The Likelihood of Positive Returns from Value-Added Calf Management Practices

Brian R. Williams, Eric A. DeVuyst, Derrell S. Peel, and Kellie Curry Raper

Extension faculty have been educating cow-calf producers about value-added management programs and the premiums available at auction from these management practices for years. Despite these efforts, producers express doubt regarding the likelihood of premiums and the profitability of value-added management practices. We use matching pairs to calculate the difference in premiums and net returns between adopters and nonadopters and calculate the likelihood of positive net returns (and premiums) for individual practices and practice bundles. The probability of positive net returns ranges from 57% for dehorning to 79% for a certified vac-45 program (calves certified by a third party to be preconditioned for a minimum of 45 days, vaccinated, and dehorned) and probabilities increase with more practices adopted.

Key Words: beef production, matching pairs, nonparametric, value-added management

JEL Classifications: Q13, Q16

For several years, Extension faculty have been educating cow-calf producers about value-added calf management programs and the premiums available at auction from these management practices. However, adoption rates remain low. McKinney (2009) reports that 12% of Oklahoma producers participate in formal value-added production and marketing practices such as age and source verification. Williams et al. (2013b) report that 41% of Oklahoma producers are weaning calves, 35% are vaccinating calves, and 14%

enroll their calves in a certified vac-45 program.[1] To explain low adoption rates in value-added management practices, research that goes beyond the traditional approach of reporting premiums and budgeted profits is needed to encourage risk-averse producers to adopt value-added management practices. Risk-averse cow-calf producers often question how many of their peers receive premiums for value-added practices and how often they would at least break even by implementing a set of management practices. This article investigates the likelihood of profit generation using individual value-added practices and bundles of practices.

The next section provides an overview of the literature on value-added management in beef calves followed by a discussion of the methods

Brian R. Williams is an assistant extension professor, Department of Agricultural Economics, Mississippi State University, Mississippi State, Mississippi. Eric A. DeVuyst is a professor, Derrell S. Peel is a professor and Breedlove Chair, and Kellie Curry Raper is an associate professor, Department of Agricultural Economics, Oklahoma State University, Oklahoma City, Oklahoma.

[1] A certified vac-45 program requires calves to be weaned a minimum of 45 days, vaccinated, dehorned, wormed, and bull calves must be castrated.

and data, the results, and finally we summarize and conclude.

Literature Review

Researchers and Extension faculty have typically taken two approaches to educate cow-calf producers about value-added marketing opportunities: reporting sale premiums and developing partial budgets. Schroeder et al. (1988) are among the first to estimate sale premiums for cattle characteristics such as health, body condition, fill, and muscling using a hedonic pricing model. Similarly, Coatney, Menkhaus, and Schmitz (1996) designed a system of hedonic equations to estimate the value of cattle characteristics. However, many of the characteristics reported by Coatney, Menkhaus, and Schmitz (1996) and Schroeder et al. (1988) involve an animal's current state of health or are influenced by long-term management decisions such as frame size, muscling, and breed.

More recently, researchers have evaluated sale premiums for value-added management practices. For example, Avent, Ward, and Lalman (2004) estimate the value of calves that are certified, weaned, and vaccinated but do not report the individual premium for certification. Hedonic price modeling is the favored approach to estimating the marginal price impacts of individual value-added practices. For example, King et al. (2006) estimate a hedonic model using data from Superior Livestock Auctions from 1995 to 2005 to evaluate the value of preconditioning programs, vaccinations, and other characteristics. Blank, Forero, and Nader (2009) also estimate a hedonic pricing model to determine premiums for various management practices using data from Western Video Market. More recently, Williams et al. (2012) and Zimmerman et al. (2012) use hedonic pricing models. Zimmerman et al. (2012) investigate the value of vaccinations, presence of horns, and breed using data from the years 2001–2010 at Superior Livestock auctions. Similarly, Williams et al. (2012) consider the marginal value of vaccinations, weaning, certification, and other value-added characteristics at value-added and traditional auctions in Oklahoma using a hedonic pricing model. Finally, Williams

et al. (2013a) estimate value-added premiums for both adopters and nonadopters using a matching pairs methodology. Williams et al. (2013a) explain that differences in incentives and opportunity costs between producers may bias results of hedonic pricing models. Williams et al. (2013a) propose a matched-pairs method to correct for selection bias. A matched-pairs estimation technique results in three estimates: an average treatment effects for all producers (ATE), for adopters of the value-added management practices (ATT), and for nonadopters (ATC).

Other researchers have weighed the premiums received for preconditioning and other value-added management practices against the costs of implementing these practices using a partial budgeting approach. Bulut and Lawrence (2007) estimate the value of calves that are certified, weaned for 30 days, and vaccinated and compare the added revenue to the costs. Dhuyvetter (2010), Dhuyvetter, Bryant, and Blasi (2005), and Lalman and Smith (2001) each compare the premium received for preconditioning calves with the cost of preconditioning. Bulut and Lawrence (2007), Dhuyvetter (2010), Dhuyvetter, Bryant, and Blasi (2005), and Lalman and Smith (2001) each focus on the net returns of a preconditioning program but do not examine the profitability of individual practices or bundles of practices.

Despite past research and Extension programming, relatively few producers adopt value-added production practices. Cow-calf producers are typically risk-averse (Fausti and Gillespie, 2006). Pope et al. (2011) find that as risk aversion increases, producers are less likely to retain calves past weaning. One explanation for this behavior is that cow-calf producers commonly reduce risk by practicing low-cost production methods (Hall et al., 2003).

An abundance of opportunities are available for cow-calf producers to increase revenues; however, like with technology in other agricultural sectors, only those in which the risk-adjusted benefits outweigh the risk-adjusted costs will be adopted. In determining appropriate production and marketing practices to adopt, a producer must weigh several factors, including the likelihood that returns exceed costs

of a given practice. One of the most common concerns that we hear from producers is that they perceive that only a few large producers are receiving premiums from value-added practices. Our goals here are to assess the likelihood that a producer will receive a premium for a given set of value-added practices and compute the likelihood of positive economic returns from adopting those practices. In other words, are "value-added" management practices really value-added? Also, what is the likelihood that they are value-added?

