The Effects of Weather and Output Price Risk on the Economic Returns of Backgrounding Feeder Cattle

R. Wes Harrison

***Abstract:** Stochastic simulation is used to analyze the effects of weather and output price risks on feeder cattle backgrounding systems common to the mid-south region of the United States. The results show that backgrounding systems beginning in the fall and ending from April to late August are associated with higher expected returns relative to summer backgrounding. However, winter backgrounding is associated with greater overall risk relative to summer backgrounding. Stochastic dominance analysis indicates that slightly risk averse backgrounders prefer both winter and summer backgrounding, but summer backgrounding is preferred by strongly risk averse decision makers.*

***Key Words and Phrases:** Feeder cattle, weather risk, price risk, stochastic dominance.*

Most feeder calves raised in the southern region of the United States go through some type of backgrounding operation prior to being placed in feedlots for finishing. The term "backgrounding" refers to assembling and growing calves from weaning weights to feedlot-ready weights between 700 and 800 pounds. Backgrounding operations usually arise when cow-calf producers opt to retain ownership of, or purchase, weaned calves in expectation of rising cattle prices. Unfortunately, profitability is by no means assured since it depends on several uncertain factors. Like most bio-economic enterprises, feeder cattle operations experience significant revenue variability because of uncertainties associated with production and marketing activities. For example, weather is often cited as a major source of production risk for crop- and forage-based agricultural systems (Parsch and Torrell). The effects of weather may be significant in some years because of drought which reduces forage growth and results in lower weight gains. Moreover, losses due to mortality and morbidity may be higher than expected in some years because of disease outbreaks and parasite infestation.

Price uncertainty is another factor that affects the profitability of backgrounding feeder cattle. Backgrounding is an intermediate production stage during which much of the adjustment occurs between the supply of calves and a sometimes volatile demand for feeder cattle. During periods when feed prices are low, feedlots increase their demand for feeder cattle. In addition, both domestic and international markets influence the demand for slaughter cattle, which, in turn, affects the demand for feeder cattle. Hence, feeder cattle prices are affected by a number of factors the impacts of

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which are difficult to predict. Consequently, they are among the most volatile of all classes of cattle (Spreen and Arnade; Bobst, Grunewald and Davis; Russell and Franzmann).

An important question faced by backgrounders is how production and price risk affect the choice of backgrounding system. However, most studies that evaluate the risks and returns of backgrounding focus on either price risk associated with marketing cattle (Spreen and Arnade; Bobst, Grunewald and Davis; O'Bryan, Bobst and Davis), or the effects of weather on the production risks of backgrounding (Brown and Loewer; Turner; Semen and Frere; Parsch and Loewer, 1987). Few studies incorporate both sources of risk in their analysis. The objective of this study is to evaluate the effects of both weather and output price risk on the economic returns of backgrounding feeder cattle in the mid-south region of the United States.

Procedures Overview

A stochastic bio-economic simulator is used to generate net returns per head for four backgrounding systems common to the mid-south region of the United States. The simulations assume that the stochastic factors affecting gross returns are animal weight gains and feeder cattle prices. The model is composed of three components. A biophysical animal performance simulator called GRAZE; a stochastic cattle price simulator; and a budget simulator for calculating net returns. The model calculates net returns by first simulating stochastic gross returns for the selected backgrounding systems and then subtracting total costs. Each component of the model is described in this section of the paper.

Simulations of Animal Performance. Field experiments designed to examine the multiple-year effects of good and bad weather on forage levels and animal performance are generally unavailable. This is partly because of the expense of multi-year field testing, and partly because of experimental designs that result from research agendas with goals not aimed at risk analysis. To assess the impact of weather variability on animal performance requires repetition of grazing experiments over a number of years to capture the frequency of weather scenarios representative of the study area (Parsch and Torell). Field trials of this sort are very costly. Consequently, field data concerning the effects of climatic conditions on forage availability and animal performance are difficult to obtain. Under these circumstances, mathematical models that allow researchers to simulate experimental data can be useful tools for risk analysis (Parsch and Torell).

