An Economic Analysis of Pasture-Raised Beef Systems in Appalachia

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ABSTRACT

Cow-calf operations are important enterprises for family farmers in Appalachia and provide significant opportunity for supplemental income. This analysis constitutes a thorough economic assessment of pasture-raised beef production, an alternative to traditional production that could benefit the region's producers in terms of profitability and mitigated risk. Stochastic budgeting was utilized for profitability and risk comparison between traditional and pasture-raised operations and accounted for seasonal variability in prices, pasture availability and animal performance. Pasture-raised systems, in relation to traditional ones, were shown to consistently yield higher returns over variable costs and were shown less likely to yield losses over total costs in typical production seasons. Economic risk for pasture-raised producers stems largely from production factors but, overall, is seemingly less pronounced than the market risk faced by traditional producers selling live cattle.

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Introduction and Background

The USDA (1997a) reports that a full 69% of viable farm land in the U.S. is owned by small farmers and that, as of 1996, farmers with less than one hundred head of cattle supplied 51% of the total U.S. beef cow inventory. So, while vertical integration may have taken some measure of market control away from the small beef producer, the industry still thrives on their output. This is not the case for other agricultural sectors. For instance, only 11% of the nation's vegetable, fruit, and nursery products originate on small operations (USDA, 1997a).

The choice to remain in the beef business over switching to alternative types of operations, aside from the relatively low labor intensity, may be rooted in topographical limitations. The quality of farmland in areas across the U.S., in terms of both fertility and topography, will not allow for crop production but is well suited for pasture. This is certainly the case for farmers in Appalachia, where much of the farmland is too mountainous for any operation other than pasture and livestock production. Specifically, in West Virginia, livestock sales accounted for 85% of the market value of agricultural products sold in 1997 (USDA, 1997b).

The importance of beef production to small family farmers in West Virginia goes beyond land restrictions on other types of production. With non-metro per capita income reported at only $19,540 in 2000 (Greene 2001), additional revenue from the sale of agricultural products is imperative to maintaining or improving the living standards of these producers. Given that beef cattle production seems a well-suited enterprise for

West Virginia land-owners, more efficient and profitable production strategies seem necessary building blocks for the state's agriculture. One such approach to heightening profitability for small-scale producers, popular amongst growing circles of agricultural enthusiasts, is via the marketing of meats or crops as "specialty" or niche items, which generally garner price premiums for the seller and predominantly are sold directly to the consumer.

It seems feasible, given the ever-increasing demand for specialty items such as those certified and labeled "organic", that a substantial market exists for natural or forage-finished livestock products, especially in light of recent consumer safety concerns over the U.S. beef supply. To support the notion that these products *could* be successful, a survey administered by the University of California (Nader and Blank, 1998) found that 56% of respondents were concerned about the quality of beef products in local stores and that 83% of all meat eaters questioned expressed an interest in "natural" beef products.

Given the importance of beef production to West Virginia family farmers, pasture-raised or "natural" beef has been analyzed as a possible alternative enterprise for producers in the region wishing to revitalize their small businesses and operate more efficiently and profitably. The timing for such a study seems appropriate, given recent trends of health consciousness among America's consumers in conjunction with the resurging popularity of protein-based diets.

The issue of whether or not pasture-raised beef constitutes a more *profitable* and *efficient* and/or less risky method of production than those currently employed by the region's producers is key and was explored here in depth via a comprehensive stochastic budget simulation.

Conceptual Framework

The purpose of this analysis is to offer theoretical prescriptions that account for the risk prevalent in agricultural production processes through a stochastic budgeting process. Several previous authors have incorporated measures designed to account for risk and uncertainty into economic analyses of efficient beef production, including Pope and Shumway (1984) who based their work on findings that beef management strategies formulated from assessment of average and not variable production conditions may not be ideal, even for risk neutral producers. Specifically, the authors incorporated forage production variability into a linear programming decision theory framework for a typical beef producer in East Texas. The results indicated that the least risky and most profitable approach to intensive forage beef production was to plan for relatively poor weather conditions and low forage production. Results also demonstrated that the assumption of constant average forage production may result in grossly exaggerated estimates of expected net return.

More fittingly, Harrison et al. (1996) used a stochastic budget simulator and generalized stochastic dominance to compare the risk management properties of grazing contracts to futures and options contracts. The stochastic factors affecting gross returns were assumed to be feeder cattle prices and climatic affects on animal performance. Cash and futures prices were simulated stochastically and combined with cash marketing and hedging models to construct probability distributions for selling prices and unit hedging revenues. The results showed that risk averse pasture owners prefer grazing contracts to integrated production when traditional hedging is used to manage price risks.

Grazing contracts do not seem to reduce the risk of the cattle owners but compare favorably with put option contracts for some pasture owners.

Falk (1994) used stochastic analysis to assess profitability of small-scale meat packing plants in New Mexico in three Monte Carlo simulations. Stochastic factors included steer live weights, feedlot prices and retail meat prices. Results revealed a better than 50% probability of net losses in every month except June-September. A slight chance for net profits was found only when budgets were assessed at maximum retail price levels.

Methods of Analysis

In order to assess profitability and risk associated with various methods of beef production, stochastic budgets were constructed that yielded profit estimations accounting for variation in animal performance, pasture yield, input requirements and revenue levels. Specifically, the stochastic budget simulator "@RISK" was employed to calculate final return distributions. Triangular distributions, which allow specification of a minimum, likely and maximum value, were used within the budgets where more highly specified and appropriate distributions were not available for certain monetary or production factors. Triangulars were used to describe variability in weaning weights, average daily gain, dry matter utilization, fertilizer requirements and length of the hay-feeding period. Distributions for other factors such as traditional production revenues, pasture and hay yields and various input requirements were formulated using Palisade's "BESTFIT" and were based on data sets from previous work specific to the study area.

