The Economics of Organic Versus Conventional Cow-calf Production

Jeffrey Gillespie
Martin D. Woodin Endowed Professor
Dept. of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, LA, USA
(225) 578-2759
jmgille@lsu.edu

Richard Nehring
Economist
USDA – Economic Research Service
Washington, DC, USA
rnehring@ers.usda.gov

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Birmingham, AL, February 4-7, 2012

The views expressed are the authors and should not be attributed to the Economic Research Service or USDA.

The Economics of Organic Versus Conventional Cow-calf Production

Jeffrey Gillespie and Richard Nehring

Abstract

Costs, returns, and profitability of cow-calf farms that are organic or transitioning to organic are compared with those of cow-calf farms that are non-organic. A method of matching samples is used for the comparison. Results suggest higher cost of organic production due to higher unpaid labor, taxes and insurance, and overhead costs.

Introduction

Organic U.S. beef production has increased over the past decade along with rising consumer demand for the product. Organic beef is increasingly available to consumers mostly through higher-end restaurants and grocery stores, farmers markets, and direct purchase from producers. In 2008, 63,680 beef cows were on U.S. organic farms compared with 13,829 in 2000, an increase of 460% (USDA-ERS, 2011). Though growth has been strong, organic beef continues to represent a small portion of total beef production; in 2008, 32.4 million beef cows calved in the U.S., so organic beef production represented 0.2% of total U.S. beef production that year. This is compared with larger percentages of dairy cows and layer hens being produced as organic in 2008, 2.7% and 1.5%, respectively. Despite the relatively small size of the organic beef segment, alternative beef production systems have received greater attention in recent years as consumers have increasingly demanded natural, local, and/or grass (forage)-fed beef. Producers for these markets are the most likely candidates for the organic market, with many weighing the benefits and costs associated with organic production in making their decisions.

The relatively small organic beef niche along with a paucity of data for organic beef farms likely explains the relatively low level of attention paid by economists to U.S. organic beef production. In 2008, certified organic beef cows were present in 39 U.S. states. The state with the largest number was California, with 13,177 cows, more than twice the number of the second-ranked state, Nebraska with 6,213 (USDA-ERS, 2011). With relatively few farms in each state, few state-level analyses have been conducted, and we are aware of no national profitability studies on the subject. The objective of this study is to determine differences between the costs of U.S. organic beef cow-calf production and those of U.S. conventional beef cow-calf production. We use matching samples to determine these differences.

Requirements for Organic Beef Production

Of the major alternative beef production systems (natural, hormone-free, etc.), production standards for organic are the most stringent. The transition period to certified organic beef production is ≥3 years, a period when the beef production system must be treated as organic, but beef cannot be sold as organic. Since the farm transitioning to organic production is effectively producing as if the farm were organic, the cost structure of the transitioning farmer is likely to be similar to the certified organic farmer. Requirements for U.S. certified organic beef production disallow genetic modification; irradiation of foods; and the use of antibiotics, growth hormones, synthetic pesticides, non-organically grown feed, and processed sewage sludge as fertilizer (Roberts et al., 2007). Any animal treated with antibiotics must be taken out of the organic program. Animals must have access to pasture and the land must have been without chemicals for three years before the resultant feed can be certified as organic. The applicant must prepare written farm plans and undergo audit trials prior to certification (Roberts et al., 2007). These restrictions serve to increase the cost of beef production. To cover the additional costs, a premium price for organic beef must be realized.

Some U.S. cattle farmers opt to raise grass (forage)-fed beef as non-organic rather than producing organic beef. Grass-fed beef, as described by USDA-AMS (2011), is produced without any grains or grain by-products. The animal must have continuous pasture access throughout the growing season and may be fed "hay, haylage, baleage, silage, crop residue without grain, and other roughage sources" (USDA-AMS, 2011). The decision to produce grass (forage)-fed rather than organic beef is likely often due to the stringent requirements of organic production, availability of quality forage throughout much of the U.S., and U.S. consumers' increased interest in grass (forage)-fed beef. It is, however, recognized that grass (forage)-fed beef disallows some feeds, such as grains, that are allowed in organic production.

