Demographic Factors Affecting the Adoption of Multiple Value-Added Practices by Oklahoma Cow-Calf Producers

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Abstract

The utilization of marketing programs to enhance feeder calf value has been met with modest success in Oklahoma. Value-added programs are continually promoted as avenues for improving cow-calf profitability, but producer adoption of value-added practices lags in spite of research showing the value of these practices. Identifying producer characteristics that increase their likelihood to adopt value-added practices is critical to developing successful outreach efforts. Results from a survey of Oklahoma producers on value-added practice adoption indicate that multiple demographic variables influence a producer's likelihood of practice adoption. For Extension specialists, results can help in targeting likely adopters and developing methods to overcome barriers to adoption by producers less likely to adopt.

JEL codes: Q12, Q16

Key Words: Beef producers, value-added practices, practice adoption, negative binomial regression, Poisson regression

Introduction

The utilization of marketing programs to enhance the value of feeder calves has met with modest success in Oklahoma. While Extension personnel continually promote value-added programs as an avenue for improving cow-calf profitability, producer adoption of value adding management and marketing practices lags. McKinney (2007) reports that a scant 12% of calves marketed through eight major Oklahoma livestock auctions in 2007 were reported as “value-added or preconditioned”, though research has shown that these calves capture premiums at market over cattle not managed with these practices (Avent, Ward and Lalman, 2004; Dhuyvetter, 2004; King and Seeger, 2004; Bulut and Lawerence, 2006; Williams, 2011). Identifying producer characteristics that increase the likelihood of value-added practice adoption is critical to developing successful outreach efforts among cow-calf producers and, ultimately, increasing participation in value-added practices and programs that may allow producers to capture higher market values for cattle.

Value-added practices in the cow-calf phase of beef production primarily encompass management practices that positively impact health and performance in subsequent phases of production or document information such as age, origin, feed ingredients, or medical treatments for use in future marketing endeavors. Some practices, such as castration and dehorning, are readily verifiable by cattle buyers and generate additional value in the market without third-party verification (Schulz et al., 2004). In an analysis of fall 2010 Oklahoma feeder calf sales, Williams (2011) found that a lot containing bull calves was discounted nearly $6 per hundredweight, even if the majority of calves in the lot were castrated. Lots containing calves with horns were discounted at $3.15 per hundredweight. Again, buyers applied the discount to the whole lot, even if a small percentage were horned.

Other value-added practices create calf attributes that are not as readily verified. This is particularly true of many practices associated with preconditioning programs. Without third-party verification, cattle buyers are left with some degree of uncertainty as to whether seller claims of practices such as administered vaccinations and extended weaning periods are true. While some market benefits can be captured without verification, dependent on the level of buyer trust in the reputation of the seller, third-party verification is typically required to capture full market benefits of practices that generate less visible cattle attributes. Preconditioning programs—programs that require specific vaccination protocols and 30 to 45 days weaned prior to sale date—require third-party verification. Williams (2011) found that lots of calves marketed as weaned and vaccinated garnered premiums of $3.50 per hundredweight while lots of calves marketed through a certified preconditioned program captured an additional $8 to $11 per hundredweight for certification, with lighter weights commanding higher premiums. Oklahoma producers have the option to participate in both brand-specific industry developed preconditioning programs and a brand-neutral program, the Oklahoma Quality Beef Network (OQBN), a joint effort of Oklahoma Cooperative Extension Service and the Oklahoma Cattlemen's Association. Though producer participation in value-added calf marketing has increased and there is evidence that Oklahoma producers who choose to participate see a positive net return (see Williams et al., 2011), the percentage of producers who participate is still small.