Only those factors considered most pertinent in adding to the risk of the beef enterprise were allowed to vary while the remainder (e.g., mature cow weight, seeding requirements, daily nutrient requirements) was fixed to provide some underlying structure to the budget analysis. A Monte Carlo sampling procedure was employed in evaluating the budget and more specifically the chosen output distributions over 1000 iterations. Outputs for selected performance measures were reported in the form of probability spreads and summarized via the moments of the distribution.

In terms of economic risk, the mean-variance efficiency rule expresses the proposition that an ordering of alternatives can be accomplished by selecting according to expected value levels in conjunction with respective variance levels (Hardaker, Huirne and Anderson, 1998). The stochastic efficiency analysis employed here goes a step further by allowing choice making in terms of full distributions of outcomes. Decisions about optimal production strategies in terms of risk were made using the decision criteria of maxi-min, maxi-max and maximum expected returns.

The budgeting process took into consideration several combinations of possible production methods ascribed to by beef producers. Comparisons across return and risk factors were made between, most generally, pasture-raised beef production and traditional beef production (defined here as a cow-calf enterprise with no restrictions on feeding practices and utilization of continuous grazing). More specifically, sixteen categories of pasture-raised producers and twenty-six categories of traditional producers were considered in order to find optimum, in terms of risk and profitability, within each type of production

Categorization of traditional producers was based on choice of calving season, calf retention time after weaning (0, 1, 2.5 or 5 months), and percentage of diet fed as grain during the post-weaning period (10%, 20%, 30% or 40%). Likewise, pasture-raised producers were categorized according to calving season but also by the choice of whether or not to stockpile forage, the choice of whether or not to provide grain during the last 45 or 60 days of finishing, and by processing alternatives (cut and wrap versus vacuum sealing). Each category of each general producer type was considered in light of three distinct farm sizes, based on average farm size in West Virginia and differentiated by allowing varying percentages of total property in viable pasture (15%,30% or 45%).

Brood cow carrying capacity for each of the farm sizes was estimated initially by allowing three acres per cow/calf unit for pasture and hay requirements, based on average acreage requirements for cattle in the Appalachian region as reported by several sources. For traditional producers who retain after weaning and pasture-raised producers (all assumed to retain 11 months after weaning), consideration was given to the issue of whether or not pasture and hay availability was sufficient to support both the cow herd and the retained weanlings.

Since no supplemental feeding during the suckling period was assumed, weaning weights were conservatively estimated using triangular distributions, based on average weaning weight data reported by the USDA (2002) for the Appalachian region. Specifically, the triangular specifications for heifer weaning weight were (450,475,500) and (475,500,525) for steers (for both traditional and pasture-raised producers). Throughout the analysis and across both major typologies, daily nutrient intake was set at 2.0% of bodyweight for adult cows and 2.5% bw for weanlings and cow-calf pair units.

Daily protein requirements were also considered so as to assess need for supplemental protein sources at various times in the production year. In terms of final product, traditional producers were assumed to sell all calves on the commercial livestock market and pasture-raised producers were assumed to have all calves processed and sell the harvested beef products directly to consumers.

Animal and Pasture Performance

Average daily gains of weanlings on pasture were initially formulated for fall-born calves entering the pasture immediately after weaning based on data published by Yohn and Rayburn (2000) which contained average gains for 550-pound steers on 100% diets of various quality forages. Gains reported were 1.37 lbs./day on poor quality forage, 1.68 lbs./day on average quality forage and 1.97 lbs./day on excellent quality forage. These three values were used to create a triangular distribution expressing daily gain for fall-born steers in Period 1 of the pasture season, with gain on the poor quality forage set as the minimum and gain on the excellent forage used as the maximum. Estimating gains for all other classes of cattle considered (fall-born heifers and all spring-born calves) and for the remaining pasture periods and stockpiled forage/hay feeding periods involved various mathematical operations using the initial aforementioned triangular distribution as a base. All estimations used were well supported by current literature.

For traditional producers who retain weanlings and feed some portion of total diet as grain (50/50 corn/corn gluten mix assumed), average daily gains were calculated as distributions of percent increase over and above average daily gains on the appropriate forage type. Body weight of animals was adjusted across the period to account for greater consumption levels with progression through retention.

Leeway was allowed in this analysis for pasture-raised producers wishing to feed a grain ration during the final 45 or 60 days of finishing to reduce the yellowness of the fat often seen on grass-fed carcasses. Average daily gains for cattle in these 45 or 60 day feeding treatments were calculated by increasing the end-period gains reported for cattle not on feed by a triangular distribution expressing data reported by Yohn and Rayburn (2000) who estimated average daily gains of cattle on various grain rations.

Pasture-raised beef producers were assumed to engage in intensive rotational grazing instead of a continuous grazing protocol, as was assumed for the traditional producer. For some pasture-raised producers considered here, stockpiling was assumed to begin in July after the second cutting of hay and cattle were assumed to eat the winter forage from the first of November through the end of December.