Using this rationale, animal performance for the selected backgrounding systems is simulated stochastically using results from the GRAZE forage/animal growth simulator. The GRAZE model is a biological-phenological model that permits simulation of beef-forage production as a function of both management and environmental variables. It can be used to design controlled experiments to assess the impact of climatic conditions on alternative grazing systems. GRAZE consists of three submodels designed to represent the three primary subsystems of a complete grazing system. These subsystems include a phenological plant growth-composition model (Smith et al.); a physiological animal growth-feed intake model (Loewer et al.); and a plant-animal interface model that represents the logic of selective grazing as a function of the environment (Loewer et al.).

The plant submodel accounts for plant growth and quality as a function of climatological input data, soil and crop growth parameters, forage removal rates, and fertilization data. The animal submodel accounts for animal growth, intake, and response to environmental factors based on a set of input parameters that describes animal composition in terms of chemical and physical characteristics. The interface model integrates the crop and animal models based on the assumption that grazing animals attempt to maximize digestible dry matter intake which is influenced by the physiological weight-age of the animal, forage quality and availability (Parsch and Loewer, 1987).

The controllable inputs of the model include the forage species and the animal type, classified as size, sex, breed and age. The managerial controls include decisions concerning stocking rate, supplemental feed, placement and removal of animals, and fertilization. Animal performance is reported as daily weight gains and net animal growth per head. The environmental inputs are maximum and minimum daily temperatures and daily precipitation levels. Hence, a key assumption of the model is that climatic conditions are the primary source of production risk.

Experimental Design of the Selected Backgrounding Systems. Four backgrounding systems common to Kentucky and the mid-south region of the United States are simulated in this study. These systems were selected after reviewing literature related to backgrounding operations for the mid-south region of the United States (Bradford et al.; Johnson, Ferguson and Rawls). The literature identified many possible systems. However, four were identified by extension specialists as the most common in the study area. The general characteristics of each system are presented in Table 1.

All simulations were designed to grow a calf from a weaned weight in the 450- to 500-pound range to a market weight between 700 and 800 pounds. Of the four systems selected, three utilize fescue pasture as the primary feed, and the other is a winter system relying primarily on harvested feeds. The winter system begins October 1 and ends April 1 of the following year. Steers weighing 450 pounds are fed a hay, grain and soybean meal ration during the winter months. The GRAZE model allows for feeding harvested feeds, and since supplemental feeds are consumed by the animal prior to any available forage, a feedlot or drylot backgrounding system can be simulated (Parsch and Loewer, 1995). The production risk associated with this system is largely due to the effects of climatic conditions on animal intake and physiology.

Of the three forage-based systems, two are mixed winter/summer systems that combine fescue pasture with harvested feeds. Both of these systems begin October 1 with one ending August 1 and the other ending September 1 of the following year. These systems involve feeding 450-pound steers a supplemental ration of corn silage

Table 1.
General Characteristics of the Selected Backgrounding Systems

	Winter	Mixed Winter/Summer		Summer
Characteristic	BS_1	BS_2	BS_3	BS_4
Animal Type & Weight	Steer 450 lbs	Steer 450 lbs	Steer 450 lbs	Steer 500 lbs
Typical Feeds & Forage	Grass Hay, Corn Grain, & Soy. Meal	Fescue Pasture Corn Silage, & Soy. Meal	Fescue Pasture Corn Silage, & Soy. Meal	Fescue Pasture
Beginning Date	October	October	October	April
Marketing Date	April	August	September	October

and soybean meal during the winter months. During the spring and summer months, the animals graze fescue pasture without supplemental feeds. The fourth system is a summer grazing operation that begins April 1 and ends October 1 of the same year. Steers weighing 500 pounds are placed on spring pastures and allowed to graze fescue through the summer and early fall. Stocking rates for all grazing periods were assumed to be one head per acre, which is typical for the study area (Rutledge et al.).

Weather Data. As discussed, the exogenous inputs for the GRAZE model are maximum and minimum daily temperatures and daily precipitation levels. These data were obtained for the Danville, Kentucky, weather station for a fifteen-year period from 1978 through 1992. This weather station was chosen because of the completeness of its data and approximate central location with respect to the feeder cattle producing regions of Kentucky. Fifteen years was considered adequate to account for long-term weather trends.