Few U.S. studies have examined the production economics of organic beef. Harper et al. (2007) estimated costs and returns of a 50-cow California organic beef operation that finished animals to slaughter weight and sold meat rather than live animals. Roberts et al. (2007) estimated total cost of organic beef production to be $612/head. U.S. studies comparing costs of organic and non-organic beef production include Acevedo et al. (2006) and Wileman et al. (2009).Roberts et al. (2007) surveyedU.S. organic beef producers to determine their production characteristics.

Methods

In this study, costs of organic and transitioning-to-organic cow-calf farms are compared directly with those of non-organic farms that are similar in size and structure. Generalizing, for each observation$i$using system W =1 (organic or transitioning to organic), another observation is identified that is similar to firm i, but using system W = 0 (non-organic). This is the basis for the method of matching samples. If $Y_i(W_i)$ is the performance measure (outcome) for firm$i$ for a given system, what is compared are $Y_i(1)$ and $Y_i(0)$, the performance measures of firm i if treated or not treated, respectively.

The method of matching samples has only recently been utilized by agricultural economists (Tauer, 2009). It is useful for cases where there is a binary treatment, such as whether a particular technology has been adopted, and the objective is to determine the treatment's effect on a scalar performance measure, such as profit. Two assumptions are required for effective use of the method (Imbens, 2004). The first is overlap – that the two treatment groups have overlapping characteristics. The second is unconfoundedness – that use of specific characteristics, such as education, farm size, etc., can be used to correct for selection bias. If selection bias cannot be effectively controlled for, then any differences found for the outcome will be biased.

Six major measures of treatment effect can be estimated using matching samples: the population average treatment (PATT) and sample average treatment (SATT) effects for the subpopulation of the treated; the population average treatment (PATC) and sample average treatment (SATC) effects for the subpopulation of the non-treated control; and the population average treatment (PATE) and sample average treatment (SATE) effects, which include all observations, both the treated and the control. Whether population or sample effects should be estimated depends upon whether inference is to be made for another sample that would be drawn from the population, where the population effect would be estimated, or if inference is to be made only for the sample, where the sample effect would be used.

We chose to use the SATT since we are dealing with a small subsample of treated (organic) farmers. Only 0.7% of our sample of U.S. cow-calf farmers was certified organic, so we match treated farmers directly to farmers from the 99.3% (untreated) sample and determine how the organic treatment influenced organic farmers' productivity using ATT measures. The ATC would have matched each of the 99.3% of nonorganic farmers to one of the 0.7% of the sample that were organic farmers.The questionable appropriateness of estimating ATC measures in this case is likewise extended to ATE estimates. Since our treated group is a relatively small subsample of the total sample of cow-calf producers, we do not estimate population effects. The SATT, which we measure, is estimated as follows from Abadie et al. (2004):

(1) $\tau^{sample,t} = \frac{1}{N_1} {}_{i|W_i=1}\{Y_i(1) - Y_i(0)\}$

where N_1 is the number of farms receiving the treatment (organic).

Using matching samples, multiple criteria may be used to match treated with similar untreated observations. If k variables are to be used to identify matched farms, then a $k \times k$ weighting matrix is used to find nearest matches. A $k \times k$ diagonal matrix of the inverse sample standard errors of the matching variables serves as the weighting index. Abadie et al. (2004) and Tauer (2009) provide more extensive discussion of the procedure. In finding the closest matches using this method, nearest matches may still look different from the treated group. In such cases, bias may be reduced by estimating separate regression functions for the treated and untreated groups, with independent variables being the covariates included in matching the samples:

(2) $\mu_\omega(x) = E(Y(\omega) | X = x)$ for $\omega = 0$ or 1.