To begin the conceptualization of rotational grazing systems for each pasture-raised producer considered, required paddock size was calculate using the following equation, published by White and Wolf (1996).

$$\frac{\text{Avg. Wt. of Animals Grazed*Dry Matter Consumption per Animal as \%BW*\# of Animals*Days on Paddock}}{\text{Dry Matter Available Per Acre in Paddock*\%of Dry Matter Utilized}} \quad (1)$$

The grazing and rest periods assumed yielded requirements of four paddocks during peak pasture performance and seven during the latter phases of the pasture season. These assumptions mandate that producers move their cattle every five days to new paddocks. In order to estimate total dry matter available in each paddock, the grazing season was divided into four distinct periods. Yield distributions for each period were calculated using BESTFIT and originated from data collected by Rayburn et al. (1997).

Cost Considerations

Costs for both traditional and pasture-raised producers were divided into fixed and variable categories, although categorization did not follow classic economic delineation of these terms. Instead, fixed costs here were those costs not directly associated with animal production and included such factors as fertilizer, seeding and fencing expenditures. These are costs that can likely be spread over a number of production seasons. Conversely, items considered as variable costs in this analysis included feed, medical expenditures, mineral and protein supplementation, fuel, labor, processing and marketing.

Of the items considered “fixed” in this analysis, limestone represented a majority of both traditional and pasture-raised producer expenditures. Lime application rates were calculated using data from industry and academic publications that suggested appropriate tonnage per acre based on current and desired soil pH. The distribution created and utilized in the analysis to specify tons applied per acre was a discrete distribution, used so as to be able to include several different application levels and the probability that each of those levels would be required, based on observations of silt and clay loam soils (predominant in the study area) (Rayburn et. al, 1997). For traditional producers, the stochastic budget also included distributions of nitrogen or combination fertilizer requirements to capture various scenarios of correct nutrient balance and nutrient deficiency. Nitrogen for pasture-raised producers’ pastures was assumed provided by legumes. However, a combination fertilizer containing no nitrogen (0-18-36) was included in the cost analysis for these producers just in case recycled nutrients are insufficient for provision of potassium and phosphorus. Room was allowed in the analysis for pasture-raised producers to provide supplemental nitrogen to stockpiled acreage in late summer. Prices of fertilizing agents were entered as fixed values, based on reports from local dealers.

The other factors considered as fixed, fencing and seeding, were applied only to pasture-raised producers since traditional producers were assumed minimalistic in terms of pasture re-establishment and management. Feed and supplement costs for both traditional and pasture-raised producers were based on calculated requirements for each sub-type of producer and were based on prices from local dealers.

Expenses incurred for yearly health practices for both types of producers included vaccination against respiratory and other diseases and parasite control. Labor costs were assessed at $6.00/hour and included feeding, hay-making, fertilizing, veterinary and miscellaneous labor. Labor involved in rotational grazing management and establishment was also included for pasture-raised producers. Processing costs for the slaughter and aging of the pasture-raised products were held stable at $10.00 per head for kill fee and $0.24/lb hanging weight for those opting to cut and wrap only and $0.44/lb. hanging weight for vacuum sealing. More detailed information about the calculation of input requirements and costs (or concerning budget construction in general) can be found online at http://kitkat.wvu.edu:8080/files/3193.1.Evans_Jason_thesis.pdf.

Revenue Considerations

Revenues for traditional producers were calculated with the assumption that these cattle are sold on the commercial market either immediately after weaning or after one of the given retention periods. Data from five northern West Virginia livestock markets was utilized in estimating revenue distributions for various classes of live cattle. Price observations from six years of weekly sales (1994-1999) were compiled and grouped by market of sale, month of sale, animal frame size, sex and weight class. BESTFIT was utilized in formulating the appropriate price distribution for each group considered. The specific best-fitting distributions for each analysis (eg., all steers in January or all 300-400 pound steers) were used as revenue measures for the applicable category of traditional producer.

In addition to making use of the feeder calf price data for generating revenue estimations, all distributions formulated by BESTFIT were converted to normal distributions to obtain means and standard deviations for each animal group considered. These means were utilized in creating linear regression models in the statistical program LIMDEP 7.0 which served to pinpoint relative coefficients for each independent variable (month of sale, market of sale, weight class, frame size and sex) with price means and price standard deviations as left-hand side variables. The models were constructed to gain an understanding of the marginal effect on a generated constant price level or a risk parameter that each of these variables had over the study period. The four specific linear regression models utilized here are identified below. Definitions of variables are included as Table 1.

$$PMEAN=\beta0+ \beta1MED+ \beta2SMALL+ \beta3THFO+ \beta4FOFI+ \beta5FISI+ \beta6SISE+ \beta7EINI+\beta8BUCK+ \beta9PARK+ \beta10WEST+ \beta11TRAL+ B12STEER+ \varepsilon; \quad (2)$$

$$PMEAN=\beta0+ \beta1JAN+ \beta2FEB+ \beta3MAR+ \beta4APR+ \beta5MAY+ \beta6JUN+ \beta7JUL+\beta8SEP +\beta9OCT+ \beta10NOV+ \beta11DEC+ \beta12HEIF+ \varepsilon. \quad (3)$$

$$PSD = \beta 0 + \beta 1JAN + \beta 2FEB + \beta 3MAR + \beta 4APR + \beta 5MAY + \beta 6JUL + \beta 7AUG + \beta 8SEP + \beta 9OCT + \beta 10NOV + \beta 11DEC + \beta 12HEIF + \varepsilon; \quad (4)$$

$$PSD = \beta 0 + \beta 1MED + \beta 2SMALL + \beta 3THFO + \beta 4FOFI + \beta 5FISI + \beta 6SEEI + \beta 7EINI + \beta 8BUCK + \beta 9PARK + \beta 10RIP + \beta 11TRAL + \beta 12HEIF + \varepsilon. \quad (5)$$

Revenues for pasture-raised producers were calculated based on the estimated final weights of each category of pasture-raised animals. These, in turn, were the culmination of the average daily gain and weaning weight distributions discussed above. Calves were assumed slaughtered at approximately 18 months of age. Calves were assumed to dress at 55% of total body weight and 38% of hanging weight was deducted from each to account for shrinkage during the aging process, bones, trimmable fat and waste.

