	2,757	273	273	273	1,467	259	259	259
Net Returns										
Flock	2,074	2,074	1,589	1,137	1,137	1,137	942	589	589	589
Per Ewe	$34.56	$34.56	$26.48	$31.59	$31.59	$31.59	$26.18	$24.54	$24.54	$24.54

Appendix Table B12. Budgets, Small Flock, With Debt, Good Management, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	6,210	6,210	7,290	3,780	3,780	3,780	4,410	2,430	2,430	2,430
Cull Ewes	473	473	1,103	263	263	263	525	210	210	210
Shorn Wool	300	300	300	180	180	180	180	120	120	120
Ram Sales	33	33	50	17	17	17	17	17	17	17
Total	7,016	7,016	8,743	4,239	4,239	4,239	5,132	2,777	2,777	2,777
Variable Expenses										
Feed										
Hay	1,732	1,732	1,695	1,046	1,046	1,046	1,025	713	713	713
Grain	1,877	1,877	1,692	1,197	1,197	1,197	1,089	820	820	820
Stubble	48	48	48	29	29	29	29	20	20	20
Comm Feed	72	72	72	43	43	43	43	29	29	29
Total Feed	3,729	3,729	3,507	2,315	2,315	2,315	2, 1-8-6 _f, 58-1	1,581	1,581	
Livestock										
Bedding	30	30	30	18	18	18	18	12	12	12
Marketing	157	157	200	100	100	100	122	71	71	71
Vet and Medicine	240	240	240	144	144	144	144	96	96	96
Power and Fuel	60	60	60	36	36	36	36	24	24	24
Util and Gen Farm	60	60	60	36	36	36	36	24	24	24
Supplies	180	180	180	108	108	108	108	72	72	72
Shearing	120	120	120	72	72	72	72	48	48	48
Total Livestock	847	847	890	514	514	514	536	347	347	347
Total Variable	4,576	4,576	4,397	2,K_9	2,829	2,829	2,722	1,928	1,928	1,928
Fixed Expenses										
Depreciation, Repairs. and Insurance										
Buildings	35	35	35	35	35	35	35	35	35	35
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	60	60	60	36	36	36	36	24	24	24
Repl. Ewes	10	10	0	6	6	6	0	4	4	4
Rams	132	132	132	66	66	66	66	66	66	66
sub-total	367	367	357	273	273	273	M7	259	259	259
Interest on Debt										
Buildings	16	16	16	16	16	0	0	0	0	0
Equipment	32	32	32	32	32	0	0	0	0	0
Ewes	206	206	206	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	14	14	14	0	0	0	0	0	0	0
sub-total	268	268	268	48	48	0	0	0	0	0
Value of Inventory Loss			2,400				1,200			
Total Fixed	635	635	3,025	320	320	273	1,467	259	259	259
Net Returns										
Flock	1,806	1,806	1,321	1,089	1,089	1,137	942	589	589	589
Per Ewe	$30.09	$30.09	$22.02	$30.26	$30.26	$31.59	$26.18	$24.54	$24.54	$24.54

Appendix Table B13. Budgets, Small Flock, No Debt, Poor Management, Years I Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	3,229	3,229	4,174	1,969	1,969	1,969	2,520	1,260	1,260	1,260
Cull Ewes	473	473	1,103	263	263	263	525	210	210	210
Shorn Wool	300	300	300	180	180	180	180	120	120	120
Ram Sales	33	33	50	17	17	17	17	17	17	17
Total	4,035	4,035	5,626	2,428	2,428	2,428	3,242	1,607	1,607	1,607
Variable Expenses										
Feed										
Hay	1,587	1,587	1,555	944	944	944	926	643	643	643
Grain	1,160	1,160	1,001	690	690	690	599	470	470	470
Stubble	48	48	48	29	29	29	29	20	20	20
Comm Feed	396	396	396	238	238	238	238	158	158	158
Total Feed	3,192	3,192	3,001	1,901	1,901	1,901	1,791	1,290	1,290	1,290
Livestock										
Bedding	30	30	30	18	18	18	18	12	12	12
Marketing	106	106	150	70	70	70	91	52	52	52
Vet and Medicine	120	120	120	72	72	72	72	48	48	48
Power and Fuel	60	60	60	36	36	36	36	24	24	24
Util and Gen Farm	60	60	60	36	36	36	36	24	24	24
Supplies 120	120	120	72	72	72	72	48	48	48	
Shearing	120	120	120	72	72	72	72	48	48	48
Total Livestock	616	616	660	376	376	376	397	256	256	256
Total Variable	3,808	3,808	3,661	2,277	2,277	2,277	2,188	1,546	1,546	1,546
Fixed Expenses										
Depreciation. Repairs. and Insurance										
Buildings	35	35	35	35	35	35	35	35	35	35
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	60	60	60	36	36	36	36	24	24	24
Repl. Ewes	10	10	0	6	6	6	0	4	4	4
Rams	66	66	66	33	33	33	33	33	33	33
sub-total	301	301	291	240	240	240	234	226	226	226
Interest on Debt										
Buildings	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0
Value of Inventory Loss			2,400				1,200			
Total Fixed	301	301	2,691	240	240	240	1,434	226	226	226
Net Return										
Flock	(74)	(74)	(726)	(88)	(88)	(88)	(380)	(166)	(166)	(166)
Per Ewe	($1.23)	($1.23)	($12.09)	($2.46)	($2.46)	($2.46)	($10.57)	($6.90)	($6.90)	($6.90)

Appendix Table B14. Budg ts, Small Flock, With Debt, Poor Management, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	3,229	3,229	4,174	1,969	1,969	1,969	2,520	1,260	1,260	1,260
Cull Ewes	473	473	1,103	263	263	263	525	210	210	210
Shorn Wool	300	300	300	180	180	180	180	120	120	120
Ram Sales	33	33	50	17	17	17	17	17	17	17
Total	4,035	4,035	5,626	2,428	2,428	2,428	3,242	1,607	1,607	1,607
Variable Expenses										
Feed										
Hay	1,587	1,587	1,555	944	944	944	926	643	643	643
Grain	1,160	1,160	1,001	690	690	690	599	470	470	470
Stubble	48	48	48	29	29	29	29	20	20	20
Comm Feed	396	396	396	238	238	238	238	158	158	158
Total Feed	3,191	3,191	3,001	1,901	1,901	1,901-	1,791-	1,290	1,290	1,290
Livestock										
Bedding	30	30	30	18	18	18	18	12	12	12
Marketing	106	106	150	70	70	70	91	52	52	52
Vet and Medicine	120	120	120	72	72	72	72	48	48	48
Power and Fuel	60	60	60	36	36	36	36	24	24	24
Util and Gen Farm	60	60	60	36	36	36	36	24	24	24
Supplies	120	120	120	72	72	72	72	48	48	48
Shearing	120	120	120	72	72	72	72	48	48	48
Total Livestock	616	616	660	376	376	376	397	256	256	256
Total Variable	3,808	3,808	3,661	2,277	2,277	2,277	2,188	1,546	1,546	1,546
Fixed Expenses										
Depreciation. Repairs. and Insurance										
Buildings	35	35	35	35	35	35	35	35	35	35
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	60	60	60	36	36	36	36	24	24	24
Repl. Ewes	10	10	0	6	6	6	0	4	4	4
Rams	66	66	66	33	33	33	33	33	33	33
sub-total	301	301	291	240	240	240	234	226	226	226
Interest on Debt										
Buildings	16	16	16	16	16	0	0	0	0	0
Equipment	32	32	32	32	32	0	0	0	0	0
Ewes	206	206	206	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	7	7	7	0	0	0	0	0	0	0
sub-total	261	261	261	48	48	0	0	0	0	0
Value of Inventory Loss			2,400				1,200			
Total Fixed	562	562	2,952	287	287	240	1,434	226	226	226
Net Returns										
Flock	(335)	(335)	(987)	(136)	(136)	(88)	(380)	(166)	(166)	(166)
Per Ewe	($5.58)	($5.58)	($16.45)	($3.79)	($3.79)	($2.46)	($10.57)	($6.90)	($6.90)	($6.90)

Appendix Table B15. Budgets, Large Flock, No Debt, Good Management Flock, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	20,700	20,700	24,300	12,420	12,420	12,420	14,580	8,280	8,280	8,280
Cull Ewes	1,575	1,575	3,675	945	945	945	1,785	630	630	630
Shorn Wool	1,000	1,000	1,000	600	600	600	600	400	400	400
Ram Sales	100	100	100	67	67	67	75	50	50	50
Total	23,375	23,375	29,075	14,032	14,032	14,032	17,040	9,360	9,360	9,360
Variable Expenses										
Feed										
Hay	5,476	5,476	5,353	3,519	3,519	3,519	3,445	2,356	2,356	2,356
Grain	4,851	4,851	4,236	4,032	4,032	4,032	3,662	2,699	2,699	2,699
Stubble	161	161	161	97	97	97	97	65	65	65
Comm Feed	240	240	240	144	144	144	144	96	96	96
Total Feed	10,728	10,728	9,989	7,792	7,792	7,792	7,347	5,216	5,216	5,216
Livestock										
Bedding	90	90	90	60	60	60	60	36	36	36
Marketing	487	487	631	298	298	298	371	204	204	204
Vet and Medicine	800	800	800	480	480	480	480	320	320	320
Power and Fuel	200	200	200	120	120	120	120	80	80	80
Util and Gen Farm	200	200	200	120	120	120	120	80	80	80
Supplies	600	600	600	360	360	360	360	240	240	240
Shearing	400	400	400	240	240	240	240	160	160	160
Total Livestock	2,777	2,777	2,921	1,678	1,678	1,678	1,751	1,120	1,120	1,120
Total Variable	13,505	13,505	12,910	9,470	9,470	9,470	9,098	6,336	6,336	6,336
Fixed Expenses										
Depreciation- Repairs, and Insurance										
Buildings	70	70	70	70	70	70	70	70	70	70
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	200	200	200	120	120	120	120	80	80	80
Repl. Ewes	32	32	0	19	19	19	0	13	13	13
Rams	396	396	396	264	264	264	264	198	198	198
sub-total	828	828	796	603	603	603	584	491	491	491
Interest on Debt										
Buildings	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0
Value of Inventory Loss			8,000				4,000			
Total Fixed	828	828	8,796	603	603	603	4,584	491	491	491
Net Returns										
Flock	$9,042	$9,042	$7,369	$3,958	$3,958	$3,958	$3,358	$2,534	$2,534	$2,534
Per Ewe	$45.21	$45.21	$36.85	$32.99	$32.99	$32.99	$27.99	$31.67	$31.67	$31.67

Appendix Table B16. Budgets, Large Flock, With Debt, Good Management, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	20,700	20,700	24,300	12,420	12,420	12,420	14,580	8,280	8,280	8,280
Cull Ewes	1,575	1,575	3,675	945	945	945	1,785	630	630	630
Shorn Wool	1,000	1,000	1,000	600	600	600	600	400	400	400
Ram Sales	100	100	100	67	67	67	75	50	50	50
Total	23,375	23,375	29,075	14,032	14,032	14,032	17,040	9,360	9,360	9,360
Variable Expenses										
Feed										
Hay	5,476	5,476	5,353	3,519	3,519	3,519	3,445	2,356	2,356	2,356
Grain	4,851	4,851	4,236	4,032	4,032	4,032	3,662	2,699	2,699	2,699
Stubble	161	161	161	97	97	97	97	65	65	65
Comm Feed	240	240	240	144	144	144	144	96	96	96
Total Feed	10,728	10,728	9,989	7,792	7,792	7,792	7,347	5,216	5,216	5,216
Livestock										
Bedding	90	90	90	60	60	60	60	36	36	36
Marketing	487	487	631	298	298	298	371	204	204	204
Vet and Medicine	800	800	800	480	480	480	480	320	320	320
Power and Fuel	200	200	200	120	120	120	120	80	80	80
Util and Gen Farm	200	200	200	120	120	120	120	80	80	80
Supplies	600	600	600	360	360	360	360	240	240	240
Shearing	400	400	400	240	240	240	240	160	160	160
Total Livestock	2,777	2,777	2,921	1,678	1,678	1,678	1,751	1,120	1,120	1,120
Total Variable	13,505	13,505	12,910	9,470	9,470	9,470	9,098	6,336	6,336	6,336
Fixed Expense										
Depreciation. Repairs. and Insurance										
Buildings	70	70	70	70	70	70	70	70	70	70
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	200	200	200	120	120	120	120	80	80	80
Repl. Ewes	32	32	0	19	19	19	0	13	13	13
Rams	396	396	396	264	264	264	264	198	198	198
sub-total	828	828	796	603	603	603	584	491	491	491
Interest on Debt										
Buildings	32	32	32	32	32	0	0	0	0	0
Equipment	32	32	32	32	32	0	0	0	0	0
Ewes	688	688	688	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	41	41	41	0	0	0	0	0	0	0
sub-total	793	793	793	64	64	0	0	0	0	0
Value of Inventory Loss			8,000				4,000			
Total Fixed	1,621	1,621	9,589	667	667	603	4,584	491	491	491
Net Returns										
Flock	$8,250	$8,250	$6,576	$3,895	$3,895	$3,958	$3,358	$2,534	$2,534	$2,534
Per Ewe	$41.25	$41.25	$32.88	$32.46	$32.46	$32.99	$27.99	$31.67	$31.67	$31.67