Stochastic Simulation of Cattle Prices. This section describes the economic model used to simulate prices for the selected backgrounding systems. Feeder cattle prices are simulated using the following formula:

$$SP_i = CP_i + CCP_i \qquad (1)$$

Sp_i = the simulated selling price for a 700- to 800-pound USDA Medium No. 1 steer with a sale date determined by the ith backgrounding system,

CP_i = the 1992 week's average cash price for a 700- to 800-pound USDA Medium No. 1 steer at the time the ith backgrounding system is initiated,

CCP_i = the stochastically simulated change in 700- to 800-pound USDA Medium No. 1 steer prices over the backgrounding period for the ith backgrounding system, and

i = 1, 2 or 3, for backgrounding systems that begin on October 1 and end with sales on April 1, August 1 and September 1, respectively; and where i equals 4 for the system that begins April 1 and ends with sales on October 1.

The model is based on the assumption that decision makers know feeder cattle prices at the beginning of each backgrounding period, but do not know the actual price they will receive when cattle are sold. Moreover, price risk is defined as the variability of the change in cattle prices over the selected backgrounding period. The model is simulated for the 1992 production year, the reference year for the study. For example, consider the simulation formula for backgrounding system BS_1 (Table 1). The variable CP_1 is the week's average price of 700- to 800-pound Medium No. 1 steers on October 1, 1992; and CCP_1 is the randomly selected change in 700- to 800-pound Medium No. 1 steer prices between October 1 and April 1.

The stochastic nature of this model is described by the means and variances of CCP_i which, in turn, is defined by the means, variances and covariance of historical beginning and ending cattle prices for the ith backgrounding system. Stochastic simulation of the model requires that a series of random draws be generated from the underlying stochastic process that generated these prices. This is accomplished by using a multivariate normal distribution to approximate the stochastic nature of historical cattle prices over each backgrounding period. The multivariate distribution ensures that covariances among beginning and ending prices are accounted for in the simulation of CCP_i.

Naylor et al. describe a method for sampling variates from the multivariate normal distribution. This procedure utilizes a theorem that states that given an m-dimensional vector, z, which contains independent standard normal variates, then there exists a unique lower triangular matrix C such that

$$x = Cz + \mu \tag{4}$$

where x is an m-dimensional vector of random variables and μ is an m-dimensional vector of expected values for each element in x. Moreover, if the variance-covariance matrix of x is defined as $V = E[(x - \mu)\bullet(x - \mu)']$, then it can be shown that $V = CC'$ (King). Therefore, the elements of C can be calculated from V and each variate in x can be generated as follows

$$x_i = \mu_i + \Sigma c_{ij} z_i, \quad i = 1,\ldots,m \tag{5}$$

where c_{ij} are the elements of C, and z_i and μ_i is elements of z and μ, respectively.

This procedure is used to randomly select 200 samples of beginning and ending prices for each backgrounding system analyzed in this study. These stochastically generated samples are used to calculate CCP_i which is used to construct probability distributions for selling prices (SP_i) for each backgrounding system. The multivariate normal distribution used to generate prices is defined by the means, variances and covariances, which were estimated from weekly averages of Kentucky cash prices for USDA Medium No. 1 steers. These data were collected over the period 1978 to 1992 for the beginning and ending dates of each backgrounding system. All prices were deflated using the consumer price index (1992 = 100).

Stochastic Simulation of Animal Performance. Stochastic simulation of animal performance was performed in a manner similar to the price distributions. However, estimates for μ and V were estimated from the means and variances obtained from the GRAZE simulations. Weight gain distributions for each backgrounding system were obtained by randomly selecting 200 samples from the multivariate distribution of animal performance. The performance samples were drawn independently from the price samples. This was deemed appropriate since Kentucky cattle production represents a relatively small portion of the national cattle market and local prices tend to be highly correlated with national trends. Pearson correlation coefficients for animal performance and local cattle prices were found not to be significantly different from zero. Therefore, the data support this assumption.

Monte Carlo sampling is used in combination with GRAZE simulations because it provides a technique for constructing gross return distributions for the selected backgrounding systems. The gross return distributions are determined by a particular production system, and by multiplying the probability distributions of animal performance and the simulated selling price distributions. Direct derivation of the means and variance of the gross return distributions from the first and second moments of the GRAZE output and selling price simulations, although possible, would be difficult.