Each of the resulting final saleable product weight distributions was then divided into pounds of individual meat cuts so that revenue analysis could be performed on a cut-by-cut basis. Each cut was priced at average retail price per pound, according to the most recent retail meat scanner data from the Economic Research Service (2003). For further analysis, a collection of per-cut prices published by internet sellers of pasture-raised beef was used in order to solidify the probability of pasture-raised producers receiving *at least* the retail prices used in calculation here and to expound upon the possibility of even greater revenues.

Results

Revenue Analysis

In processing all of the live cattle price data to garner traditional revenue estimations, appropriate revenue distributions were formulated for each group of cattle. If assessed by means, the best performing group in terms of price per pound was medium-framed steers in the 300-400 or 400-500 weight class. This goes along with conventional wisdom. Although means were higher, variation around the means was also higher for these lighter classes of cattle, perhaps indicating greater market risk. March was found to be the month of peak prices and greatest variance across the time period. In general and according to means, prices generally fall through November, finally picking up strength once again in December and increasing steadily through January and February before hitting peak again. 500-600 lb. steer monthly price per pound means across the six years of data collection were plotted as a representation of the variation in live cattle prices across time—the object is included as Figure 1.

Results of the linear regression models are presented as Table 2. In general, most months of sale and all weight class delineations were found to have significant effect ($p<.05$) on live cattle price means. Only one market of sale was found to have had significant effect on price means, but data from this market was rather incomplete and sale levels were consistently much lower than those for the other markets in question. Small frames yielded significant negative effects on price means. When the variables were regressed against price standard deviation, it was found that all months of sale except one (June) had significant ($p<.05$) effect on standard deviations (or, price variation) as did all weight class delineations and most markets of sale (unexplainable but interesting). Overall, statistical model indicators reveal relatively good fit and no evident misspecification problems. Again, regression analysis was done on the live cattle revenue estimations in order to more fully understand the market risk associated with selling commercially, as was assumed done with the traditionally-produced cattle.

Just as a pattern across time was formed with mean live cattle price data (Figure 1), data over the same time period (1994-1999, all months) on mean retail beef prices published by the E.R.S. (2003) were put into graphical form using Microsoft Excel, included here as Figure 2. It is clear from comparison between the live cattle and retail price lines that retail prices are much more stable across time than live prices which appear to be quite erratic and indicate much volatility. Again, retail meat prices on a cut-by-cut basis were used as revenue estimations for pasture-raised products. Thus, the relative stability of these prices could be interpreted to mean greater amount of market security for these pasture-raised beef producers who are selling directly to consumers and are using retail for reference pricing. Table 3 contains per-animal total revenue means for each category of pasture-raised producer. Although differences in revenues among the categories are negligible, spring calving regimens seem to consistently outperform fall regimens. When total revenues were divided by weights of final saleable product in the associated production category, average price per pound of product sold across all categories and farm sizes was found to be $3.41.

Cost Analysis

For all types of producers, total farm costs, total variable costs, average total costs and average variable costs were calculated. Since many of the factors included were entered as distributions, resulting cost measures were also assessed as distributions. For both traditional and pasture-raised producers, fall-calving operations tended to show higher cost levels and, of course, producer categories that retain longer and feed grain supplements face higher costs. Interestingly, across all categories, average variable costs fall as farm size increases. There could indeed be some effects of scale economies expressed here. Included as Tables 4 and 5 are listings of mean average variable cost levels for all traditional and pasture-raised producers, respectively. Traditional producers exhibit approximately a 17% spread between lowest and highest cost operations within each farm size.

It is immediately clear that average variable cost measures are higher across-the-board for pasture-raised production—generally two to four times higher. This is to be expected, since these producers are retaining longer, processing instead of selling, and require much more intensive management in terms of animal nutrition and pasture cultivation. It should be noted that considering only cutting and wrapping for these producers instead of vacuum sealing drops variable cost levels by approximately 30%, indicating that processing decisions will play a large role in the costs faced. Values reported in Table 5 for pasture-raised AVC represent the vacuum-seal option.

Profit and Risk Analysis

Results of the stochastic budget simulation revealed that no category of traditional producer on any farm size is expected to cover total costs at mean performance levels. In fact, each producer suffers considerable loss per animal when all price and production factors are at their average levels. For all farm sizes, producers in the spring calving, 5-month retention, 10% feeding proportion category experienced the least loss at the mean.

This same category of producer also yielded the highest minimum value across all farm sizes, indicating that this production protocol would come closer than any other to meeting its costs over most seasons and may be the best for mitigating market risk issues.

In considering the calculated 90% probability spreads, all categories except for those involving fall calving, 5-month retention within the large farm scenario show potential of covering total costs in one year (since the intervals do become positive at the 90% level) plus minimal profits. Twelve of the twenty-six regimens for the small farm appear to be able to cover all costs in one year according to the probability spreads and seventeen within the intermediate scenario.

All traditional production categories across all farm sizes cover their variable costs when all output, input and price factors are at mean levels. As with the total cost analysis, spring calving regimens with 5-month retention and 10% feeding proportion carry the highest mean returns. In assessing minimum values, all best minimums occur within the spring calving, 2.5-month retention protocol for all farm sizes. All categories across all farm sizes are able to cover variable costs and make some level of profit according to probability spreads, as both interval extremes for all are positive. It should be noted that performance increases on every measure as farm size increases. It was also found that several categories within each size scenario experience losses over variable costs at minimum performance levels, indicating that money could potentially be lost on each animal in the worst of years. The 90% probability spreads for returns over variable costs are presented in Table 6 for all farm sizes and traditional production categories.

