Women Farm Operators in the U.S. Meat Goat Production: Who is More Productive?

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Abstract

Costs and returns of female-operated meat goat farms are compared with those of male-operated meat goat farms using matching samples. Costs and returns data are used for both whole-farm and goat enterprise-level estimates. Female-operated meat goat farms are matched to male-operated meat goat farms on the basis of operation size, region, farmer demographics, and production systems. Results show for female-operated farms lower meat goat, breeding stock and total farm returns on total bases. On an enterprise basis, results show for female-operated farms, lower total fixed costs per breeding doe; meat goat, breeding stock, and total enterprise returns on total bases; and fixed and total costs on total bases.

Keywords: Gender, meat goat, average treatment effect, matching samples

JEL Classifications: Q10, Q12

Introduction

Women have a growing presence in U.S. agriculture and are operating more farms, ranches, and land, and producing a greater value of agricultural products than in previous years. The percentage of U.S. female-operated farms nearly tripled over the past three decades with an increase from 5% in 1978 to 14% by 2007 (Hoppe and Korb, 2013). From 1982 to 2007, the number of farms operated by women increased from 121,600 to 306,200 with increases in all sales classes. The number of farms operated by men dropped by 220,800 with the only growth in the largest and smallest sales classes (Hoppe and Korb, 2013). The majority of female-operated farms are smaller compared to male-operated farms.

According to the 2012 Census of Agriculture, almost half of female-operated farms specialized in grazing livestock, with nearly 23% of farms specialized in raising beef cattle other than in feedlots, 17% specialized in horses and other equines, and more than 6% specialized in sheep and goats. The meat goat industry is relatively new compared to other livestock industries such as beef, poultry, etc., and is one of the fastest growing livestock industries in the U.S. (Qushim et al., 2015). The average meat goat production operation size is small compared to other livestock operations. Many of these small-size farms are operated and owned by women (Solaiman, 2005).

There have been a few studies analyzing the role of gender in the economic efficiency of agricultural production, but very limited work has addressed the impact of gender in U.S. meat goat production. Of the studies that have investigated gender differences in agricultural productivity and/or in livestock efficiency, all we are aware of have focused on agricultural production in developing countries (Bezabih and Holden 2006; Chavas, Petrie, and Roth, 2005; Gilbert, Sakala, and Benson, 2002; Goldstein and Udry, 2008; Holden, Shiferaw, and Pender 2001; Horrell and Krishnan, 2007; Kinkingninhoun-Mêdagbê et al., 2008; Oladeebo and

Fajuyigbe, 2007; Peterman et al., 2010; Quisumbing, 1996; Thapa, 2008; Tiruneh et al., 2001; Udry, 1996; Udry et al., 1995). Using census data from 1978 through 2007, Hoppe and Korb (2013) examined detailed information about women farmers and the types of farms they operate, and performed statistical comparisons between female-operated and male-operated farms by farm and farmer characteristics.

The U.S. meat goat industry is a comparatively new livestock industry; therefore, there is comparatively limited information available about U.S. meat goat production, specifically factors that can impact meat goat farm efficiency (Qushim et al., 2015). We are unaware of previous studies that have examined gender differences in the efficiency and productivity of meat goat farms in a developed country or in a country where the goat industry is newly expanded such as the USA. However, a recent study by Qushim, Gillespie, and McMillin (2016) examined the economic and farm/farmer specific factors influencing scale, scope, and technical efficiencies of Southeastern U.S. meat goat farms. They found that female meat goat producers were more technically efficient than male producers in both whole-farm and meat goat enterprise.

Females represent a substantial portion of U.S. meat goat production. According to the 2012 Census Agriculture, women are the principal operators of nearly 14 percent of U.S. farms, but their share varies widely by farm specialization. Women operate a disproportionately large portion of sheep/goat farms, about 27% of all U.S farms.

This study investigates a number of questions on gender differences in U.S. meat goat production profitability and productivity. There are a few questions which have not been addressed in previous studies: 1) With respect to costs and returns for goat meat operations and operators, what comparisons can be made, if any, between operations operated by men and those operated by women? 2) How do components related to the costs and returns of goat meat production differ amongst operators that are men and operators that are women? 3) What

measures of productivity and/or managerial efficiencies are there, if any, that could be implemented to highlight any differences and/or stress any similarities extant between those operators that are male and those operators that are female?

The specific objectives of this research are to determine differences in productivity measures such as costs, returns, and profitability of meat goat farms operated by females relative to male operators in U.S. meat goat production.

Previous Studies Examining the Gender Differences in Agricultural Productivity

A number of studies have examined the differences in economic measures between female and male producers in agricultural production. There is much interest in agricultural productivity differences among male and female farmers, particularly in Sub-Saharan Africa. Study estimates in Quisumbing (1996) of gender differences in technical efficiency using a production function showed that male and female farmers were equally efficient farm managers, controlling for levels of inputs and human capital. Studies comparing productivity of female producers versus male producers using data collected in African households have shown significantly lower farm productivity and yield for female-owned plots and female-headed households, accounting for a range of socioeconomic variables, agricultural inputs, crop choices and patterns (Peterman et al., 2010; Quisumbing et al., 2001; and Udry et al., 1995). Recent study by Quisumbing et al. (2014) found that farm yield could increase 20% - 30% if women farmers had equal access to the productive resources possessed by males.

