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**ECONOMICS OF PAST, CURRENT AND PENDING
CHANGE IN THE U.S. SHEEP INDUSTRY WITH
AN EMPHASIS ON SUPPLY RESPONSE**

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**ECONOMICS OF PAST, CURRENT, AND PENDING CHANGE
IN THE U.S. SHEEP INDUSTRY WITH AN EMPHASIS ON SUPPLY RESPONSE**

Wayne D. Purcell, Jeffrey Reeves, Warren Preston*

Introduction

The sheep industry in the United States has suffered a decrease in size unequaled by any other livestock sector. Sheep numbers in the United States declined from 33.2 million head in 1960 to 11.2 million head in 1991. This decline occurred despite government incentive payments for wool and efforts by industry groups to counter the negative trend. Though the inventory has leveled off in recent years, questions about the cause of the prolonged liquidation and the possibility of returning to a growth mode in the future remain unanswered.

Resources used for sheep production can usually be used for other ruminant production or, in some cases, for crops. The reverse, however, is not necessarily true since sheep usually require better fencing and more specialized facilities than other grazing species. However, sheep are more adaptable to poorer pasture conditions than most other ruminants and can therefore utilize some roughage resources other species cannot. Sheep are known to be less resistant to internal parasites, more susceptible to predation from wildlife and domestic pets, and more labor intensive than most other livestock, however (Stillman, Crawford, and Aldrich, March 1989).

Sheep production is unique compared to other livestock since sheep produce two products, meat and wool. Both outputs have different uses and must deal with different competitive products. Genetically, wool and meat production are competitive. Few breeds of sheep are capable of producing both high lamb crops and high-quality wool, and this inconsistency hampers genetic improvement and adaptability to changing lamb and wool markets.

The uniqueness of the sheep industry makes analysis of change within the industry difficult compared to other agricultural enterprises. Historically, few conclusive results have been obtained as to the reasons for changes in sheep numbers within the United States. Gee, Magleby, Neilsen, and Stevens cited predator and labor problems as primary factors influencing contraction. Parker and Pope suggested seasonality of production, high seasonal labor requirements, and predator difficulties as probable causes of the decline in inventories. Predator losses and labor costs can be included in costs of production, however. Budgeted profitabilities for sheep continued to show positive returns to producers during most years of the inventory decline (USDA-ERS, Costs and Returns). The failure of budgeted profitabilities to explain declining inventories suggests that some factor or factors other than predator losses or labor problems have had a significant effect on sheep producers' decisions.

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Problem Statement

There is little specific information regarding the factors influencing the decline in U. S. sheep numbers. This lack of information makes it difficult for industry support groups to develop an effective strategy to reverse the industry decline. The current status of the industry, along with historical changes, and the reasons for those changes, need to be analyzed to provide a base of information for industry policies and programs.

Objective

The purpose of this study is to re-evaluate past studies and historical trends, analyze the current situation, and combine this information into a supply model that explains the decline in sheep numbers.

Procedures

A national survey of the sheep industry was conducted to determine current producer characteristics, attitudes, and plans for the future and to determine which factors influence producers' decisions regarding changes in flock size. The survey was used to compare the importance of these various factors among different demographic groups and across geographic regions to gain insight as to what groups of producers and which specific problems industry leaders should target.

The factors of importance were then incorporated with conventional econometric supply model variables into regional and national models of breeding sheep inventories to obtain parameter estimates of variables affecting sheep production. Models based on data from 1950 to 1988 were used to explain past behavior and to forecast breeding inventories through 1993.

Literature Review

Few studies of supply response exist for the United States sheep industry. Several studies and surveys of the industry have been conducted to attempt to determine the factors causing the decline in inventories. These studies, however, generally do not include statistical modeling efforts. Existing models of U.S. sheep inventories vary in both structure and content with few conclusive results.

The Production and Marketing Administration, along with the Bureau of Agricultural Economics of the U. S. Department of Agriculture, conducted a study of the sheep industry in 1949 to determine the status of the domestic wool supply. The report considered lack of dependable labor, increased labor costs, predation losses, and loss of public grazing lands as key factors influencing the decline in sheep numbers from 1942 to 1950. The study predicted a leveling off of inventories and a gradual increase through 1955, with the increases occurring primarily in Texas and Rocky Mountain states. The study also estimated that approximately 37 million head of sheep were needed for full economic utilization of feed resources particularly suited for sheep. The researchers involved saw cattle as the primary competitive enterprise on sheep farms and ranches. They found returns per animal unit for sheep to be historically higher compared to returns for cattle. They stated, however, that production risk and difficulty in finding competent labor associated with sheep create a non-budgeted cost for sheep producers that influences any comparison of cattle and sheep returns (USDA Bureau of Ag. Econ. 1950).