While not technically a "break-even" analysis, price per pound required for pasture-raised producers to cover their variable costs *and* match returns experienced by the best-performing traditional producer was calculated. Even in the worst-case scenario (maximum price required to beat traditional at optimum), farms of all sizes and across all categories cover with ease with their $3.41/lb. revenues calculated previously.

More specifically, the highest max value required to cover variable costs and out-perform the optimal traditional producer across all operations was $1.99/lb. (found for small farms, fall calving, 60-day feeding, vacuum-seal). Mean requirement values ranged from $1.39/lb. to $1.85/lb. when taking vacuum sealing into consideration and from $1.07/lb to $1.53/lb with cutting and wrapping only. The calculated revenues for pasture-raised beef producers are more than double that required to perform better than the optimal traditional alternative in some cases, especially for large farms.

In considering results of the pasture-raised profitability analysis, intermediate and large-scale farms easily cover total costs at mean profit levels across all categories of production when processing involves only cutting and wrapping. Small farms cover at the means only when not employing stockpiling. All minimum observations for all farm sizes indicate possibility of loss on each animal over total costs. Probability spread information shows that large farms can be expected to cover total costs with 90% confidence except when fall calving and feeding grain (at which point the low extreme of the probability spread becomes marginally negative). As has been the case throughout, spring calving outperforms fall calving and large farms more easily cover total costs than their smaller counterparts. The most positive probability spread occurs on all farm sizes where producers are spring calving and not stockpiling. Employing vacuum-sealing reduces expected profitability over total costs. In fact, all minimum profit values for the vacuum-sealing option are negative, implying loss at worst-case scenario.

For both vacuum sealing and cutting/wrapping, most probability spreads entail a 300-400 dollar spread between the extremes, indicating significant uncertainty. In spite of the chances of loss seen here, it should be noted that, in terms of profits, pasture-raised producers were found much more likely than their traditional counterparts to make money in typical production seasons This is especially notable since pasture-raised costs are much higher than those faced by traditional producers as calculated for this analysis.

The returns listed over *variable* costs for pasture-raised producers in Table 7 can be expected for years when no or few reclamation or upkeep expenditures have to be made (90% probability spreads reported). The values reported are significantly higher than those reported for traditional returns over variable costs. Again, the large farms generally experience higher return levels and spring calving outperforms fall calving.

For each farm size, producers employing spring calving and stockpiling (and not feeding grain) experience the most positive probability spreads and highest mean return over variable cost levels. Return on feed investment is not sufficient enough to warrant yellow-fat feeding, as long as the individual producer's consumers are not discouraged by the presence of yellow fat on the final product (not established to be an issue with grass-fed carcasses in Appalachia).

Pasture-raised producers engaging in stockpiling should have surplus hay for sale in most seasons and when considering these hay sales, the best performing protocol in terms of mean profit switches from non-stockpiling to stockpiling, implying that stockpiling does indeed have merit in attempting to cover all costs in one year of production.

As stated, pasture-raised revenues were calculated based on current retail prices. A review of internet pasture-raised beef suppliers yielded a collection of price levels actually charged by these producers across the country (approximately twelve were considered) for each cut. After assessment, it was concluded that the price levels utilized here actually underestimate those currently charged by pasture-raised beef suppliers, indicating a further lessened risk of economic loss for these producers.

Summary and Conclusions

It has been the purpose of this analysis to explore through stochastic budgeting the viability of pasture-raised beef production as an attractive and profitable alternative to traditional production methods. A general summation of the results would suggest that the investments of time, management and money required for pasture-raised beef production carry greater returns than those commonly employed in the cow-calf sector of Appalachia. In addition, results suggest that the sale of packaged beef is not as risky a venture as selling cattle on the live markets, meaning more assurance of returns across time and market conditions.

Specifically, producers wishing to employ pasture-raised methodologies face significant establishment costs if the farm is not currently set up for rotational grazing and stockpiling practices. Although this analysis did not take cost factors such as property taxes, interest on loans or depreciation into consideration, all factors employed were estimated to *conservatively* pin-point return expectations. All pasture-raised beef producers considered in this analysis cover their variable costs when pricing at current retail price levels, which were shown to be much less volatile than live-cattle prices and actually much less than prices currently received by internet pasture-raised beef suppliers.

Even in the worst-case scenarios across all input and output factors, it was found that pasture-raised producers could receive more than double the money required per pound to cover variable costs. It was also found that any of the pasture-raised production typologies considered could exceed the level of return above variable costs experienced by the optimal traditional producer with ease. Maximum returns over variable costs for traditional producers were generally much less than the *minimum* levels estimated for pasture-raised beef producers, implying that pasture-raised producers can be more confident than their traditional counterparts that returns from production, even in the worst years, will cover the costs directly involved with operating. It was concluded that risk for pasture-raised producers stems more from inputs required for production (production risk) than from output price levels (market risk), as for traditional producers.