Appendix Table B17. Budgets, Large Flock, No Debt, Poor Management, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	10,710	10,710	13,860	6,458	6,458	6,458	8,348	4,253	4,253	4,253
Cull Ewes	1,523	1,523	3,623	893	893	893	1,733	630	630	630
Shorn Wool	1,000	1,000	1,000	600	600	600	600	400	400	400
Ram Sales	100	100	100	67	67	67	75	50	50	50
Total	13,333	13,333	18,583	8,017	8,017	8,017	10,755	-5,333	5,333	5,333
Variable Expenses										
Feed										
Hay	5,257	5,257	5,152	3,161	3,161	3,161	3,097	2,123	2,123	2,123
Grain	3,836	3,836	3,310	2,311	2,311	2,311	1,995	1,544	1,544	1,544
Stubble	160	160	160	96	96	96	96	65	65	65
Comm Feed	1,320	1,320	1,320	792	792	792	792	528	528	528
Total Feed	10,574	10,574	9,942	6,360	6,360	6,360	5,980	4,260	4,260	4,260
Livestock										
Bedding	90	90	90	60	60	60	60	36	36	36
Marketing	316	316	460	196	196	196	268	136	136	136
Vet and Medicine	400	400	400	240	240	240	240	160	160	160
Power and Fuel	200	200	200	120	120	120	120	80	80	80
Util and Gen Farm	200	200	200	120	120	120	120	80	80	80
Supplies	400	400	400	240	240	240	240	160	160	160
Shearing	400	400	400	240	240	240	240	160	160	160
Total Livestock	2,006	2,006	2,150	1,216	1,216	1,216	1,288	812	812	812
Total Variable	12,579	12,579	12,092	7,575	7,575	7,575	7,268	5,072	5,072	5,072
Fixed Expenses										
Depreciation, Repairs, and Insurance										
Buildings	70	70	70	70	70	70	70	70	70	70
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	200	200	200	120	120	120	120	80	80	80
Repl. Ewes	32	32	0	19	19	19	0	13	13	13
Rams	198	198	198	132	132	132	132	99	99	99
sub-total	630	630	598	471	471	471	452	392	392	392
Interest on Debt										
Buildings	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0
Ewes	0	0	0	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	0	0	0	0	0	0	0	0	0	0
sub-total	0	0	0	0	0	0	0	0	0	0
Value of Inventory Loss			8,000				4,000			
Total Fixed	630	630	8,598	471	471	471	4,452	392	392	392
Net Returns										
Flock	$123	$123	($2,107)	($30)	($30)	($30)	($965)	($131)	($131)	($131)
Per Ewe	$0.62	$0.62	($10.54)	($0.25)	($0.25)	($0.25)	($8.04)	($1.64)	($1.64)	($1.64)

Appendix Table B18. Budgets, Large Flock, With Debt, Poor Management, Years 1 Through 10

	Years of Leafy Spurge Control									
	1	2	3	4	5	6	7	8	9	10
Revenues										
Lambs Sold	10,710	10,710	13,860	6,458	6,458	6,458	8,348	4,253	4,253	4,253
Cull Ewes	1,523	1,523	3,623	893	893	893	1,733	630	630	630
Shorn Wool	1,000	1,000	1,000	600	600	600	600	400	400	400
Ram Sales	100	100	100	67	67	67	75	50	50	50
Total	13,333	13,333	18,583	8,017	8,017	8,017	10,755	5,333	5,333	5,333
Variable Expenses										
Feed										
Hay	5,257	5,257	5,152	3,161	3,161	3,161	3,097	2,123	2,123	2,123
Grain	3,836	3,836	3,310	2,311	2,311	2,311	1,995	1,544	1,544	1,544
Stubble	160	160	160	96	96	96	96	65	65	65
Comm Feed	1,320	1,320	1,320	792	792	792	792	528	528	528
Total Feed	10,574	10,574	9,942	6,360	6,360	6,360	5,980	4,260	4,260	4,260
Livestock										
Bedding	90	90	90	60	60	60	60	36	36	36
Marketing	316	316	460	196	196	196	268	136	136	136
Vet and Medicine	400	400	400	240	240	240	240	160	160	160
Power and Fuel	200	200	200	120	120	120	120	80	80	80
Util and Gen Farm	200	200	200	120	120	120	120	80	80	80
Supplies	400	400	400	240	240	240	240	160	160	160
Shearing	400	400	400	240	240	240	240	160	160	160
Total Livestock	2,006	2,006	2,150	1,216	1,216	1,216	1,288	812	812	812
Total Variable	12,579	12,579	12,092	7,575	7,575	7,575	7,268	5,072	5,072	5,072
Fixed Expenses										
Depreciation. Repairs, and Insurance										
Buildings	70	70	70	70	70	70	70	70	70	70
Equipment	130	130	130	130	130	130	130	130	130	130
Ewes	200	200	200	120	120	120	120	80	80	80
Repl. Ewes	32	32	0	19	19	19	0	13	13	13
Rams	198	198	198	132	132	132	132	99	99	99
sub-total	630	630	598	471	471	471	452	392	392	392
Interest on Debt										
Buildings	32	32	32	32	32	0	0	0	0	0
Equipment	32	32	32	32	32	0	0	0	0	0
Ewes	688	688	688	0	0	0	0	0	0	0
Repl. Ewes	0	0	0	0	0	0	0	0	0	0
Rams	21	21	21	0	0	0	0	0	0	0
sub-total	772	772	772	64	64	0	0	0	0	0
Value of Inventory Loss			8,000				4,000			
Total Fixed	1,402	1,402	9,370	535	535	471	4,452	392	392	392
Net Returns										
Flock	($649)	($649)	($2,880)	($94)	($94)	($30)	($965)	($131)	($131)	($131)
Per Ewe	($3.25)	($3.25)	($14.40)	($0.78)	($0.78)	($0.25)	($8.04)	($1.64)	($1.64)	($1.64)

APPENDIX C

Fencing Expenses

Fencing costs were based on the overall size of the pasture containing the leafy spurge infestation(s). Thus, if 100 acres of leafy spurge were located in a 250-acre pasture, fencing costs would be estimated based on the 250-acre pasture.

Fencing costs were estimated independently from the sheep enterprise budgets. Estimating fencing costs separate from the enterprise budgets allowed flexibility to assign the proper fencing charge based on grazing strategy, infestation size, pasture size, debt, and new or modified fence.

Fencing costs for sheep leasing were estimated the same as if the sheep enterprise was owned. Debt and no debt scenarios, for fence expenses, were allowed with sheep leasing.

In a rotational grazing system, ranchers were assumed to already be in a rotational system when modifying existing fence. Thus, two barb wires were added to perimeter and internal fences. Internal fence dimensions were assumed to equivalent to the width (of a square area) of the overall pasture. In new fence scenarios, a five-wire internal fence was assumed to be constructed under rotational grazing.

In seasonal grazing strategies, new fence expenses were based on a perimeter fence of six barb wires. Two rows of barb wire were added to an existing fence. Modified fence expenses assumed no materials other than wire were required in either the seasonal or rotational grazing scenarios..

Unit costs for fencing materials were based on retail prices in Hettinger in August, 1998. The following unit costs were used:

Corners	3---8'x6" posts @ $8 each
	2---6'x3" posts @ $4 each
	$2 per corner for miscellaneous expenses
Wire	$32 per 1,320 feet of barb wire
	1 percent of wire expense added for fastening, tying, etc.
Line Posts	$2 per line post, placed every 20 feet
Labor	Labor expense in building new or modifying existing fence was not included in fence expenses.

Appendix Table C1. Approximate Material Requirements for New Barb Wire Fence, Seasonal Grazing

Pasture Size	Total Perimeter	Fencing Requirements		
			Posts	
		Wire	Corner	Line
acres	feet	feet		
1	835	5,059	20	42
5	1,867	11,313	20	93
10	2,640	15,998	20	132
20	3,734	22,625	20	187
30	4,573	27,710	20	229
50	5,903	35,774	20	295
75	7,230	43,813	20	361
100	8,348	50,591	20	417
125	9,334	56,563	20	467
150	10,225	61,962	20	511
175	11,044	66,926	20	552
200	11,806	71,547	20	590
225	12,523	75,887	20	626
250	13,200	79,992	20	660
275	13,844	83,896	20	692
300	14,460	87,627	20	723
325	15,050	91,205	20	753
350	15,618	94,648	20	781
375	16,167	97,970	20	808
400	16,697	101,183	20	835
425	17,211	104,297	20	861
450	17,710	107,321	20	885
475	18,195	110,261	20	910
500	18,668	113,126	20	933
525	19,129	115,919	20	956
550	19,579	118,647	20	979
575	20,019	121,314	20	1,001
600	20,449	123,923	20	1,022
625	20,871	126,478	20	1,044
650	21,284	128,983	20	1,064

Notes: Wire requirements based on six barb wires. One percent additional wire for tying and fastening. Five wood posts per corner. Line posts every 20 feet.

Appendix Table C2. Approximate Material Requirements for Modified Barb Wire Fence, Seasonal Grazing

Pasture Size	Total Perimeter	Fencing Requirements	
		Wire	Posts
acres	feet	feet	
1	835	1,670	0
5	1,867	3,734	0
10	2,640	5,280	0
20	3,734	7,467	0
30	4,573	9,145	0
50	5,903	11,806	0
75	7,230	14,460	0
100	8,348	16,697	0
125	9,334	18,668	0
150	10,225	20,449	0
175	11,044	22,088	0
200	11,806	23,613	0
225	12,523	25,045	0
250	13,200	26,400	0
275	13,844	27,689	0
300	14,460	28,920	0
325	15,050	30,101	0
350	15,618	31,237	0
375	16,167	32,333	0
400	16,697	33,394	0
425	17,211	34,421	0
450	17,710	35,419	0
475	18,195	36,390	0
500	18,668	37,335	0
525	19,129	38,257	0
550	19,579	39,158	0
575	20,019	40,038	0
600	20,449	40,899	0
625	20,871	41,742	0
650	21,284	42,569	0

Notes: Wire requirements based on adding two barb wires. No additional posts required. Existing fencing was assumed to be either a three- or four-wire fence.

Appendix Table C3. Approximate Material Requirements for New Barb Wire Fence, Rotational Grazing

Pasture Size	Total Perimeter	Fencing Requirements		
			Posts	
		Wire	Corner	Line
acres	feet	feet		
1	835	6,103	24	52
5	1,867	13,646	24	117
10	2,640	19,298	24	165
20	3,734	27,292	24	233
30	4,573	33,426	24	286
50	5,903	43,153	24	369
75	7,230	52,851	24	452
100	8,348	61,027	24	522
125	9,334	68,230	24	583
150	10,225	74,742	24	639
175	11,044	80,731	24	690
200	11,806	86,305	24	738
225	12,523	91,540	24	783
250	13,200	96,492	24	825
275	13,844	101,202	24	865
300	14,460	105,702	24	904
325	15,050	110,018	24	941
350	15,618	114,171	24	976
375	16,167	118,178	24	1,010
400	16,697	122,054	24	1,044
425	17,211	125,810	24	1,076
450	17,710	129,458	24	1,107
475	18,195	133,005	24	1,137
500	18,668	136,460	24	1,167
525	19,129	139,830	24	1,196
550	19,579	143,121	24	1,224
575	20,019	146,337	24	1,251
600	20,449	149,485	24	1,278
625	20,871	152,567	24	1,304
650	21,284	155,589	24	1,330

Notes: Wire requirements based on six barb wires. One percent additional wire for tying and fastening. Five wood posts per corner. Line posts every 20 feet. Five barb wires for internal fence

Appendix Table C4. Approximate Material Requirements for Modified Barb Wire Fence, Rotational Grazing

External Pasture Size	Total Perimeter	Fencing Requirements Wire	Posts
acres	feet	feet	
1	835	2,087	0
5	1,867	4,667	0
10	2,640	6,600	0
20	3,734	9,334	0
30	4,573	11,432	0
50	5,903	14,758	0
75	7,230	18,075	0
100	8,348	20,871	0
125	9,334	23,335	0
150	10,225	25,562	0
175	11,044	27,610	0
200	11,806	29,516	0
225	12,523	31,307	0
250	13,200	33,000	0
275	13,844	34,611	0
300	14,460	36,150	0
325	15,050	37,626	0
350	15,618	39,046	0
375	16,167	40,417	0
400	16,697	41,742	0
425	17,211	43,027	0
450	17,710	44,274	0
475	18,195	45,487	0
500	18,668	46,669	0
525	19,129	47,822	0
550	19,579	48,947	0
575	20,019	50,047	0
600	20,449	51,123	0
625	20,871	52,178	0
650	21,284	53,211	0

Notes: Wire requirements based on adding two barb wires to external and internal fence. No additional posts required. External fence assumed to be either a three or four-wire fence.