Gee, et al., conducted a series of four surveys of the sheep industry in 17 western states in the mid-1970s. These surveys were conducted to determine factors causing the decline in inventories which began in 1961. The first survey of a random sample of sheep farmers analyzed producer characteristics. Gee found producers to be in good financial positions with generally diversified operations. Producers' average age, however, was high with over 20 percent nearing retirement. The later three studies included only previously surveyed producers with more than 50 sheep. One survey focused on predator losses. Aggregated budgets for different regions and flock sizes were developed from another survey. The final study involved a survey of former producers in representative states to determine specific factors behind the decline in sheep numbers. Major factors influencing exodus from the industry were low prices, predator losses, and labor shortages. A majority of the former sheep producers remained in farming and shifted to cattle production. Most producers exiting the sheep industry had good equity positions, but their returns were lower than most producers and sometimes below cash costs. U.S. budgets, however, showed positive returns above cash costs of \$4.61, \$3.40, and \$2.24 per ewe on average for 1972, 1973, and 1974, respectively (Stillman, Crawford, and Aldrich, 1989). The largest number of producers exiting the business had less than 1,000 head but the largest percent decline occurred among producers with more than 2,500 head.

In 1982, Parker and Pope conducted an in-depth analysis of the U.S. sheep industry. They discussed several possible factors influencing declining inventories including predation, lack of adequate ovine research, labor shortages, and the inherent seasonality of production of sheep. Parker and Pope perceived a trend toward increased numbers of smaller commercial and purebred farm flocks as demonstrated by increases in breed registrations during the prior decade. They also pointed out the increasing amount of vacant public grazing permits and unutilized resources suited primarily for sheep.

In March of 1989, Stillman, Crawford, and Aldrich completed a study of the current situation of the sheep industry in compliance with the Omnibus Trade and Competitiveness Act of 1988. Their review of the industry dealt primarily with lamb production since the study was conducted to aid in determining the influence of lamb and mutton imports in 1988. Along with findings indicating that lamb imports had no significant impact on domestic prices in 1988, they also suggested several factors that may have influenced the decline in the industry since World War II. Included in these factors were competition for resources with beef cattle, labor difficulties, and predation. Stillman, Crawford, and Aldrich also suggested that sheep required higher returns than similar competitive enterprises to compensate managers for additional management skills and increased labor intensity.

The decline of lamb and mutton imports in the 1960s and 70s concurrent with declining domestic production also suggest declining consumer demand as a possible key factor in decreasing sheep inventories. Though the wool incentive program and returns from wool were included in profit analyses, changes in the wool industry structure and wool imports were not considered. Stillman, Crawford, and Aldrich suggested, however, that the decline in inventories had ceased and that the industry was entering a typical livestock cycle of expansionary and contractual phases.

Gardner developed several models of inventories and wool production in his evaluation of U.S. wool policy. Whipple and Menkhaus developed a supply model for the U.S. sheep industry based on a dynamic framework originally designed to model the U.S. dairy industry (Chavas and Klemme). Whipple and Menkhaus also released a revised model in a study of lamb import policies. Due to the similar biological and pricing cycles of livestock, models of other livestock sectors or of sheep industries in other countries can also be applicable to the U.S. sheep industry and several are included in this review.

Gardner's model of total sheep numbers included lagged inventories as an explanatory variable. Sheep numbers were modeled as a function of inventories lagged one year, time trend, and weighted lagged price variables over the period 1949 to 1979. Lamb and wool prices were combined into a weighted average price in accordance with their relation to total returns. Representation of expectations was incorporated through a four-year weighted lag. This four-year weighting procedure was also used with beef cattle prices and with wool incentive payments to producers. Beef prices were included as a proxy for competitive returns of beef cattle enterprises. Time trend was included to account for unmeasured factors of labor difficulties, predator problems, technological change associated with the sheep industry, and other omitted variables.

Gardner's results implied an elasticity of sheep numbers to the weighted price variable of .30 and a cross elasticity with respect to beef prices of -.19. All variables except time trend were significant and the R^2 was .989. No Durbin-Watson statistic was reported, but the author indicated that autocorrelation was a problem.

Whipple and Menkhaus developed a dynamic model of sheep supply in a capital stock management framework. Whipple and Menkhaus modeled the replacement decision and incorporated these results into a model of stock sheep for each age bracket. Fleece weight and lamb weight were also estimated and combined with identities for stock sheep to determine total output. Data from 1924 to 1983 were used in model estimation.

The model included changes in lambing rates and death loss rates. The number of replacements retained was modeled as a function of lamb price, wool price, and beef price all indexed over alfalfa hay price with lags of two, one, and one year, respectively. Labor price and a measure of the five-year variation in lamb price were also included. Stock sheep were then modeled by adding replacement estimates to estimates of stock sheep. Age cohorts were modeled as a function of lamb price, wool price, and slaughter ewe price indexed over labor prices with lags of one year. Other explanatory variables included were the number of sheep deaths (nonslaughter), hay price, beef price, and a variable measuring the productivity of different age groups in the flock. Live weight of lambs was modeled as a function of lamb price, corn price, and time trend. Fleece weight was modeled as a function of lagged fleece weight, the price of wool, and lamb prices. These models were then combined with stock sheep estimates in identities to determine lamb and wool production.