The Budget Simulator. Once distributions of animal performance and cattle prices are simulated, gross returns per head are calculated by multiplying the corresponding performance and price distributions. Net return distributions are then calculated by subtracting the appropriate costs for each backgrounding system. The budgets for each backgrounding system are presented in Table 2 and based on 1993 University of Kentucky extension budgets for livestock enterprises. Costs are assessed on a per head basis and include both variable and fixed costs. For example, variable cost items include the calf, pasture maintenance, feeds, salt and minerals, medical, death loss, marketing, and interest on operating capital. Fixed cost items include fencing, buildings, depreciation, taxes and insurance, and family labor. Hence,

Table 2.

Budgeted Costs for the Selected Backgrounding Systems[a]

Variable Costs	BS_1 Oct-Apr	BS_2 Oct-Aug	BS_3 Oct- Sept	BS_4 Apr-Oct
	($/hd)			
Feeder Steer	405.00	405.00	405.00	472.50
Pasture Maintenance	NA[b]	18.00	18.00	18.00
Feeds				
Grass Hay	46.15	NA	NA	NA
Grain	21.71	NA	NA	NA
Corn Silage	NA	39.60	39.60	NA
Protein	28.82	16.50	16.50	NA
Salt & Minerals	4.50	4.50	4.50	4.50
Medical	5.00	5.00	5.00	5.00
Death Loss	8.94	8.84	8.97	9.78
Marketing	17.00	17.00	17.00	17.00
Machinery	6.00	6.00	6.00	6.00
Total Var. Costs	543.12	520.44	520.57	532.78
Fixed Costs				
Depreciation	10.00	10.00	10.00	8.00
Taxes & Insurance	1.50	1.50	1.50	1.50
Family Labor	21.00	14.00	14.00	14.00
Total Fixed Costs	32.50	25.50	25.50	23.50
Interest				
Working Capital	24.44	41.64	46.85	23.98
Total Costs	600.06	587.58	592.92	580.26

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[a] All costs were adapted from Livestock Budget Estimates for Kentucky - 1993. University of Kentucky Cooperative Extension Service.

[b] NA indicates a category is not applicable.

subtracting these costs from gross returns yields returns to land, risk and management for each backgrounding system.

This study assumes that costs are nonstochastic. This is not unrealistic for some of the key inputs associated with backgrounding. For example, the most significant cost of backgrounding is the cost of the feeder calf, and calf prices are known at the time the backgrounding system is initiated. Medical costs associated with preconditioning are also known at the beginning of the backgrounding period, and other costs are fixed. On the other hand, the market risk associated with feed prices is a source of uncertainty that is excluded from the analysis. Moreover, a restriction of the GRAZE model is that supplemental feeding is predetermined by choice of a particular backgrounding system. Therefore, it is not possible to simulate unexpected feeding, which may be needed during a drought. The ability to simulate mortality and morbidity is similarly restricted by the GRAZE model.

Results

Summary statistics from the GRAZE results and the stochastically simulated animal performance distributions are presented in Table 3. Both GRAZE output and results from the stochastic simulations are reported to verify that the Monte Carlo simulations described earlier are properly calibrated. The discussion that follows refers specifically to the stochastic simulation output.

The winter backgrounding system that begins October 1 and ends April 1 (hereafter, referred to as BS_1) yields 329.88 pounds of gain. The mixed winter/summer systems that begin October 1 and end August 1 and September 1 (hereafter, referred to as BS_2 and BS_3, respectively) averaged 300.73 and 330.97 pounds of gain, respectively. And the summer grazing system that begins April 1 and ends October 1 (hereafter, referred to as BS_4) yields 239.52 pounds of gain on average.

Backgrounding system BS_1 results in the highest ADG (1.81 pounds per day) because it utilizes harvested feeds for a relatively short intensive feeding program. The mixed systems seek only to maintain weight during the winter months, deferring weight gain for grazing of fescue pasture during the early spring and summer months. Consequently, BS_2 and BS_3 result in ADGs of approximately 1.00 pound per day. Backgrounding system BS_4 utilizes fescue pasture during spring, summer and early fall, producing ADGs of 1.32 pounds per day given average weather conditions. All backgrounding systems produce feeder steers with average ending weights between 739.52 and 780.97 pounds.