Targeted development of educational programs that encourage value-added practice adoption requires knowledge of how demographics impact the likelihood of adoption. Previous research that explores producers' willingness to adopt multiple management practices focuses primarily on practices associated with environmental conservation related to crops and forages, such as grazing management or sediment control practices (e.g., Rahelizatovo and Gillespie, 2004; Gillespie et al., 2007). A handful of researchers examine management practice adoption in the beef industry at the cow-calf level. Ward et al. (2008) survey recipients of the Oklahoma Beef Cattle Manual and find that significant differences in adoption exist between larger producers with more dependence on income from cattle and small producers less dependent on cattle as an income source. However, the study focuses on individual management practices rather than the number of practices adopted. Gillespie et al. (2004) employ a binary logit model to find the probability that a cow-calf producer uses alternative marketing practices based on their characteristics and management practices. Popp et al. (1999) also use a binary logit model to estimate the probability that a cow-calf producer is a "value-added producer", defined as a cow-calf producer who backgrounds calves (a specific subset of practices). They find that farm size does not have a significant impact on the backgrounding decision. Anecdotally, there is evidence that cattle management practices and willingness to adopt may differ widely across quadrants of the state, though such differences may be driven by other demographics. Overall, little is available regarding the influences on the number of value-added management practices adopted by producers.

We expand on previous research to explore the relationship between cow-calf producers' characteristics and the number of value-added management practices they choose to adopt. Methodology similar to Rahelizatovo and Gillespie (2004) and Gillespie et al. (2007) is applied to data from a survey of Oklahoma cow-calf producers. Both the Poisson and the negative binomial model are estimated and a likelihood ratio test is employed to determine which model is more appropriate for the data.

Data

A mail survey was sent to 17,511 of the approximately 34,500 cow-calf producers in the state of Oklahoma, covering about half of the producers in the state. The survey was sent to a representative sample of cow-calf producers across producer sizes and geographical regions. The National Agricultural Statistics Service's Oklahoma City office was contracted to sample, send and collect surveys, and compile survey data. A total of 1,861 surveys were completed, resulting in a 12.1 percent response rate. Observations in which variables of interest had missing data were deleted, leaving 1,453 usable observations for the analysis. The survey included questions about producer demographics such as age, education, income, and experience as well as questions related to adoption of 14 management and marketing practices.

Methodology

Traditional economic theory suggests that cattle producers maximize expected utility. Assume a producer's utility is a function of profits as well as the labor necessary to obtain the profits. The management practices of interest are inputs that are expected to have a positive impact on revenue, but that are also expected to increase monetary costs and decrease leisure time. The resulting expected utility maximizing objective function can be written as:

$$(\mathbf{1})\quad \max_{\boldsymbol{X},\boldsymbol{Y}} EU((\pi(\boldsymbol{Y},\boldsymbol{X}), Leisure(\boldsymbol{X}))|\boldsymbol{Z})$$

where π is the uncertain profit as a function of inputs, ***Y***, and management practices adopted, ***X***, *Leisure* is an inverse function of management practices adopted, and ***Z*** is a vector of producer attributes.

Economic theory suggests that no two producers' utility functions are the same. Producers may differ in level of risk aversion, in the value placed on leisure time, or in the level of enjoyment derived from implementing certain management practices while others may dread using them. Labor cost and accessibility may also differ. These differences among producers may help to explain why some choose to adopt more value-added management practices than others, all else equal. Producer characteristics that are expected to influence the adoption decision include herd size, region, years in cow-calf industry, age, education, income, percent of total income from cattle, and participation in training programs.

Estimation Procedure

We first investigate the likelihood of a producer with a given set of characteristics to adopt value-added production practices. Assuming that individual producers are independent of one another, the density function using the Poisson distribution is:

$$(\mathbf{2})\quad f(Total_i|x_i) = \frac{e^{-\mu_i}\mu_i^{Total_i}}{Total_i!}$$

where $Total_i$ is the total number of practices adopted by producer i, x_i is a vector of characteristics for producer i, and μ_i is the mean equation. The mean equation is:

$$(\mathbf{3})\quad \mu_i = E[Total_i|x_i] = \exp(\boldsymbol{X_i'\beta})$$

where $\boldsymbol{\beta}$ is a vector of parameters to be estimated. One limitation of the Poisson regression is that it assumes that mean and variance are equal. This assumption may be too restrictive and, as a result, standard errors of $\widehat{\boldsymbol{\beta}}$ will be biased (Cameron and Trivedi, 1986.) One method of relaxing this assumption suggested by Gourieroux, Monfort, and Trognon (1984) is adding a random error term to Equation 3 as shown:

$$(\mathbf{4})\quad \mu_i\tau_i = E[Total_i|x_i,\tau_i] = \exp(\boldsymbol{X_i'\beta} + \varepsilon_i)$$

where $\tau_i = \exp(\varepsilon_i)$ is the unobserved heterogeneity term (SAS, 2011). This gives a conditional density function of:

$$(\mathbf{5})\quad f((Total_i|x_i,\tau_i) = \frac{e^{-\mu_i\tau_i}(\mu_i\tau_i)^{Total_i}}{Total_i!}$$