Appendix Table C5. Fence Expenses, New and Modified Fence, Seasonal Grazing

Pasture Size	New Fence Expenses: Corners	Wire	Posts	Total	Cost per Acre	Modify Fence: Wire Expense	Cost per Acre
acres			$				
1	136	123	83	342	342.13	40	40.48
5	136	274	187	597	119.38	91	18.10
10	136	388	264	788	78.78	128	12.80
20	136	548	373	1,058	52.89	181	9.05
30	136	672	457	1,265	42.17	222	7.39
50	136	867	590	1,594	31.87	286	5.72
75	136	1,062	723	1,921	25.62	351	4.67
100	136	1,226	835	2,197	21.97	405	4.05
125	136	1,371	933	2,441	19.52	453	3.62
150	136	1,502	1,022	2,661	17.74	496	3.30
175	136	1,622	1,104	2,863	16.36	535	3.06
200	136	1,734	1,181	3,051	15.26	572	2.86
225	136	1,840	1,252	3,228	14.35	607	2.70
250	136	1,939	1,320	3,395	13.58	640	2.56
275	136	2,034	1,384	3,554	12.92	671	2.44
300	136	2,124	1,446	3,706	12.35	701	2.34
325	136	2,211	1,505	3,852	11.85	730	2.25
350	136	2,294	1,562	3,992	11.41	757	2.16
375	136	2,375	1,617	4,128	11.01	784	2.09
400	136	2,453	1,670	4,259	10.65	810	2.02
425	136	2,528	1,721	4,385	10.32	834	1.96
450	136	2,602	1,771	4,509	10.02	859	1.91
475	136	2,673	1,819	4,628	9.74	882	1.86
500	136	2,742	1,867	4,745	9.49	905	1.81
525	136	2,810	1,913	4,859	9.26	927	1.77
550	136	2,876	1,958	4,970	9.04	949	1.73
575	136	2,941	2,002	5,079	8.83	971	1.69
600	136	3,004	2,045	5,185	8.64	991	1.65
625	136	3,066	2,087	5,289	8.46	1,012	1.62
650	136	3,127	2,128	5,391	8.29	1,032	1.59

Appendix Table C6. Fence Expenses, New and Modified Fence, Rotational Grazing

External Pasture Size	New Fence Expenses					Modify Fence	
	Corners	Wire	Posts	Total	Cost per Acre	Wire Expense	Cost per Acre
acres				$			
1	160	148	104	412	412.30	51	50.60
5	160	331	233	724	144.83	113	22.63
10	160	468	330	958	95.78	160	16.00
20	160	662	467	1,288	64.42	226	11.31
30	160	810	572	1,542	51.40	277	9.24
50	160	1,046	738	1,944	38.88	358	7.16
75	160	1,281	904	2,345	31.27	438	5.84
100	160	1,479	1,044	2,683	26.83	506	5.06
125	160	1,654	1,167	2,981	23.85	566	4.53
150	160	1,812	1,278	3,250	21.67	620	4.13
175	160	1,957	1,380	3,498	19.99	669	3.82
200	160	2,092	1,476	3,728	18.64	716	3.58
225	160	2,219	1,565	3,944	17.53	759	3.37
250	160	2,339	1,650	4,149	16.60	800	3.20
275	160	2,453	1,731	4,344	15.80	839	3.05
300	160	2,562	1,807	4,530	15.10	876	2.92
325	160	2,667	1,881	4,708	14.49	912	2.81
350	160	2,768	1,952	4,880	13.94	947	2.70
375	160	2,865	2,021	5,046	13.46	980	2.61
400	160	2,959	2,087	5,206	13.01	1,012	2.53
425	160	3,050	2,151	5,361	12.61	1,043	2.45
450	160	3,138	2,214	5,512	12.25	1,073	2.39
475	160	3,224	2,274	5,659	11.91	1,103	2.32
500	160	3,308	2,333	5,802	11.60	1,131	2.26
525	160	3,390	2,391	5,941	11.32	1,159	2.21
550	160	3,470	2,447	6,077	11.05	1,187	2.16
575	160	3,548	2,502	6,210	10.80	1,213	2.11
600	160	3,624	2,556	6,340	10.57	1,239	2.07
625	160	3,699	2,609	6,467	10.35	1,265	2.02
650	160	3772	2,661	6,592	10.14	1,290	1.98

APPENDIX D

Alternative Leafy Spurge Control Scenarios

Appendix Table D1. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Good Management, Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	118.3	119.6	122.5	106.3	107.6	110.5	151.0	152.2	155.2	147.4	148.6	151.6
0.30	118.6	120.5	125.0	106.6	108.5	113.0	151.3	153.2	157.6	147.7	149.6	154.0
0.40	118.9	121.5	127.4	106.9	109.4	115.4	151.6	154.1	160.0	148.0	150.5	156.4
0.50	119.2	122.4	129.8	107.2	110.4	117.8	151.9	155.0	162.5	148.3	151.4	158.9
0.60	119.5	123.3	132.2	107.5	111.3	120.2	152.2	156.0	164.9	148.6	152.4	161.3
0.70	119.9	124.3	134.7	107.8	112.3	122.7	152.5	156.9	167.3	148.9	153.3	163.7
0.80	120.2	125.2	137.1	108.2	113.2	125.1	152.8	157.8	169.7	149.2	154.2	166.1
0.90	120.5	126.1	139.5	108.5	114.1	127.5	153.1	158.8	172.1	149.5	155.2	168.5
	---------- 10-year Period ----------											
0.20	166.8	169.9	174.5	145.0	148.0	152.7	208.6	211.6	216.2	202.0	205.0	209.6
0.30	168.7	173.3	180.3	146.9	151.5	158.4	210.4	214.9	221.9	203.9	208.4	215.3
0.40	170.7	176.8	186.0	148.8	154.9	164.2	212.3	218.3	227.5	205.8	211.8	221.0
0.50	172.6	180.2	191.8	150.7	158.3	169.9	214.2	221.7	233.2	207.6	215.2	226.7
0.60	174.5	183.6	197.6	152.6	161.8	175.7	216.1	225.1	238.9	209.5	218.5	232.4
0.70	176.4	187.1	203.3	154.5	165.2	181.5	218.0	228.5	244.6	211.4	221.9	238.0
0.80	178.3	190.5	209.1	156.4	168.7	187.2	219.8	231.9	250.3	213.3	225.3	243.7
0.90	180.2	194.0	214.8	158.4	172.1	193.0	221.7	235.3	256.0	215.2	228.7	249.4
	---------- 15-year Period ----------											
0.20	199.3	203.2	208.0	169.3	173.3	178.0	250.8	254.6	259.4	241.8	245.6	250.4
0.30	203.6	209.6	216.7	173.7	179.6	186.7	255.0	260.8	267.9	246.0	251.8	258.9
0.40	208.0	215.9	225.4	178.0	185.9	195.4	259.2	266.9	276.4	250.2	257.9	267.4
0.50	212.3	222.2	234.1	182.3	192.2	204.1	263.5	273.1	284.9	254.5	264.1	275.9
0.60	216.7	228.5	242.8	186.7	198.5	212.8	267.7	279.2	293.4	258.7	270.2	284.4
0.70	221.0	234.8	251.5	191.0	204.8	221.5	271.9	285.3	301.9	262.9	276.3	292.9
0.80	225.3	241.1	260.2	195.4	211.1	230.2	276.1	291.5	310.4	267.1	282.5	301.5
0.90	229.7	247.4	268.9	199.7	217.4	238.9	280.4	297.6	319.0	271.4	288.6	310.0

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D2. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Good Management, Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	102.8	104.0	107.0	83.1	84.4	87.4	138.9	140.2	143.1	133.0	134.3	137.2
0.30	103.1	105.0	109.4	83.4	85.3	89.8	139.2	141.1	145.5	133.3	135.2	139.7
0.40	103.4	105.9	111.9	83.7	86.3	92.2	139.5	142.0	148.0	133.6	136.1	142.1
0.50	103.7	106.9	114.3	84.1	87.2	94.6	139.8	143.0	150.4	133.9	137.1	144.5
0.60	104.0	107.8	116.7	84.4	88.1	97.1	140.1	143.9	152.8	134.2	138.0	146.9
0.70	104.3	108.7	119.1	84.7	89.1	99.5	140.4	144.8	155.2	134.5	138.9	149.3
0.80	104.6	109.7	121.6	85.0	90.0	101.9	140.7	145.8	157.6	134.8	139.9	151.7
0.90	104.9	110.6	124.0	85.3	91.0	104.3	141.0	146.7	160.0	135.2	140.8	154.2
	10-year Period											
0.20	151.3	154.4	159.0	121.8	124.8	129.5	196.5	199.5	204.1	187.6	190.6	195.2
0.30	153.2	157.8	164.8	123.7	128.3	135.2	198.4	202.9	209.8	189.5	194.0	200.9
0.40	155.1	161.2	170.5	125.6	131.7	141.0	200.2	206.3	215.5	191.4	197.4	206.6
0.50	157.0	164.7	176.3	127.5	135.2	146.8	202.1	209.6	221.2	193.3	200.8	212.3
0.60	159.0	168.1	182.0	129.4	138.6	152.5	204.0	213.0	226.8	195.1	204.2	218.0
0.70	160.9	171.6	187.8	131.4	142.0	158.3	205.9	216.4	232.5	197.0	207.6	223.7
0.80	162.8	175.0	193.6	133.3	145.5	164.0	207.8	219.8	238.2	198.9	210.9	229.4
0.90	164.7	178.4	199.3	135.2	148.9	169.8	209.6	223.2	243.9	200.8	214.3	235.1
	15-year Period											
0.20	183.8	187.7	192.5	146.2	150.1	154.9	238.7	242.5	247.3	227.4	231.3	236.0
0.30	188.1	194.0	201.2	150.5	156.4	163.6	242.9	248.7	255.8	231.6	237.4	244.5
0.40	192.5	200.3	209.9	154.8	162.7	172.3	247.2	254.8	264.3	235.9	243.5	253.0
0.50	196.8	206.6	218.6	159.2	169.0	180.9	251.4	261.0	272.8	240.1	249.7	261.5
0.60	201.1	212.9	227.3	163.5	175.3	189.6	255.6	267.1	281.3	244.3	255.8	270.1
0.70	205.5	219.2	236.0	167.8	181.6	198.3	259.8	273.3	289.9	248.5	262.0	278.6
0.80	209.8	225.6	244.6	172.2	187.9	207.0	264.1	279.4	298.4	252.8	268.1	287.1
0.90	214.1	231.9	253.3	176.5	194.2	215.7	268.3	285.6	306.9	257.0	274.3	295.6

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D3. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-17.7	-16.5	-13.5	-29.7	-28.5	-25.5	-8.7	-7.4	-4.5	-12.3	-11.0	-8.1
0.30	-17.4	-15.5	-11.1	-29.4	-27.5	-23.1	-8.4	-6.5	-2.0	-12.0	-10.1	-5.6
0.40	-17.1	-14.6	-8.7	-29.1	-26.6	-20.7	-8.1	-5.6	0.4	-11.7	-9.2	-3.2
0.50	-16.8	-13.7	-6.2	-28.8	-25.7	-18.2	-7.8	-4.6	2.8	-11.4	-8.2	-0.8
0.60	-16.5	-12.7	-3.8	-28.5	-24.7	-15.8	-7.5	-3.7	5.2	-11.1	-7.3	1.6
0.70	-16.2	-11.8	-1.4	-28.2	-23.8	-13.4	-7.2	-2.8	7.6	-10.8	-6.4	4.0
0.80	-15.9	-10.8	1.0	-27.9	-22.8	-11.0	-6.9	-1.8	10.0	-10.5	-5.4	6.4
0.90	-15.6	-9.9	3.5	-27.6	-21.9	-8.5	-6.5	-0.9	12.5	-10.1	-4.5	8.8
	10-year Period											
0.20	-28.6	-25.6	-20.9	-50.5	-47.5	-42.8	-11.4	-8.4	-3.8	-18.0	-15.0	-10.3
0.30	-26.7	-22.1	-15.2	-48.6	-44.0	-37.1	-9.5	-5.0	1.9	-16.1	-11.6	-4.7
0.40	-24.8	-18.7	-9.4	-46.7	-40.6	-31.3	-7.6	-1.6	7.6	-14.2	-8.2	1.0
0.50	-22.9	-15.3	-3.7	-44.8	-37.1	-25.5	-5.8	1.8	13.3	-12.3	-4.8	6.7
0.60	-21.0	-11.8	2.1	-42.9	-33.7	-19.8	-3.9	5.1	19.0	-10.4	-1.4	12.4
0.70	-19.1	-8.4	7.8	-40.9	-30.3	-14.0	-2.0	8.5	24.7	-8.6	2.0	18.1
0.80	-17.2	-5.0	13.6	-39.0	-26.8	-8.3	-0.1	11.9	30.3	-6.7	5.4	23.8
0.90	-15.2	-1.5	19.4	-37.1	-23.4	-2.5	1.8	15.3	36.0	-4.8	8.7	29.5
	15-year Period											
0.20	-34.0	-30.0	-25.3	-64.0	-60.0	-55.2	-9.1	-5.3	-0.5	-18.2	-14.4	-9.7
0.30	-29.7	-23.7	-16.6	-59.6	-53.7	-46.6	-4.9	1.0	8.1	-14.0	-8.3	-1.1
0.40	-25.3	-17.4	-7.9	-55.3	-47.4	-37.9	-0.6	7.2	16.7	-9.8	-2.1	7.4
0.50	-21.0	-11.1	0.8	-51.0	-41.1	-29.2	3.7	13.4	25.3	-5.6	4.0	15.9
0.60	-16.6	-4.8	9.5	-46.6	-34.8	-20.5	8.0	19.6	33.9	-1.3	10.2	24.4
0.70	-12.3	1.5	18.2	-42.3	-28.5	-11.8	12.2	25.8	42.5	2.9	16.3	32.9
0.80	-8.0	7.8	26.9	-37.9	-22.2	-3.1	16.5	32.1	51.1	7.1	22.5	41.4
0.90	-3.6	14.1	35.6	-33.6	-15.9	5.6	20.8	38.3	59.7	11.3	28.6	49.9