Studies comparing economic measures in agricultural production between female verses male farmers in Africa have not been focused on explaining gender differences explicitly but rather they include gender as an explanatory variable in their analyses (Peterman et al., 2010). By controlling for socioeconomic and input differences, Gilbert et al. (2002) found that crop yield between Malawi female and male farmers was not significantly different. Oladeebo and

Fajuyigbe (2007) found that female rice farmers were more technically efficient compared to male farmers in Osun State, Nigeria. Studies examining differences in female and male farmers using data on agricultural production in African countries include Kinkingninhoun-Mêdagbê et al. (2008), Benin; and Goldstein and Udry (2008), Ghana. Both found productivity and profit differences between male and female farmers explained by scheme membership, access to land and equipment, and the duration of the fallow period.

Other studies have found mixed results on the differences between female and male farmers in agricultural productivity measures when using male-headed household or female-headed household as a gender indicator. Studies found lower productivity measures for female-headed households compared to male-headed households in Ethiopia (Bezabih and Holden 2006; Holden et al. 2001; and Tiruneh et al. 2001). Imposing control on inputs, studies finding no significant productivity differences by gender of household head in Gambia and Nepal include Chavas et al. (2005) and Thapa (2008), respectively. Horrell and Krishnan (2007) found equal productivity measures for female-headed and male-headed households in Zimbabwe.

A recent study using cost and returns data to examine the factors influencing meat goat production technical efficiency and to quantify scale and scope economies for meat goat production in the Southeastern U.S. was Qushim et al. (2016). Qushim et al. (2016) estimated an input distance function for meat goat farms included in 2011 nationwide mail survey of U.S. commercial meat goat producers, finding that female meat goat producers in the Southeastern U.S. region were more technically efficient compared to male producers.

Methodology and Data

Estimation methods such as linear programming models (Peterson, 1955) were among the first approaches used for determining the relative profitability, productivity, and other economic measures of alternative production systems. In addition to linear programming models, research

studies have made direct comparisons of profitability using experimental data (Gillespie et al., 2008), regression analysis to determine the impacts of production systems on profitability (McBride and Greene, 2009), and production frontier analysis to compare efficiency measures (Mayen et al., 2010). Matching methods have increased researchers' ability to compare economic performance of similar farms by matching samples of treated farms with samples of untreated farms (Gillespie and Nehring, 2014 and 2013). The samples of treated farms are those that the system of interest, and the samples of untreated farms are those that do not use the system of interest. Observed covariates such as farm size, region, and other farm/farmer characteristics are used to compare economic performance measures after the samples are matched to one another. In other words, farm i using S=1 system is identified to compare with a similar farm using a different S=0 system for comparison. Then, an economic performance measure $Yi(Si = 1)$ for farm i is compared with $Yi(Si = 0)$. Matching methods are extensive popularity in fields such as economics, political science, and epidemiology since the first applications in the field of medicine with Billewicz (1964) and Cochran (1953).

The method of matching samples is an effective procedure if the following two key assumptions hold. The first key assumption is *unconfoundedness* (Rubin, 1990),

$$(Y_i(0), Y_i(1)) \perp D_i | X_i$$

where the treatment indicator D_i equals one $(D_i = 1)$ if unit or firm i receives treatment and zero otherwise $(D_i = 0)$; the potential outcomes are then defined as $Y_i(D_i)$ for each unit or firm; X_i is a set of observable covariates; $\perp$ denotes independence, i.e. that $Y_i(0), Y_i(1)$ and D_i are independent conditional on X_i. The second key assumption is *overlap*,

$$0 < P(D = 1|X) < 1 ,$$

where $P(D = 1|X) = E[D_i|X_i = x] = \Pr(D_i = 1|X_i = x)$ is the *propensity score* (Rosenbaum and Rubin, 1983).

The combination of these two key assumptions is referred to as *strong ignorability* (Rosenbaum and Rubin, 1983). These two assumptions together can be used to reduce selection bias. Outcome differences will be biased if either assumption does not hold. Using matching samples, six treatment effect measures can be estimated (Abedie and Imbens, 2002; Imbens, 2004): population average treatment of the treated (PATT), sample average treatment of the treated (SATT), population average treatment of the control (PATC), sample average treatment of the control (SATC), population average treatment effects (PATE), and sample average treatment effects (SATE). In making the decision for which treatment effect to use, the researcher must decide whether the inference that is to be drawn is to be applicable for the entire population or for the sample alone. This decision hinges upon whether or not the sample data is a veritable representation of the entire population. If the researcher is of the mind that, if another sample would be drawn from the population, a similar result would be obtained, then the argument could be made that the inference could be applied generally to the population. The researcher must then decide on the appropriateness of linking control observations with treated observations in matched pairs, linking treated observations with control observations, or, if applicable, both methods outlined previously herein. The PATT and SATT match untreated (control) observations to each of the treated observations. The PATC and SATC match treated observations to each of the control (untreated) observations. The PATE and SATE include all observations with all treated and control (untreated) observations being matched to control and treated observations.