To obtain a density function that is no longer conditional on τ_i, we can integrate with respect to τ_i:

$$(\mathbf{6})\quad f((Total_i|x_i) = \int \frac{e^{-\mu_i\tau_i}(\mu_i\tau_i)^{Total_i}}{Total_i!} g(\tau_i)\mathrm{d}\tau_i,$$

resulting in the negative binomial regression model. Through further simplification, we find the negative binomial model allows variance to differ from the mean, as shown in equations 7 and 8 below:

$$(\mathbf{7})\quad \mu_i = E[Total_i|x_i] = \exp(X_i'\beta)$$

$$(\mathbf{8})\quad var(Total_i) = \mu_i(1 + \alpha\mu_i)$$

A more complete explanation of these derivations can be found in the SAS user's manual (SAS, 2011).

Both the Poisson and negative binomial models are estimated using maximum likelihood. Cameron and Trivedi (1986) suggest using a Likelihood Ratio test to determine whether the variance differs from the mean. If $\alpha = 0$ in equation 8, then the variance and mean are equal. If $\alpha \neq 0$, then the variance and mean differ, implying that the appropriate model for estimation is the negative binomial model. The test statistic is calculated as:

$$(\mathbf{9})\quad -2\ln\big(L(Poisson) - L(negative\ binomial)\big) \xrightarrow{d} \chi_1^2.$$

As a result of the model's nonlinear nature, the marginal effect is no longer β_j. Instead, the marginal effect is calculated as the derivative of the mean equation with respect to $x_{j,}$ as shown in Equation 10:

$$(\mathbf{10})\quad \frac{dE[Total_i|x_i]}{dx_{i,j}} = \beta_j\exp(\bar{\boldsymbol{X}}_{\boldsymbol{i}}'\boldsymbol{\beta}),$$

where x's are evaluated at their means. Standard errors of marginal effects are found using Monte Carlo Integration.

Results

The degree of individual practice adoption reported in the survey is illustrated in Figure 1. The most widely adopted practice is castration of bull calves with 72 percent of producers reporting practice adoption. Other more common practices are deworming calves (63%), getting calves accustomed to feed bunks ((50%), and dehorning calves (49%). A breakdown of producers by herd size employing castration as a standard management practice suggests that herd size impacts practice adoption (see Figure 2). Figure 3 illustrates that regional differences exist in the adoption of dehorning calves. Not surprisingly, the least common practice is no antibiotic use with only 12 percent of producers employing this practice.

Descriptive statistics for producer characteristics are reported in Table 2. The typical herd size in Oklahoma, as indicated by Number of Cattle, is less than 100 head, with 76 percent of respondents falling in this category. Additionally, over 80 percent of survey respondents are over 50 years old while 86 percent have been in the business 16 years or more. This is reflective of national trends in the industry as well. More than 80 percent of Oklahoma cow-calf producers receive at least 20 percent of their income from non-cattle sources.

Table 3 reports results from the negative binomial and Poisson regression models. Parameter estimates are similar for both models. However, the standard errors are lower for the Poisson regression than for the negative binomial model. The implicit restriction of equal mean and variance when using the Poisson distribution can generate the standard errors that are inappropriately small (Cameron and Trivedi, 1986), inflating test statistics. Comparing models yields a likelihood ratio test statistic of 572, which is asymptotically distributed as $\chi^2(1)$, and results in rejecting the null hypothesis that $\alpha = 0$ in Equation 8. This suggests that the negative binomial model is more appropriate for this data.