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D4. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-32.9	-31.7	-28.7	-52.6	-51.3	-48.4	-20.5	-19.2	-16.3	-26.4	-25.1	-22.2
0.30	-32.6	-30.7	-26.3	-52.3	-50.4	-45.9	-20.2	-18.3	-13.8	-26.1	-24.2	-19.7
0.40	-32.3	-29.8	-23.9	-52.0	-49.5	-43.5	-19.9	-17.4	-11.4	-25.8	-23.2	-17.3
0.50	-32.0	-28.9	-21.4	-51.7	-48.5	-41.1	-19.6	-16.4	-9.0	-25.5	-22.3	-14.9
0.60	-31.7	-27.9	-19.0	-51.4	-47.6	-38.7	-19.3	-15.5	-6.6	-25.2	-21.4	-12.5
0.70	-31.4	-27.0	-16.6	-51.1	-46.6	-36.2	-18.9	-14.5	-4.2	-24.8	-20.4	-10.1
0.80	-31.1	-26.0	-14.2	-50.8	-45.7	-33.8	-18.6	-13.6	-1.8	-24.5	-19.5	-7.7
0.90	-30.8	-25.1	-11.7	-50.4	-44.8	-31.4	-18.3	-12.7	0.7	-24.2	-18.6	-5.2
	10-year Period											
0.20	-43.8	-40.8	-36.1	-73.4	-70.3	-65.7	-23.2	-20.2	-15.6	-32.0	-29.0	-24.4
0.30	-41.9	-37.3	-30.4	-71.4	-66.9	-59.9	-21.3	-16.8	-9.9	-30.2	-25.7	-18.7
0.40	-40.0	-33.9	-24.6	-69.5	-63.4	-54.2	-19.4	-13.4	-4.2	-28.3	-22.3	-13.1
0.50	-38.1	-30.5	-18.9	-67.6	-60.0	-48.4	-17.5	-10.0	1.5	-26.4	-18.9	-7.4
0.60	-36.2	-27.0	-13.1	-65.7	-56.6	-42.6	-15.7	-6.6	7.2	-24.5	-15.5	-1.7
0.70	-34.3	-23.6	-7.4	-63.8	-53.1	-36.9	-13.8	-3.3	12.9	-22.6	-12.1	4.0
0.80	-32.4	-20.2	-1.6	-61.9	-49.7	-31.1	-11.9	0.1	18.6	-20.8	-8.7	9.7
0.90	-30.4	-16.7	4.2	-60.0	-46.2	-25.4	-10.0	3.5	24.2	-18.9	-5.3	15.4
	15-year Period											
0.20	-49.2	-45.3	-40.5	-86.8	-82.9	-78.1	-21.0	-17.2	-12.5	-32.3	-28.5	-23.7
0.30	-44.9	-38.9	-31.8	-82.5	-76.6	-69.4	-16.8	-11.1	-3.9	-28.1	-22.3	-15.2
0.40	-40.5	-32.6	-23.1	-78.1	-70.3	-60.7	-12.6	-4.9	4.6	-23.9	-16.2	-6.7
0.50	-36.2	-26.3	-14.4	-73.8	-64.0	-52.0	-8.4	1.2	13.1	-19.6	-10.0	1.8
0.60	-31.8	-20.0	-5.7	-69.5	-57.7	-43.3	-4.1	7.4	21.6	-15.4	-3.9	10.3
0.70	-27.5	-13.7	3.0	-65.1	-51.4	-34.6	0.1	13.5	30.1	-11.2	2.2	18.8
0.80	-23.2	-7.4	11.7	-60.8	-45.1	-26.0	4.3	19.7	38.6	-7.0	8.4	27.3
0.90	-18.8	-1.1	20.4	-56.5	-38.7	-17.3	8.5	25.8	47.1	-2.7	14.5	35.9

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D5. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Good Management, Rotational Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	117.5	118.7	121.5	102.9	104.1	107.0	150.6	151.9	154.7	146.2	147.5	150.3
0.30	117.7	119.6	123.8	103.1	105.0	109.2	150.9	152.7	157.0	146.5	148.3	152.6
0.40	117.9	120.4	126.1	103.3	105.8	111.5	151.1	153.6	159.2	146.7	149.2	154.9
0.50	118.2	121.3	128.4	103.6	106.7	113.8	151.3	154.4	161.5	146.9	150.0	157.1
0.60	118.4	122.1	130.7	103.8	107.5	116.1	151.5	155.3	163.8	147.2	150.9	159.4
0.70	118.6	123.0	132.9	104.0	108.4	118.3	151.8	156.1	166.0	147.4	151.7	161.7
0.80	118.9	123.8	135.2	104.3	109.2	120.6	152.0	157.0	168.3	147.6	152.6	163.9
0.90	119.1	124.7	137.5	104.5	110.1	122.9	152.2	157.8	170.6	147.9	153.5	166.2
	10-year Period											
0.20	165.2	168.3	172.8	138.6	141.7	146.2	207.9	210.9	215.4	199.9	202.9	207.4
0.30	167.0	171.6	178.4	140.4	145.0	151.8	209.6	214.1	220.8	201.6	206.1	212.9
0.40	168.7	174.9	183.9	142.2	148.3	157.3	211.3	217.3	226.3	203.3	209.4	218.3
0.50	170.5	178.2	189.5	143.9	151.6	162.9	213.0	220.6	231.8	205.0	212.6	223.8
0.60	172.2	181.4	195.0	145.7	154.9	168.4	214.7	223.8	237.3	206.8	215.8	229.3
0.70	174.0	184.7	200.6	147.4	158.1	174.0	216.5	227.0	242.8	208.5	219.0	234.8
0.80	175.8	188.0	206.1	149.2	161.4	179.5	218.2	230.3	248.2	210.2	222.3	240.3
0.90	177.5	191.3	211.7	150.9	164.7	185.1	219.9	233.5	253.7	211.9	225.5	245.7
	15-year Period											
0.20	197.1	201.1	205.7	160.7	164.6	169.3	249.8	253.7	258.3	238.9	242.8	247.4
0.30	201.2	207.2	214.2	164.8	170.7	177.7	253.8	259.6	266.6	242.9	248.7	255.6
0.40	205.4	213.3	222.6	168.9	176.8	186.2	257.8	265.6	274.8	246.9	254.6	263.9
0.50	209.5	219.4	231.0	173.0	182.9	194.6	261.8	271.5	283.1	250.9	260.6	272.2
0.60	213.6	225.5	239.5	177.2	189.1	203.0	265.9	277.5	291.3	254.9	266.5	280.4
0.70	217.7	231.6	247.9	181.3	195.2	211.5	269.9	283.4	299.6	258.9	272.5	288.7
0.80	221.8	237.7	256.4	185.4	201.3	219.9	273.9	289.3	307.9	262.9	278.4	296.9
0.90	226.0	243.8	264.8	189.5	207.4	228.3	277.9	295.3	316.1	266.9	284.4	305.2

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D6. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Good Management, Rotational Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	101.5	102.7	105.6	77.6	78.8	81.7	138.4	139.7	142.5	131.2	132.5	135.3
0.30	101.7	103.6	107.9	77.8	79.7	84.0	138.6	140.5	144.8	131.5	133.3	137.6
0.40	102.0	104.4	110.1	78.1	80.5	86.2	138.9	141.4	147.0	131.7	134.2	139.9
0.50	102.2	105.3	112.4	78.3	81.4	88.5	139.1	142.2	149.3	131.9	135.0	142.1
0.60	102.4	106.2	114.7	78.5	82.3	90.8	139.3	143.1	151.6	132.2	135.9	144.4
0.70	102.7	107.0	117.0	78.8	83.1	93.1	139.6	143.9	153.8	132.4	136.7	146.7
0.80	102.9	107.9	119.2	79.0	84.0	95.3	139.8	144.8	156.1	132.6	137.6	148.9
0.90	103.1	108.7	121.5	79.2	84.8	97.6	140.0	145.6	158.4	132.9	138.4	151.2
	10-year Period											
0.20	149.3	152.3	156.9	113.4	116.4	121.0	195.6	198.7	203.2	184.9	187.9	192.4
0.30	151.0	155.6	162.4	115.1	119.7	126.5	197.4	201.9	208.6	186.6	191.1	197.9
0.40	152.8	158.9	168.0	116.9	123.0	132.1	199.1	205.1	214.1	188.3	194.4	203.3
0.50	154.5	162.2	173.5	118.6	126.3	137.6	200.8	208.4	219.6	190.0	197.6	208.8
0.60	156.3	165.5	179.1	120.4	129.6	143.2	202.5	211.6	225.1	191.8	200.8	214.3
0.70	158.0	168.8	184.6	122.1	132.9	148.7	204.3	214.8	230.5	193.5	204.0	219.8
0.80	159.8	172.0	190.1	123.9	136.1	154.3	206.0	218.0	236.0	195.2	207.3	225.3
0.90	161.5	175.3	195.7	125.6	139.4	159.8	207.7	221.3	241.5	196.9	210.5	230.7
	15-year Period											
0.20	181.2	185.1	189.8	135.4	139.4	144.0	237.6	241.5	246.1	223.9	227.8	232.4
0.30	185.3	191.2	198.2	139.5	145.5	152.5	241.6	247.4	254.4	227.9	233.7	240.6
0.40	189.4	197.3	206.6	143.6	151.6	160.9	245.6	253.4	262.6	231.9	239.6	248.9
0.50	193.5	203.4	215.1	147.8	157.7	169.3	249.6	259.3	270.9	235.9	245.6	257.1
0.60	197.6	209.5	223.5	151.9	163.8	177.8	253.6	265.3	279.1	239.9	251.5	265.4
0.70	201.7	215.6	231.9	156.0	169.9	186.2	257.7	271.2	287.4	243.9	257.5	273.7
0.80	205.9	221.7	240.4	160.1	176.0	194.6	261.7	277.1	295.6	247.9	263.4	281.9
0.90	210.0	227.8	248.8	164.2	182.1	203.1	265.7	283.1	303.9	251.9	269.4	290.2

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D7. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Rotational Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-18.6	-17.3	-14.5	-33.2	-31.9	-29.1	-9.0	-7.8	-5.0	-13.4	-12.2	-9.3
0.30	-18.4	-16.5	-12.2	-32.9	-31.1	-26.8	-8.8	-7.0	-2.7	-13.2	-11.3	-7.1
0.40	-18.1	-15.6	-9.9	-32.7	-30.2	-24.5	-8.6	-6.1	-0.4	-13.0	-10.5	-4.8
0.50	-17.9	-14.8	-7.7	-32.5	-29.4	-22.3	-8.4	-5.3	1.8	-12.7	-9.6	-2.5
0.60	-17.7	-13.9	-5.4	-32.3	-28.5	-20.0	-8.1	-4.4	4.1	-12.5	-8.8	-0.3
0.70	-17.4	-13.1	-3.1	-32.0	-27.7	-17.7	-7.9	-3.5	6.4	-12.3	-7.9	2.0
0.80	-17.2	-12.2	-0.8	-31.8	-26.8	-15.4	-7.7	-2.7	8.6	-12.0	-7.1	4.3
0.90	-17.0	-11.4	1.4	-31.6	-25.9	-13.2	-7.4	-1.8	10.9	-11.8	-6.2	6.5
	10-year Period											
0.20	-30.2	-27.2	-22.6	-56.8	-53.8	-49.2	-12.1	-9.1	-4.6	-20.1	-17.1	-12.6
0.30	-28.5	-23.9	-17.1	-55.1	-50.5	-43.7	-10.4	-5.9	0.9	-18.4	-13.8	-7.1
0.40	-26.7	-20.6	-11.5	-53.3	-47.2	-38.1	-8.7	-2.6	6.4	-16.6	-10.6	-1.6
0.50	-25.0	-17.3	-6.0	-51.6	-43.9	-32.6	-6.9	0.6	11.8	-14.9	-7.4	3.9
0.60	-23.2	-14.0	-0.5	-49.8	-40.6	-27.0	-5.2	3.8	17.3	-13.2	-4.1	9.3
0.70	-21.5	-10.7	5.1	-48.1	-37.3	-21.5	-3.5	7.1	22.8	-11.5	-0.9	14.8
0.80	-19.7	-7.5	10.6	-46.3	-34.0	-15.9	-1.8	10.3	28.3	-9.8	2.3	20.3
0.90	-18.0	-4.2	16.2	-44.6	-30.8	-10.4	-0.1	13.5	33.8	-8.0	5.6	25.8
	15-year Period											
0.20	-36.2	-32.2	-27.5	-72.6	-68.7	-64.0	-10.2	-6.3	-1.7	-21.1	-17.3	-12.6
0.30	-32.1	-26.1	-19.1	-68.5	-62.6	-55.6	-6.2	-0.4	6.5	-17.1	-11.3	-4.4
0.40	-27.9	-20.0	-10.7	-64.4	-56.4	-47.1	-2.2	5.5	14.8	-13.1	-5.4	3.9
0.50	-23.8	-13.9	-2.2	-60.3	-50.3	-38.7	1.8	11.5	23.1	-9.1	0.6	12.1
0.60	-19.7	-7.8	6.2	-56.1	-44.2	-30.3	5.8	17.4	31.3	-5.1	6.5	20.4
0.70	-15.6	-1.7	14.6	-52.0	-38.1	-21.8	9.8	23.4	39.6	-1.1	12.4	28.6
0.80	-11.5	4.4	23.1	-47.9	-32.0	-13.4	13.8	29.3	47.8	2.9	18.4	36.9
0.90	-7.3	10.5	31.5	-43.8	-25.9	-5.0	17.9	35.3	56.1	6.9	24.3	45.2