Whipple and Menkhaus' replacement model results indicated only the lamb-to-hay price and wool-to-hay price ratios were statistically significant, but all variables had theoretically correct signs. The stock sheep model showed higher statistical significance across all variables when compared to the replacement model. Calf price, however, had a positive sign in the stock sheep model, and this is inconsistent with the hypothesis that cattle compete with sheep for resources. The lamb weight equation showed statistical significance and anticipated signs across all variables while the fleece weight model showed significance in only the lagged fleece weight variable. No autocorrelation measures were reported for the models. Elasticities for lamb production with respect to lamb price ranged from .68 in two years to 2.83 in 10 years. The estimated supply elasticity of wool with respect to wool price was .35 in two years and 1.38 in 10. The elasticity of inventories to lamb price was .87 in two years and 3.05 in 10 years. Inventory elasticities in relation to wool price were .32 and 1.34, for the two-year and ten-year time horizons, respectively.

The supply elasticities are relatively high. The .87 for the two-year horizon, for example, suggests that a 1.0 percent increase in lamb prices would, within two years, prompt a .87 percent increase in inventory

numbers. In ten years, over a 3.0 percent increase would develop in response to a 1.0 percent increase in lamb prices.

The model results also appear to have limitations due to the length of time over which estimation was done, the failure to deflate price variables in several models, and the problems of possible multicollinearity that exist among price ratio variables. An updated model presented by Whipple, Menkhaus, and Hewlett in an analysis of lamb import policies using data from 1950 to 1987 changed several explanatory variables. Output-to-hay price ratios were used in both the replacement and stock sheep equations in place of output-to-labor price ratios used previously in the stock sheep equation. Explanatory variables generally had lower or statistically insignificant t-values. The stock sheep model exhibited a mean simulation error of -7.1 percent.

Reynolds and Gardiner developed a dynamic model of Australian sheep inventories in a capital goods framework. Inventory adjustment, turn-off (culling) behavior, and production rate were modeled and combined through simple mathematical identities to establish outputs of lamb and wool for the industry. Changes in wool price were shown to be the primary long-run industry stimulus while lamb and mutton prices dictated short-run changes in flock size and composition. Resource substitution between beef cattle and sheep showed considerable significance, but very little competition between sheep and crops appeared to exist. Changes in seasonal conditions also proved to be of considerable importance in short-run production decisions of producers. Pasture acreage was also found to be a primary factor in determining total production, but was almost totally explained by a measure of seasonal conditions. This model effectively estimated changes in output, but some autocorrelation was obvious. Reynolds and Gardiner's research suggested the presence of greater restrictions on expansion than on contraction in the sheep industry of Australia.

Martin and Haack developed a dynamic model of the U.S. cattle industry based on quarterly data. The model included nested equations estimating stocker cattle price, breeding inventories, heifer and steer slaughter, culling, and carcass weight. Results were then combined into an identity determining total quarterly production. Production was shown to be directly linked to lagged steer and feed prices as far back as four years. Lag structures exhibited both short and long run price effects on inventories and production. Regional modeling, and the inclusion of some measure of seasonal conditions, were suggested as possible improvements to the accuracy of such livestock models.

Previous research regarding livestock supply response thus suggests sheep modeling efforts should include lagged measures of returns, returns for competitive enterprises, input costs, changes in technology, and seasonal factors. Previous models of U.S. sheep inventories have exhibited problems with autocorrelation and a lack of significance among explanatory variables. Modeling efforts used in this study attempted to improve upon previous research and provide for accurate estimation of changes in sheep inventories.

National Survey

A national survey of sheep producers was conducted in the fall of 1988 to obtain information on current producer attitudes and characteristics and to obtain previously unsolicited information on the degree to which various factors may influence producers' decisions regarding changes in flock size. A follow-up survey on labor issues was conducted in June of 1989 to further analyze factors influencing producers' decisions regarding expansion and contraction. The survey forms are provided in Appendix I.

Development of the first or major survey revolved around three goals. The primary goal was to obtain information regarding the influence of various factors such as competitive enterprises, forage conditions, labor and facility availability, capital availability, market conditions, personal preference, and other factors on producers' decisions regarding changes in flock size. The second goal was to obtain information regarding producer attitudes toward the industry and their future plans for their sheep enterprises. The third objective was to obtain demographic information regarding size, location, economic status, and current marketing and production practices among producers to aid in the analysis of responses to other questions. Questions were developed in coordination with the National Wool Growers' Association and The American Sheep Producers' Council.

As with all surveys, a compromise was reached regarding the volume of information obtained and the response rate desired. The survey was limited to four pages to encourage a high response rate. To ensure question clarity and reduce respondent confusion, the survey was field tested informally with several local producers and extension personnel before it was mailed.

Survey Sampling Procedure

A national sample of 1,000 sheep producers was generated from names and addresses obtained from the American Sheep Producers' Council's list of approximately 98,000 producers receiving incentive payments for wool produced in 1987. To obtain a sample representative of sheep numbers and producer concentration, the sampling was first stratified according to sheep numbers. Seventy-five percent of the surveys were allotted to the four Western regions and 25 percent to the three Eastern regions of the American Sheep Producers' Council. The regions used are as follows:

East

- Region 1 - East Coast and Southeastern states;
- Region 2 - Ohio Valley and Great Lake states;
- Region 3 - Midwestern Plains states;

West

- Region 4 - Northern Plains states;
- Region 5 - Texas;
- Region 6 - Rocky Mountain states;
- Region 7 - West Coast and Southwestern states.