Marginal effects for the negative binomial model are presented in Table 4. The marginal effect for all herd size variables is positive and is significant for herd sizes from 50 to 499 head. The marginal effect increases with size and is highest for producers who have 250 to 499 head of cattle, indicating that as herd size increases, a producer is likely to implement more value added management practices. Economically, as a herd size increases, the total benefit of implementing a management practice also increases. Conversely, due to economies of scale the costs of implementing some management practices could exhibit a concave total cost function. In other words, as herd size increases, the marginal cost of implementing certain management practices will decrease. These results are consistent with Ward et al. (2008) who find that larger producers have higher rates of castration, vaccination, implanting, and individual animal identification than smaller producers.

The marginal effect for region of the state is positive for the Southwest, Northwest, and the Panhandle but is negative for the Southeast relative to that of the Northeast. This would indicate that producers in the western half of the state implement a greater number of management practices than those in the eastern half of the state. This may be a result of two factors: culture and available resources. For example, more wheat is grown in western Oklahoma which allows more opportunities for winter grazing and may be more conducive to adopting more value added management practices.

Results indicate that as a cattle producer gains experience, they adopt more management practices. Those with 16 to 25 years of experience adopt the most practices when compared to the base of those with less than five years of experience. Interestingly, marginal effects for age are increasingly negative, but are not statistically significant. Gillespie et al. (2007) found that as age increased, the probability of adopting several best management practices increased. This conflict may be a result of the nature of the practice studied. Gillespie et al. (2007) studied best management practices related to conservation programs that may increase expenses while this paper studied value-added management practices that increase revenue.

Producers with education beyond high school are more likely than those without post-secondary education to adopt more value-added practices. Results also indicate a statistically significant relationship between income and the number of management practices adopted. As the income classification increases to $90,000 and above, producers will adopt more management practices than those with income classifications lower than $90,000. Some value-added practices require an initial cash outlay, which may deter adoption by producers with lower incomes.

Results reveal that, beyond post-secondary education, participation in programs such as Beef Quality Assurance and Oklahoma State University's Master Cattleman program increase the likelihood that a producer adopts more value added management practices. It could be argued that participants in these programs have greater exposure to information regarding how to implement value added practices as well as on the likely benefits of such practices. It may also be that producers more likely to adopt higher numbers of value added practices self-select into such programs as they search for innovative ways to increase their productivity and profits.

Conclusions

Our survey of Oklahoma cow-calf producers shows that the value-added management practices most commonly adopted are castrating bull calves, dehorning, deworming, and getting calves accustomed to feed bunks. Each of these practices is known to increase sale prices of calves, yet many producers do not adopt these and other value-added practices. By understanding the characteristics of producers who adopt more or fewer management practices, extension educators can develop more targeted programs to increase the level of participation in value added management practices and programs.

This research identifies relationships between producer characteristics and the number of management practices each producer adopts. Results indicate that producers with greater experience and greater income levels adopt more management practices. This presents an opportunity for educators to design programs tailored to producers with less experience to help them to understand opportunities available for increasing revenue. Smaller producers were also found to adopt fewer value-added management practices, presenting additional extension opportunities. The results are a valuable resource for extension faculty and educators in identifying a target audience for programs that educate cow-calf producers on increasing revenues through value-added management practice adoption.