In terms of profitability, neither pasture-raised nor traditional operations were found to consistently cover total costs with one year of production. Although notable profits are feasible for pasture-raised beef producers, there is considerable risk of loss. However, *no* traditional producer on any farm size was able to cover total costs in one year of production at mean profit expectations, while a *majority* of the grass-fed producer types cover at the means. Interestingly, the traditional producer categories that performed the best in this study were those which entailed relatively long retention (2.5 or 5 months) and little grain feeding (10%-20% of total diet), or, those which were most like the methodology followed by pasture-raised counterparts

Further research in the economic realm of pasture-raised beef production is necessary before full confidence can be placed in pasture-raised protocol, though. Most importantly, consumer attitudes in the Appalachian region and surrounding metropolitan areas must be assessed in order to ensure that demand for pasture-raised beef is sufficient for the potential supply. Also, this analysis did not take into consideration a portfolio approach to beef production, in which producers reserve only a portion of their weanlings for pasture-finishing and sell the remainder on the commercial market or via some alternative venue. This analysis will be imperative if it is concluded that demand for the product is not great enough to warrant full-scale changes in production.

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Table 1. Definition of Variables in Live Cattle Price Data Models

VARIABLE	DESCRIPTION
Dependent Variables	
PMEAN	Mean live cattle price level ($/cwt)
PSD	Standard deviation around the mean of live cattle price level
Independent Variables	
JAN	1 if sold in January, 0 if otherwise
FEB	1 if sold in February, 0 if otherwise
MAR	1 if sold in March, 0 if otherwise
APR	1 if sold in April, 0 if otherwise
MAY	1 if sold in May, 0 if otherwise
JUN	1 if sold in June, 0 if otherwise
JUL	1 if sold in July, 0 if otherwise
AUG	1 if sold in August, 0 if otherwise
SEP	1 if sold in September, 0 if otherwise
OCT	1 if sold in October, 0 if otherwise
NOV	1 if sold in November, 0 if otherwise
DEC	1 if sold in December, 0 if otherwise
HEIF	1 if a heifer, 0 if otherwise
STEER	1 if a steer, 0 if otherwise
MED	1 if medium framed, 0 if otherwise
SMALL	1 if small framed, 0 if otherwise
LARGE	1 if large framed, 0 if otherwise
THFO	1 if in 300-400 weight class, 0 if otherwise
FOFI	1 if in 400-500 weight class, 0 if otherwise
FISI	1 if in 500-600 weight class, 0 if otherwise
SISE	1 if in 600-700 weight class, 0 if otherwise
SEEI	1 if in 700-800 weight class, 0 if otherwise
EINI	1 if in 800-900 weight class, 0 if otherwise
BUCK	1 if sold at Buckhannon, 0 if otherwise
PARK	1 if sold at Parkersburg, 0 if otherwise
WEST	1 if sold at Weston, 0 if otherwise
TRAL	1 if sold at Terra Alta, 0 if otherwise
RIP	1 if sold at Ripley, 0 if otherwise

Table 2. Regression Results

	Model 1	Model 2	Model 3	Model 4
VARIABLE	Coefficient	Coefficient	Coefficient	Coefficient
JAN		-1.11	-8.23*	
FEB		11.1*	3.32*	
MAR		15.88*	4.91*	
APR		13.25*	4.81*	
MAY		8.34*	1.34	
JUN		6.51*		
JUL		.386	-7.23*	
AUG			-8.55*	
SEP		-3.74	-9.7*	
OCT		-6.13*	-9.34*	
NOV		-6.53*	-9.78*	
DEC		-3.33*	-7.55*	
THFO	9.65*			3.68*
FOFI	8.48*			4.31*
FISI	7.82*			3.82*
SISE	3.49*			
SEEI				-1.78*
EINI	-5.0*			-4.75*
HEIF		-8.84*	-1.61*	-1.32*
STEER	7.77*			
MED	.82			1.28*
SMALL	-8.997*			-1.15*
LARGE				
BUCK	1.17			-3.28
WEST	.586			
TRAL	-8.17*			-2.74*
RIP				3.66*
PARK	1.5			2.23*
CONSTANT	56.65	69.68	21.44	14.2
R-SQUARED	.886	.98	.95	.66
D.W. STAT	2.2	2.3	2.7	2.38