Prior research such as Blank, Forero, and Nader (2009), King et al. (2006), Williams et al. (2012, 2013a), and Zimmerman et al. (2012) each focus on average premiums for value-added practices but do not take into account the fact that the costs may outweigh the premium for some producers. Furthermore, these studies do not consider the likelihood that any one producer will receive a premium. One of the most consistent concerns of producers is that only a few large reputation producers actually receive premiums and that the "little guy" does not.

To estimate the probability of a positive return from value-added management practices, lots of cattle with and without the practice are matched using propensity score matching and then probabilities are estimated using nonparametric methods. Rosenbaum and Rubin (1983) first proposed a propensity score to avoid omitting observations when exact matches are not feasible. Propensity score matching estimates the probability of an observation to be in the treatment group. This probability is the propensity score and observations are matched based on that score.

Propensity score matching has been widely used in consumer research; however, use has been limited in agricultural marketing and farm management. Tauer (2009) used matching to estimate the cost differences in dairy operations with and without the use of growth hormones. More recently, Gillespie (2012) uses propensity score matching to compare the costs of production for organic versus nonorganic cow-calf operations and Williams et al. (2013a) provide point estimates of premiums for value-added management practices using propensity score matching.

Methods and Data

The probability of receiving a positive return from a value-added management practice is one minus the cumulative density function (CDF) of net return evaluated at zero. The probability of receiving a positive return from adopting a practice is defined as:

(1) $$P(Return_i \geq 0) = 1 - F(x_i)$$

where $F(x_i)$ is the cumulative density function of the premium or net return for implementing the value-added management practice or bundle of practices i. Expected or average net return is calculated using a partial budget for each management practice or bundle of practices and the marginal price impact of each value-added practice or bundle of practices. As explained subsequently, hedonic estimations yield the probability that a premium is greater than zero averaged over all lots of cattle; however, we are interested in the probability for an individual producer. For this reason, we use matched pairs to estimate an individual's probability to receive a positive premium or net return for adopting a value-added management practice or group of practices. The marginal price impact of each value-added practice or bundle of practices is re-estimated using a nearest-neighbor method similar to that used by Williams et al. (2013a).

To perform a nearest-neighbor match, a propensity score is needed. Following Williams et al. (2013a), the propensity score for each bundle of practices is estimated as:

$$F(X_i) = \beta_0 + \beta_1 head_i + \beta_2 head_i^2 + \beta_3 avgwt_i$$

$$+ \beta_4 avgwt_i^2 + \sum_{j=1}^{7} \beta_{4+j} color_{ij}$$

(2)
$$+ \beta_{11} Brahman_i + \sum_{k=1}^{2} \beta_{11+k} flesh_{ik}$$

$$+ \sum_{l=1}^{2} \beta_{13+l} gender_{il} + \sum_{m=1}^{2} \beta_{15+m} fill_{im}$$

$$+ \beta_{18} Health_i.$$

where $F(X_i)$ is the propensity score for lot i, $head_i$ is the number of head in the lot, $avgwt_i$ is the average weight of calves in the lot, $color_{ij}$ is

a series of binary variables indicating calf color (black, mixed, red, red mixed, hereford, dairy, white, and other), $Brahman_i$ is a binary variable indicating Brahman influence, $flesh_{ik}$ are binary variables indicating calves' average body condition score, $gender_{il}$ are binary variables indicating calves' gender, $fill_{im}$ are binary variables indicating average stomach fill, and $health_i$ is a binary variable equal to one if the calf appears healthy and zero otherwise.

The marginal price impact of each value-added practice or bundle of practices is re-estimated using a nearest-neighbor method similar to that used by Williams et al. (2013a).

The nearest-neighbor method minimizes

$$(3) \qquad C_i = \min_{j} \|P(T_i) - P(T_j)\|$$

where C_i is the set of controls matched to treated lot i, $P(T_i)$ is the propensity score for treated lot i, and $P(T_j)$ is the propensity score for control lot j (Becker and Ichino, 2002). Following Becker and Ichino (2002), the algorithm in Stata (StataCorp, 2011) used to estimate the propensity scores ensures that all assumptions are met and that the balancing condition applies. The ATE is then estimated as:

$$(4) \qquad \text{ATE} = E(Y_i(1)|T_i = 1) - E(Y_i(0)|T_i = 0)$$

where $E(Y_i(1)|T_i = 1)$ is the expected premium for observation i given that calves have received the treatment and $E(Y_i(0)|T_i = 0)$ is the expected premium for observation i given that the calves in the lot do not have the value-added characteristic. A more detailed description of the matching method can be found in Williams et al. (2013a).

These values are used to generate point (mean) estimates of per-head net returns from individual value-added practices. Additionally, the impact of bundles of practices on the distribution of net returns is considered. The model from Williams et al. (2013a) is reformulated to estimate the marginal impacts of simultaneously adopting two or more practices. For comparison, the hedonic model from Williams et al. (2012) is also re-estimated for bundles of practices using the matched data used to calculate treatment effects. Following Williams et al. (2012), the hedonic model is re-estimated as:

$$(5)$$

$$
\begin{aligned}
Basis_i = {}& \beta_0 + \beta_1 head_i + \beta_2 head_i^2 + \beta_3 avgwt_i \\
& + \beta_4 avgwt_i^2 + \beta_5 Bundle_i \\
& + \sum_{j=1}^{7} \beta_{5+j} color_{ij} \\
& + \beta_{12} Brahman_i + \sum_{k=1}^{2} \beta_{12+k} flesh_{ik} \\
& + \sum_{l=1}^{2} \beta_{14+l} gender_{il} + \sum_{m=1}^{2} \beta_{16+m} fill_{im} \\
& + \beta_{19} Health_i.
\end{aligned}
$$

where $Basis_i$ is the basis for lot i, $head_i$ is the number of head in the lot, $avgwt_i$ is the average weight of calves in the lot, $Bundle_i$ is a binary variable equal to one if the animal has the bundle of characteristics and zero otherwise, $color_{ij}$ is a series of binary variables indicating calf color (black, mixed, red, red mixed, hereford, dairy, white, and other), $Brahman_i$ is a binary variable indicating Brahman influence, $flesh_{ik}$ are binary variables indicating calves' average body condition score, $gender_{il}$ are binary variables indicating calves' gender, $fill_{im}$ are binary variables indicating average stomach fill, and $health_i$ is a binary variable equal to one if the calf appears healthy and zero otherwise.