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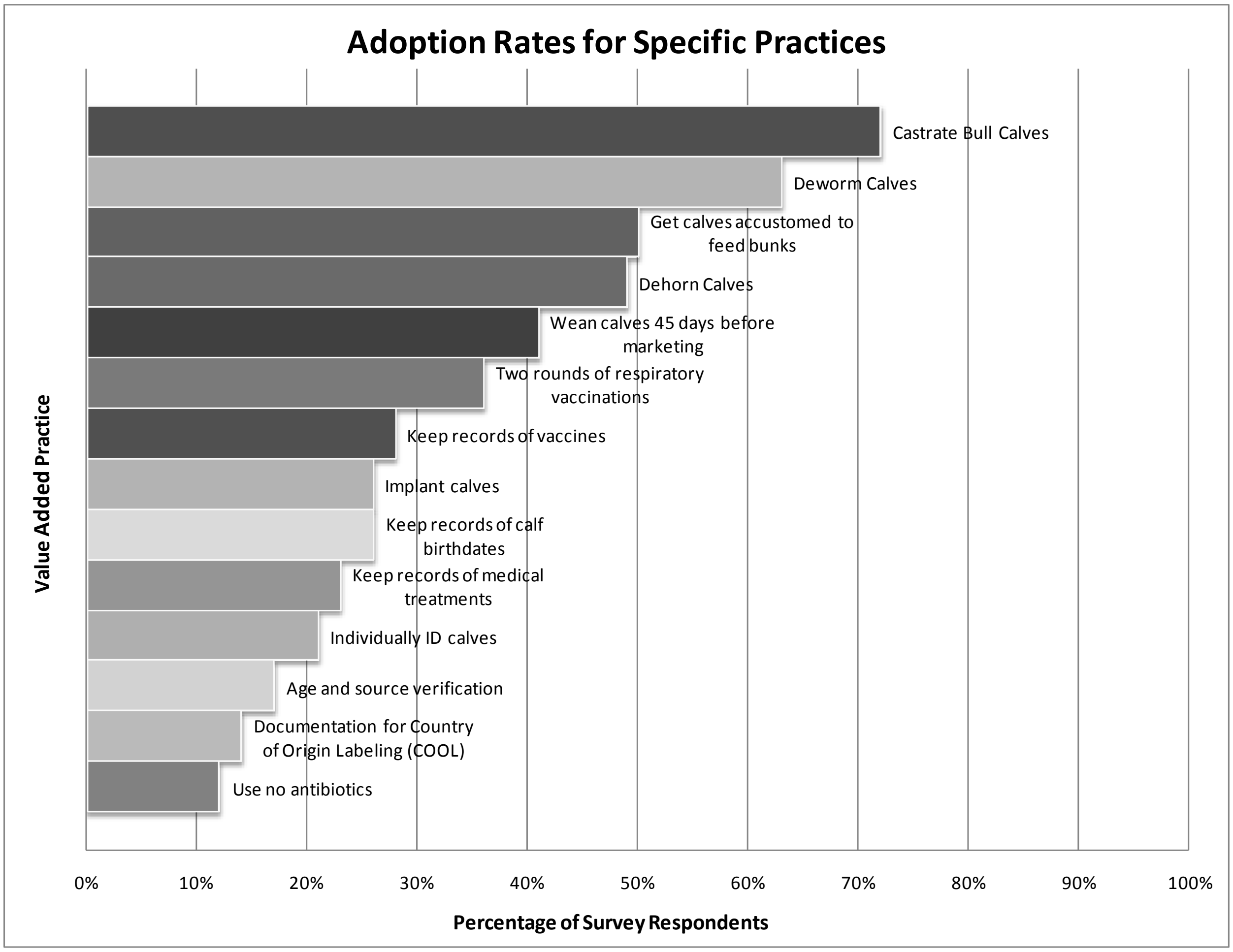

Figure 1. Respondent Adoption Rates for Specific Value Added Management Practices.