Following Rubin (1979) and similar to Tauer (2009), we use this bias correction method and refer the reader to those papers for greater detail on the bias-correction procedure. The z-test, which assumes a normal distribution, is used to determine differences in means, with differences considered at level$P \leq 0.10$. Readers interested in using STATA's nnmatch command for the method of matching samples are referred to Abadie et al. (2004).

Data

Phase III 2008 Agricultural Resource Management Survey (ARMS), cow-calf version, data are used to compare performance measures of organic with non-organic beef farms. The data include 1,966 usable observations from 22 U.S. states. Farms included in the survey were chosen from a list of farms held by the USDA-National Agricultural Statistics Service. These farms must have had ≥20 beef cows on the operation during 2008. In 2007, farms with <20 cows represented 53% of U.S. beef farms according to the 2007 U.S. Census of Agriculture, but these farms represented only 10% of the U.S. beef cow inventory. The farms in this sample represent 96% of U.S. beef cow-calf farms having ≥20 beef cows (McBride and Mathews, 2011).

Of 1,966 observations, 14 were classified as organic and 4 were classified as transitioning to organic. Thus, if each organic plus transitioning-to-organic farm was used, then 18 × 2 = 36 observations would be used for the analysis. We match farms in three ways: (1) with only one match each; (2) with two matches each, resulting in 54 observations; and (3) with four matches each, resulting in 90 observations. The use of several numbers of matches is consistent with Uematsu and Mishra (2011), who used propensity score matching; Tauer (2009) used four matches. The advantage of using one match for each farm is that the farm closest by the selection criteria to the treated farm is compared to the treated farm. The advantage, however, with more matches is that an "average" of more farms may reduce the influence of performance measures that are effectively outliers not accounted for by the selection criteria. This is likely to be particularly important in cases of relatively small sample size.

Performance Measures for Comparison

We examine a number of cost measures using matching samples. Cost measures developed by William McBride with USDA-Economic Research Service are for the beef enterprise alone. All measures were estimated on per-cow basis, with the number of beef cows being the maximum number present on the farm during 2008. Variable cost measures on per-cow bases include: *Total Feed Cost, Purchased Feed Cost, Veterinary and Medicine Cost, Marketing Cost,* and *Total Operating Cost*. *Total Operating Cost* includes costs for feed, cattle for backgrounding, veterinarian and medicine, bedding and litter, marketing, custom services, fuel, lube, electricity, repairs, and interest on operating costs.

Allocated overhead cost measures on per-cow bases include: *Hired Labor, Opportunity Cost of Unpaid Labor*, *Capital Recovery of Machinery and Equipment*, *Opportunity Cost of Land*(rental rate)*, Taxes and Insurance, General Farm Overhead,* and *Total Allocated Overhead. General Farm Overhead* includes electricity, utilities, farm supplies, maintenance and repair of buildings, vehicle registration and licensing, fees paid for services, and general business expenses. *Total Cost* is the sum of *Total Operating Cost* and *Total Allocated Overhead. Net Return over Total Cost* is *Total Cattle Sales* less *Total Cost. Net Return over Operating Cost* is *Total Cattle Sales* less *Total Operating Cost.* Cost measures are examined for both certified organic only and combined organic + transitioning farms, as transitioning farms would be expected to have similar cost structures to organic farms since they use similar inputs.

Variables Used for Matching Organic with Conventional Farms

Using matching samples, some variables can be designated for exact matches. We chose five variables for exact matching: (1) farm resource region in which the farm resided (Figure 1); (2) state in which the farm resided; (3) farm size category as <100 Cows, 100 ≤ Cows < 200, 200 ≤ Cows < 400, or ≥400 Cows; (4) whether the farm backgrounded calves past weaning; and (5) whether the farm finished cattle to slaughter weight. Since location, farm size, and participation in segments downstream from the cow-calf segment were considered critical for effective matching of organic with conventional cattle farms, these variables were chosen for exact matches. The option to choose variables for exact matches is one of the advantages of this method versus traditional propensity score matching, as used by Uematsu and Mishra (2011), who compared organic versus conventional crop farms. Using traditional propensity score matching, a probit model is generally used to estimate predicted probabilities of inclusion / non-inclusion; “included” observations are matched with “not included” observations that have the closest predicted probabilities of adoption, so exact matches are not accommodated.