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D8. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Rotational Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-34.2	-33.0	-30.1	-58.1	-56.9	-54.1	-21.0	-19.7	-16.9	-28.1	-26.9	-24.1
0.30	-34.0	-32.1	-27.9	-57.9	-56.0	-51.8	-20.7	-18.9	-14.6	-27.9	-26.0	-21.8
0.40	-33.8	-31.3	-25.6	-57.7	-55.2	-49.5	-20.5	-18.0	-12.4	-27.7	-25.2	-19.5
0.50	-33.5	-30.4	-23.3	-57.4	-54.3	-47.2	-20.3	-17.2	-10.1	-27.4	-24.3	-17.3
0.60	-33.3	-29.6	-21.0	-57.2	-53.5	-44.9	-20.0	-16.3	-7.8	-27.2	-23.5	-15.0
0.70	-33.1	-28.7	-18.8	-57.0	-52.6	-42.7	-19.8	-15.5	-5.5	-27.0	-22.6	-12.7
0.80	-32.8	-27.9	-16.5	-56.7	-51.8	-40.4	-19.6	-14.6	-3.3	-26.8	-21.8	-10.4
0.90	-32.6	-27.0	-14.2	-56.5	-50.9	-38.1	-19.4	-13.8	-1.0	-26.5	-20.9	-8.2
	10-year Period											
0.20	-45.9	-42.8	-38.3	-81.8	-78.7	-74.2	-24.0	-21.0	-16.5	-34.8	-31.8	-27.3
0.30	-44.1	-39.5	-32.7	-80.0	-75.4	-68.6	-22.3	-17.8	-11.0	-33.1	-28.5	-21.8
0.40	-42.4	-36.3	-27.2	-78.3	-72.1	-63.1	-20.6	-14.5	-5.6	-31.3	-25.3	-16.3
0.50	-40.6	-33.0	-21.6	-76.5	-68.9	-57.5	-18.9	-11.3	-0.1	-29.6	-22.1	-10.8
0.60	-38.9	-29.7	-16.1	-74.8	-65.6	-52.0	-17.1	-8.1	5.4	-27.9	-18.9	-5.4
0.70	-37.1	-26.4	-10.6	-73.0	-62.3	-46.4	-15.4	-4.9	10.9	-26.2	-15.6	0.1
0.80	-35.4	-23.1	-5.0	-71.3	-59.0	-40.9	-13.7	-1.6	16.4	-24.5	-12.4	5.6
0.90	-33.6	-19.8	0.5	-69.5	-55.7	-35.4	-12.0	1.6	21.8	-22.7	-9.2	11.1
	15-year Period											
0.20	-51.8	-47.9	-43.2	-97.6	-93.6	-89.0	-22.1	-18.3	-13.6	-35.9	-32.0	-27.4
0.30	-47.7	-41.8	-34.8	-93.5	-87.5	-80.5	-18.1	-12.3	-5.4	-31.8	-26.0	-19.1
0.40	-43.6	-35.7	-26.3	-89.3	-81.4	-72.1	-14.1	-6.4	2.9	-27.8	-20.1	-10.8
0.50	-39.5	-29.5	-17.9	-85.2	-75.3	-63.6	-10.1	-0.4	11.1	-23.8	-14.2	-2.6
0.60	-35.3	-23.4	-9.5	-81.1	-69.2	-55.2	-6.1	5.5	19.4	-19.8	-8.2	5.7
0.70	-31.2	-17.3	-1.0	-77.0	-63.1	-46.8	-2.1	11.5	27.7	-15.8	-2.3	13.9
0.80	-27.1	-11.2	7.4	-72.9	-57.0	-38.3	1.9	17.4	35.9	-11.8	3.7	22.2
0.90	-23.0	-5.1	15.8	-68.7	-50.9	-29.9	5.9	23.3	44.2	-7.8	9.6	30.4

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D9. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.70	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
	---------- 10-year Period ----------											
0.20	no	no	no	no	no	no	no	no	yes	no	no	yes
0.30	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.80	no	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	---------- 15-year Period ----------											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D10. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	no	no	no	no
0.50	no	no	no	no	no	no	no	no	yes	no	no	no
0.60	no	no	no	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	no	no	no	yes	no	no	yes
	---------- 10-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	no
0.40	no	no	no	no	no	no	no	yes	yes	no	yes	no
0.50	no	no	yes	no	no	no	no	yes	yes	no	yes	no
0.60	no	no	yes	no	no	no	no	yes	yes	no	yes	no
0.70	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
	---------- 15-year Period ----------											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.40	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D11. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Rotational Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	no
0.40	no	no	no	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.80	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
	---------- 10-year Period ----------											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.80	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.90	no	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	---------- 15-year Period ----------											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D12. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Rotational Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	no	no	no	no
0.50	no	no	no	no	no	no	no	no	yes	no	no	no
0.60	no	no	no	no	no	no	no	no	yes	no	no	no
0.70	no	no	no	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	no	no	no	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	no
0.40	no	no	no	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.80	no	yes	yes	no	no	yes	yes	yes	yes	no	no	yes
0.90	no	yes	yes	no	no	yes	yes	yes	yes	no	no	yes
	15-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.40	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D13. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($1.00 per head per month), Seasonal Grazing Scenario ($12 per AUM)[a]

	50-acre Infestation Infestation Canopy Cover						250-acre Infestation Infestation Canopy Cover					
Carrying Capacity	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-17.9	-16.6	-13.6	-32.3	-31.0	-28.1	-15.2	-13.9	-11.0	-18.1	-16.8	-13.8
0.30	-17.6	-15.7	-11.2	-32.0	-30.1	-25.6	-14.9	-13.0	-8.5	-17.8	-15.9	-11.4
0.40	-17.3	-14.7	-8.8	-31.7	-29.1	-23.2	-14.6	-12.1	-6.1	-17.5	-14.9	-9.0
0.50	-17.0	-13.8	-6.4	-31.4	-28.2	-20.8	-14.3	-11.1	-3.7	-17.2	-14.0	-6.6
0.60	-16.7	-12.9	-4.0	-31.1	-27.3	-18.4	-14.0	-10.2	-1.3	-16.8	-13.1	-4.2
0.70	-16.3	-11.9	-1.5	-30.7	-26.3	-15.9	-13.7	-9.3	1.1	-16.5	-12.1	-1.8
0.80	-16.0	-11.0	0.9	-30.4	-25.4	-13.5	-13.4	-8.3	3.5	-16.2	-11.2	0.7
0.90	-15.7	-10.1	3.3	-30.1	-24.5	-11.1	-13.0	-7.4	6.0	-15.9	-10.3	3.1
	---------- 10-year Period ----------											
0.20	-24.5	-21.5	-16.8	-50.8	-47.7	-43.1	-19.7	-16.7	-12.1	-24.9	-21.9	-17.3
0.30	-22.6	-18.0	-11.1	-48.9	-44.3	-37.3	-17.8	-13.3	-6.4	-23.1	-18.5	-11.6
0.40	-20.7	-14.6	-5.3	-46.9	-40.8	-31.6	-15.9	-9.9	-0.7	-21.2	-15.2	-5.9
0.50	-18.8	-11.2	0.4	-45.0	-37.4	-25.8	-14.0	-6.5	5.0	-19.3	-11.8	-0.3
0.60	-16.9	-7.7	6.2	-43.1	-34.0	-20.0	-12.2	-3.1	10.7	-17.4	-8.4	5.4
0.70	-15.0	-4.3	11.9	-41.2	-30.5	-14.3	-10.3	0.2	16.4	-15.5	-5.0	11.1
0.80	-13.1	-0.8	17.7	-39.3	-27.1	-8.5	-8.4	3.6	22.0	-13.7	-1.6	16.8
0.90	-11.1	2.6	23.5	-37.4	-23.6	-2.8	-6.5	7.0	27.7	-11.8	1.8	22.5
	---------- 15-year Period ----------											
0.20	-26.8	-22.8	-18.1	-62.7	-58.8	-54.0	-20.3	-16.4	-11.7	-27.5	-23.6	-18.9
0.30	-22.4	-16.5	-9.4	-58.4	-52.5	-45.3	-16.0	-10.3	-3.2	-23.2	-17.5	-10.4
0.40	-18.1	-10.2	-0.7	-54.1	-46.2	-36.7	-11.8	-4.1	5.3	-19.0	-11.3	-1.9
0.50	-13.8	-3.9	8.0	-49.7	-39.9	-28.0	-7.6	2.0	13.9	-14.8	-5.2	6.7
0.60	-9.4	2.4	16.7	-45.4	-33.6	-19.3	-3.4	8.2	22.4	-10.6	1.0	15.2
0.70	-5.1	8.7	25.4	-41.1	-27.3	-10.6	0.9	14.3	30.9	-6.3	7.1	23.7
0.80	-0.8	15.0	34.1	-36.7	-21.0	-1.9	5.1	20.4	39.4	-2.1	13.2	32.2
0.90	3.6	21.3	42.8	-32.4	-14.7	6.8	9.3	26.6	47.9	2.1	19.4	40.7

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D14. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($2.00 per head per month), Seasonal Grazing Scenario ($12 per AUM)[a]

	50-acre Infestation Infestation Canopy Cover						250-acre Infestation Infestation Canopy Cover					
Carrying Capacity	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-33.0	-31.7	-28.8	-47.4	-46.1	-43.2	-30.3	-29.1	-26.1	-33.2	-31.9	-29.0
0.30	-32.7	-30.8	-26.3	-47.1	-45.2	-40.8	-30.0	-28.1	-23.7	-32.9	-31.0	-26.6
0.40	-32.4	-29.9	-23.9	-46.8	-44.3	-38.3	-29.7	-27.2	-21.3	-32.6	-30.1	-24.1
0.50	-32.1	-28.9	-21.5	-46.5	-43.3	-35.9	-29.4	-26.3	-18.8	-32.3	-29.1	-21.7
0.60	-31.8	-28.0	-19.1	-46.2	-42.4	-33.5	-29.1	-25.3	-16.4	-32.0	-28.2	-19.3
0.70	-31.5	-27.1	-16.7	-45.9	-41.5	-31.1	-28.8	-24.4	-14.0	-31.7	-27.3	-16.9
0.80	-31.2	-26.1	-14.2	-45.6	-40.5	-28.6	-28.5	-23.5	-11.6	-31.4	-26.3	-14.5
0.90	-30.9	-25.2	-11.8	-45.3	-39.6	-26.2	-28.2	-22.5	-9.2	-31.1	-25.4	-12.1
	---------- 10-year Period ----------											
0.20	-46.8	-43.7	-39.1	-89.8	-85.8	-81.1	-41.9	-38.9	-34.3	-54.5	-50.7	-45.9
0.30	-44.8	-40.3	-33.3	-85.4	-79.5	-72.4	-40.0	-35.5	-28.6	-50.3	-44.5	-37.4
0.40	-42.9	-36.8	-27.5	-81.1	-73.2	-63.7	-38.1	-32.1	-22.9	-46.0	-38.4	-28.9
0.50	-41.0	-33.4	-21.8	-76.8	-66.9	-55.0	-36.3	-28.7	-17.2	-41.8	-32.2	-20.4
0.60	-39.1	-29.9	-16.0	-72.4	-60.6	-46.3	-34.4	-25.4	-11.5	-37.6	-26.1	-11.9
0.70	-37.2	-26.5	-10.3	-68.1	-54.3	-37.6	-32.5	-22.0	-5.9	-33.4	-19.9	-3.3
0.80	-35.3	-23.1	-4.5	-63.8	-48.0	-28.9	-30.6	-18.6	-0.2	-29.1	-13.8	5.2
0.90	-33.4	-19.6	1.2	-59.4	-41.7	-20.2	-28.7	-15.2	5.5	-24.9	-7.6	13.7
	---------- 15-year Period ----------											
0.20	-53.8	-49.9	-45.1	-89.8	-85.8	-81.1	-47.3	-43.5	-38.7	-54.5	-50.7	-45.9
0.30	-49.5	-43.6	-36.4	-85.4	-79.5	-72.4	-43.1	-37.3	-30.2	-50.3	-44.5	-37.4
0.40	-45.1	-37.3	-27.7	-81.1	-73.2	-63.7	-38.8	-31.2	-21.7	-46.0	-38.4	-28.9
0.50	-40.8	-31.0	-19.0	-76.8	-66.9	-55.0	-34.6	-25.0	-13.2	-41.8	-32.2	-20.4
0.60	-36.5	-24.7	-10.3	-72.4	-60.6	-46.3	-30.4	-18.9	-4.7	-37.6	-26.1	-11.9
0.70	-32.1	-18.3	-1.6	-68.1	-54.3	-37.6	-26.2	-12.7	3.9	-33.4	-19.9	-3.3
0.80	-27.8	-12.0	7.1	-63.8	-48.0	-28.9	-21.9	-6.6	12.4	-29.1	-13.8	5.2
0.90	-23.5	-5.7	15.7	-59.4	-41.7	-20.2	-17.7	-0.4	20.9	-24.9	-7.6	13.7