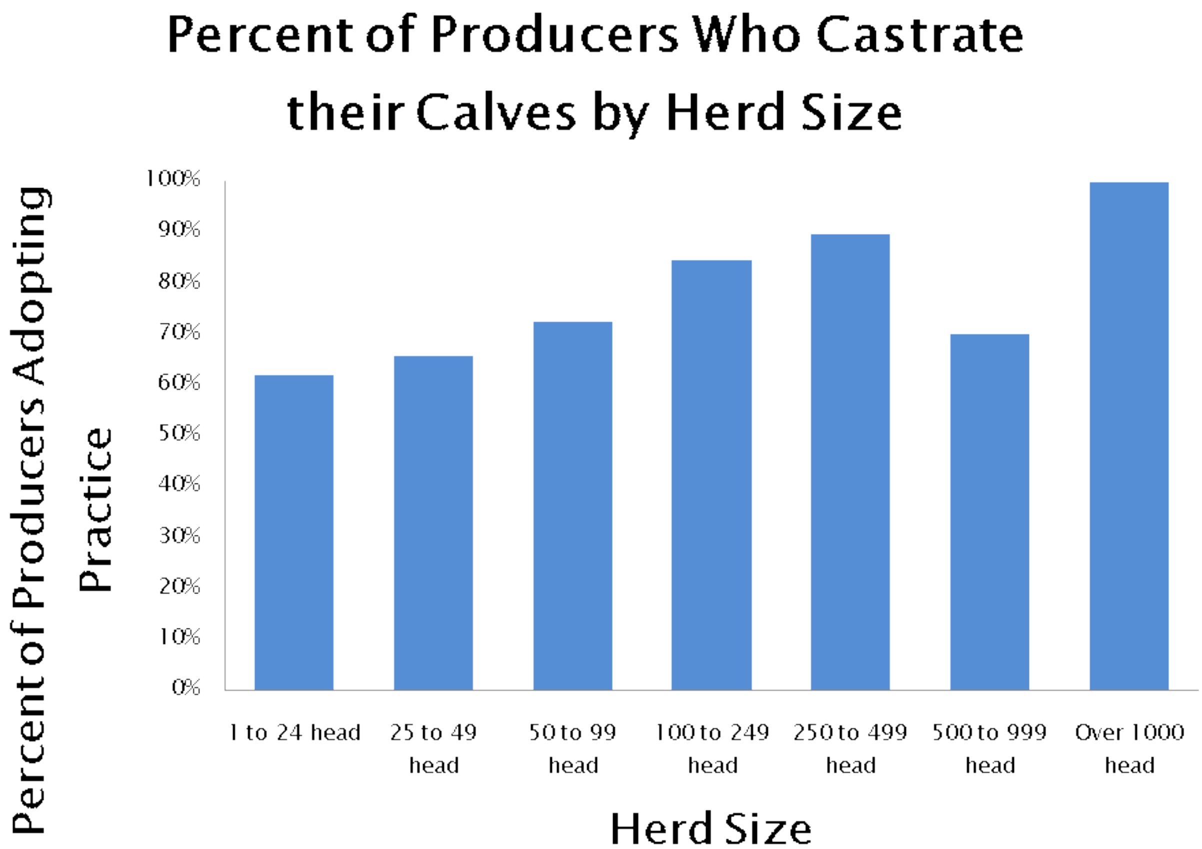

Figure 2. Differences in Adoption of Castration as Management Practice by Herd Size