*Values are significantly different from zero, p<.05

Figure 1. Average Monthly Steer Prices, 1994-1999

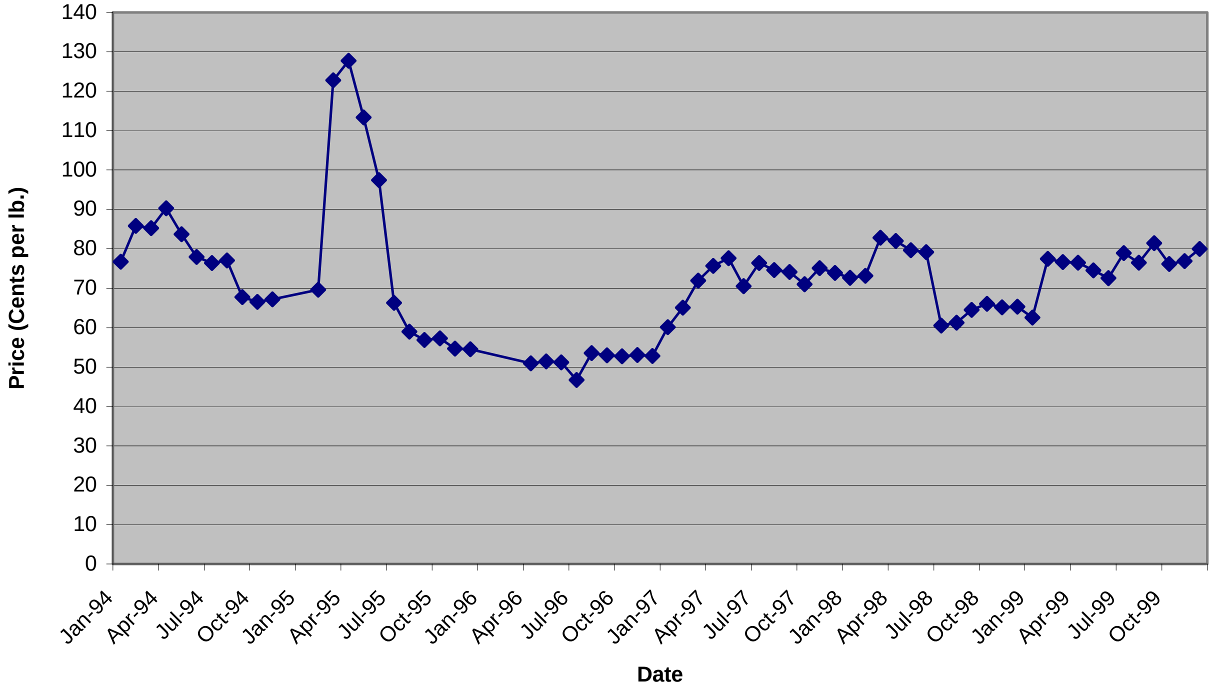

Figure 2. Average Monthly Retail Meat Prices, 1994-1999

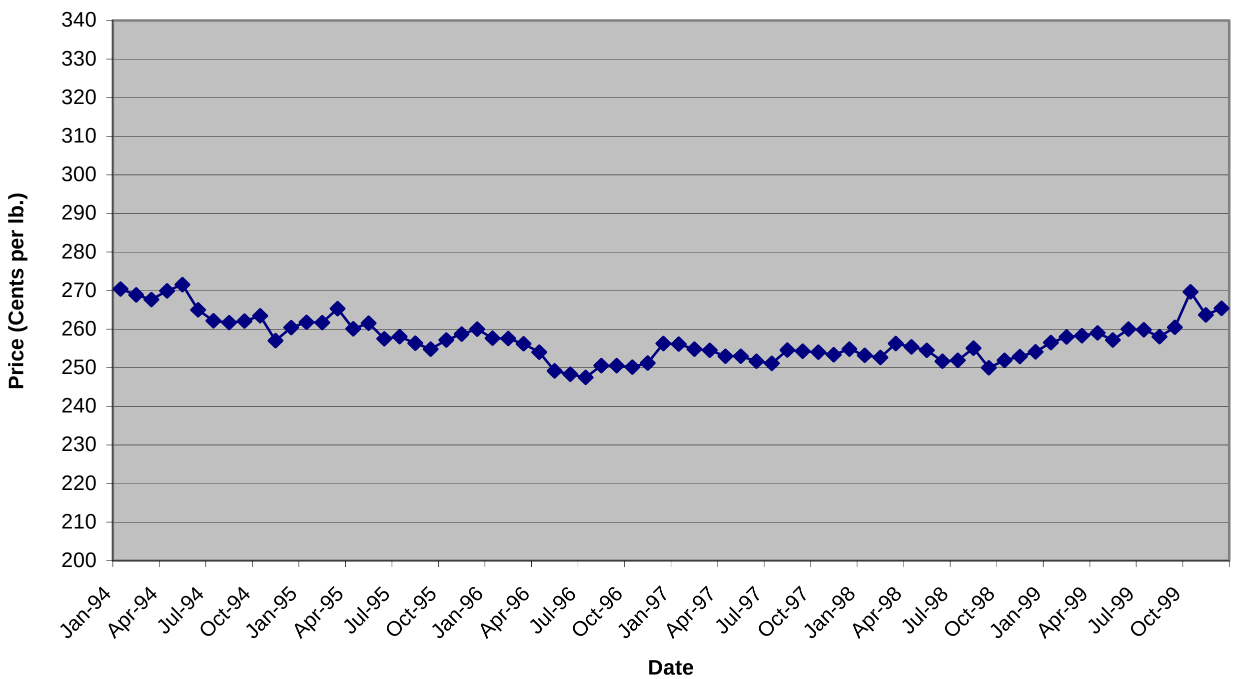

Table 3. REVENUE PER WEANLING, PASTURE-RAISED		
CATEGORY	**HEIFERS**	**STEERS**
STOCKPILE, SPRING CALV	1161*	1285
STOCKPILE, FALL CALV	1161	1285
NO STOCKPILE, SPRING CALV	1152	1274
NO STOCKPILE, FALL CALV	1146	1268
STOCKPILE, SPRING CALV, YF45**	1203	1334
STOCKPILE, SPRING CALV, YF60	1217	1350
STOCKPILE, FALL CALV, YF45	1199	1329
STOCKPILE, FALL CALV YF60	1215	1347