In addition to the exact-match variables, variables chosen that did not require exact matches were: (1) maximum number of beef cows on the operation during 2008; (2) number of acres operated; (3) whether the farmer was >55 years old; (4) whether the farmer held a 4-year college degree; (5) whether the farmer had adopted ≥3 of nine technologies and management practices includingartificial insemination, embryo transfer and/or sexed semen, regularly scheduled veterinary services, use of a nutritionist to design rations and/or purchase feed, forage testing, keeping individual animal records, use of a computer to manage cow-calf record-keeping, use of the internet for beef cow-calf information, identification of animals as belonging to the operation, and use of a calving season; (6) whether the farmer utilized a rotational grazing system; and (7) whether the farmer utilized improved pasture. These factors ensured that matched farms would be selected on the basis of farm size, which affects cost structure; farmer demographics, which influence a farmer’s ability to effectively adopt new systems and corrects for selection bias; and adoption of technologies and systems, which influence costs.

Results

Table 1 presents means of performance measures in cases where one match was made for each treatment farm. The most significant *Operating Cost* was for feed, about 70% of *Operating*

Cost. The largest *Allocated Cost* category was for unpaid labor, about 61% of *Allocated Cost*. *Capital Recovery Cost* was also a significant portion of *Allocated Cost*.

Of interest in using matching samples is how well matched the farms are. In examining variables used for exact matching, one match per treatment farm resulted in 89% being exact. Exact matches were found for all observations on resource region, size category, whether backgrounding was conducted, and whether animals were raised to finishing weight. In two cases, exact matches were not found for the state where the operation was located. In both cases, however, the matched farm was in a state neighboring the treatment farm. Since a matched farm in a neighboring state may be closer in distance, structure, and environment than a matched farm in the same state, this did not yield great concern. When two matches were used, 83% of the organic + transitioning matches were exact. When four matches were used, 76% of the organic + transitioning matches were exact. We tried using eight matches per observation, but in that case, only 67% of the organic and organic + transitioning matches were exact, respectively. While including more than one match per farm has the advantage of "averaging out" performance measures in cases of outliers, a downside is that fewer exact matches can be expected.

Table 2 presents the means of selection variables used in the matching analyses for both the treated (organic) and matched samples. Overall, differences between the organic and matched samples show organic samples more likely to be >55 years old, slightly smaller-scale, greater adopters of technology and improved pasture, and keeping higher percentages of heifers as replacements. It is noted that the average size of organic farms in this group was 169 cows, compared with 102 for all farms in the 2008 ARMS cow-calf survey (McBride and Mathews, 2011). A priori, these differences could point toward higher cost (improved pasture, higher replacement rates, lower scale economies) for organic + transitioning treatment farms. The higher costs associated with improved pasture have been shown by Boucher and Gillespie (2011): cow-calf cost of production using improved pasture was estimated to be $255 / cow higher than cost of production using unimproved pasture. Though the differences between organic and matched samples were not great, differences underscore the challenges associated with identifying close matches – with 1,948 non-organic, non-transitioning farms available to match to 18 organic + transitioning farms, sample differences remained. The bias adjustment regression was used to reduce bias that might have resulted from dissimilar matching farms.

Results of the Matching Analyses

Results of analyses of differences between treatment and matched samples are shown in Table 3. Differences in *Total Operating Costs* were not found. Despite initial expectations of higher *Feed Costs* for organic farms, significant differences were not found. This is likely due to the almost exclusive use of pasture forage systems for cow-calf production. Even in cases where animals were fed to slaughter weight in the Acevedo et al. (2006) study, feed cost differences were not great in comparing organic grass-fed with natural grass-fed: an8% difference. Roberts et al. (2007) found that only 20% of organic beef producers purchased organic feed in 2002, with most of the feedstock homegrown.