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Appendix Table D15. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($1.00 per head per month), Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	yes	no	no	no	no	no	yes	no	no	no
0.30	no	yes	yes	no	no	no	no	yes	yes	no	yes	yes
0.40	yes	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D16. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($2.00 per head per month), Seasonal Grazing Scenario ($12 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	no	no	no	no
0.50	no	no	no	no	no	no	no	no	no	no	no	no
0.60	no	no	no	no	no	no	no	no	no	no	no	no
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	no	no	no	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	yes	yes	no	yes	yes	yes	yes	yes
0.90	no	yes	yes	no	yes	yes	no	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	yes	yes	no	no	no	no	yes	yes	no	no	yes
0.60	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	yes	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $12.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D17. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Good Management, Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	118.6	120.5	125.0	106.6	108.5	113.0	151.3	153.2	157.6	147.7	149.6	154.0
0.30	119.1	121.9	128.6	107.1	109.9	116.6	151.7	154.6	161.2	148.1	151.0	157.6
0.40	119.5	123.3	132.2	107.5	111.3	120.2	152.2	156.0	164.9	148.6	152.4	161.3
0.50	120.0	124.7	135.9	108.0	112.7	123.9	152.7	157.4	168.5	149.1	153.8	164.9
0.60	120.5	126.1	139.5	108.5	114.1	127.5	153.1	158.8	172.1	149.5	155.2	168.5
0.70	120.9	127.5	143.1	108.9	115.5	131.1	153.6	160.2	175.7	150.0	156.6	172.1
0.80	121.4	129.0	146.8	109.4	117.0	134.8	154.0	161.6	179.4	150.4	158.0	175.8
0.90	121.8	130.4	150.4	109.8	118.4	138.4	154.5	163.0	183.0	150.9	159.4	179.4
	10-year Period											
0.20	168.7	173.3	180.3	146.9	151.5	158.4	210.4	214.9	221.9	203.9	208.4	215.3
0.30	171.6	178.5	188.9	149.8	156.6	167.1	213.3	220.0	230.4	206.7	213.5	223.8
0.40	174.5	183.6	197.6	152.6	161.8	175.7	216.1	225.1	238.9	209.5	218.5	232.4
0.50	177.4	188.8	206.2	155.5	166.9	184.3	218.9	230.2	247.5	212.3	223.6	240.9
0.60	180.2	194.0	214.8	158.4	172.1	193.0	221.7	235.3	256.0	215.2	228.7	249.4
0.70	183.1	199.1	223.5	161.2	177.3	201.6	224.5	240.3	264.5	218.0	233.8	258.0
0.80	186.0	204.3	232.1	164.1	182.4	210.2	227.4	245.4	273.0	220.8	238.8	266.5
0.90	188.8	209.4	240.7	167.0	187.6	218.9	230.2	250.5	281.6	223.6	243.9	275.0
	15-year Period											
0.20	203.6	209.6	216.7	173.7	179.6	186.7	255.0	260.8	267.9	246.0	251.8	258.9
0.30	210.1	219.0	229.8	180.2	189.0	199.8	261.3	270.0	280.6	252.4	261.0	271.7
0.40	216.7	228.5	242.8	186.7	198.5	212.8	267.7	279.2	293.4	258.7	270.2	284.4
0.50	223.2	237.9	255.8	193.2	207.9	225.9	274.0	288.4	306.2	265.0	279.4	297.2
0.60	229.7	247.4	268.9	199.7	217.4	238.9	280.4	297.6	319.0	271.4	288.6	310.0
0.70	236.2	256.8	281.9	206.2	226.9	251.9	286.7	306.8	331.7	277.7	297.9	322.7
0.80	242.7	266.3	294.9	212.7	236.3	265.0	293.0	316.1	344.5	284.0	307.1	335.5
0.90	249.2	275.8	308.0	219.2	245.8	278.0	299.4	325.3	357.3	290.4	316.3	348.3

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D18. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Good Management, Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	103.1	105.0	109.4	83.4	85.3	89.8	139.2	141.1	145.5	133.3	135.2	139.7
0.30	103.6	106.4	113.1	83.9	86.7	93.4	139.7	142.5	149.2	133.8	136.6	143.3
0.40	104.0	107.8	116.7	84.4	88.1	97.1	140.1	143.9	152.8	134.2	138.0	146.9
0.50	104.5	109.2	120.4	84.8	89.6	100.7	140.6	145.3	156.4	134.7	139.4	150.5
0.60	104.9	110.6	124.0	85.3	91.0	104.3	141.0	146.7	160.0	135.2	140.8	154.2
0.70	105.4	112.0	127.6	85.7	92.4	108.0	141.5	148.1	163.7	135.6	142.2	157.8
0.80	105.9	113.4	131.3	86.2	93.8	111.6	142.0	149.5	167.3	136.1	143.6	161.4
0.90	106.3	114.8	134.9	86.7	95.2	115.2	142.4	150.9	170.9	136.5	145.0	165.0
	10-year Period											
0.20	153.2	157.8	164.8	123.7	128.3	135.2	198.4	202.9	209.8	189.5	194.0	200.9
0.30	156.1	163.0	173.4	126.6	133.4	143.9	201.2	207.9	218.3	192.3	199.1	209.5
0.40	159.0	168.1	182.0	129.4	138.6	152.5	204.0	213.0	226.8	195.1	204.2	218.0
0.50	161.8	173.3	190.7	132.3	143.8	161.2	206.8	218.1	235.4	198.0	209.2	226.5
0.60	164.7	178.4	199.3	135.2	148.9	169.8	209.6	223.2	243.9	200.8	214.3	235.1
0.70	167.6	183.6	207.9	138.1	154.1	178.4	212.5	228.3	252.4	203.6	219.4	243.6
0.80	170.4	188.8	216.6	140.9	159.2	187.1	215.3	233.3	261.0	206.4	224.5	252.1
0.90	173.3	193.9	225.2	143.8	164.4	195.7	218.1	238.4	269.5	209.2	229.5	260.6
	15-year Period											
0.20	188.1	194.0	201.2	150.5	156.4	163.6	242.9	248.7	255.8	231.6	237.4	244.5
0.30	194.6	203.5	214.2	157.0	165.9	176.6	249.3	257.9	268.6	238.0	246.6	257.3
0.40	201.1	212.9	227.3	163.5	175.3	189.6	255.6	267.1	281.3	244.3	255.8	270.1
0.50	207.6	222.4	240.3	170.0	184.8	202.7	261.9	276.3	294.1	250.7	265.1	282.8
0.60	214.1	231.9	253.3	176.5	194.2	215.7	268.3	285.6	306.9	257.0	274.3	295.6
0.70	220.6	241.3	266.4	183.0	203.7	228.7	274.6	294.8	319.7	263.3	283.5	308.4
0.80	227.1	250.8	279.4	189.5	213.1	241.8	281.0	304.0	332.4	269.7	292.7	321.1
0.90	233.7	260.2	292.5	196.0	222.6	254.8	287.3	313.2	345.2	276.0	301.9	333.9

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D19. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-17.4	-15.5	-11.1	-29.4	-27.5	-23.1	-8.4	-6.5	-2.0	-12.0	-10.1	-5.6
0.30	-17.0	-14.1	-7.4	-29.0	-26.1	-19.4	-7.9	-5.1	1.6	-11.5	-8.7	-2.0
0.40	-16.5	-12.7	-3.8	-28.5	-24.7	-15.8	-7.5	-3.7	5.2	-11.1	-7.3	1.6
0.50	-16.0	-11.3	-0.2	-28.0	-23.3	-12.2	-7.0	-2.3	8.8	-10.6	-5.9	5.2
0.60	-15.6	-9.9	3.5	-27.6	-21.9	-8.5	-6.5	-0.9	12.5	-10.1	-4.5	8.8
0.70	-15.1	-8.5	7.1	-27.1	-20.5	-4.9	-6.1	0.5	16.1	-9.7	-3.1	12.5
0.80	-14.7	-7.1	10.7	-26.7	-19.1	-1.3	-5.6	1.9	19.7	-9.2	-1.7	16.1
0.90	-14.2	-5.7	14.4	-26.2	-17.7	2.4	-5.2	3.3	23.3	-8.8	-0.3	19.7
	10-year Period											
0.20	-26.7	-22.1	-15.2	-48.6	-44.0	-37.1	-9.5	-5.0	1.9	-16.1	-11.6	-4.7
0.30	-23.9	-17.0	-6.5	-45.7	-38.9	-28.4	-6.7	0.1	10.4	-13.3	-6.5	3.9
0.40	-21.0	-11.8	2.1	-42.9	-33.7	-19.8	-3.9	5.1	19.0	-10.4	-1.4	12.4
0.50	-18.1	-6.7	10.7	-40.0	-28.5	-11.1	-1.1	10.2	27.5	-7.6	3.7	20.9
0.60	-15.2	-1.5	19.4	-37.1	-23.4	-2.5	1.8	15.3	36.0	-4.8	8.7	29.5
0.70	-12.4	3.6	28.0	-34.2	-18.2	6.1	4.6	20.4	44.6	-2.0	13.8	38.0
0.80	-9.5	8.8	36.6	-31.4	-13.1	14.8	7.4	25.4	53.1	0.8	18.9	46.5
0.90	-6.6	14.0	45.3	-28.5	-7.9	23.4	10.2	30.5	61.6	3.7	24.0	55.1
	15-year Period											
0.20	-29.7	-23.7	-16.6	-59.6	-53.7	-46.6	-4.9	1.0	8.1	-14.0	-8.3	-1.1
0.30	-23.1	-14.3	-3.5	-53.1	-44.3	-33.5	1.6	10.3	21.0	-7.7	1.0	11.6
0.40	-16.6	-4.8	9.5	-46.6	-34.8	-20.5	8.0	19.6	33.9	-1.3	10.2	24.4
0.50	-10.1	4.6	22.5	-40.1	-25.3	-7.4	14.4	29.0	46.8	5.0	19.4	37.2
0.60	-3.6	14.1	35.6	-33.6	-15.9	5.6	20.8	38.3	59.7	11.3	28.6	49.9
0.70	2.9	23.5	48.6	-27.1	-6.4	18.6	27.2	47.6	72.6	17.7	37.8	62.7
0.80	9.4	33.0	61.6	-20.6	3.0	31.7	33.6	56.9	85.5	24.0	47.0	75.5
0.90	15.9	42.5	74.7	-14.1	12.5	44.7	40.0	66.3	98.4	30.4	56.3	88.3