For our study, we apply the PATE to compare female-operated meat goat farms with male-operated farms because there are roughly equally numbers of female-operated farms and male-operated farms in our sample (the costs and returns data for U.S. meat goat producers). The PATE is estimated following Abadie et al. (2004) as:

(1) $\tau_P = E\{Y_i(1) - Y_i(0)\}$

For matching farms, x variables and the vector norm $\| x \|_v = (x'Vx)^{1/2}$ are used. V is the positive definite variance matrix. This is an $x \times x$ diagonal matrix of the inverse sample standard errors with the matching variables serving as the weights. The weighting matrix allows for normalization of each of the variables by their standard deviations. Assume that treated farm i has covariate values x and a potential matching control farm has covariate value y. Then $\| y - x \|_v$ is defined to be the distance between vectors y and x with positive definite matrix v. Applying this weighting matrix to all observations determines the nearest match for each observation. For more extensive discussion of these methods, the reader is referred to Abadie et al. (2004) and Tauer (2009).

Using matching samples, selected *M* matched for each treated observations must be at least as close to the treatment observations as the M^{th} match. To reduce bias of average treatment effect measures, we estimate the dependent variable using regression functions for both the treated and control groups, and covariates used in matching the samples serve as the independent variables:

(2) $\mu_\rho(x) = E\{Y(\rho)|X = x\}$ for ρ = zero or one.

For average treatment effect measures, all observations with all treated and control observations being matched to control and treated observations are included in the regressions. To reduce selection bias that might result from differences in the matches, the values of the covariates for each treatment (control) observation are used in the regression to determine predicted values for the matched control (treatment) observations. Therefore, we used the matching method to reduce selection bias by following Abadie et al. (2004), Rubin (1979), and Tauer (2009).

Following the PATE procedure and using the nearest neighbor-matching estimator, we matched both directions: one female-operated meat goat farm with each male-operated meat goat

farm and one male-operated meat goat farm with each female-operated meat goat farm. Robust standard errors were estimated using the Huber-White estimator (Huber, 1967; White 1980).

Data

We collected cost and returns data for 2011 U.S. commercial meat goat procedures during Winter, 2013, using a nationwide mail survey. This cost and return survey was a follow-up to an earlier mail survey which had collected in formation on production technology, marketing, farmer attitudes, and farm/farmer characteristics of U.S. commercial meat goat farms in Summer, 2012. By randomly selecting addresses of these meat goat producers from an extensive Internet search, the first survey was sent to 1,600 producers who advertised their meat goat product online or were members of meat goat production associations. The survey was designed using Dillman's (2007) Tailored Design Method. After sending two surveys and two postcard reminders, a total of 584 completed responses from the earlier survey were received. Our first survey response rate was 43% after adjusting for producers who did not produce meat goats in 2011 and undeliverable surveys.

The last question of the first survey asked producers about their willingness to fill out a second survey on costs and returns of meat goat production. A total of 435 meat goat producers indicated their willingness to fill out the second questionnaire. Two mailings of the second questionnaire were sent to those producers. A total of 124 completed responses were received for the second questionnaire for an effective return rate of 30% after adjusting for incomplete and undeliverable surveys. The second survey asked detailed questions about the farm's revenues and costs. The survey questions closely followed the format of USDA's Agricultural Resource Management Survey. A multiple imputation method was used for the 17 survey responses that were missing a few data points to impute missing information and fully complete those responses. The reader is referred to Qushim (2014) for details on this procedure.

Comparing Performance Measures

Performance measures compared by meat goat farm operator, female and male farmers, include both whole-farm and enterprise measures. Whole-farm measures include *Total Farm Returns, Farm Profit, Net Farm Profit, Farm Gross Margin, Farm Efficiency, Total Farm Expenses, Total Farm Operating Expenses, and Total Farm Fixed Expenses.* These measures are compared on total, per breeding doe, and per land acreage bases. *Total Farm Returns* include the gross value of crops, gross value of hay, gross value of vegetables, gross value of cattle, gross value of meat goats, gross value of other animals, gross value of breeding stock, and gross value of goat meat. *Farm Profit* over total operating cost equals total farm gross return less total operating expenses. *Net Farm Profit* over total cost equals total farm gross returns less total farm expenses. *Farm Gross Margin* is the total farm return minus total operating cost, divided by the total farm return, expressed as a percentage. *Farm Efficiency* is the ratio of total gross return to total variable costs. *Total Farm Expenses* include variable and fixed expenses.

Total Farm Operating Expenses include *Feed, Marketing Charges, Seeds/Plants, Fertilizer, Chemicals, Purchased Goats, Bedding/Litter, Veterinary/Medical, Fuel/Oil, Electricity, Utilities, Supplies, Maintenance on Buildings,* and *Repair on Equipment. Management Services* is the cost of professional or farm management services such as record-keeping, accounting, tax and business planning, farm product advice, conservation practices, etc.; *Cash Wages* are the wages paid to hired farm and ranch labor plus payroll taxes and benefits; *Custom Machine and Hired Labor* is the cost of custom work, performed by machines and labor hired as a unit; and *Cash Value of Non-Cash Payment for Farm Work* is the cash value of feed, farm commodities, fuel, housing, meals, other food, utilities, vehicles for personal use, and other non-cash payment for farm work. These operating cost measures sum to the total operating expenses, with must be covered for the farm to meet short-term financial obligations.