The most significant differences between treated and matched farms were with *Allocated Costs*. *Unpaid Labor Cost* was estimated to range from $152.80 - $162.22/cow higher for organic farms than had the farms been conventional. Higher labor costs for organic production are expected due to increased labor and management requirements: organic systems generally require more labor since pesticides cannot be used and other restrictions limit the use of labor-saving practices. Our results do not suggest that greater paid labor was used, but that increased labor requirements were conducted by unpaid (likely family) labor. Organic production has been widely reported to be more labor-using than conventional, with studies using ARMS data showing this to be the case for other enterprises: McBride and Greene (2009a) for organic relative to conventional soybeans, McBride and Greene (2009b) for organic relative to conventional milk production, and Uematsu and Mishra (2011) for organic crop production.

Tax and Insurance Costs were estimated to be \$16.43 - \$21.33/ cow greater for organic production than would have been the case had the farms been conventional. Property taxes and insurance are estimated based upon the gross margin of the cow-calf enterprise relative to the whole-farm. *Overhead Costs* were also higher for organic than had the farms been conventional, by \$36.65 - \$46.77/cow.

We first rule out several potential reasons why taxes, insurance, and general overhead would be greater for organic farms. Our farms were generally matched within the same states, so different state property tax codes would not explain the difference. We would not initially expect large differences in insurance on machinery and equipment between organic and conventional beef production, particularly since similar production systems were matched. *Capital Recovery Cost* did not differ significantly between organic and conventional, though non-significant differences were positive and rather large, suggesting if there were differences in machinery and equipment values, they would likely be higher for organic. Acevedo, Lawrence, and Smith (2006) did not indicate differences in machinery, equipment, and housing between organic and natural beef systems. No differences were seen in farm specialization in beef, so greater allocation of general farm expenses toward or away from beef would not explain the difference. Differences were not found in grazing intensity by organic / conventional status.

We attribute differences in taxes and insurance expenses to higher insurance rates for greater numbers of higher-valued animals and inputs: organic farmers used more improved pasture, were greater technology adopters, and kept more replacements. Though the latter may not differ greatly from conventional production in the future as the organic industry matures, greater replacement rates were characteristic of organic farms during 2008. Uematsu and Mishra (2010) found higher insurance costs for organic relative to conventional crop producers. We attribute differences in overhead expense to be the result of increased general business expenses associated with organic production: transaction costs associated with securing specialized organic inputs, the annual organic certification fee, and increased record-keeping expenses.

Overall, considering higher unpaid labor, taxes and insurance, and overhead costs per cow for organic, as well as positive but non-significant differences in other expenses such as capital recovery cost, *Allocated Cost* for organic $245.05 - $276.55/cow higher for organic than had the beef enterprises been conventional. These results suggest the organic beef enterprise must realize substantially greater returns to cover fixed expenses than if the farm had been conventional. To gain perspective on additional revenue required by the organic beef enterprise to cover *Total Costs*, our organic beef enterprises had higher costs of $269.26 - $476.52/cow than if they had been conventional.

Conclusions

Comparisons of costs among production systems can present challenges in cases where there are relatively few farmers producing under one system. Though experimental data has strong advantages, it is expensive to collect, specific to the location(s) where it is collected, and may not fully represent farmers' actual production practices. An alternative is to compare farms using both systems by matching farms that are similar in all ways except for the system of interest. We use the method of matching samples to compare organic + transitioning with conventional cow-calf farms. By matching organic farms with other farms similar in size, structure and producer characteristics, differences that might accrue due to selection bias, economies of size, or land productivity can be minimized such that comparisons can be made.