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D20. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-32.6	-30.7	-26.3	-52.3	-50.4	-45.9	-20.2	-18.3	-13.8	-26.1	-24.2	-19.7
0.30	-32.2	-29.3	-22.6	-51.8	-49.0	-42.3	-19.7	-16.9	-10.2	-25.6	-22.8	-16.1
0.40	-31.7	-27.9	-19.0	-51.4	-47.6	-38.7	-19.3	-15.5	-6.6	-25.2	-21.4	-12.5
0.50	-31.2	-26.5	-15.4	-50.9	-46.2	-35.0	-18.8	-14.1	-3.0	-24.7	-20.0	-8.9
0.60	-30.8	-25.1	-11.7	-50.4	-44.8	-31.4	-18.3	-12.7	0.7	-24.2	-18.6	-5.2
0.70	-30.3	-23.7	-8.1	-50.0	-43.4	-27.8	-17.9	-11.3	4.3	-23.8	-17.2	-1.6
0.80	-29.9	-22.3	-4.5	-49.5	-42.0	-24.1	-17.4	-9.9	7.9	-23.3	-15.8	2.0
0.90	-29.4	-20.9	-0.8	-49.1	-40.5	-20.5	-17.0	-8.5	11.5	-22.9	-14.4	5.6
	10-year Period											
0.20	-41.9	-37.3	-30.4	-71.4	-66.9	-59.9	-21.3	-16.8	-9.9	-30.2	-25.7	-18.7
0.30	-39.1	-32.2	-21.8	-68.6	-61.7	-51.3	-18.5	-11.7	-1.4	-27.3	-20.6	-10.2
0.40	-36.2	-27.0	-13.1	-65.7	-56.6	-42.6	-15.7	-6.6	7.2	-24.5	-15.5	-1.7
0.50	-33.3	-21.9	-4.5	-62.8	-51.4	-34.0	-12.8	-1.6	15.7	-21.7	-10.4	6.9
0.60	-30.4	-16.7	4.2	-60.0	-46.2	-25.4	-10.0	3.5	24.2	-18.9	-5.3	15.4
0.70	-27.6	-11.6	12.8	-57.1	-41.1	-16.7	-7.2	8.6	32.8	-16.1	-0.3	23.9
0.80	-24.7	-6.4	21.4	-54.2	-35.9	-8.1	-4.4	13.7	41.3	-13.2	4.8	32.4
0.90	-21.8	-1.2	30.1	-51.4	-30.8	0.6	-1.6	18.7	49.8	-10.4	9.9	41.0
	15-year Period											
0.20	-44.9	-38.9	-31.8	-82.5	-76.6	-69.4	-16.8	-11.1	-3.9	-28.1	-22.3	-15.2
0.30	-38.3	-29.5	-18.7	-76.0	-67.1	-56.4	-10.5	-1.8	8.8	-21.8	-13.1	-2.5
0.40	-31.8	-20.0	-5.7	-69.5	-57.7	-43.3	-4.1	7.4	21.6	-15.4	-3.9	10.3
0.50	-25.3	-10.6	7.3	-63.0	-48.2	-30.3	2.2	16.6	34.4	-9.1	5.3	23.1
0.60	-18.8	-1.1	20.4	-56.5	-38.7	-17.3	8.5	25.8	47.1	-2.7	14.5	35.9
0.70	-12.3	8.3	33.4	-50.0	-29.3	-4.2	14.9	35.0	59.9	3.6	23.7	48.6
0.80	-5.8	17.8	46.4	-43.5	-19.8	8.8	21.2	44.3	72.7	9.9	33.0	61.4
0.90	0.7	27.3	59.5	-37.0	-10.4	21.9	27.6	53.5	85.5	16.3	42.2	74.2

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D21. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Good Management, Rotational Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	117.7	119.6	123.8	103.1	105.0	109.2	150.9	152.7	157.0	146.5	148.3	152.6
0.30	118.0	120.8	127.2	103.5	106.3	112.6	151.2	154.0	160.4	146.8	149.6	156.0
0.40	118.4	122.1	130.7	103.8	107.5	116.1	151.5	155.3	163.8	147.2	150.9	159.4
0.50	118.7	123.4	134.1	104.1	108.8	119.5	151.9	156.6	167.2	147.5	152.2	162.8
0.60	119.1	124.7	137.5	104.5	110.1	122.9	152.2	157.8	170.6	147.9	153.5	166.2
0.70	119.4	126.0	140.9	104.8	111.4	126.3	152.6	159.1	174.0	148.2	154.7	169.6
0.80	119.8	127.3	144.3	105.2	112.7	129.7	152.9	160.4	177.4	148.6	156.0	173.0
0.90	120.1	128.5	147.7	105.5	114.0	133.1	153.3	161.7	180.8	148.9	157.3	176.4
	10-year Period											
0.20	167.0	171.6	178.4	140.4	145.0	151.8	209.6	214.1	220.8	201.6	206.1	212.9
0.30	169.6	176.5	186.7	143.0	149.9	160.1	212.2	218.9	229.1	204.2	211.0	221.1
0.40	172.2	181.4	195.0	145.7	154.9	168.4	214.7	223.8	237.3	206.8	215.8	229.3
0.50	174.9	186.4	203.3	148.3	159.8	176.8	217.3	228.6	245.5	209.3	220.7	237.5
0.60	177.5	191.3	211.7	150.9	164.7	185.1	219.9	233.5	253.7	211.9	225.5	245.7
0.70	180.1	196.2	220.0	153.6	169.6	193.4	222.5	238.3	261.9	214.5	230.4	254.0
0.80	182.8	201.2	228.3	156.2	174.6	201.7	225.1	243.2	270.1	217.1	235.2	262.2
0.90	185.4	206.1	236.6	158.8	179.5	210.0	227.6	248.0	278.4	219.7	240.0	270.4
	15-year Period											
0.20	201.2	207.2	214.2	164.8	170.7	177.7	253.8	259.6	266.6	242.9	248.7	255.6
0.30	207.4	216.3	226.8	171.0	179.9	190.4	259.8	268.5	279.0	248.9	257.6	268.0
0.40	213.6	225.5	239.5	177.2	189.1	203.0	265.9	277.5	291.3	254.9	266.5	280.4
0.50	219.8	234.6	252.1	183.3	198.2	215.7	271.9	286.4	303.7	260.9	275.4	292.8
0.60	226.0	243.8	264.8	189.5	207.4	228.3	277.9	295.3	316.1	266.9	284.4	305.2
0.70	232.1	253.0	277.4	195.7	216.5	241.0	283.9	304.2	328.5	273.0	293.3	317.6
0.80	238.3	262.1	290.1	201.9	225.7	253.6	289.9	313.1	340.9	279.0	302.2	329.9
0.90	244.5	271.3	302.7	208.0	234.8	266.3	295.9	322.0	353.3	285.0	311.1	342.3

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D22. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Good Management, Rotational Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	101.7	103.6	107.9	77.8	79.7	84.0	138.6	140.5	144.8	131.5	133.3	137.6
0.30	102.1	104.9	111.3	78.2	81.0	87.4	139.0	141.8	148.2	131.8	134.6	141.0
0.40	102.4	106.2	114.7	78.5	82.3	90.8	139.3	143.1	151.6	132.2	135.9	144.4
0.50	102.8	107.4	118.1	78.9	83.5	94.2	139.7	144.3	155.0	132.5	137.2	147.8
0.60	103.1	108.7	121.5	79.2	84.8	97.6	140.0	145.6	158.4	132.9	138.4	151.2
0.70	103.5	110.0	124.9	79.6	86.1	101.0	140.4	146.9	161.8	133.2	139.7	154.6
0.80	103.8	111.3	128.3	79.9	87.4	104.4	140.7	148.2	165.2	133.6	141.0	158.0
0.90	104.2	112.6	131.8	80.3	88.7	107.9	141.1	149.5	168.6	133.9	142.3	161.4
	10-year Period											
0.20	151.0	155.6	162.4	115.1	119.7	126.5	197.4	201.9	208.6	186.6	191.1	197.9
0.30	153.7	160.5	170.7	117.8	124.6	134.8	200.0	206.7	216.9	189.2	196.0	206.1
0.40	156.3	165.5	179.1	120.4	129.6	143.2	202.5	211.6	225.1	191.8	200.8	214.3
0.50	158.9	170.4	187.4	123.0	134.5	151.5	205.1	216.4	233.3	194.3	205.7	222.5
0.60	161.5	175.3	195.7	125.6	139.4	159.8	207.7	221.3	241.5	196.9	210.5	230.7
0.70	164.2	180.3	204.0	128.3	144.4	168.1	210.3	226.1	249.7	199.5	215.4	238.9
0.80	166.8	185.2	212.3	130.9	149.3	176.4	212.9	231.0	257.9	202.1	220.2	247.2
0.90	169.4	190.1	220.7	133.5	154.2	184.8	215.4	235.8	266.2	204.7	225.0	255.4
	15-year Period											
0.20	185.3	191.2	198.2	139.5	145.5	152.5	241.6	247.4	254.4	227.9	233.7	240.6
0.30	191.4	200.4	210.9	145.7	154.6	165.1	247.6	256.3	266.7	233.9	242.6	253.0
0.40	197.6	209.5	223.5	151.9	163.8	177.8	253.6	265.3	279.1	239.9	251.5	265.4
0.50	203.8	218.7	236.2	158.0	172.9	190.4	259.7	274.2	291.5	245.9	260.4	277.8
0.60	210.0	227.8	248.8	164.2	182.1	203.1	265.7	283.1	303.9	251.9	269.4	290.2
0.70	216.2	237.0	261.5	170.4	191.2	215.7	271.7	292.0	316.3	258.0	278.3	302.6
0.80	222.3	246.1	274.1	176.6	200.4	228.4	277.7	300.9	328.7	264.0	287.2	314.9
0.90	228.5	255.3	286.8	182.8	209.5	241.0	283.7	309.8	341.1	270.0	296.1	327.3

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D23. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Rotational Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-18.4	-16.5	-12.2	-32.9	-31.1	-26.8	-8.8	-7.0	-2.7	-13.2	-11.3	-7.1
0.30	-18.0	-15.2	-8.8	-32.6	-29.8	-23.4	-8.5	-5.7	0.7	-12.8	-10.1	-3.7
0.40	-17.7	-13.9	-5.4	-32.3	-28.5	-20.0	-8.1	-4.4	4.1	-12.5	-8.8	-0.3
0.50	-17.3	-12.6	-2.0	-31.9	-27.2	-16.6	-7.8	-3.1	7.5	-12.2	-7.5	3.1
0.60	-17.0	-11.4	1.4	-31.6	-25.9	-13.2	-7.4	-1.8	10.9	-11.8	-6.2	6.5
0.70	-16.6	-10.1	4.8	-31.2	-24.7	-9.7	-7.1	-0.6	14.3	-11.5	-4.9	9.9
0.80	-16.3	-8.8	8.3	-30.9	-23.4	-6.3	-6.7	0.7	17.7	-11.1	-3.7	13.3
0.90	-15.9	-7.5	11.7	-30.5	-22.1	-2.9	-6.4	2.0	21.1	-10.8	-2.4	16.8
	10-year Period											
0.20	-28.5	-23.9	-17.1	-55.1	-50.5	-43.7	-10.4	-5.9	0.9	-18.4	-13.8	-7.1
0.30	-25.9	-19.0	-8.8	-52.4	-45.5	-35.4	-7.8	-1.0	9.1	-15.8	-9.0	1.1
0.40	-23.2	-14.0	-0.5	-49.8	-40.6	-27.0	-5.2	3.8	17.3	-13.2	-4.1	9.3
0.50	-20.6	-9.1	7.9	-47.2	-35.7	-18.7	-2.6	8.7	25.5	-10.6	0.7	17.6
0.60	-18.0	-4.2	16.2	-44.6	-30.8	-10.4	-0.1	13.5	33.8	-8.0	5.6	25.8
0.70	-15.3	0.8	24.5	-41.9	-25.8	-2.1	2.5	18.4	42.0	-5.4	10.4	34.0
0.80	-12.7	5.7	32.8	-39.3	-20.9	6.3	5.1	23.2	50.2	-2.9	15.2	42.2
0.90	-10.1	10.6	41.2	-36.7	-16.0	14.6	7.7	28.1	58.4	-0.3	20.1	50.4
	15-year Period											
0.20	-32.1	-26.1	-19.1	-68.5	-62.6	-55.6	-6.2	-0.4	6.5	-17.1	-11.3	-4.4
0.30	-25.9	-17.0	-6.5	-62.3	-53.4	-42.9	-0.2	8.5	18.9	-11.1	-2.4	8.0
0.40	-19.7	-7.8	6.2	-56.1	-44.2	-30.3	5.8	17.4	31.3	-5.1	6.5	20.4
0.50	-13.5	1.4	18.8	-50.0	-35.1	-17.6	11.8	26.3	43.7	0.9	15.4	32.8
0.60	-7.3	10.5	31.5	-43.8	-25.9	-5.0	17.9	35.3	56.1	6.9	24.3	45.2
0.70	-1.2	19.7	44.1	-37.6	-16.8	7.7	23.9	44.2	68.5	12.9	33.2	57.5
0.80	5.0	28.8	56.8	-31.4	-7.6	20.3	29.9	53.1	80.9	19.0	42.2	69.9
0.90	11.2	38.0	69.4	-25.3	1.5	33.0	35.9	62.0	93.2	25.0	51.1	82.3