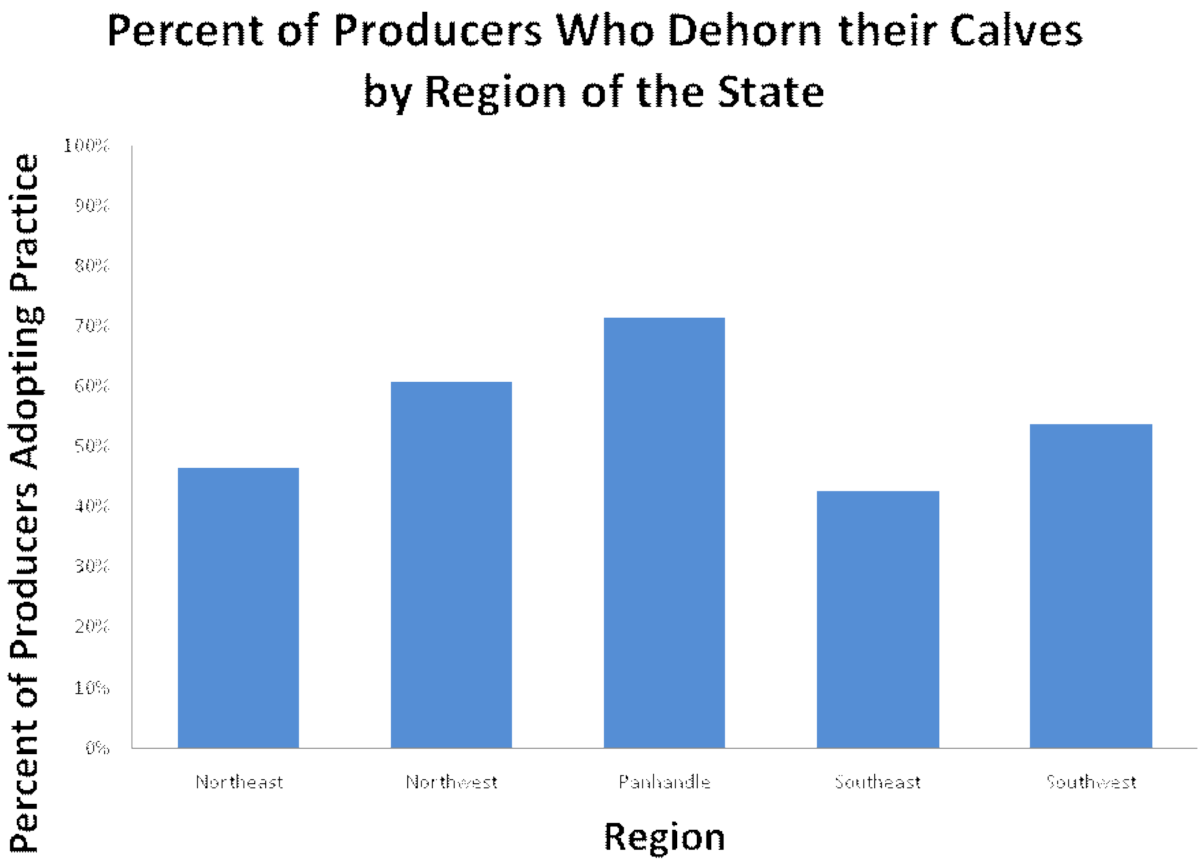

Figure 3. Differences in Adoption of Dehorning as Management Practice by Region

Table 2. Distribution of Producer Characteristics Across Demographic Variables

Category/Variable	Percent of Producers	Number of Producers
Number of Cattle		
1 to 24	14.52%	211
25 to 49	29.25%	425
50 to 99	32.69%	475
100 to 249	18.65%	271
250 to 499	4.06%	59
500 to 999	0.69%	10
Over 1000	0.14%	2
Region		
Northeast	30.28%	440
Northwest	15.07%	219
Panhandle	1.45%	21
Southeast	32.48%	472
Southwest	20.72%	301
Years in Cattle Production		
Less than 5	0.96%	14
5 to 15	12.11%	176
16 to 25	18.31%	266
over 25	68.62%	997
Age		
Under 30	0.41%	6
31 to 40	3.99%	58
41 to 50	13.42%	195
51 to 64	39.64%	576
65 or Older	42.53%	618
Education		
High School Graduate	34.34%	499
Vocational, Technical, or 2 year degree	24.71%	252
Bachelor's Degree	17.34%	359
Graduate or Professional Degree	19.61%	285
None of these	3.99%	58
Total Income		
Less than $30,000	12.32%	179
$30,000 to $59,999	27.19%	395
$60,000 to $89,999	27.05%	393
$90,000 to $119,999	15.97%	232
$120,000 and Above	17.48%	254

Table 2. Distribution of Producer Characteristics Across Demographic Variables (Continued)

Category/Variable	Percent of Producers	Number of Producers
Percent of Income from Cattle		
Zero Percent	5.51%	80
1 to 20 Percent	53.34%	775
21 to 40 Percent	22.30%	324
41 to 60 Percent	11.42%	166
61 to 80 Percent	4.40%	64
81 to 100 Percent	3.03%	44
Master Cattlemen Program		
Yes	3.85%	56
No	96.15%	1397
Quality Assurance Training		
Yes	7.71%	112
No	92.29%	1341
Total practices adopted (Average)	4.775	