After the initial stratification, surveys were allocated based on the number of producers within each region. A random sample of the predetermined number of producers was drawn from each region to make up the sample. The surveys, detail on the regions, and the number of surveys sent to each region along with response rates are presented in Appendices 1-3.

The original mailing contained a cover letter from the American Sheep Producers' Council. A reminder card was mailed one week later. Three weeks after the original mailing, a follow up mailing of a second cover letter and replacement survey was mailed to those who had not yet responded.

Survey Results

An overall response rate of 60 percent was obtained with regional response rates varying from 55 to 65 percent. A total of 530 usable responses was obtained. Surveys returned due to incorrect address and those respondents who returned the survey uncompleted because they had liquidated their sheep enterprise were subtracted from the original sample for response rate calculations. All questions were analyzed by region and selected questions were analyzed by producer size and type categories.

Size Distribution of Sheep Operations

The size and type of sheep enterprises is likely to dominate any strategic planning by industry groups. Table 1 shows the differences in size among regions and between full and part-time producers. Of all producers surveyed, over 56 percent have less than 50 head of breeding sheep and 26 percent have 51 to 299 breeding sheep. The East Coast and Southeastern states and Ohio Valley and Great Lake states have the highest proportion of small producers. The Northern Plains states and Texas have the highest percent of large operations. Almost six percent of Region 4 producers and over 13 percent of Texas producers have more than 1,000 breeding sheep. The largest percent of full-time farmers also have less than 50 head, indicating that the sheep enterprise is secondary to other farm enterprises. Similarly, almost 70 percent of part-time producers have less than 50 breeding sheep. Responses which indicated the producers no longer had sheep were included in the "none" category in Table 1. The "feedlot" entry encompasses those producers who only feed sheep and do not have a ewe flock.

Acreage Distribution of Sheep Operations

Acreage used for sheep follow patterns similar to flock size distribution, with the largest mean private land usage in Texas and the greatest mean public grazing use in the Rocky Mountain region. The smallest average acreage devoted to sheep are in the Ohio Valley and Great Lake states and in the Midwestern Plains.

Proportion of Income Received From Sheep

The percentage of total farm receipts that originate from the sheep enterprise shows moderate regional differences, but practically no difference between full and part-time operations. Nationally, sheep enterprises account for less than 25 percent of total farm receipts for 60 percent of sheep producers. Only 25 percent of producers receive more than 50 percent of their total farm receipts from sheep. Forty-two percent of producers with more than 1,000 head receive more than 75 percent of their total receipts from sheep, while 48 percent of producers with 51 to 999 head receive less than 25 percent of their receipts from sheep.

Table 1. U.S. Breeding Flock Size Distribution by Regions, 1988

Category	Flock Size							Feedlot	None
	1 -50	51 -299	300 -599	600 -999	1000 -2499	> 2500			
(Percentages)									
Region:									
East Coast	78.6	16.6	0	0	0	0	2.4	2.4	
Ohio Valley	84.6	10.3	2.6	0	0	0	0	2.6	
Midwest	62.9	27.4	3.2	0	0	0	3.2	3.2	
N. Plains	35.2	45.1	6.6	2.2	3.3	2.2	5.5	0	
Texas	24.3	35.1	13.5	4.1	10.8	2.7	2.7	6.8	
Rocky Mts.	64.9	21.6	5.4	1.4	2.7	1.4	2.7	0	
West Coast	65.0	19.3	3.6	0.7	0	1.4	6.4	3.6	
Operation Type:									
Full-time	37.7	35.4	11.3	2.4	5.7	3.3	3.3	0.9	
Part-time	69.3	20.5	1.3	0.3	0	0	4.6	4.0	
U. S.	56.3	26.4	5.4	1.3	2.5	1.3	4	2.7	

Source: Original Survey

Distribution of Alternative Enterprises

Since most sheep producers rely on sources of income other than their sheep enterprise, consideration must be given to what enterprises compete with sheep for resources and labor. Table 2 shows the breakdown of alternative enterprises from which sheep producers receive income. As anticipated, beef cattle account for the largest percent of all alternative enterprises. Nationally, over 41 percent of all additional enterprises are beef cattle. Beef cattle account for 38 percent of all other enterprises for sheep farmers with less than 50 sheep, but account for 57 percent of alternative enterprises for producers with more than 1,000 head of sheep.

**Table 2. Regional and Flock Size Distributions of Alternatives to Sheep,
Percent of All Enterprises, 1988**

Category	Beef Cattle	Dairy	Other Livestock	Cash Crops
(Percentages)				
East Coast	52.8	11.1	11.1	25
Ohio Valley	26.3	2.6	15.8	55.3
Midwestern Plains	29.3	4.3	19.6	46.7
Northern Plains	40.4	3.5	16.7	39.5
Texas	54.9	0	23.2	22
Rocky Mountains	40.7	5.1	10.2	44.1
West Coast	44.7	2.6	29.8	22.8
1-50 Head	38.1	4.5	23.2	34.3
51-999 Head	43.7	2.5	15.2	38.6
> 1000 Head	57.1	0	19	23.8
U.S.	41.5	3.6	19.8	35.1

Source: Original Survey

In the Ohio Valley and Great Lake states and in the Midwestern Plains states, beef cattle account for only 25 percent of alternative enterprises for sheep producers. In these two regions, cash crops are the most commonly indicated alternative enterprises. Dairy cattle account for less than four percent of additional enterprises nationally. Only in the East Coast and Southeastern states do dairies make up more than 10 percent of additional enterprises from which sheep producers receive income. Regionally, Texas and the West Coast and Southwestern states have "other livestock" as the second most important alternative enterprise. This category would include swine, poultry, goats, and other relatively minor livestock enterprises.