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D24. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Rotational Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	-34.0	-32.1	-27.9	-57.9	-56.0	-51.8	-20.7	-18.9	-14.6	-27.9	-26.0	-21.8
0.30	-33.7	-30.9	-24.5	-57.6	-54.8	-48.4	-20.4	-17.6	-11.2	-27.6	-24.8	-18.4
0.40	-33.3	-29.6	-21.0	-57.2	-53.5	-44.9	-20.0	-16.3	-7.8	-27.2	-23.5	-15.0
0.50	-33.0	-28.3	-17.6	-56.9	-52.2	-41.5	-19.7	-15.0	-4.4	-26.9	-22.2	-11.6
0.60	-32.6	-27.0	-14.2	-56.5	-50.9	-38.1	-19.4	-13.8	-1.0	-26.5	-20.9	-8.2
0.70	-32.3	-25.7	-10.8	-56.2	-49.6	-34.7	-19.0	-12.5	2.4	-26.2	-19.7	-4.8
0.80	-31.9	-24.4	-7.4	-55.8	-48.3	-31.3	-18.7	-11.2	5.8	-25.8	-18.4	-1.4
0.90	-31.6	-23.1	-4.0	-55.5	-47.1	-27.9	-18.3	-9.9	9.2	-25.5	-17.1	2.0
	10-year Period											
0.20	-44.1	-39.5	-32.7	-80.0	-75.4	-68.6	-22.3	-17.8	-11.0	-33.1	-28.5	-21.8
0.30	-41.5	-34.6	-24.4	-77.4	-70.5	-60.3	-19.7	-12.9	-2.8	-30.5	-23.7	-13.6
0.40	-38.9	-29.7	-16.1	-74.8	-65.6	-52.0	-17.1	-8.1	5.4	-27.9	-18.9	-5.4
0.50	-36.2	-24.8	-7.8	-72.1	-60.7	-43.7	-14.6	-3.2	13.6	-25.3	-14.0	2.8
0.60	-33.6	-19.8	0.5	-69.5	-55.7	-35.4	-12.0	1.6	21.8	-22.7	-9.2	11.1
0.70	-31.0	-14.9	8.9	-66.9	-50.8	-27.0	-9.4	6.5	30.0	-20.2	-4.3	19.3
0.80	-28.4	-10.0	17.2	-64.2	-45.9	-18.7	-6.8	11.3	38.3	-17.6	0.5	27.5
0.90	-25.7	-5.0	25.5	-61.6	-40.9	-10.4	-4.2	16.1	46.5	-15.0	5.4	35.7
	15-year Period											
0.20	-47.7	-41.8	-34.8	-93.5	-87.5	-80.5	-18.1	-12.3	-5.4	-31.8	-26.0	-19.1
0.30	-41.5	-32.6	-22.1	-87.3	-78.4	-67.9	-12.1	-3.4	7.0	-25.8	-17.1	-6.7
0.40	-35.3	-23.4	-9.5	-81.1	-69.2	-55.2	-6.1	5.5	19.4	-19.8	-8.2	5.7
0.50	-29.2	-14.3	3.2	-74.9	-60.1	-42.6	-0.1	14.4	31.8	-13.8	0.7	18.1
0.60	-23.0	-5.1	15.8	-68.7	-50.9	-29.9	5.9	23.3	44.2	-7.8	9.6	30.4
0.70	-16.8	4.0	28.5	-62.6	-41.7	-17.3	11.9	32.3	56.6	-1.8	18.5	42.8
0.80	-10.6	13.2	41.1	-56.4	-32.6	-4.6	18.0	41.2	68.9	4.2	27.4	55.2
0.90	-4.5	22.3	53.8	-50.2	-23.4	8.0	24.0	50.1	81.3	10.2	36.4	67.6

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D25. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	yes
0.30	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.60	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
	10-year Period											
0.20	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.30	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.40	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D26. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	yes	no	no	no
0.40	no	no	no	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D27. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the No Debt, Poor Management, Rotational Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.50	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.60	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.70	no	no	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
	10-year Period											
0.20	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	no	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.30	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.40	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D28. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing, Under the With Debt, Poor Management, Rotational Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	yes	no	no	no
0.50	no	no	no	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
	10-year Period											
0.20	no	no	no	no	no	no	no	no	yes	no	no	no
0.30	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	yes	yes	no	yes	yes
0.50	no	yes	yes	no	no	no	no	yes	yes	no	yes	yes
0.60	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.70	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	no	no	no	no	no	no	yes	yes	no	no	yes
0.30	no	no	yes	no	no	no	yes	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	no	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D29. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($1.00 per head per month), Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-17.6	-15.7	-11.2	-32.0	-30.1	-25.6	-14.9	-13.0	-8.5	-17.8	-15.9	-11.4
0.30	-17.1	-14.3	-7.6	-31.5	-28.7	-22.0	-14.4	-11.6	-4.9	-17.3	-14.5	-7.8
0.40	-16.7	-12.9	-4.0	-31.1	-27.3	-18.4	-14.0	-10.2	-1.3	-16.8	-13.1	-4.2
0.50	-16.2	-11.5	-0.3	-30.6	-25.9	-14.7	-13.5	-8.8	2.3	-16.4	-11.7	-0.6
0.60	-15.7	-10.1	3.3	-30.1	-24.5	-11.1	-13.0	-7.4	6.0	-15.9	-10.3	3.1
0.70	-15.3	-8.6	7.0	-29.7	-23.0	-7.5	-12.6	-6.0	9.6	-15.5	-8.9	6.7
0.80	-14.8	-7.2	10.6	-29.2	-21.6	-3.8	-12.1	-4.6	13.2	-15.0	-7.5	10.3
0.90	-14.3	-5.8	14.2	-28.7	-20.2	-0.2	-11.7	-3.2	16.8	-14.6	-6.1	13.9
	---------- 10-year Period ----------											
0.20	-22.6	-18.0	-11.1	-48.9	-44.3	-37.3	-17.8	-13.3	-6.4	-23.1	-18.5	-11.6
0.30	-19.8	-12.9	-2.4	-46.0	-39.1	-28.7	-15.0	-8.2	2.1	-20.2	-13.5	-3.1
0.40	-16.9	-7.7	6.2	-43.1	-34.0	-20.0	-12.2	-3.1	10.7	-17.4	-8.4	5.4
0.50	-14.0	-2.6	14.8	-40.3	-28.8	-11.4	-9.3	1.9	19.2	-14.6	-3.3	14.0
0.60	-11.1	2.6	23.5	-37.4	-23.6	-2.8	-6.5	7.0	27.7	-11.8	1.8	22.5
0.70	-8.3	7.7	32.1	-34.5	-18.5	5.9	-3.7	12.1	36.3	-9.0	6.8	31.0
0.80	-5.4	12.9	40.7	-31.6	-13.3	14.5	-0.9	17.2	44.8	-6.1	11.9	39.5
0.90	-2.5	18.1	49.4	-28.8	-8.2	23.1	1.9	22.2	53.3	-3.3	17.0	48.1
	---------- 15-year Period ----------											
0.20	-22.4	-16.5	-9.4	-58.4	-52.5	-45.3	-16.0	-10.3	-3.2	-23.2	-17.5	-10.4
0.30	-15.9	-7.1	3.7	-51.9	-43.0	-32.3	-9.7	-1.1	9.6	-16.9	-8.3	2.4
0.40	-9.4	2.4	16.7	-45.4	-33.6	-19.3	-3.4	8.2	22.4	-10.6	1.0	15.2
0.50	-2.9	11.8	29.7	-38.9	-24.1	-6.2	3.0	17.4	35.1	-4.2	10.2	27.9
0.60	3.6	21.3	42.8	-32.4	-14.7	6.8	9.3	26.6	47.9	2.1	19.4	40.7
0.70	10.1	30.7	55.8	-25.9	-5.2	19.8	15.7	35.8	60.7	8.5	28.6	53.5
0.80	16.6	40.2	68.9	-19.4	4.2	32.9	22.0	45.0	73.5	14.8	37.8	66.3
0.90	23.1	49.7	81.9	-12.9	13.7	45.9	28.3	54.2	86.2	21.1	47.0	79.0

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D30. Long-term Net Returns Per Acre from the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($2.00 per head per month), Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	-32.7	-30.8	-26.3	-47.1	-45.2	-40.8	-30.0	-28.1	-23.7	-32.9	-31.0	-26.6
0.30	-32.2	-29.4	-22.7	-46.6	-43.8	-37.1	-29.5	-26.7	-20.0	-32.4	-29.6	-22.9
0.40	-31.8	-28.0	-19.1	-46.2	-42.4	-33.5	-29.1	-25.3	-16.4	-32.0	-28.2	-19.3
0.50	-31.3	-26.6	-15.4	-45.7	-41.0	-29.8	-28.6	-23.9	-12.8	-31.5	-26.8	-15.7
0.60	-30.9	-25.2	-11.8	-45.3	-39.6	-26.2	-28.2	-22.5	-9.2	-31.1	-25.4	-12.1
0.70	-30.4	-23.8	-8.2	-44.8	-38.2	-22.6	-27.7	-21.1	-5.5	-30.6	-24.0	-8.4
0.80	-29.9	-22.4	-4.5	-44.3	-36.8	-18.9	-27.3	-19.7	-1.9	-30.1	-22.6	-4.8
0.90	-29.5	-21.0	-0.9	-43.9	-35.4	-15.3	-26.8	-18.3	1.7	-29.7	-21.2	-1.2
	---------- 10-year Period ----------											
0.20	-44.8	-40.3	-33.3	-85.4	-79.5	-72.4	-40.0	-35.5	-28.6	-50.3	-44.5	-37.4
0.30	-42.0	-35.1	-24.7	-78.9	-70.1	-59.3	-37.2	-30.4	-20.1	-43.9	-35.3	-24.6
0.40	-39.1	-29.9	-16.0	-72.4	-60.6	-46.3	-34.4	-25.4	-11.5	-37.6	-26.1	-11.9
0.50	-36.2	-24.8	-7.4	-65.9	-51.2	-33.3	-31.6	-20.3	-3.0	-31.2	-16.9	0.9
0.60	-33.4	-19.6	1.2	-59.4	-41.7	-20.2	-28.7	-15.2	5.5	-24.9	-7.6	13.7
0.70	-30.5	-14.5	9.9	-52.9	-32.3	-7.2	-25.9	-10.1	14.0	-18.6	1.6	26.5
0.80	-27.6	-9.3	18.5	-46.4	-22.8	5.9	-23.1	-5.1	22.6	-12.2	10.8	39.2
0.90	-24.8	-4.2	27.2	-39.9	-13.3	18.9	-20.3	0.0	31.1	-5.9	20.0	52.0
	---------- 15-year Period ----------											
0.20	-22.4	-16.5	-9.4	-85.4	-79.5	-72.4	-16.0	-10.3	-3.2	-50.3	-44.5	-37.4
0.30	-15.9	-7.1	3.7	-78.9	-70.1	-59.3	-9.7	-1.1	9.6	-43.9	-35.3	-24.6
0.40	-9.4	2.4	16.7	-72.4	-60.6	-46.3	-3.4	8.2	22.4	-37.6	-26.1	-11.9
0.50	-2.9	11.8	29.7	-65.9	-51.2	-33.3	3.0	17.4	35.1	-31.2	-16.9	0.9
0.60	3.6	21.3	42.8	-59.4	-41.7	-20.2	9.3	26.6	47.9	-24.9	-7.6	13.7
0.70	10.1	30.7	55.8	-52.9	-32.3	-7.2	15.7	35.8	60.7	-18.6	1.6	26.5
0.80	16.6	40.2	68.9	-46.4	-22.8	5.9	22.0	45.0	73.5	-12.2	10.8	39.2
0.90	23.1	49.7	81.9	-39.9	-13.3	18.9	28.3	54.2	86.2	-5.9	20.0	52.0

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Appendix Table D31. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($1.00 per head per month), Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)	250-acre Infestation, Infestation Canopy Cover: Low (Modify Fence)	Medium (Modify Fence)	High (Modify Fence)	Low (New Fence)	Medium (New Fence)	High (New Fence)
AUMs/acre	5-year Period											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.40	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.50	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	yes	no	yes	yes	no	no	yes
0.70	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.80	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.90	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
	10-year Period											
0.20	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.30	no	yes	yes	no	no	no	no	yes	yes	no	yes	yes
0.40	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
	15-year Period											
0.20	no	yes	yes	no	no	no	no	yes	yes	no	yes	yes
0.30	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.40	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.50	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.

Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.

Appendix Table D32. Least-loss Analysis of the Control of Leafy Spurge Using Sheep Grazing with Sheep Leasing ($2.00 per head per month), Seasonal Grazing Scenario ($18 per AUM)[a]

Carrying Capacity	50-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High	250-acre Infestation, Infestation Canopy Cover: Low	Medium	High	Low	Medium	High
	------ Modify Fence ------			------- New Fence -------			------ Modify Fence ------			------- New Fence -------		
AUMs/acre	---------- 5-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	no	no	no	no	no	no	no	no	no	no
0.40	no	no	no	no	no	no	no	no	no	no	no	no
0.50	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.60	no	no	yes	no	no	no	no	no	yes	no	no	yes
0.70	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.80	no	no	yes	no	no	yes	no	no	yes	no	no	yes
0.90	no	no	yes	no	no	yes	no	no	yes	no	no	yes
	---------- 10-year Period ----------											
0.20	no	no	yes	no	no	no	no	no	yes	no	no	no
0.30	no	yes	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	---------- 15-year Period ----------											
0.20	no	no	no	no	no	no	no	no	no	no	no	no
0.30	no	no	yes	no	no	no	no	yes	yes	no	no	yes
0.40	no	yes	yes	no	no	yes	no	yes	yes	no	yes	yes
0.50	yes	yes	yes	no	no	yes	yes	yes	yes	yes	yes	yes
0.60	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.70	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
0.80	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
0.90	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

[a]Fencing costs based on a 350-acre pasture. Returns discounted annually at 4 percent. Low, medium, and high rates of leafy spurge canopy cover translate to about 17, 50, and 100 percent reductions in cattle grazing within the leafy spurge infestations, respectively. AUMs valued at $18.
Note: In situations where net returns from using sheep to control leafy spurge are negative, least-loss analysis indicates if using sheep grazing to control leafy spurge would result in less economic loss than if the leafy spurge infestation was left uncontrolled.