Total Farm Fixed Expenses include *Depreciation, Insurance, Interest/Fees, Vehicle/Licensing Fees, Taxes,* and *Operating.*

Variables Used for Matching Female-Operated and Male-Operated Meat Goat Farms

To match female-operated and male-operated meat goat farms, the following variables are used: 1) farm sizes are included to control for scale effects; 2) production systems are included to control for farm resources and feed sources; 3) farmer demographics are included to reduce selection bias; and 4) geographic regions are included to ensure that matched farms operated in similar environmental conditions. These regional variables are chosen as exact match variables as available using Stata's nnmatch command, which means they are weighted more heavily that the other match variables.

Farmer demographics included in the matching samples were operator age and education level (the operator held a four-year college degree or higher). Conditions that tend to be unobservable but contribute to selection bias (i.e., time constraints, management ability to effectively make timely decisions, or other objectives that impinge upon farm performance) are of concern. The variables of education and age were included to offset selection bias that results from extant differences in conditions that contribute to the introduction of selection bias. Qushim et al. (2015) showed that older U.S. meat goat producers were more technically efficient. Qushim et al. (2014) showed that older and more highly educated Southeastern U.S. meat goat producers were more technically efficient. Gillespie et al. (2009) showed differences in dairy profitability by farmer age. The assumption is that, amongst producers, the levels of education and profit are positively correlated with managerial expertise. Similarly, because of differences in experience, age of facilities, or differences in incentives tied to the family firm life cycle (Boehlje, 1973), one would assume that the profitability levels between older farmers and those of younger farmers would be different. To reduce selection bias, researchers have utilized age and education

variables in their studies of agricultural production systems (Gillespie and Nehring, 2014 and 2013; Mayen, Balagtas, and Alexander, 2010; Uematsu and Mishra, 2012). One must bear in mind that even though we utilize the age and education variables to reduce selection bias, selection bias may not be completely eliminated from the model as there may be unobservable factors contributing to an agricultural producer's decision as to which particular production system is to be adopted.

Farm size variables used for matching the samples included number of acres operated, number of breeding does, percentage of goat sales for breeding stock and show, and percentage of farm income from the goat operation to ensure that matched female-operated meat goat farms were of similar farm size and diversification as the male-operated farms. Land acreage is generally considered to be a primary farm size measure for meat goat operations. Since goats are grazing animals, many farmers establish production operation size based on land acreage. Number of breeding does is the second important farm size by category, which is not directly proportional to acreage depending upon land productivity and production system used.

The following production systems were included to control for the impacts of male-operated versus female-operated farms in determining costs, returns, profitability, and economic measures: use of extensive range and pasture, pasture without rotation, pasture with rotation, and dry lot system. An extensive-range or pasture/woods production system allows goats to browse freely on extensive pasture or rangeland and uses little labor, fertilizer, and capital inputs. The pastured but not rotated production system also required less producer participation in farm production on a daily basis, and lower capital and other inputs are required compared to an intensive production system. Producers using the pastured and rotated production system are generally more heavily involved with their goats on a daily basis. This system generally requires more labor and capital. As an intensive production system, producers have the potential to more

extensively incorporate new technologies and management practices to improve meat goat efficiency. A dry lot system is an alternative production system to the above discussed systems in which producers completely depend on purchased feed, hay, and other supplementary feedstuffs to raise and produce animals. A dry lot production system requires additional labor resources, facilities, faster depreciation of capital assets, and increased maintenance cost.

The U.S. regions have different forage availability, grazing periods, and weather conditions, and require different housing for goat production. Therefore, the U.S. regions were included as exact match variables to ensure that the meat goat farms were producing under similar environmental conditions such as heat, humidity, and forage type; similar economic conditions such as input prices; and similar farm typology, i.e., crop and livestock mixes. Three regional variables: *Southeast, Northeast,* and *West* are included in this study for the matching samples. The Southeastern U.S. region includes AL, AR, FL, GA, KY, LA, MS, NC, Eastern OK, SC, TN, Eastern TX, VA, and WV. The Northern U.S. region includes DE, IA, IL, IN, MD, ME, MI, MO, NH, NY, H, PA, SD, and WI. Western U.S. region includes CA, CO, ID, KS, MT, Western OK, OR, UT, Western TX, and WA.

Meat goat enterprise measures include *Total Enterprise Returns, Enterprise Profit, Net Enterprise Profit, Enterprise Gross Margin, Enterprise Efficiency, Total Enterprise Expenses, Total Enterprise Operating Expenses,* and *Total Enterprise Fixed Expenses.* We used the same specific operating and fixed expenses as for the whole-farm analysis. In the survey questionnaire, for the most of expenses, the respondents were asked to provide the share that was for the meat goat enterprise. We did not, however, request enterprise-specific expenses for the following inputs: *Seeds/Plants, Fertilizer, Chemicals, Utilities, Supplies, Repairs on Equipment* and *Custom Machine and Hired Labor.* In order to estimate enterprise-specific expenses for those input variables, we followed USDA ERS method (USDA/ERS, 2015) where the portion of the

meat goat enterprise total operating cost was calculated as the quotient of the total meat goat enterprise profit (GEP) divided by the total whole farm profit (TFP), or GEP/TFP. To estimate meat goat enterprise-specific expenses for those expenses where farmers were not specifically asked to allocate them to the meat goat enterprise, the whole-farm expenses were multiplied by GEP/TFP.