Proportion of Full and Part-time Producers

Operation type shows significant but anticipated differences across the country, with 41 percent of the nation's sheep producers classifying themselves as full-time farmers. Over two-thirds of sheep producers in the Ohio Valley and Great Lake states and in the West Coast and Southwestern states and over four-fifths of producers in East Coast and Southeastern states consider their farm operation as part-time employment. Only the Midwestern Plains states and Northern Plains states have over 50 percent of their sheep producers full-time farmers.

Distribution of Producer Age and Years In Business

The number of years producers have been in the sheep business shows only small differences from region to region. In the United States, 36 percent of producers have been in the sheep business for more than 20 years while 17 percent have been in the business for less than five years.

Thus, only a moderate influx of new sheep producers has occurred in recent years. Of those producers entering the business within the last 10 years, 73 percent are part-time producers, but only 50 percent of producers in business for more than 10 years are part-time producers. Regionally, the Midwestern Plains states exhibit the largest number of new producers, while 58 percent of Texas' producers have been in the sheep business for more than 20 years. Age distribution of producers shows similar results, with 30 percent of all producers above the age of 60 and 12 percent under the age of 30.

Initial analysis of producer characteristics suggested a logical grouping of producer size categories for further analysis of the remaining questions. Producers with less than 50 head are considered small producers. This size group represents mostly part-time farmers who maintain sheep as a primary or secondary enterprise for personal use or supplementary income.

Mid-size producers were considered to be producers with 51 to 999 head. This category should represent mostly diversified full-time farmers who maintain sheep as a primary, secondary, or tertiary enterprise. The third category, large producers, consists of those producers with more than 1,000 head for whom sheep are most likely a primary enterprise.

Lambing Practices

Lambing seasons vary from region to region, but a slim majority of producers in the United States lamb in the spring. Winter lambing is most popular in the East Coast and Southeastern states while Texas is the only region showing a significant percentage of producers lambing in the fall. Over 90 percent of producers in the East and Midwestern regions lamb in barns or sheds. Almost 76 percent of Texas producers and over 42 percent of producers in the West Coast and Southwestern states lamb on range or pasture. Only 16 percent of large producers lamb under shelter, while 65 percent of mid-sized producers and 82 percent of small producers lamb under shelter.

Lambing Rates

In the United States, the largest group of producers (28 percent) had lambing rates between 1.0 and 1.25 lambs per ewe in 1987, while 26 percent had less than 1.0 lambs per ewe, and 23 percent had more than 1.5 lambs per ewe. The East Coast and Southeastern states had the largest percent of producers with more than 1.25 lambs per ewe, followed closely by the Northern Plains states. Producers in the Midwestern Plains, Rocky Mountain, and Ohio Valley and Great Lake states showed similar distributions of lambing rates. Slightly more than half of the sheep producers in these regions had lambing percentages greater than 1.25 in 1987. Texas was strikingly different from other regions with almost 57 percent of its producers having less than 1.0 lambs per ewe and nearly 90 percent having less than 1.25 lambs per ewe. The West Coast and Southwestern states had 69 percent of their producers with lambing percentages below 1.25 lambs per ewe. Producers with less than 50 head and mid-sized producers had similar lambing rate distributions. Over half of large sheep producers, however, had lambing rates below 1.0 lambs per

ewe. Full-time producers were mostly grouped around 1.0 to 1.5 lambs per ewe while part-time producers were more evenly distributed through all ranges.

Death Loss

Death loss has been considered a major drawback to sheep production since sheep are more prone to sickness and predation than other livestock. Death losses reported in the survey are representative of 1987 and can only serve as a proxy for other years since weather conditions and predation cycles vary between years and regions. The majority of producers in the United States had losses between 0 and 5 percent of all sheep in 1987 and one-fourth had losses between 6 and 10 percent. Six percent had losses between 11 and 15 percent and approximately three percent had losses of 16 percent or more. Death losses appeared to be higher in the East Coast region and in the Northern Plains. Death losses were higher in 1987 for larger producers and for full-time producers.

Causes of death loss were rated by respondents as major, moderate, minor, or none. Values were then assigned and mean values used to compare different factors. Values are: Major=1, Moderate=2, Minor=3, and None=4. The highest rated factor in death losses in the U.S. is unknown causes with a mean value of 2.94. Second is lambs lost to predators with a mean score of 3.14. Losses of lambs and ewes to predators is more significant to producers in Texas and the Rocky Mountain states than in other regions. Lamb loss to starvation or exposure is rated higher in the Northern Plains states than other regions with a mean value of 3.09. Producers with more than 1,000 head ranked lambs lost to predators first with a mean value of 1.7 followed by lambs lost to exposure and ewes lost to predators at 2.5.