Summary statistics for cost of gain distributions are calculated by dividing the total cost of adding weight to the animal by the distributions of gain (Table 3). BS_1 is associated with the highest average cost of gain ($.49/lb), which might be expected since it is associated with higher feed costs relative to the other three backgrounding systems. The two mixed systems, BS_2 and BS_3, have lower average costs of gain

Table 3.
Summary Statistics of Animal Performance for the Selected Backgrounding System

Backgrounding System	GRAZE[a] Simulations (lbs/hd)	Stochastic Simulations (lbs/hd)	Costs of Grain ($/lb)
Oct-April (BS1)			
Mean	329.88	329.89	.49
	(779.88)	(779.89)	
Standard Dev.	3.19	3.16	.005
Coef. of Var.	.0097	.0096	.0102
Avg. Daily Gain	1.81	1.81	
Oct-Aug (BS2)			
Mean	300.71	300.73	.44
	(750.71)	(750.73)	
Standard Dev.	9.49	9.77	.015
Coef. of Var.	.0316	.0325	.0341
Avg. Daily Gain	1.00	1.00	
Oct-Sept (BS3)			
Mean	330.98	330.97	.40
	(780.98)	(780.97)	
Standard Dev.	11.10	11.03	.014
Coef. of Var.	.0335	.0333	.0350
Avg. Daily Gain	1.00	1.00	
April-Oct (BS4)			
Mean	239.55	239.52	.27
	(739.55)	(739.52)	
Standard Dev.	13.96	13.92	.017
Coef. of Var.	.0583	.0581	.0630
Avg. Daily Gain	1.32	1.32	

[a] Weight gains are reported as live weights and ending weights are reported in parentheses.

because they depend more heavily on relatively low-cost grazing of fescue pasture during the spring and mid-summer months. Similarly, the summer backgrounding system BS $_4$ has the lowest cost of gain because it relies solely on grazing of fescue pasture. The variability associated with the costs of gain are directly related to performance variability. Hence, the cost of gain for BS$_4$ is associated with the greatest variability. This is shown by a standard deviation of $.017/lb, which is higher than any other system. On the other hand, the cost of gain for BS$_1$ is associated with the least amount of variation, as indicated by its relatively low standard deviation, \$.005/lb (Table 3).

These results indicate that the mixed winter/summer and summer systems are associated with greater production risk relative to the winter system, but they are more cost efficient on average. That is, costs of gain are reduced as grazing fescue pasture is substituted for harvested feeds in the feeding ration, but as harvested feeds are reduced, greater performance variability results. Furthermore, two of the three grazing systems produce animals with average ending weights below the winter system. For example, BS$_2$ and BS$_4$ produce animals with average ending weights of 750.73 and 739.52 pounds, respectively. Lower ending weights result in lower gross revenues for these systems relative to the winter system, given comparable selling prices. However, these lower revenues will be partially offset by the lower cost of summer grazing.

It should be noted that under ideal conditions, the GRAZE results would be compared to actual field data for validation. Unfortunately, there are no field data available to validate the accuracy of the GRAZE output for this particular study. The field trials required to generate this type of data would be quite costly. However, a number of case studies have been conducted that help validate the model's performance in simulating grazing systems for tall fescue pasture (Brown and Loewer; Seman and Frere; and Turner). In general, these studies reported that the GRAZE model simulated grazing tall fescue reasonably well. In particular, Turner's study compared GRAZE simulations to field trials of a 112-day continuous grazing experiment in Kentucky. He found that the model did quite well simulating the ending weight and average daily gains of steers grazing tall fescue during the summer grazing period.

Price Simulations and Economic Returns. Summary statistics for cattle price simulations and net returns are presented in Table 4. Both the stochastically simulated prices and historical prices over the period 1978 to 1992 are presented. The average cash price difference is positive for each backgrounding system, which indicates that ending prices are generally higher than beginning prices for each system over the sample period. The most significant price increases are associated with backgrounding systems BS$_1$, BS$_2$ and BS$_3$, which begin in the fall and end in the spring and mid-summer months. The average price change indicates that prices associated with these systems increase by \$.0462, \$.0428 and \$.0541 per pound on average, respectively. Conversely, prices increase very little on average between spring and fall, since the average difference between ending and beginning prices for BS$_4$ is approximately \$.0041 per pound. Hence, cattle prices tended to increase more dramatically between fall and spring than between spring and summer over the sample period.