The significant differences in costs between organic and conventional beef production were for unpaid labor, taxes and insurance, and overhead. All were higher for organic than conventional production. The difference for unpaid labor was as expected, given the nature of organic markets and increased labor associated with organic agricultural production. The latter two, however, are likely due to the structure of most organic relative to conventional beef farms: insuring higher-valued inputs (and *more* inputs in the case of replacements) and the greater general business expense associated with organic farming. Cost of production during 2008 was several hundred dollars per cow greater for organic farms than had the farms been conventional. If one 500-lb calf is assumed to be sold per cow, then the premium the farmer must receive to cover the additional cost ranges from \$269.26/500 lbs = \$0.54/lb to \$476.52/500 lbs = \$0.95/lb in order to cover the added costs of organic production.

More discussion on the number of matches to be chosen is warranted. In our case, five performance measures showed significant differences, each under all four matching rules. Estimates differ depending upon the number of matches, usually by only a few dollars, but sometimes the differences are more substantial. For instance, the difference in *Total Cost* for organic versus conventional farms when moving from one to four matches was \$207.26. Inferences using the method of matching samples can depend upon the number of matches assumed. We found little guidance in selecting the number of matches, as this is left to the investigator depending upon the data. In our case, more matches led to fewer matches on variables for which we desired exact matching, to the point where only about two-thirds of the matches would have been exact had we reported eight matches. We recommend carefully considering the nature of the data, including variability of each of the variables of interest and whether outliers are present in the performance measures when selecting the number of matches.

References

Abadie, A., Drukker, D., Herr, J.L., Imbens, G.W., 2004. Implementing matching estimators for average treatment effects in Stata. The Stata J. 4, 290-311.

Acevedo, N., Lawrence, J., Smith, M., 2006. Organic, Natural, and Grass-fed Beef: Profitability and Constraints to Production in the Midwestern U.S. Iowa Beef Center and Leopold Center at Iowa State University. Special Report, August.

Boucher, R., Gillespie, J., 2011. Projected Costs and Returns for Beef Cattle and Associated Forage Crop Production in Louisiana, 2011. A.E.A. Information Series No. 274, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center.

Imbens, G.W., 2004. Nonparametric estimation of average treatment effects under exogeneity: A review. Rev. Econ. Stat. 86,1: 4-29.

Harper, J.M., Klonsky, K.M., Livingston, P., 2007. Sample Costs for a 50-head Organic Cow-calf Operation in the North Coast Region of California (Mendocino and Lake Counties). Publication 8282, University of California, Division of Agriculture and Natural Resources.

McBride, W.D., Greene, C., 2009. Costs of organic milk production on U.S. dairy farms. Rev. Agric. Econ.31, 793-813.

McBride, W.D., Greene, C., 2009. The profitability of organic soybean production. Renewable Agric. Food Syst.24,276-284.

McBride, W.D., Mathews, K., 2011. The Diverse Structure and Organization of U.S. Beef Cow-calf Farms. Economic Information Bulletin #73, USDA Economic Research Service, March.

Roberts, C., Spurgeon, C., Fowler, J., 2007. Characteristics of the United States Organic Beef Industry. Report 67, Range Improvement Task Force, New Mexico State University.

Rubin, D.B., 1979. Using multivariate matched sampling and regression adjustment to control bias in observational studies. J. Am. Stat. Assoc. 74, 318-328.

Tauer, L.W., 2009. Estimation of treatment effects of recombinant bovine somatotropin using matching samples. Rev. Agric. Econ. 31, 411-423.

Uematsu, H., Mishra, A., 2011. Are Organic Farmers Really Better Off than Conventional Farmers? Paper presented at the annual meetings of the Agricultural and Applied Economics Association, Pittsburg, PA, July.

U.S. Dept of Agriculture, Agricultural Marketing Service. Grass Claim Marketing Standards. http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateN&navID=GrassFedMarketingClaimStandards&rightNav1=GrassFedMarketingClaimStandards&topNav=&leftNav=GradingCertificationandVerfication&page=GrassFedMarketingClaims&resultType=&acct=lss. Accessed November 8, 2011.