Results

Summary statistics and parameter definitions for the U.S. meat goat producers are presented in Table 1. The average total acreage for the meat goat farms was 113 with an average of 30 breeding does per farm. Producers' annual net farm income from goat operations was, on average, about 35%. On average, there were almost 8 breeding-aged goats in the extensive range and pasture/wood (not handled much) production system. Producers reported that, on average, there were about 14 and 20 breeding-aged goats in pasture without rotational and pasture with rotational grazing systems, respectively. On average, the lowest number of breeding-aged goats was in the dry lot production system (about 5 per operation). Meat goat farmers sold 33% and 17% of their goats for breeding stock and show, respectively. Most producers had some college or a college degree, on average. The average age of meat goat producers was 40.

Means of measures for U.S. meat goat farms by female-operated and male-operated farmers are shown in Table 2. Thirty-seven percent of the meat goat farms were female principal operators versus 63% male farmers. Thirty-six percent farm production value was produced by female farmers than male farmers with 64%. Enterprise production value was lower to female producers than male farmers with 40% and 60%, respectively. Average number of breeding does per farm were 29 for female-operated farms compared to male farmers with 31 per farm. Numbers of breeding-aged goats in extensive range and pasture production systems were significantly lower in female-operated farms than male-operated farms. However, numbers of

breeding-aged goats in pasture without rotation, pasture with rotation, and dry lot production systems did not differ by operator gender. There were no significant differences among the female and male farmers in terms of percentage of sales for breeding stock and show, and farm income from the goat enterprise. Means suggest that female producers were more likely to hold a 4-year college degree than male farmers. Whole-farm total returns for female farmers were significantly lower than for male farmers.

Tables 3 and 4 provide estimates of per breeding doe, per land acreage, and total economic differences between female-operated and matched male-operated meat goat whole-farms. The base unit is male-operated farms, so negative (positive) signs indicate that the measure was lower (higher) for female-operated relative to male-operated farms. Estimates suggest that there is no difference between female-operated and male-operated farmers in gross returns, profitability, and farm efficiency per acre or per breeding doe. However, in total whole-farm returns, female-operated farms sold lower values of meat goats and breeding stock and realized lower total farm returns.

Among the operating expenses, purchased goats, maintenance on buildings, and custom machine and hired labor were $21.69, $45.87, and $40.28 lower per breeding doe on female-operated farms compared to the matched male-operated farms, whereas utilities expenses were $23.64 higher per breeding doe on female-operated farms. Fertilizer and purchased goat expenses were $13.30 and $16.97 lower per land acreage on female-operated farms compared to the matched male-operated farms. Among fixed expenses, land rental was $19.37 lower per land acreage on female-operated farms compared to the matched male-operated farms. Measures of other expenses did not differ statistically. Among the variable expenses, fertilizer, purchased goats, maintenance on buildings, and custom machine and hired labor were $587.04, $266.77, $896.36, and $326.28 lower in total, respectively, on female-operated farms compared to the

matched male-operated farms, whereas utilities and management services expenses were $412.82 and $232.89 higher in total, respectively, on female-operated farms. Fixed cost expense that was significantly lower for female-operated farms than for the matched male-operated farms was taxes with $619.24 in total.

Tables 5 and 6 provide estimates of per breeding doe, per land acreage, and total economic differences between female-operated and male-operated meat goat enterprises. Measures of gross returns, profitability, and efficiency were not statistically different between female-operated farms and the matched male-operated farm per breeding doe or per acre. However, returns from meat goats and breeding stock, as well as total enterprise returns, were lower for female-operated farms.

Among the operating expenses, fertilizer, purchased goats, maintenance on buildings, and custom machine and hired labor were $9.18, $21.69, $32.11, and $24.12 lower per breeding doe on female-operated farms compared to the matched male-operated farms, whereas utilities expenses were $13.14 higher per breeding doe on female-operated farms. An a per land acreage basis, purchased goats, maintenance on buildings, and custom machine and hired labor were respectively $24.09, $28.87, and $27.35 lower on female-operated farms compared to the matched male-operated farms, whereas utilities expenses were $17.59 per land acreage on female-operated farms. Total fixed expense was $147.33 lower per breeding doe on female-operated farms compared to matched male-operated farms. Among the fixed expenses, interest fees and land rental were $37.32 and $7.53 lower, respectively, per breeding doe on female-operated farms compared to the matched male-operated farms. Measures of other expenses did not differ statistically.

Expenses were $5,431.72 lower in total on female-operated farms compared to the matched male-operated farms. Among the variable expenses, fertilizer, purchased goats,

bedding/litter, electricity, repair on equipment, maintenance on buildings, and custom machine and hired labor were respectively $187.71, $266.77, $72.91, $107.77, $324.52, $799.13, and $158.37 lower in total on female-operated farms compared to the matched male-operated farms, whereas utilities and management services expenses were $251.35 and $125.34 higher in total, respectively, on female-operated farms. Total fixed expenses were $2,497.84 lower in total on female-operated farms compared to the matched male-operated farms. Among the fixed expense that were significantly lower for female-operated farms than for matched male-operated farms were interest/fees, taxes, land rental, and depreciation with $387.60, $382.11, $92.91, and $1,521.37 in total, respectively.