Summary statistics for the stochastically simulated net returns are also presented in Table 4. Of the four backgrounding systems modeled, BS$_3$ yields \$29.36 per head, followed by BS$_1$, BS$_2$ and BS$_4$, which yield \$15.28, \$2.25 and -\$23.95 per head, respectively. Since costs for BS$_4$ are lower relative to the other systems, the relatively low returns associated with this system result from a combination of relatively low

Table 4.
Summary Statistics of Cattle Price Simulations and Net Returns for the Selected Backgrounding System

Backgrounding System	Beg-End Price Change (CCP)		Selling Price (SP)	Net[a] Return
	Historical ($/lb)	Simulated ($/lb)	---------Simulated--------- ($/lb)	($/hd)
Oct-April (BS1)				
Mean	.0459	.0462	.8134	15.28
Standard Dev.	.1310	.1295	.1298	98.55
Coef. of Var.	2.85	2.80	.1596	6.45
Oct-Aug (BS2)				
Mean	.0429	.0428	.8100	2.25
Standard Dev.	.1606	.1657	.1661	121.23
Coef. of Var.	3.74	3.87	.2051	53.88
Oct-Sept (BS3)				
Mean	.0537	.0541	.8213	29.36
Standard Dev.	.1580	.1564	.1568	119.51
Coef. of Var.	2.94	2.89	.1909	4.07
<u>April-Oct (BS4)</u>				
Mean	.0038	.0041	.7751	-23.95
Standard Dev.	.0837	.0795	.0797	57.32
Coef. of Var.	22.03	19.39	.1028	NA

[a]Net returns are calculated using market weights, i.e., live weight adjusted for a 3% shrink.

probabilities that cattle prices increase over this backgrounding period and relatively lower weight gains. This is indicated by a lower average change in prices for BS_4 relative to the other backgrounding systems. The average change in prices for BS_4 is $.0041 per pound, whereas, the average increase in prices for BS_1 is $.0459 per pound (Table 4). On the other hand, although yielding the lowest average net return, BS_4 is associated with the least amount of variability in net returns. This is indicated by a standard deviation of returns that is lower relative to the other three backgrounding systems (Table 4).

The coefficients of variation (CV) demonstrate the significance of price risk relative to production risk for the backgrounding operation. For example, the coefficient of variation for animal performance of BS_1 is .0096, which is significantly lower than the CV for the corresponding selling price (.1596, Table 4). Hence, price risks significantly outweigh production risks for this backgrounding system. This result is evident for all backgrounding systems, but more pronounced for the winter and mixed systems. One reason for low production risk is the light stocking rates in the study area.

Stochastic Dominance Analysis. Comparisons of the summary statistics for net returns are not very useful without the aid of a risk-return efficiency criteria to determine the preferred systems. This is because the preference of any particular system over another depends on the relative risk and return of the system and the risk attitudes of the backgrounder. For example, BS_3 has a higher average return relative to BS_1, but BS_1 has a lower standard deviation. If a decision maker is indifferent to risk, then BS_3 is the preferred strategy since it yields the higher average return. However, risk averse individuals may be attracted to BS_1 because it is relatively less risky. Similarly, risk averse individuals may be attracted to other backgrounding systems because of relative risk-return tradeoffs.

Mean-variance (E-V) and generalized stochastic dominance (GSD) analysis are the predominant methods used for evaluating risky alternatives. Stochastic dominance and E-V analysis are closely related since both provide a mechanism for constructing efficient sets, which exclude alternatives that, if chosen, would lower the decision maker's expected utility. In fact, E-V and second degree stochastic dominance (SSD), a special case of GSD, yield equivalent results when outcome distributions are normal. However, in many cases both EV and SSD lack the discriminatory power to aid in decision making. For this reason, GSD is often more useful than EV or SSD because it allows efficient sets to be constructed given various levels of risk aversion. Generalized stochastic dominance is used to evaluate the risk-return tradeoffs for the selected backgrounding systems in this study.