Parameter estimates and the associated standard errors for each value-added management practice/bundle as reported by Williams et al. (2013a) represent the average treatment effect over all producers rather than for individual producers. For this reason, any probability calculated using equation (1) results in the probability that the mean return for adoption over all individuals is greater than zero. Rather, the focus of this article is to estimate the probability that an individual producer will receive positive net returns. This is estimated using a nonparametric method.

Partial budgets are developed for individual matched pair. To assign each matched pairs, each lot of cattle is assigned a propensity score as described by Rosenbaum and Rubin (1983). Next, observations are matched based on their propensity score using a method developed by Becker and Ichino (2002). Three sets of matched pairs are included: matches used for calculating

the average treatment effect for all producers (ATE), matches used for calculating the average treatment effect for adopters (ATT), and matches used for calculating the average treatment effect for nonadopters (ATC). Mean net return is calculated as the average over all producers in each group. To estimate the cumulative density functions of returns and premiums for each practice (or bundle of practices), a nonparametric approach is used. For each matched pair of lots, the model adds up the number of times the value-added lot receives a higher price than its nonvalue-added matched lot. Similarly, the returns to cow-calf expenses of the two matched lots are compared.

The probability of a producer receiving a positive premium is calculated as

$$(6) \quad \frac{\text{\# recieving positive premium}}{\text{total \# of matches}}.$$

Similarly, the probability of an individual producer receiving a positive net return is calculated as

$$(7) \quad \frac{\text{\# recieving positive net returns}}{\text{total \# of matches}}.$$

Probabilities are calculated for three value-added management practices, including calves announced as weaned (typically weaned a minimum of 21 days before marketing), vaccinating, and dehorning, and three bundles of practices, including weaning plus vaccinating, weaning plus vaccinating plus dehorning, and a vac-45 preconditioning program consisting of a 45-day preconditioning period, vaccinating, dehorning, and certification.

Data

Data used to create matches include 2973 lots consisting of 22,363 head of cattle (Williams et al., 2012). Data were collected at 16 feeder cattle auctions from October through December 2010, eight of which include Oklahoma Quality Beef Network-certified preconditioned (OQBN) cattle and two are comprised entirely of OQBN cattle (Williams et al., 2012). OQBN is a third-party certification program offered by the Oklahoma Cooperative Extension Service that requires cattle to be weaned a minimum of

45 days, vaccinated, castrated, and dehorned. Information on price, lot size, management practices, and phenotype was collected for each lot of cattle. Producer participation in management practices such as vaccinating, weaning, certification from a preconditioning program, and age and source verification was also collected. To account for cattle price variation over time, a basis is calculated as the difference between the sale price of each lot and the weekly average Oklahoma City price for a 750-pound steer (U.S. Department of Agriculture, Agricultural Marketing Service [USDA-AMS], 2010). Observations with a mean lot weight of less than 300 pounds or greater than 800 pounds, observations with missing data, and observations with recording errors are removed from the data set. The final data set consists of 2762 observations, including 816 OQBN-certified lots and 1946 uncertified lots (Williams et al., 2013a).

Revenue

Two revenues are calculated: a baseline revenue and a management revenue. Baseline revenue is the revenue received by the nonadopters and is computed as price times the observed weight. The price used in calculating the baseline revenue is estimated as the weekly average price for a 750-pound steer in Oklahoma City (USDA-AMS, 2010) averaged over all sale dates in the data set ($113.95/cwt) plus the basis for that observation plus an adjustment for the difference in weight between the adopter and nonadopter estimated by Williams et al. (2013a). The base price adjusted for weight differences between the treated and the control lot is calculated as:

$$
\begin{aligned}
(8) \quad \text{Base Price} = {}& 113.95 + \text{Control Basis} \\
& + ((15.77 * (\text{Sale Wt} - \text{Wt Adj}) \\
& + 0.87 * (\text{Sale Wt} - \text{Wt Adj})^2) \\
& - (15.77 * (\text{Base Wt}) \\
& + 0.87 * (\text{Base Wt})^2)
\end{aligned}
$$

where *Sale Wt* is the weight of the treated lot when sold, *Base Wt* is the weight of the control lot, *Control Basis* is the basis reported for the control group, and *Wt Adj* is defined as:

$$(9) \quad Wt\,Adj = \frac{2\,lbs}{day}$$
$$* (\#\ of\ days\ for\ management\ practice).$$

An average daily gain of two pounds is assumed for both a 45-day preconditioning period (Dhuyvetter, 2010) and a 21-day postweaning period (Price et al., 2003). The management price is calculated as $113.95 plus the basis for treated observations reported for each lot in the data.

The difference between the baseline and management revenue is compared with the cost of implementing each value-added management practice and the probability that practices, singly and in bundles, generate positive returns is calculated.

Costs

In addition to the estimated revenues, the cost of implementing each value-added management practice or practice bundle is needed to create a series of partial budgets calculating the expected net return from implementation. The cost of weaning consists of labor, death loss, interest costs, and feed costs. Because mortality rates peak in the first three weeks after weaning (Kelly and Janzen, 1986), we use a death loss of $1.80 reported by Dhuyvetter (2010) for weaning. Also, following Dhuyvetter (2010), we assume feed costs of $0.85 per day, labor costs of $0.11 per day, and an interest rate of seven percent over a 45-day postweaning period.