Discussion and Conclusions

Goat farms operated by female producers were compared to those operated by male producers. Despite lower returns per breeding doe or per land acreage, female-operated meat goat farms have lower total production cost, so they were competitive with male-operated meat goat farms. In the current literature, limited work has examined the competitiveness of female-operated meat goat operations on a national basis and compared the specific cost and returns components that allow female-operated meat goat farms to remain competitive. Identifying the areas where female-operated returns are lower-cost and/or costs are higher than those of male-operated meat goat operations can provide insights into how female-operated meat goat farms can become more competitive.

On the revenue side, total farm returns per breeding doe and per land acreage were not statistically significant between female-operated farms and the matched male-operated farms. Total farm returns in total, however, were lower for female-operated farms than the matched male-operated farms. This is because of greater sales of meat goat and breeding stock on male-operated farms. Estimates of these values were significant at the $P \leq 0.05$ level, providing

sufficient evidence to conclude a difference. Goat enterprise returns per breeding doe and per land acreage were not statistically significant between female-operated farms and the matched male-operated farms. However, goat enterprise returns in total were lower on female-operated farms than male-operated farms. We assume that this is because of greater sales of other products (i.e. gross value of animals) on male-operated farms. To test, we compared the value of other farm products (other than goat products) sold. Although the nominal difference in the value of other farm products sold was quite large with sign pointing toward greater sales of other products on male-operated farms, it was not significant at the $P \leq 0.10$ level, providing insufficient evidence to conclude a difference.

Specific whole-farm variable expenses per breeding doe, per land acreage, and in total that were lower on female-operated farms were fertilizer, purchased goats, maintenance on buildings, and custom machine and hired labor, whereas utilities per breeding doe and in total was higher on female-operated farms, and management services were higher in total on female-operated farms. Land rental cost per land acreage and taxes in total were lower on female-operated farms. Goat enterprise operating variable expense numbers were consistent with the whole-farm numbers with female-operated farms achieving lower expenses per breeding doe, per land acreage, and in total. It is, however, worthwhile to note that goat enterprise fixed costs per breeding doe, and fixed and total costs in total were lower for female-operated goat enterprises. When examining from the whole-farm basis, nominal differences were smaller. This is because of lower expenses of interest fees, taxes, land rental, and depreciation on male-operated farms. Estimates of these values were significant at the $P \leq 0.10$ level, providing sufficient evidence to conclude a difference.

Overall, costs and returns comparison matching analysis for the U.S. meat goat whole-farm and enterprise show that variable, fixed, and total expenses per breeding doe, per land

acreage, and in total for female-operated farms were lower than male-operated farms. This is due partially to more intensive production systems being used on female-operated farms compared to male-operated farms.

Overall, results of this matching samples study suggest that the relative competitiveness of female-operated farms depends on increasing the size of their meat goat operations. Qushim et al. (2015) and Qushim, Gillespie, and McMillin (2016) found that increasing returns to scale on U.S. meat goat farms exist so that producers can increase the size of their operations, resulting in less overall input usage per unit produced. This study suggests that extension education could be used by the goat industry to encourage female-operated meat goat farms with significantly lower levels of technology to utilize new technologies and size of operations to improve their farming efficiency and profitability.

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Table 1. Summary Statistics and Parameter Definition for U.S. Meat Goat Producers

Parameters	Definition	Means	Std. Dev.
Farm land	Total acres of farm land	112.55	228.73
Breeding doe	Total number of breeding doe	30.23	32.62
Goat income	% of annual net farm income from goat operations: 1 = <= 19; 2 = 20 - 39; 3 = 40 - 59; 4 = 60 - 79; 5 = 80 - 100	2.70	1.77
Extensive range and pasture	Total number of breeding-aged goats on farm in the extensive-range production system	7.65	30.31
Pasture without rotation	Total number of breeding-aged goats on farm in the pastured but not rotated production system	14.44	30.51
Pasture with rotation	Total number of breeding-aged goats on farm in the pastured and rotated production system	20.10	46.29
Dry lot	Total number of breeding-aged goats on farm in the dry lot production system	4.62	14.64
Breeding stock	% of goat sales for breeding stock	33.05	29.69
Show	% of goat sales for show	17.10	27.34
Education	1 = less than high school; 2 = high school; 3 = some college; 4 = Bachelor's; 5 = Advanced degrees	3.56	1.01
Operator age	Operator age: 1: ≤30; 2: 31-45; 3: 46-60; 4: 61-75; 5: ≥76	2.90	0.93

Table 2. Means of Measures for U.S. Meat Goat Farms Operated by Female and Male Operators