Generalized stochastic dominance (GSD) efficient sets are presented in Table 5. Risk preferences are not available for backgrounders in the study area. The risk categories used in this study were taken from a study by Williams et al. Their risk aversion coefficients were used to evaluate net returns for a group of Kansas farmers. Efficient sets were constructed using a GSD computer program developed by Goh et al. A ✓ in Table 5 indicates a strategy is a member of an efficient set. All strategies not included in an efficient set are dominated by at least one strategy in the set.

The slightly risk averse (SLRA) efficient set excludes backgrounding system BS_2 because it is dominated by BS_1 and BS_3. That is, these systems are stochastically more efficient. Consider BS_2, which yields average returns of \$2.25 with a standard deviation of \$121.23. Both BS_1 and BS_3 have higher means and lower standard deviations relative to BS_2 (Table 4). The dominance of BS_3 can be traced to the relative production and price risks associated with these systems. For example, there is only a small difference between the standard deviations of animal performance for BS_2 and BS_3, however, BS_3 yields an additional 30.27 pounds of gain (Table 3). This yields a higher gross revenue and lower cost of gain given comparable prices and costs. Moreover, the ending prices associated with BS_3 tend to be slightly higher on average, and they are less variable (Table 4). Hence, more efficient performance

Table 5.
Generalized Stochastic Dominance Efficient Sets for the Selected Backgrounding Systems

Backgrounding System	Slightly[a] Risk Averse	Moderately Risk Averse	Strongly Risk Averse
Oct-April (BS_1)	✔	✔	
Oct-Aug (BS_2)			
Oct-Sept (BS_3)	✔		
April-Oct (BS_4)		✔	✔

[a] ✔ indicates a strategy is a member of the efficient set. All strategies not included in the efficient set are dominated by at least one strategy in the efficient set.
[b] Slight, moderate, and strong risk aversion categories are defined by Arrow-Pratt risk intervals of 0.0 to 0.0105, 0.0105 to .052, and 0.052 to 0.105, respectively (Williams et al., 1993).

(higher average gains resulting in lower costs of gain) coupled with more favorable and less variable prices results in BS_3 dominating BS_2. The GSD analysis also shows the importance of the risk-return tradeoff for the moderately (MRA) and strongly risk averse (STRA) backgrounder. The efficient sets for these classes of decision maker exclude the mixed winter/summer systems because they are the most risky. Moreover, the summer system is the dominant strategy for the STRA producer because it is the least risky of all backgrounding systems. This occurs because the summer system is associated with the least amount of price risk.

Conclusions and Future Research

Several conclusions follow from the results of this study. First, output price risk tends to overshadow production risk for all backgrounding systems considered. Thus, when stocking rates are one head per acre, most of the risk of backgrounding is associated with output price variability. This is particularly true for winter and mixed backgrounding systems that begin in the fall and end in the spring and mid-summer months. This suggests that while managing production risk should not be neglected, mid-south backgrounders should perhaps place greater emphasis on managing price risk.

Results also show that winter and mixed backgrounding systems are associated with higher average returns relative to systems that begin in the spring and end in the fall. This occurs because of higher probabilities that prices increase over the winter months. Hence, mid-south producers have a better chance of positive returns using backgrounding systems that begin in the fall and end in the spring and summer. However, even though winter backgrounding systems are more profitable on average, they are also associated with more risk. Therefore, even though summer backgrounding is less profitable on average, it is attractive to strongly risk averse backgrounders.

It should be noted that the benefits of being able to simulate both production and price risk come at the expense of some detail on the production side. This study did not incorporate the effects of feed price uncertainty, unexpected supplemental feeding, mortality or morbidity on the risks of backgrounding. These additional sources of risk were beyond the scope of the study, but their effects are probably not trivial and may alter the relative risk rankings of the backgrounding systems. Future research is needed to evaluate the effects of these factors on the risk and returns of backgrounding.

As previously discussed, the GRAZE biophysical model was used because adequate field data to estimate probability distributions for animal performance is not available. This study demonstrates the usefulness of biophysical simulation for risk analysis. However, the analysis used only the animal weight gain output from GRAZE. This represents only a fraction of the output generated by the model, which also yields detailed output on forage growth and animal physiology. This information could be used by other studies concerned with the risks of backgrounding. Moreover, studies that evaluate the risks and returns of other production systems and price expectations represent another direction for future research.

Notes

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