*Values reported here are means of the respective distributions

**"YF" here refers to yellow-fat feeding; 45 and 60 refer to the number of feeding days

Table 4. AVERAGE VARIABLE COSTS, TRADITIONAL ($ per head, MEAN VALUES)			
CATEGORY	**SMALL**	**INTERM.**	**LARGE**
Sp. Calv, 0 Retent	146.6	135.8	122.1
Sp. Calv, 1 Ret, 10%	156.4	142.7	129.7
Sp. Calv, 1 Ret, 20%	160.1	146.4	133.4
Sp. Calv, 1 Ret, 30%	163.7	150.1	137.1
Sp. Calv, 1 Ret, 40%	167.3	153.7	140.7
Sp. Calv, 2.5 Ret 10%	171.4	153.6	145.9
Sp. Calv, 2.5 Ret 20%	181.2	163.3	155.6
Sp. Calv, 2.5 Ret 30%	191.1	173.3	165.6
Sp. Calv, 2.5 Ret 40%	201.2	183.4	175.6
Sp. Calv, 5 Ret, 10%	198.1	173.2	168.7
Sp. Calv, 5 Ret, 20%	219.9	195.1	190.4
Sp. Calv, 5 Ret, 30%	242.7	217.8	213.2
Sp. Calv, 5 Ret, 40%	266.3	241.4	236.7
Fl. Calv, 0 Retent	156.9	146.8	132.5
Fl. Calv, 1 Ret, 10%	168.6	155.8	141.9
Fl. Calv, 1 Ret, 20%	172.3	159.4	145.5
Fl. Calv, 1 Ret, 30%	175.9	163.1	149.2
Fl. Calv, 1 Ret, 40%	179.6	166.7	152.9
Fl. Calv, 2.5 Ret 10%	183.8	166.7	158.1
Fl. Calv, 2.5 Ret 20%	193.6	176.5	167.9
Fl. Calv, 2.5 Ret 30%	203.6	186.5	177.9
Fl. Calv, 2.5 Ret 40%	213.7	196.6	188.1
Fl. Calv, 5 Ret, 10%	237.8	224.6	221.4
Fl. Calv, 5 Ret, 20%	260.1	246.8	243.6
Fl. Calv, 5 Ret, 30%	283.2	269.8	266.7
Fl. Calv, 5 Ret, 40%	307.2	293.5	290.5

Table 5. AVERAGE VARIABLE COSTS, Pasture-Raised ($ per head, Mean Values)			
Category	**Small**	**Interm.**	**Large**
Stockpile, Sp.Calv	568	517	489
Stockpile, Fl. Calv	585	537	498
No Stockpile, Sp. Calv	565	517	489
No Stockpile, Fl. Calv	591	548	508
Stockpl., Sp.Calv, yf45	625	569	542
Stockpl., Sp.Calv, yf60	645	588	562
Stockpl., Fl.Calv, yf45	645	592	554
Stockpl., Fl.Calv, yf60	645	611	573

Table 6. 90% PROBABILITY SPREADS FOR Per-Head RETURNS OVER VC, TRADITIONAL PRODUCTION ($)

CATEGORY	SMALL	INTERM.	LARGE
Sp. Calv, 0 Retent*	71-261	81-275	94-285
Sp. Calv, 1 Ret, 10%**	99-283	108-298	127-314
Sp. Calv, 1 Ret, 40%	99-293	113-309	119-317
Sp. Calv, 2.5 Ret 10%	112-309	132-322	136-327
Sp. Calv, 2.5 Ret 40%	117-307	139-329	143-333
Sp. Calv, 5 Ret, 10%	149-332	172-358	182-368
Sp. Calv, 5 Ret, 40%	125-298	144-320	154-330
Fl. Calv, 0 Retent	122-294	69-263	84-276
Fl. Calv, 1 Ret, 10%	61-252	101-284	119-301
Fl. Calv, 1 Ret, 40%	84-281	102-298	114-310
Fl. Calv, 2.5 Ret 10%	87-279	123-321	136-332
Fl. Calv, 2.5 Ret 40%	122-300	132-328	141-334
Fl. Calv, 5 Ret, 10%	111-306	126-312	124-307
Fl. Calv, 5 Ret, 40%	84-265	97-271	96-280

***** "Retent" or "Ret" here refers to the period of weanling retention, either 0, 1, 2.5 or 5 months
**The percentages here refer to the proportion of total diet fed as grain (20%,30% rations omitted) Sp., Fl. denote fall or spring calving

Table 7. 90% PROBABILITY SPREADS for Per-Head RETURNS OVER VC, PASTURE-RAISED ($)*

	CUT/WRAP	VAC-SEAL
SMALL FARM		
Stockpile, Sp.Calv	721-809	610-689
Stockpile, Fl. Calv	703-792	593-672
No Stockpile, Sp. Calv	709-807	598-687
No Stockpile, Fl. Calv	688-764	579-646
Stockpl., Sp.Calv, yf45	712-804	598-679
Stockpl., Sp.Calv, yf60	707-800	591-674
Stockpl., Fl.Calv, yf45	689-779	574-655
Stockpl., Fl.Calv, yf60	687-778	571-652
INTERMEDIATE FARM		
Stockpile, Sp.Calv	766-866	650-750
Stockpile, Fl. Calv	744-846	629-732
No Stockpile, Sp. Calv	749-859	633-744
No Stockpile, Fl. Calv	725-812	610-699
Stockpl., Sp.Calv, yf45	758-865	635-746
Stockpl., Sp.Calv, yf60	745-864	630-744
Stockpl., Fl.Calv, yf45	733-839	611-720
Stockpl., Fl.Calv, yf60	731-840	608-719
LARGE FARM		
Stockpile, Sp.Calv	794-895	677-779
Stockpile, Fl. Calv	784-885	667-770
No Stockpile, Sp. Calv	778-888	662-772
No Stockpile, Fl. Calv	765-851	650-737
Stockpl., Sp.Calv, yf45	785-893	664-774
Stockpl., Sp.Calv, yf60	781-892	658-771
Stockpl., Fl.Calv, yf45	768-876	646-757
Stockpl., Fl.Calv, yf60	767-876	643-755

*Lowest and Highest Mean Values within each farm size are significantly different at the 95% confidence level. Highest Mean Values reported for each farm size are sig. different from those for the alternative sizes at the 95% c.l. Highest Mean Values for each farm size are Also sig.different (95% c.l.) from the Highest Mean Return Values for *traditional* producers of same size.