Measures	Female Operated Farm, A	Male Operated Farm, B
Sample characteristics		
Number of observations	41	69
Percent of farms represented	37	63
Percent of value of farm production represented	36	64
Percent of value of enterprise production represented	40	60
Means of variables used for sample selection		
Number of breeding does	29	31
Extensive range and pasture	**1.59 B**	**11.61 A**
Pasture without rotation	17.71	12.29
Pasture with rotation	23.10	18.13
Dry lot	3.09	5.59
Breeding stock	33.48	29.91
Show	18.48	16.27
Income from goat operation	1.24	1.26
Operator education	**3.73 B**	**3.44 A**
Operator age	2.94	2.99
Total farm acres	90.32	127.07
Means of exact match variables		
Northeast region	0.26	0.33
Southeast region	0.39	0.38
West region	0.35	0.29
Means of costs and returns		
Total return of production	**11,417.29 B**	**20,480.88 A**
Total return of goat enterprise production	4,614.92	6,940.74
Total expenses	24,727.64	28,597.20
Total operating expenses	16,906.12	20,377.51
Total fixed expenses	7,803.95	8,170.13
Total goat enterprise expenses	14,701.30	16,714.14
Total goat enterprise operating expenses	10,215.22	12,368.03
Total goat enterprise fixed expenses	4,486.08	4,346.11

Notes: Letters (A, B) indicate significant differences ($P < 0.10$) in means across columns with A = meat goat farms operated by female operators, B = meat goat farms operated by male operators.

Table 3. Estimates of Economic Measure Differences in Female and Male Operators in U.S. Meat Goat Production

Measures	Estimate per Breeding Doe	Std. Error per Breeding Doe	Estimate per Land Acreage	Std. Error per Land Acreage
Whole-farm returns and efficiency				
Gross value of crop	-67.92	85.81	-19.71	14.83
Gross value of hay	129.93	122.40	18.91	23.46
Gross value of vegetable	-3.42	4.58	-0.59	2.03
Gross value of animal	-717.70	878.56	-116.74	81.32
Gross value of cattle	44.67	109.86	-47.31	51.87
Gross value of meat goat	-12.92	31.39	-26.89	41.93
Gross value of breeding stock	-19.12	32.54	-16.36	47.79
Gross value of goat meat	1.93	3.34	-1.06	4.40
Total farm returns	-644.55	895.56	-209.75	138.25
Farm profit	-422.90	856.29	96.57	276.55
Farm net profit	-213.81	783.49	114.53	350.09
Operating inputs				
Marketing Charges	-4.77	7.35	-4.48	9.37
Seeds/Plants	-21.61	18.36	-26.96	24.30
Fertilizer	-26.44	13.87	**-13.30***	7.83
Chemicals	-11.94	11.32	-7.48	10.89
Purchased Goats	**-21.69***	13.15	**-16.97***	8.95
Purchased Livestock	-24.36	26.40	-4.41	17.18
Feed	33.30	60.26	-33.53	89.12
Bedding/Litter	-4.14	6.06	-7.83	8.38
Veterinary/Medical	-13.95	10.53	-14.41	15.55
Fuel/Oil	-31.30	40.56	-65.98	59.99
Electricity	-7.12	23.65	-3.58	32.17
Utilities	**23.64****	9.82	7.27	7.24
Supplies	19.44	35.61	41.38	45.71
Repair on Equipment	-11.66	23.99	-2.45	10.29
Maintenance on Buildings	**-45.87****	22.57	-13.99	16.55
Cash Wages	15.68	31.59	-4.53	8.49
Custom Machine and Hired Labor	**-40.28****	17.18	-29.97	23.44
Cash Value of Non-cash Payment for Farm Work	-54.15	70.59	-106.39	102.64
Management Services	5.57	5.98	1.30	8.40
Total Operating Costs	-221.65	197.32	-306.32	303.08
Insurance	-45.97	65.32	-3.85	16.42
Interest/Fees	-97.41	62.52	6.65	17.46
Taxes	-59.70	40.95	-26.60	29.39
Equipment Rental	-1.28	2.34	-0.31	0.47
Land Rental	-12.74	16.86	**-19.37***	11.34
Vehicle/Licensing Fees	3.13	3.79	1.28	2.07
Depreciation	4.87	111.70	24.27	91.75
Total Fixed Costs	-209.09	197.65	-17.96	127.86
Total Costs	-430.74	333.86	-324.28	387.47

Table 4. Estimates of Economic Measure Differences in Female and Male Operators in U.S. Meat Goat Production

Measures	Estimate Total	Std. Error Total
Whole farm returns and efficiency		
Gross value of crop	-1741.12	1670.30
Gross value of hay	1444.46	1772.23
Gross value of vegetable	-1.26	57.74
Gross value of animal	-4433.09	2967.79
Gross value of cattle	560.59	1744.51
Gross value of meat goat	**-2248.30****	1039.12
Gross value of breeding stock	**-1691.04****	737.11
Gross value of goat meat	104.73	79.71
Total farm returns	**-8005.02***	4423.11
Farm profit	-4065.88	4492.97
Farm net profit	-1969.74	5137.42
Operating inputs		
Marketing Charges	-170.62	134.79
Seeds/Plants	-125.90	266.19
Fertilizer	**-587.04***	312.30
Chemicals	-167.74	210.39
Purchased Goats	**-266.77***	166.55
Purchased Livestock	-560.88	375.77
Feed	-1650.89	1339.59
Bedding/Litter	-66.64	104.05
Veterinary/Medical	-217.40	188.18
Fuel/Oil	-208.76	428.66
Electricity	-95.29	475.99
Utilities	**412.82****	166.34
Supplies	793.41	1075.28
Repair on Equipment	-396.04	380.66
Maintenance on Buildings	**-896.36*****	337.81
Cash Wages	-106.85	744.04
Custom Machine and Hired Labor	**-326.28***	175.77
Cash Value of Non-cash Payment for Farm Work	465.26	830.43
Management Services	**232.89***	125.96
Total Operating Costs	-3939.14	3731.38
Insurance	-174.86	318.49
Interest/Fees	-751.77	647.74
Taxes	**-619.24****	300.77
Equipment Rental	-28.19	46.86
Land Rental	-264.37	233.78
Vehicle/Licensing Fees	18.48	68.87
Depreciation	-276.18	1778.32
Total Fixed Costs	-2096.14	2418.73
Total Costs	-6035.28	5049.28