Assuming calves are already rounded up (as they would be for weaning), vaccinating requires running them through a chute and administering the vaccine. Published literature estimating the time required to administer a vaccination is unavailable, but based on the authors' experience, vaccinating calves requires an additional 1.5 minutes per head over the time required to corral and sort the calves. Assuming a wage rate of $10/head for workers in the cattle sector in the Southern Plains (U.S. Department of Agriculture, National Agricultural Statistics Service, 2012), the labor cost for vaccinating is $0.25/head. Research has shown that vaccinating calves does not adversely affect death loss (Thurber, Bass, and Beckenhauer, 1977), so no

death loss is assumed for vaccinations. There is an $8.00/head (Lalman and Smith, 2001) charge for the vaccination and supplies. The total cost of vaccinating is $8.25 per head, consistent with the cost reported by Donnell, Ward, and Swigert (2008).

To minimize stress, infections, and weight loss, Hopkins, Neel, and Kirkpatrick (2009) recommend dehorning calves early, preferably before one month of age. Although no published estimates are available breaking down the cost components of dehorning, Hopkins, Neel, and Kirkpatrick (2009) and Rhinehart (2009) both estimate the total cost of dehorning a calf at a young age to be $5/head. For ease of calculating, the entire cost of dehorning is categorized under cost for supplies and medical costs.

In addition to calculating individual costs for weaning, vaccinating, and dehorning, we also calculate the cumulative cost of 1) weaning and vaccinating; 2) weaning, vaccinating, and dehorning; and 3) a certified vac-45 program consisting of weaning, vaccinating, dehorning, a 45-day preconditioning period, and certification. The cost for weaning and vaccinating together includes cumulative costs for supplies and labor. The cost of rounding up and sorting calves is not included because calves must be corralled and sorted to be sold regardless of whether they are vaccinated. The combined cost for weaning, vaccinating, and dehorning has cumulative supplies and medical cost of $13.00/head from the vaccination and dehorning costs described previously and a death loss of $1.80/head reported by Dhuyvetter (2010). A labor cost of $2.56/head includes the marginal cost of $0.25/head for vaccinating described above plus $0.11/head/day for postweaning care.

We follow Dhuyvetter (2010) in calculating the cost for a certified vac-45 preconditioning program. Because producers who choose to precondition typically already have the required facilities, facilities costs are subtracted from Dhuyvetter's total and an adjustment is made to the interest cost according to calf weight. Dhuyvetter's budget was constructed at approximately the same time data for this research were collected and represents an accurate approximation of costs for the time period

and location; hence, no other changes are made.

Example budgets for premiums estimated using a matched-pairs method are presented in Tables 1, 2, and 3 and assume a mean sale weight of 529 lbs from the data set used by Williams et al. (2013a).

Results

The ATE, average treatment effects for the treatment groups (ATT), and average treatment effects for the control groups (ATC) for individual value-added management practices and bundles of practices estimated using a nearest-neighbor matching method are displayed in Table 4. As reported by Williams et al. (2013a), the ATE for weaning, vaccinating, and dehorning are $5.23/cwt, $6.79/cwt, and $5.26/cwt, respectively. The ATT for weaning, vaccinating, and dehorning reported by Williams et al. (2013a) are $4.93/cwt, $5.40/cwt, and $5.36/cwt, respectively. Williams et al. (2013a) report the ATC for weaning as $5.80/cwt, for

vaccinating as $8.02/cwt, and for dehorning as $3.77/cwt.

In addition to the estimates reported by Williams et al. (2013a), we estimated the value of bundles of value-added characteristics. The ATE for weaning and vaccinating together is $4.86/cwt, the ATT for weaning and vaccinating together is $5.25/cwt, and the ATC for weaning and vaccinating together is $4.42/cwt. For comparison, we re-estimated the Hedonic model from Williams et al. (2012) to find the hedonic estimate of three combinations of management practices. Results from this re-estimation are in Table 5. When estimated in a hedonic model, weaning and vaccinating results in a premium of $3.70/cwt as shown in Table 5. Each of these values is less than the sum of the individual premiums for weaning and vaccinating, indicating subadditivity in premiums. The premium received for management practices is reflected only in the price producers receive for their calves but does not account for the cost of adoption. The ATE for weaning, vaccinating, and dehorning as a bundle

Table 1. Prices for Value-added Management Practices for Calves with a Sale Weight of 529 Pounds and Premiums Estimated Using a Matching Pairs Average Treatment Effect (ATE),[a] Average Treatment Effect for the Treatment Group (ATT),[b] and Average Treatment Effect for the Control Group (ATC)[c]

	Wean[b]	Vaccinate	Dehorn	Wean, Vaccinate[b]	Wean, Vac, Dehorn[d]	Wean, Vac, Dehorn, Certify[e]
Baseline returns to cow-calf expenses						
Weaning weight (lbs)	487	529	529	487	487	439
Price ($/cwt)	$116.89	$113.98	$113.98	$116.89	$116.89	$120.60
Prices with value-added practice(s)						
Sale weight (lbs)	529	529	529	529	529	529
Baseline sale price ($/cwt)	$113.98	$113.98	$113.98	$113.98	$113.98	$113.98
Added premium for ATE ($/cwt)	$5.23	$6.79	$5.26	$4.86	$8.78	$12.46
Added premium for ATT ($/cwt)	$4.93	$5.40	$5.36	$5.25	$8.65	$12.59
Added premium for ATC ($/cwt)	$5.80	$8.02	$3.77	$4.42	$9.07	$11.26

[a] The ATE is the treatment effect for all observations and is equivalent to the marginal effect in a hedonic model.

[b] The average treatment effect for the treated (ATT) yields the premium received by producers who adopt a management practice.

[c] The average treatment effect for the control (ATC) is the premium nonadopters would have received for adopting a practice.

[d] Assumes a 21-day weaning period and a weight gain of 2 pounds/day.

[e] Assumes a 45-day weaning period with a weight gain of 2 pounds/day.