Lamb Marketing

Marketing of lambs can also be a key factor in determining profitability. To aid in determining which price series producers would be most familiar with, producers were asked what percentage of lambs were sold as feeders or for slaughter and what percentage was kept as replacements in 1987. In the United States, almost half of all lambs were sold directly to slaughter, approximately one-third were sold as feeders, and approximately one-fifth kept as replacements in 1987. Regionally, almost three-fourths of all lambs were sold as slaughter lambs by breeders on the East Coast and in the Southeast in 1987. Most other regions had slightly over half of all lambs marketed as slaughter lambs except Texas and the Northern Plains. Slightly over half of the lambs in Texas were sold as feeders. In the Northern Plains, approximately two-fifths were sold as slaughter lambs and slightly more than two-fifths were sold as feeders. As producer size increased, so did the percentage of lambs sold as feeders. Replacement rates among the seven regions ranged between 17 and 24 percent of the lamb crop.

The marketing channels used by producers also differ greatly from region to region and among size groups. The most commonly indicated sales method is through stockyards, which accounts for over half of all sale methods used by producers in the United States. Order buyers are second and feeder buyers are the third most popular option. Direct-to-packer sales is fourth followed by electronic marketing. Stockyards are used less in the West Coast and Southwestern states. Electronic marketing has only limited usage, limited primarily to the two Eastern regions. Large producers market through order buyers more than any other option, while mid-size and smaller producers use primarily stockyards to market their lambs.

Wool Production and Marketing

Wool production is known to be more important in western regions and can also be used as a good indicator of mean flock size for a given region. The largest mean wool production per producer is in Texas at 3349 pounds. Texas is followed by the Northern Plains region and then by the Rocky Mountain and West Coast regions. Among the eastern three regions, the Midwestern Plains states had the highest mean production of 536 pounds.

Current Producer Attitudes and Behavior

The current status of the sheep industry and its future greatly depend upon the attitudes of individual producers. Producers' attitudes and beliefs influence all decisions and may be as important as economic influences. Therefore, a major portion of the survey was dedicated to determining producer attitudes and evaluating factors that influence producer decisions.

Wool Incentive Program

To obtain an indication of the effect of the current wool incentive program, producers were asked to indicate whether they agreed, tended to agree, tended to disagree, or disagreed with the following statement: "The wool incentive program is a major factor in my decision to continue my sheep enterprise." Nationally, 40 percent of producers agree with that statement and 69 percent agree or tend to agree. Regionally, Texas has the largest percentage agreeing (nearly 63 percent) while the East Coast has the most disagreeing (almost 29 percent). Seventy-five percent of full-time farmers raising sheep tend to agree or agree with the statement, while 65 percent of part-time farmers agree or tend to agree.

Expansion Plans

Producers were asked about their plans for 1989 and over a 5-year horizon to obtain information for comparison with modeling predictions. Nationally, 20 percent of producers planned on expanding by 10 percent or more in 1989, 18 percent plan on expanding by 1 to 10 percent, 40 percent plan on remaining stable, 8 percent plan on decreasing flock size by 1 to 10 percent, 8 percent plan on decreasing by more than 10 percent, and 6 percent plan on liquidating their sheep enterprises. The Northern Plains had the largest proportion of its producers planning on increasing flock size in 1989. The East Coast and Southeastern states have the largest percentage of producers planning to decrease or drop their sheep enterprise in 1989. Over 44 percent of mid-size producers plan on increasing flock size in 1989 while only 18 percent plan on decreasing. Almost 39 percent of producers with more than 1,000 head plan on expanding but 33 percent plan on contracting. Compared to other size categories, fewer small producers plan on expanding or contracting.

Almost 46 percent of sheep producers plan on expanding by 1993. Both part-time and full-time producers and sheep producers who also have beef cattle indicated plans for expansion. Among the size categories, mid-sized producers have the largest percentage of respondents planning on expansion. Small producers have the lowest percent planning to expand in five years. Regionally, over half of the producers in the Northern Plains plan on expanding by 1993. The East Coast and Rocky Mountain regions exhibit the largest percentage decreasing their flock by 1993. Almost 16 percent of producers in the Rocky Mountain

states plan on selling out in the five years prior to 1993, the highest of all regions. In all, 80 percent of producers plan on maintaining their herd size or expanding by 1993.

Factors Influencing Expansion and Contraction

Factors influencing expansion or contraction of sheep numbers have been sought in several surveys. Due in part to failure of models to explain changes in flock size, and to undeniable changes in producer types and attitudes over time, producers were asked why they had or had not expanded their flocks in the past five years. Specifically, respondents were asked to rate a list of factors regarding their decision to expand or not to expand. Factors could be rated on a scale of 1 to 4 with: 1 = Strong; 2 = Moderate; 3 = Weak; and 4 = None.