	Negative Binomial			Poisson		
Parameter	Coefficient	Standard Error	P-Value	Coefficient	Standard Error	P-Value
Intercept	1.084	0.452	0.016	1.126	0.231	<0.001
25 to 49 head	0.075	0.077	0.331	0.055	0.044	0.213
50 to 99 head	0.158	0.079	0.045	0.131	0.044	0.003
100 to 249 head	0.384	0.091	<0.001	0.348	0.049	<0.001
250 to 499 head	0.548	0.143	<0.001	0.475	0.069	<0.001
500 to 999 head	0.463	0.284	0.103	0.390	0.138	0.005
Over 1000 head	0.277	0.606	0.648	0.246	0.297	0.407
Northwest	0.139	0.072	0.054	0.111	0.037	0.003
Panhandle	0.360	0.188	0.055	0.358	0.088	<0.001
Southeast	-0.047	0.059	0.427	-0.054	0.032	0.085
Southwest	0.063	0.066	0.343	0.066	0.034	0.054
5 to 15 years of experience	0.138	0.255	0.589	0.154	0.149	0.300
16 to 25 years of experience	0.243	0.252	0.333	0.241	0.147	0.101
over 25 years of experience	0.166	0.249	0.505	0.163	0.146	0.263
31 to 40 years old	-0.328	0.358	0.360	-0.301	0.163	0.064
41 to 50 years old	-0.312	0.349	0.371	-0.250	0.158	0.112
51 to 64 years old	-0.426	0.346	0.218	-0.364	0.156	0.020
65 years or older	-0.593	0.347	0.088	-0.533	0.157	0.001
High School Graduate	0.153	0.128	0.232	0.113	0.074	0.127
Vocational, tech, or 2 year degree	0.227	0.133	0.087	0.185	0.076	0.015
Bachelor's Degree	0.212	0.135	0.117	0.165	0.077	0.032
Graduate or Professional Degree	0.205	0.135	0.129	0.160	0.077	0.038
$30,000 - $59,999 annual income	0.158	0.083	0.058	0.148	0.048	0.002
$60,000 - $89,999 annual income	0.220	0.085	0.009	0.204	0.048	<0.001
$90,000 - $119,999 annual income	0.258	0.093	0.006	0.225	0.052	<0.001
$120,000 and above annual income	0.246	0.093	0.008	0.242	0.052	<0.001
1 - 20 Percent income from cattle	0.131	0.108	0.228	0.111	0.061	0.070
21 - 40 Percent income from cattle	0.135	0.117	0.249	0.136	0.065	0.038
41 - 60 Percent income from cattle	0.170	0.129	0.186	0.140	0.071	0.048
61 - 80 Percent income from cattle	0.262	0.155	0.091	0.258	0.082	0.002
81 - 100 Percent income from cattle	0.121	0.178	0.497	0.153	0.091	0.092
Master Cattleman Graduate	0.282	0.122	0.021	0.270	0.055	<0.001
Quality Assurance Training	0.290	0.089	0.001	0.291	0.041	<0.001
Dispersion/Scale	0.534	0.033		1.000	0.000	

Table 4. Marginal Probabilities for Negative Binomial Model

Parameter	Marginal Effect	Standard Error
Intercept	5.108**	2.418
25 to 49 head	0.368	0.367
50 to 99 head	0.759*	0.552
100 to 249 head	1.807***	0.809
250 to 499 head	2.587**	1.305
500 to 999 head	2.255	2.102
Over 1000 head	1.521	3.704
Northwest	0.663*	0.402
Panhandle	1.721*	1.164
Southeast	-0.188	0.370
Southwest	0.323	0.535
5 to 15 years of experience	0.637***	0.128
16 to 25 years of experience	1.152*	0.614
over 25 years of experience	0.803	0.656
31 to 40 years old	-1.596	1.477
41 to 50 years old	-1.526	1.492
51 to 64 years old	-2.040	1.419
65 years or older	-2.798	1.393
High School Graduate	0.659	0.556
Vocational, Technical, or 2 year degree	1.014***	0.290
Bachelor's Degree	0.959***	0.090
Graduate or Professional Degree	0.922***	0.158
$30,000 to $59,999 annual income	0.709***	0.119
$60,000 to $89,999 annual income	1.003***	0.022
$90,000 to $119,999 annual income	1.180***	0.092
$120,000 and above annual income	1.116***	0.042
1 to 20 Percent income from cattle	0.501	1.347
21 to 40 Percent income from cattle	0.513	1.476
41 to 60 Percent income from cattle	0.668	1.527
61 to 80 Percent income from cattle	1.097	1.399
81 to 100 Percent income from cattle	0.450	1.473
Master Cattleman Graduate	1.324***	0.555
Quality Assurance Training	1.311***	0.141

*Significant $p \leq 0.1$; **Significant $p \leq 0.05$; ***Significant $p \leq 0.01$.