Table 2. Expenses for Value-added Management Practices

	Wean[a]	Vaccinate	Dehorn	Wean, Vaccinate[a]	Wean, Vac, Dehorn[b]	Wean, Vac, Dehorn, Certify[b]
Value-added expenses						
Labor ($/head)	$2.31	$0.25		$2.56	$2.56	$5.00
Death loss ($/head)	$1.80			$1.80	$1.80	$1.80
Supplies and medical ($/head)		$8.00	$5.00	$8.00	$13.00	$18.00
Interest ($/head)	$2.34			$2.35	$2.36	$4.85
Feed ($/head)	$17.89			$17.89	$17.89	$38.34
Certification costs ($/head)						$3.00
Total costs ($/head)	$24.34	$8.25	$5.00	$32.61	$37.62	$70.99

[a] Assumes a 21-day weaning period and a weight gain of 2 pounds/day.
[b] Assumes a 45-day weaning period with a weight gain of 2 pounds/day.

is $8.78/cwt; the ATT is $8.65/cwt; and the ATC for weaning, vaccinating, and dehorning is $9.07/cwt. The ATE, ATT, and ATC for weaning, vaccinating, and dehorning together are subadditive as well. Hedonic models re-estimated in this article estimate the range of premiums for weaning, vaccinating, and dehorning as a bundle from –$7.65/cwt for a 350-pound calf to $3.05/cwt for a 650-pound calf. The ATE for certification, weaning, vaccinating, and dehorning together is $12.46/cwt, the ATT is $12.59/cwt, and the ATC is $11.26/cwt. As shown in Table 5, the hedonic premium for certification, weaning, vaccinating, and dehorning

Table 3. Partial Budget Results for Value-added Management Practices for Calves with a Sale Weight of 529 Pounds and Premiums Estimated Using a Matching Pairs Average Treatment Effect for the Control Group (ATC),[a] Average Treatment Effect for the Treatment Group (ATT),[b] and Average Treatment Effect for the Control Group (ATC)[c]

	Wean[d]	Vaccinate	Dehorn	Wean, Vaccinate[d]	Wean, Vac, Dehorn[d]	Wean, Vac, Dehorn, Certify[e]
Baseline returns to cow-calf expenses	$569.27	$602.97	$602.97	$569.27	$569.27	$529.42
Returns to cow-calf expenses with value-added practice(s)						
ATE	$606.30	$630.64	$625.79	$596.07	$611.80	$597.89
ATT	$604.71	$623.29	$626.32	$598.14	$611.11	$598.58
ATC	$609.31	$637.15	$617.91	$593.75	$613.33	$591.54
Net returns from value-added practice(s) ($/head)						
ATE	$37.02	$27.67	$22.83	$26.80	$42.53	$68.47
ATT	$35.44	$20.32	$23.35	$28.86	$41.84	$69.16
ATC	$40.04	$34.18	$14.94	$24.47	$44.06	$62.12

[a] The average treatment effect for the control (ATC) is the premium nonadopters would have received for adopting a practice.
[b] The average treatment effect for the treated (ATT) yields the premium received by producers who adopt a management practice.
[c] The average treatment effect for the control (ATC) is the premium non-adopters would have received for adopting a practice.
[d] Assumes a 21-day weaning period and a weight gain of 2 pounds/day.
[e] Assumes a 45-day weaning period with a weight gain of 2 pounds/day.

Table 4. Premiums for Value-added Management Practices for ATE, ATT, and ATC Using a Matched Pairs Method

Practice Adopted	Average Treatment Effect[b]		Average Treatment Effect for Treated[c]		Average Treatment Effect for Control[d]	
	Estimate	*p* Value	Estimate	*p* Value	Estimate	*p* Value
Weaned[a]	$5.23	≤0.001	$4.93	≤0.001	$5.80	≤0.001
Vaccinated[a]	$6.79	≤0.001	$5.40	≤0.001	$8.02	≤0.001
Dehorned[a]	$5.26	0.001	$5.36	0.020	$3.77	0.037
Weaned and vaccinated	$4.86	≤0.001	$5.25	≤0.001	$4.42	≤0.001
Weaned, vaccinated, and dehorned	$8.78	0.011	$8.65	≤0.001	$9.07	0.070
Weaned, vaccinated, dehorned, and certified	$12.46	≤0.001	$12.59	≤0.001	$11.26	≤0.001

[a] Premiums taken from Williams et al. (2013a).
[b] The ATE is the treatment effect for all observations and is equivalent to the marginal effect in a hedonic model.
[c] The average treatment effect for the treated (ATT) yields the premium received by producers who adopt a management practice (or the discount if they had not implemented the practice).
[d] The average treatment effect for the control (ATC) is the premium nonadopters would have received had they adopted a management practice.

together is $27.88/cwt for 350-pound calves and 3.87/cwt for 650-pound calves.

Table 6 presents the mean difference in basis between matched pairs and the probability that an individual producer will receive a positive premium. The mean calculated ATE for weaning is $5.13/cwt and a producer will receive a positive premium 59% of the time. The mean calculated ATT is $4.93 and the ATC is $5.40/cwt with probabilities of a positive premium 58% and 59% of the time, respectively. These results are similar to the results reported in Table 4 with the difference attributed to an adjustment for differences in weight. The mean calculated ATE for vaccinating is $6.01/cwt, $5.48/cwt for ATT, and $6.56/cwt for ATC with probabilities of 64%, 63%, and 65%, respectively. Similarly, the mean calculated ATE for calves without horns is $6.31/cwt, the calculated ATT is $6.49/cwt, and the calculated ATC is $4.84/cwt with probabilities of 59%, 60%, and 57%, respectively. The calculated ATE for weaning and vaccinating together is $5.36/cwt, the calculated ATT is $5.62/cwt, and the calculated ATC is $5.07/cwt with probabilities of 58%, 59%, and 58%, respectively. Weaning, vaccinating, and dehorning together results in a calculated ATE of $10.98/cwt, a calculated ATT of $10.86/cwt, and a calculated ATC of $11.25/cwt and probabilities of

receiving positive premiums of 67%, 67%, and 87%, respectively. The calculated ATE for a vac-45 program is $12.90/cwt with a probability of a positive premium of 79%, the ATT is $12.98/cwt with a probability of a positive premium of 80%, and the ATC is $12.58 with a probability of a positive premium of 77%.