U.S. Dept of Agriculture, Economic Research Service. Organic Production Datasets. http://www.ers.usda.gov/data/organic/#statedata, 2011. Accessed November 8, 2011.

U.S. Dept of Agriculture, National Agricultural Statistics Service, 2003. Agricultural Statistics. U.S. Government Printing Office, Washington, DC.

Wileman, B.W., Thomson, U., Reinhardt, C.D., Renter, D.G., 2009. Analysis of modern technologies commonly used in beef cattle production: Conventional beef production versus nonconventional production using meta-analysis. J. Anim. Sci. 87, 3418-3426.

Table 1. Means of Costs per Cow with One Match.

Measure of Interest	Organic + Transitioning Data, 36 Observations
Operating Cost	505.95
Feed Cost	352.27
Veterinary and Medicine Cost	18.84
Marketing Cost	9.81
Allocated Cost	864.42
Paid Labor Cost	25.14
Unpaid Labor Cost	524.34
Capital Recovery Cost	247.99
Land Cost	0.14
Taxes and Insurance Cost	22.01
Overhead Cost	44.80
Total Cost	1370.37
Net Return over Total Cost	-918.32

Table 2. Means of Selection Variables for Organic Treatment Samples and Matching Samples, by Match Size.

Selection Variable	Organic and Transition	Sample Matched to Org & Trans 1 Match	Sample Matched to Org & Trans 2 Matches	Sample Matched to Org & Trans 4 Matches
Senior	0.39	0.50	0.56	0.60
College	0.22	0.22	0.28	0.31
Cows	204.39	225.28	211.31	217.08
Breeder Percent/100	0.05	0.03	0.05	0.04
Adopter	0.56	0.50	0.42	0.47
Improved Pasture	0.50	0.28	0.28	0.26
Replacement Percent/100	0.20	0.13	0.13	0.13
Rotational Grazing	0.72	0.72	0.67	0.71
Acres	2,536.56	3,061.50	3,558.81	3,544.08
Observations	18	18	36	54

Table 3. Impact of Organic Treatment on U.S. Cow-calf Farms Using Matching Samples with Bias Correction, per Cow.

Measure	Average Treatment For the Treated 1 Match	Average Treatment For the Treated 2 Matches	Average Treatment For the Treated 4 Matches
Operating Cost Measures			
Operating Cost			
Estimate	199.97	89.56	24.21
Standard Error	124.41	94.18	82.54
Feed Cost			
Estimate	125.33	30.65	-15.05
Standard Error	95.35	72.16	64.07
Veterinary and Medicine Cost			
Estimate	-4.20	-2.35	0.32
Standard Error	5.57	3.88	3.71
Allocated Cost Measures			
Allocated Cost			
Estimate	276.55 **	251.14 **	245.05 **
Standard Error	134.06	106.27	95.79
Paid Labor Cost			
Estimate	25.71	18.28	18.12
Standard Error	30.11	25.46	36.83
Unpaid Labor Cost			
Estimate	155.26 *	152.80 *	162.22 **
Standard Error	93.03	82.61	79.84
Capital Recovery Cost			
Estimate	27.46	22.46	9.43
Standard Error	42.89	31.31	30.02
Land Cost			
Estimate	0.02	0.02	-0.01
Standard Error	0.03	0.04	0.04
Tax and Insurance Cost			
Estimate	21.33 **	20.94 ***	16.43 **
Standard Error	8.60	7.07	7.27
Overhead Cost			
Estimate	46.77 ***	36.65 **	38.87 ***
Standard Error	16.20	15.20	12.20
Total Cost Measure			
Total Cost			
Estimate	476.52 ***	340.70 **	269.26 **
Standard Error	174.29	148.22	132.65