The largest percentage of producers expanding over the past five years has been in the Northern Plains and in the Midwestern Plains, with slightly over 50 percent expanding. The regions of Texas, the Rocky Mountains, and the West Coast and South West all had more than 60 percent of their producers contracting or remaining stable over the same time period. The East Coast and Ohio Valley regions both had 50 percent of their producers expanding over the same five years. Fifty-seven percent of mid-sized producers have expanded with the highest percentage being among those producers with 300 to 599 head. Only 21 percent of producers with more than 1,000 head and 41 percent of small producers have expanded since 1983.

Affecting these changes were several nonfinancial factors which have been neglected in supply response research. Table 3 summarizes the results for both those people who have expanded and for producers who chose not to expand. Respondents rated personal preference for sheep as the factor having the greatest influence on their decision to expand. Across all size groups and regions, personal preference had the highest mean influence level. Although part-time producers rated personal preference slightly higher (1.67) than full-time operators (2.0), preference was still the most influential factor for both groups. Perhaps contrary to expectations, larger producers ranked preference higher than smaller producers. The second most influential factor with a mean influence of 2.22 for all size groups and operation types was the comparative profitability of sheep to other enterprises. Mean influence level increased with operation size, and was higher for full-time compared to part-time farmers.

Overall, the third highest ranked reason for expansion was the presence of underutilized pasture or range with a mean response of 2.54. For the mid-size operators, the third ranked factor was the desire to stabilize income, and pasture availability was ranked fourth. Stabilizing income was ranked fourth for all operators and by large producers, but was sixth for producers with less than 50 breeding sheep.

The availability of any unused facilities was ranked fifth overall by both small and mid-sized producers, while producers with more than 1,000 head ranked the availability of financing as their fifth most influential factor regarding expansion. The presence of new lamb markets ranked fourth among small producers, sixth for mid-size producers, and was sixth behind the availability of unused facilities for all producers. As seen in Table 3, remaining factors, including lower predation and labor availability, had mean influence levels above 3.0 indicating these factors as having weak or almost no influence on

Table 3. Mean Responses for Factors Influencing Flock Size by Flock Size*

Factor	1-50 head	51-999 head	> 1000 head	All
Influencing Expansion:				
Personal Preference	1.91	1.71	1.00	1.81
Higher Profitability	2.39	2.04	1.00	2.22
Underutilized Forage	2.45	2.65	2.00	2.54
Stabilize Income	2.91	2.38	2.25	2.65
Available Facilities	2.84	2.88	3.00	2.86
New Lamb Markets	2.80	3.01	3.00	2.91
Available Capital	3.21	3.14	3.50	3.18
Available Financing	3.54	3.23	2.75	3.37
Lower Predation	3.60	3.50	3.25	3.56
Available Labor	3.62	3.48	3.75	3.57
Percent Expanding	40.9	57.5	21.1	44.7
Influencing Non-Expansion:				
Limited Acreage	2.34	2.26	2.08	2.33
Drought Conditions	3.06	2.75	2.30	2.92
Lower Profitability	2.98	3.21	3.42	3.07
Higher Predation	3.34	2.86	2.31	3.09
Near Retirement	2.98	3.12	3.83	3.12
Personal Preference	3.11	3.08	4.00	3.13
Inadequate Fencing	3.05	3.23	3.75	3.13
Limited Lamb Markets	3.25	3.16	3.25	3.22
Limited Wool Markets	3.31	3.08	3.25	3.25
Limited Labor	3.49	2.98	3.00	3.27
Limited Capital	3.39	3.35	2.82	3.35
Excessive Debt	3.49	3.27	2.64	3.38
Percent Not Expanding	59.1	42.5	78.9	55.3

* Possible responses for degree of influence: 1 = Strong; 2 = Moderate; 3 = Weak; 4 = None;

Source: Original Survey

producers' expansion decisions. Prior analysis of the sheep industry (Gee, *et al*; Parker and Pope) had indicated that labor and predation were key factors in producers' decisions regarding flock size. The lack of influence of these factors on producers' decisions to expand may indicate either technological advancements which diminished the impact of labor availability and predation or an exodus of producers who were influenced by labor problems.

In contrast to the reasons for expansion, preference for other enterprises played a much smaller part in producers' decisions not to expand during the 1983 to 1988 period. Among all size groups, the most influential factor governing decisions not to expand was limited range or pasture acreage with a mean influence of 2.33. The second most important factor, which is closely related to limited acreage, was drought conditions with a mean influence level of 2.92. Drought conditions were second among all producers except those with less than 50 head, for which higher profitability of other enterprises (likely off-farm employment) and retirement tied as the next most important factor.

After the two highest ranked factors, differences in mean influences from one rank to the next were generally very small for the aggregate sample. Profitability of other enterprises was the third most important factor influencing producers' decisions to not expand with a mean level of 3.07. Increased predation, however, was third for producers with more than 1,000 head. Predation was ranked fourth by all producers followed by retirement in fifth position. Small producers ranked inadequate fencing and drought as fourth and fifth, while mid-sized producers ranked lack of labor and limited wool markets in those positions. Large producers ranked excessive debt and lack of capital in fourth and fifth, possibly indicating lower equity positions compared to smaller producers. Preferences for other enterprise was ranked sixth overall by both small and mid-sized producer groups, but was much less important for large producers.