Table 6 also presents the expected net returns and the associated probability of receiving positive net returns. Expected net returns reflect both the additional premium for adopting the value-added management practice or bundle of practices as well as the cost of adoption. The mean net return for weaning calves is $31.14/head using an ATE, $24.62/head using an ATT, and $39.84/head using an ATC with a probability of positive net returns in 62%, 61%, and 64% of lots, respectively. The probability of negative net returns approaching 40% for weaning combined with the risk-averse nature of cow-calf producers partially explains why fewer than 60% of Oklahoma cow-calf producers (Williams et al. 2013b) sell their calves without first weaning them for at least 21 days.

The expected net return for vaccination ranges from $17.17/head using an ATT to $30.18/head using an ATC with a probability of a positive net return between 0.60 and 0.61 for all three estimates. Dehorning calves garners an expected net return of $27.85/head for

Table 5. Select Results from Re-estimating Hedonic Pricing Models Using Data from Three Matched Samples

Variable	Wean + Vaccinate[a]		Wean + Vaccinate + Dehorn[b]		Certified Vac-45	
	Estimate	p Value	Estimate	p Value	Estimate	p Value
Intercept	47.48	<0.01	220.52	<0.01	−88.01	0.02
Log(head)	2.52	<0.01	−0.57	0.40	3.07	<0.01
Average weight	−11.72	<0.01	−77.08	<0.01	32.60	0.01
Average weight squared	0.46	0.02	6.56	<0.01	−3.37	0.01
Wean + Vac + Dehorn + Cert					165.70	<0.01
Wean + Vac + Dehorn			−128.35	0.04		
Wean + Vac	3.70	<0.01				
Cert	23.46	0.03				
Bundle*weight	−8.76	0.02	51.14	0.02	−56.27	<0.01
Bundle*weight squared	0.79	0.01	−4.76	0.01	4.83	0.00
Red	−4.58	<0.01	−3.51	0.17	−1.23	0.60
Hereford	−5.84	<0.01			−3.79	0.50
White	−3.15	<0.01	−2.17	0.44	−3.78	0.07
Dairy	−23.92	<0.01				
Other	−10.64	<0.01				
Blackmix	−0.58	0.67			−1.53	0.54
Redmix	−4.09	<0.01	−0.46	0.78	−3.13	0.05
Brahman	−4.49	<0.01	1.88	0.38	−3.71	0.01
Heifer	−11.93	<0.01	−9.76	<0.01	−11.18	<0.01
Bull	−2.69	0.34				
Horns	−3.51	<0.01				

[a] Wean + vaccinate = calves that have been both weaned and vaccinated.

[b] Wean + vaccinate + dehorn = calves that have been weaned, vaccinated, and dehorned.

[c] Certified Vac-45 = calves that are certified by a third party to have been weaned a minimum of 45 days, vaccinated, and dehorned.

nonadopters, $15.49/head for adopters, and $16.86/head for all producers, yielding a positive net return 59%, 56%, and 60% of the time, respectively. With 41% of producers losing money from vaccinating calves, many have an incentive to forgo vaccination to avoid losses.

Weaning and vaccinating calves results in an expected net return of $28.44/head for the ATE, $20.90/head for the ATC, and $36.88/head for the ATT. Producers who do not currently wean and vaccinate (ATC) will have a positive net return 59% of the time by choosing to wean and vaccinate their calves, whereas those who already wean and vaccinate their calves (ATT) receive a positive net return 60% of the time.

Calves that are weaned, vaccinated, and dehorned have an ATT expected net return of $37.43/head, $49.18/head for the ATE, and $61.85/head for the ATC. The probability a lot

receiving a positive net return for weaning, vaccinating, and dehorning is 68% using an ATE, 67% using an ATT, and 88% using an ATC. These results suggest that although most producers benefit, those who do not wean, vaccinate, and dehorn their calves are the ones who would receive the highest premium from implementing value-added management practices. Similarly, calves certified in a vac-45 program receive an expected net return of $58.78/head using the ATE. This result is higher than the net return of $47.29 for a 600-pound steer found by Bulut and Lawrence (2007) and the net return of $14.16 found by Dhuyvetter, Bryant, and Blasi (2005). Producers who already participate in a vac-45 program receive an expected net return of $58.84/head using the ATT, and producers who do not yet participate will receive an expected net return of $57.76/head if they choose to participate in a vac-45 certification

Table 6. Average Sale Price Premiums, Net Returns, and Probabilities for Value-added Management Practices

		Weaned	Vaccinated	Dehorn/ polled	Weaned + Vaccinated	Weaned + Vaccinated + Dehorned	Certified Vac-45
ATE[a]	Premium	$5.13 (0.588)	$6.01 (0.644)	$6.31 (0.594)	$5.36 (0.585)	$10.98 (0.674)	$12.90 (0.794)
	(Prob > 0)						
ATT[b]	Premium	$4.93 (0.583)	$5.48 (0.634)	$6.49 (0.596)	$5.62 (0.594)	$10.86 (0.672)	$12.98 (0.800)
	(Prob > 0)						
ATC[c]	Premium	$5.40 (0.594)	$6.56 (0.655)	$4.84 (0.573)	$5.07 (0.575)	$11.25 (0.877)	$12.58 (0.768)
	(Prob > 0)						
ATE[a]	Net return	$31.14 (0.622)	$23.59 (0.595)	$16.86 (0.566)	$28.44 (0.596)	$49.18 (0.682)	$58.73 (0.787)
	(Prob > 0)						
ATT[b]	Net return	$24.62 (0.612)	$17.17 (0.614)	$15.49 (0.563)	$20.90 (0.604)	$37.43 (0.672)	$58.84 (0.793)
	(Prob > 0)						
ATC[c]	Net return	$39.84 (0.635)	$30.18 (0.606)	$27.85 (0.591)	$36.88 (0.587)	$61.85 (0.877)	$57.76 (0.629)
	(Prob > 0)						

[a] The ATE is the treatment effect for all observations and is equivalent to the marginal effect in a hedonic model.