Table 5. Estimates of Economic Measure Differences in Female and Male Operators in U.S. Enterprise Meat Goat Production

Measures	Estimate per Breeding Doe	Std. Error per Breeding Doe	Estimate per Land Acreage	Std. Error per Land Acreage
Goat enterprise returns and efficiency				
Meat goat return	-12.92	31.38	-70.51	53.84
Breeding stock return	-19.12	32.54	-15.14	59.92
Goat meat return	1.93	3.34	-1.40	5.24
Total enterprise returns	-30.11	45.04	-87.06	87.45
Enterprise profit	86.42	151.88	184.21	236.72
Enterprise net profit	233.76	185.28	1597.11	1835.11
Operating inputs				
Marketing Charges	-2.98	4.62	-4.43	10.22
Seeds/Plants	-13.58	11.27	-21.55	19.84
Fertilizer	**-9.18***	3.07	-10.24	11.38
Chemicals	-3.84	3.06	-5.03	7.08
Purchased Goats	**-21.69***	13.14	**-24.09****	10.45
Feed	81.34	51.63	7.28	62.41
Bedding/Litter	-3.35	3.30	-4.87	3.51
Veterinary/Medical	-11.60	8.58	-11.98	13.76
Fuel/Oil	-35.04	36.60	-66.17	59.35
Electricity	-3.19	4.01	-0.32	5.94
Utilities	**13.14****	5.46	**17.59***	9.43
Supplies	4.85	11.30	2.63	13.71
Repair on Equipment	-6.42	7.33	-2.11	9.13
Maintenance on Buildings	**-32.11****	16.34	**-28.87***	15.53
Cash Wages	-9.68	10.71	-0.12	18.61
Custom Machine and Hired Labor	**-24.12****	11.71	**-27.35***	16.57
Cash Value of Non-cash Payment for Farm Work	-41.61	66.43	-98.59	106.63
Management Services	2.56	2.51	6.96	5.78
Total Operating Costs	-116.53	152.74	-271.27	254.75
Insurance	-15.40	18.65	-15.73	20.28
Interest/Fees	**-37.32***	22.16	-5.82	22.32
Taxes	-34.73	29.16	-23.67	23.06
Equipment Rental	-0.16	0.23	-1.17	2.26
Land Rental	**-7.53***	4.37	-11.18	7.70
Vehicle/Licensing Fees	1.99	2.11	2.48	3.62
Depreciation	-54.18	47.78	-49.25	62.39
Total Fixed Costs	**-147.33***	84.17	-104.37	100.35
Total Costs	-263.87	196.46	-375.65	315.65

Table 6. Estimates of Economic Measure Differences in Female and Male Operators in U.S. Enterprise Meat Goat Production

Measures	Estimate Total	Std. Error Total
Goat enterprise returns and efficiency		
Meat goat return	**-2248.30****	1039.12
Breeding stock return	**-1691.04****	737.11
Goat meat return	104.73	79.71
Total enterprise returns	**-3834.61*****	1413.74
Enterprise profit	-900.72	1700.19
Enterprise net profit	1597.11	1835.11
Operating inputs		
Marketing Charges	-148.06	132.73
Seeds/Plants	-51.90	90.03
Fertilizer	**-187.71***	101.40
Chemicals	-44.28	60.69
Purchased Goats	**-266.77***	166.55
Feed	-922.84	1006.95
Bedding/Litter	**-72.91***	38.48
Veterinary/Medical	-185.27	127.51
Fuel/Oil	-197.11	286.40
Electricity	**-107.77***	65.42
Utilities	**251.35****	97.64
Supplies	101.95	285.73
Repair on Equipment	**-324.52***	175.81
Maintenance on Buildings	**-799.13*****	273.96
Cash Wages	-424.44	454.22
Custom Machine and Hired Labor	**-158.37****	75.24
Cash Value of Non-cash Payment for Farm Work	478.58	581.68
Management Services	**125.34*****	43.08
Total Operating Costs	-2933.89	2149.13
Insurance	-110.14	104.22
Interest/Fees	**-387.60***	212.10
Taxes	**-382.11***	223.60
Equipment Rental	-4.40	4.88
Land Rental	**-92.91*****	31.97
Vehicle/Licensing Fees	0.69	41.96
Depreciation	**-1521.37***	806.96
Total Fixed Costs	**-2497.84****	1015.53
Total Costs	**-5431.72****	2471.43