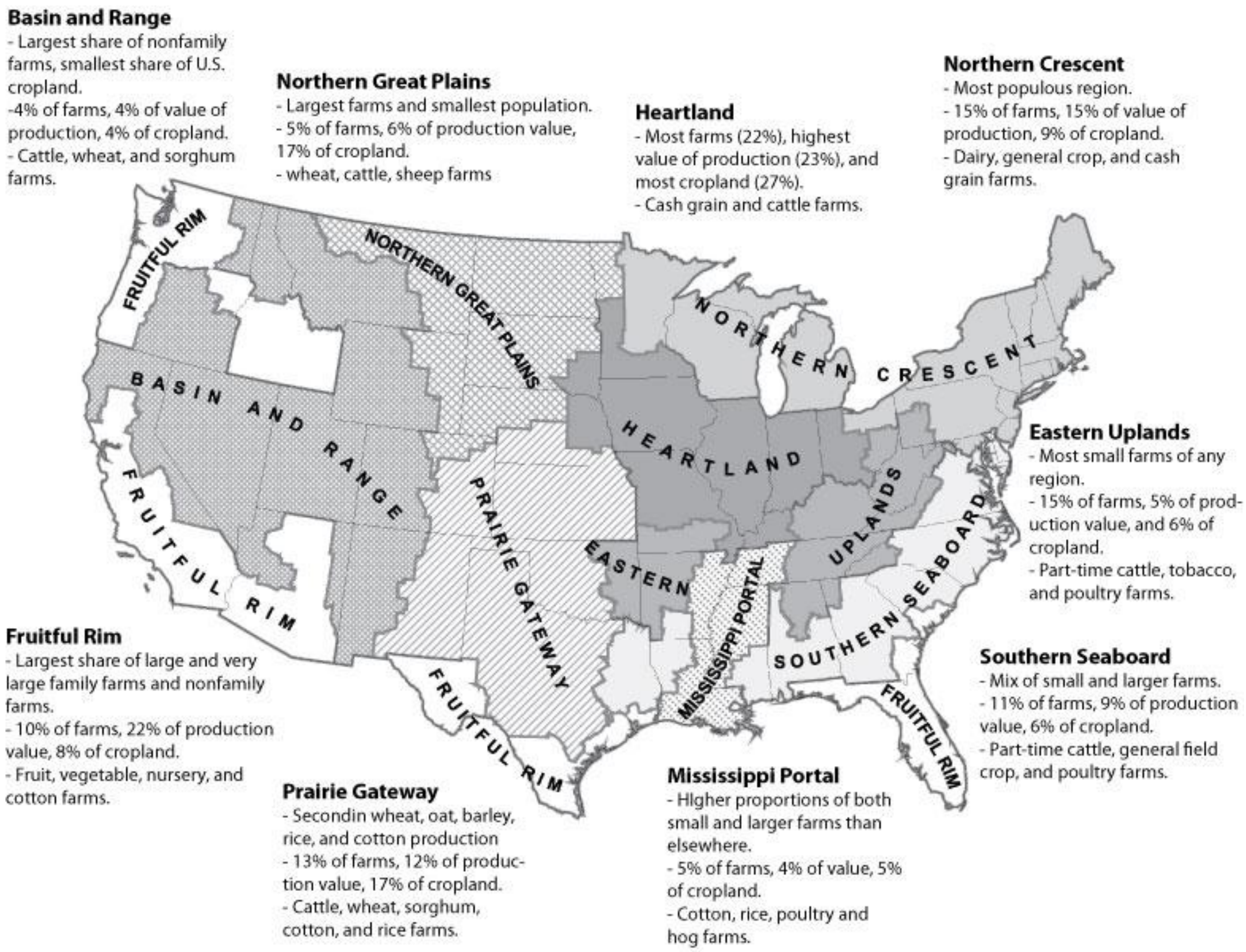

Figure 1. USDA Farm Resource Regions Used in the Agricultural Resource Management Survey.