[b] The average treatment effect for the treated (ATT) yields the premium received by producers who adopt a management practice (or the discount if they had not implemented the practice).

[c] The average treatment effect for the control (ATC) is the premium nonadopters would have received had they adopted a management practice.

program. Probabilities of positive net returns for a vac-45 program using ATE, ATT, and ATC are 79%, 79%, and 63%, respectively. Despite the high percentage of producers who would receive a positive net return from participating in a vac-45 certification program, only 14% of producers enroll in a program (Williams et al., 2013b). It interesting to note that the probability of returns for nonadopters is 16% lower than for adopters. This suggests that there may be economical reasons such as risk aversion for nonadoption by some producers.

Conclusions

Published research extensively explores premiums for value-added management practices as a way for cow-calf producers to increase revenue. Others have created partial budgets incorporating the cost of implementing value-added management practices, but none have accounted for the variation in premiums. Given the uncertainty surrounding premiums and the cost incurred to realize each premium, cow-calf producers often question the profitability of implementing value-added management practices. We use a matched-pairs estimation approach to estimate the premiums for bundles of value-added management practices and create partial budgets calculating the expected net return of each management practice and bundle of practices. The probabilities for the estimations are calculated using nonparametric techniques with the matched pairs.

Using a matched-pairs method, the ATE for weaning and vaccinating is $4.86/cwt, the average treatment effect for the treated (ATT) for weaning and vaccinating is $5.25/cwt, and the average treatment effect for the controls (ATC) for weaning and vaccinating is $4.42/cwt. Each estimate for weaning and vaccinating is subadditive. When estimated as a bundle, the ATE for weaning, vaccinating, and dehorning is $8.78, the ATT is $8.65, and the ATC is $9.07. Compared with the sum of the premiums estimated individually, the ATE, ATT, and ATC for weaning, vaccinating, and dehorning together are subadditive. The ATE for a certified vac-45 program is $12.46/cwt, the ATT is $12.59/cwt, and the ATC is $11.26/cwt.

Among individual practices, vaccinating has the highest probability of receiving a positive premium with probabilities ranging from 63% for adopters to 65% for non-adopters. The probability of a lot of cattle receiving a positive premium tends to increase with the number of practices adopted. Nonadopters would receive a positive premium for weaning, vaccinating, and dehorning 88% of the time. Adopters are found to receive a positive premium 80% of the time.

Partial budgets are created for each of the matched pairs to calculate the expected net return of implementing each practice and bundle of practices and their associated probabilities. Weaning is found to have an expected net return of $31.14/head using an ATE, $24.62/head using an ATT, and $39.84/head using an ATC. The associated probabilities of a positive net return for weaning range between 61% and 64%.

We find the expected net return for vaccinating ranges from $17.17/head using the ATT to $30.18/head using the ATC with a probability of a positive net return between 60% and 61%. Dehorning calves yields an expected net return between $15.49/head and $27.85/head with a probability of positive net returns between 56% and 59% of the time; however, this estimate is low because some producers have polled calves and will not incur the additional cost of dehorning.

Weaning and vaccinating results in an expected net return between $20.90/head and $36.88/head with probabilities of receiving a positive net return between 59% and 60%. Weaning, vaccinating, and dehorning calves before selling results in an expected net return of $49.18/head using an ATE, $37.43/head using an ATT, and $61.85/head using an ATC. Regardless of the estimation method for the premium, the probability of receiving positive net returns is close to 70% under our cost assumptions with the ATC estimate approaching 88%. Similarly, calves certified in a vac-45 program receive an expected net return of $58.73/head using an ATE, $58.84/head using an ATT, and $57.76/head using an ATC and probabilities of positive net returns near 80% for the ATE and ATT estimates.

The results in this research have important implications for cow-calf producers and extension

educators. Results suggest that producers who at least wean, vaccinate, and dehorn their cattle will see positive economic returns over 70% of the time. The expected net returns and the probability of positive net returns increase with the number of value-added practices adopted. By simply weaning and vaccinating their calves, producers realize an expected net return of $28.44/head. They could gain an additional $30.29/head over weaning and vaccinating by participating in a certified vac-45 preconditioning program (calves certified by a third party to be preconditioned for a minimum of 45 days, vaccinated, and dehorned). Producers who currently implement none of these practices will receive an expected net return of $57.76–61.85 per head by choosing to wean, vaccinate, and dehorn their calves or participate in a vac-45 preconditioning program. For a small producer selling 25 head, that translates into an extra $1546.25 in net returns by weaning, vaccinating, and dehorning their calves.

Although previous research has reported increases in cattle prices and profits for producers who certify their calves in a vac-45 program and market them as such, the majority of producers still choose not to adopt value-added management practices. With probabilities of positive net returns for nonadopters of 88% calves that are weaned, vaccinated, and dehorned but not certified, this research provides valuable information that should provide an incentive for value-added practice adoption by risk-averse cow-calf producers and confirms that value-added management practices really do add value to calves.

References

Avent, R.K., C.E. Ward, and D.L. Lalman. "Market Valuation of Preconditioning Feeder Calves." *Journal of Agricultural and Applied Economics* 36(2004):173–83.

Becker, S.O., and A. Ichino. "Estimation of Average Treatment Effects Based on Propensity Scores." *The Stata Journal* 2(2002): 358–77.

Blank, S.C., L.C. Forero, and G.A. Nader. "Video Market Data for Calves and Yearlings Confirms Price Discounts for Western Cattle." *California Agriculture* 63(2009):225–31.

Bulut, H., and J.D. Lawrence. "The Value of Third-Party Certification of Preconditioning Claims at Iowa Feeder Cattle Auctions." *Journal of Agricultural and Applied Economics* 39(2007):625–40.

Coatney, K.T., D.J. Menkhaus, and J.D. Schmitz. "Feeder Cattle Price Determinants: An Hedonic System of Equations Approach." *Review of Agricultural Economics.* 18(1996):193–211.

Dhuyvetter, K. *Economics of Preconditioning Calves—Outlook for Fall 2010*. Department of Agricultural Economics, Kansas State University. 2010. Internet site: www.agmanager.info (Accessed April 23, 2012).

Dhuyvetter, K.C., A.M. Bryant, and D.A. Blasi. "Case Study: Preconditioning Beef Calves: Are Expected Premiums Sufficient to Justify the Practice?" *The Professional Animal Scientist* 21(2005):502–14.

Donnell, J., C.E. Ward, and S. Swigert. *Costs and Benefits Associated with Preconditioning Beef Calves*. Division of Agricultural and Natural Resources, Oklahoma State University, Stillwater, OK. Oklahoma Cooperative Extension Service Fact Sheet AGEC 247. 2008.

Fausti, S., and J. Gillespie. "Measuring Risk Attitude of Agricultural Producers Using a Mail Survey: How Consistent Are the Methods?" *The Australian Journal of Agricultural and Resource Economics* 50(2006):171–88.

Gillespie, J. "The Economics of Organic Versus Conventional Cow-Calf Production." Southern Agricultural Economics Association Annual Meeting Conference Proceedings. Birmingham, AL, February 4–7, 2012.

Hall, D.C., T.O. Knight, K.H. Coble, A.E. Baquet, and G.F. Patrick. "Analysis of Beef Producers' Risk Management Perceptions and Desire for Further Management Education." *Review of Agricultural Economics.* 25(2003):430–48.

Hopkins, F. M., J. B. Neel, and F. D. Kirkpatrick. *Dehorning Calves*. Agricultural Extension Service, University of Tennessee PB 1684, Knoxville, TN. 2009.

Kelly, A.P., and E.D. Janzen. "A Review of Morbidity and Mortality Rates and Disease Occurrence in North American Feedlot Cattle." *The Canadian Veterinary Journal. La Revue Veterinaire Canadienne* 27(1986):496–500.

King, M.E., M.D. Salman, T.E. Wittum, K.G. Odde, J.T. Seeger, D.M. Grotelueschen, G.M. Rogers, and G.A. Quakenbush. "Effect of Certified Health Programs on the Sale Price of Beef

Calves Marketed Through a Livestock Video-Tape Auction Service from 1995 through 2005." *Journal of the American Veterinary Medical Association* 229(2006):1389–400.

Lalman, D. and R. Smith. *Effects of Preconditioning on Health, Performance, and Prices of Weaned Calves*. Oklahoma State University Extension Fact Sheet F-3529, Stillwater, OK. 2001.

McKinney, D. *Marketing Opportunities Available to Oklahoma Beef Cattle Producers*. Division of Agricultural and Natural Resources, Oklahoma State University. Oklahoma Cooperative Extension Service Fact Sheet ANSI-3288, Stillwater, OK. 2009.

Pope, K.F., T.C. Schroeder, M.R. Langemeier, and K.L. Herbel. "Cow-Calf Producer Risk Preference Impacts on Retained Ownership Strategies." *Journal of Agricultural and Applied Economics* 43(2011):497–513.

Price, E.O., J.E. Harris, R.E. Borgwardt, M.L. Sween, and J.M. Connor. "Fenceline Contact of Beef Calves with Their Dams at Weaning Reducers the Negative Effects of Separation on Behavior and Growth Rate." *Journal of Animal Science* 81(2003):116–21.

Rhinehart, J. "Dehorning: Economically Important but Often Overlooked." *Cattle Business in Mississippi*. Mississippi Cattlemen's Association. Jackson, MS, September 2009.

Rosenbaum, P.R., and D.B. Rubin. "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrica* 70(1983): 41–55.

Schroeder, T.C., J. Mintert, F. Brazle, and O. Grunewald. "Factors Affecting Feeder Cattle Price Differentials." *Journal of Agricultural and Resource Economics* 13(1988):71–81.

StataCorp. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP, 2011.

Tauer, L.W. "Estimation of Treatment Effects of Recombinant Novine Somatotrophin Using Matching Samples." *Review of Agricultural Economics*. 11(2009):411–23.

Thurber, E.T., E.P. Bass, and W.H. Beckenhauer. "Field Trial Evaluation of a Reo-coronavirus Calf Diarrhea Vaccine." *Canadian Journal of Comparative Medicine and Veterinary Science* 41(1977):131–36.

U.S. Department of Agriculture, Agricultural Marketing Service. *KO_LS155*. October 27–December 15, 2010. Internet site: search.ams.usda.gov/mnsearch/mnsearch.aspx (Accessed January 2011).

U.S. Department of Agriculture, National Agricultural Statistics Service. 2012. "Farm Labor." Internet site: http://usda01.library.cornell.edu/usda/nass/FarmLabo//2010s/2012/FarmLabo-05-17-2012.pdf (Accessed May 17, 2012).

Williams, B.R., E.A. DeVuyst, D. Peel, and K.C. Raper. "Reducing Self-Selection Bias in Feeder Cattle Premium Estimates using Matched Sampling." Working paper, Department of Agricultural Economics, Oklahoma State University, 2013a (in review).

Williams, B.R., K.C. Raper, E.A. DeVuyst, D. Peel, D. Lalman, C. Richards, and D. Doye. "Demographic Factors Affecting the Adoption of Multiple Value-Added Practices by Oklahoma Cow-Calf Producers." *Journal of Extension* (2013b):in press.

Williams, G.S., K.C. Raper, E.A. DeVuyst, D. Peel, and D. McKinney. "Determinants of Price Differentials in Oklahoma Value-Added Feeder Cattle Auctions." *Journal of Agricultural and Resource Economics* 37(2012): 114–27.

Zimmerman, L.C., T.C. Schroeder, K.C. Dhuyvetter, K.C. Olson, G.L. Stokka, J.T. Seeger, and D.M. Grotelueschen. "The Effect of Value-Added Management on Calf Prices at Superior Livestock Auction Video Markets." *Journal of Agricultural and Resource Economics* 37(2012): 128–43.