In comparing factors influencing producers' decisions regarding flock size, it appears that forage availability, profitability, predation and other economic factors significantly influence industry expansion or contraction. Other non-financial factors such as preference and a desire to stabilize income, however, are also shown to be significant in determining changes in flock size. In addition, preference for the sheep enterprise appears to play a much larger role in expansion decisions than in decisions not to expand or to contract, suggesting the existence of a nonfinancial constraint.

Comparative Profitability Of Sheep and Cattle

In order to obtain an indication of producers' perceptions regarding the profitability of sheep and cattle, producers were asked to indicate how they perceived the long term comparative profitability of these two enterprises. Nationally, 45 percent of sheep producers think sheep are more profitable than cattle, 25 percent think they are equally profitable to cattle, and 13 percent think cattle provide higher returns than sheep in the long run. Over half of all sheep producers in the larger grazing regions of Texas, the Rocky Mountain states, and the Northern Plains thought sheep were more profitable.

To determine the profit incentives required for sheep and cattle for producers to change their flock sizes, producers who had both sheep and cattle were asked if they would increase, decrease, or maintain their flock size given different comparative returns. Substantial confusion was apparent on the part of respondents answering the question and therefore results cannot be considered conclusive. Surprisingly, response to increased profitability of sheep

appeared to be more elastic than response to increased profitability of cattle. Thirty-three percent of producers with sheep and cattle indicated they would decrease their flock size if sheep were 25 percent less profitable, while 44 percent indicated they would increase their flock if sheep were 25 percent more profitable.

Solicited Respondent Comments

Three open-ended questions were included at the end of the survey to solicit producers' perceptions of their lamb and wool markets and other factors affecting their sheep enterprise that may not have been covered in the survey. Those responding to the question regarding lamb markets expressed a desire for the establishment of industry standards regarding weight and cutability and both education and economic (presumably price)incentives to direct production toward these goals. Concerns were also voiced regarding increasing instability of lamb prices and increased packer concentration and feeder-packer integration.

Fewer concerns were expressed about wool markets. Primarily, producers requested incentives for clean, plastic and tag free wool that were adequate enough to increase producer awareness and response. Several respondents called for an end to buyer grading, particularly at wool pools, and a more accurate and consistent grading system in general.

Remaining comments regarding individual operations centered around the lack of effective predator control and personal reasons for maintaining the sheep enterprise. Many felt there were inadequate pet control systems in their areas which contributed to their predator losses. Others expressed concern over environmental issues protecting predators at the expense of producers. Most producers stated that their sheep enterprises were used for supplemental income and to graze untillable or poor pasture land because sheep required a lower initial investment and were easier to handle than other livestock.

Follow-up Survey

The lack of influence of labor issues on flock size in the first survey raised concerns regarding the validity and accuracy of producer responses. Previous research had indicated labor problems as a major factor in producers' decisions to contract or exit the industry (Gee, et. al., Parker and Pope). The low influence of labor availability on producers' decisions thus contradicts the results of previous research. This could be the result of question structure, or it could indicate that producers have scaled down to sizes where hired labor is no longer a problem. To clarify this issue, a survey regarding the influence of labor problems on flock size was sent to all producers responding to the first survey. Questions were also asked about activities competing for producers' time and resources, and about the level of lamb and wool prices needed for them to expand their sheep flock. The survey form is presented in Appendix 1 and the response rate is in Appendix 4.

Respondents were asked four questions regarding decisions to change flock size during the 1970s and 1980s. They were then asked if labor costs or labor availability was the major factor influencing that decision. If it was not, respondents were asked to list in order of importance the three major factors that influenced that decision. The answers to the open-ended list of factors were categorized in the tabulation procedure. To obtain a measure of importance, the number of responses for each factor in each rank was

determined and taken as a percentage of the total number of factors listed in all ranks. These percentages were then multiplied by 3, 2, or 1 for rank categories of first, second, and third, respectively. The sums of these three values for each factor were then used to compare the importance of various factors. In this scheme, therefore, higher values indicate greater factor frequency and higher levels of importance to producers.

Factors Influencing Contraction

One of the four questions asked of producers was whether the last change in flock size of more than 5 percent was a reduction. Forty-five percent of producers responding indicated that their last change was a reduction while 55 percent said it was not. Factors influencing contraction are presented in Table 4. The highest ranked factor influencing the decision to contract was labor difficulties with a value of .76. This was followed in second by drought conditions with a value of .37 and in third by profitability at .34. The fourth and fifth rated factors were acreage restrictions and predator problems, respectively. These results follow those of the initial survey except for the rank of labor. Though persons listing time constraints as a factor were included in the labor category and producers who indicated labor as the primary factor influencing their decision generally did not list other factors, the importance of labor on decisions to contract appears to be larger than the initial survey indicated. This may be due to the consideration of their own labor by respondents in answers to the second survey.

Factors Constraining Expansion

A question of the same format was asked regarding expansion. Thirty-nine percent of producers indicated that their last change in flock size was an expansion of more than 5 percent. Producers were then asked if labor was the primary constraint limiting expansion and if not, they were asked to list the top three constraining factors. Results are presented in Table 4. The primary factor limiting producer expansion was available acreage with a value of .79 followed in second by labor at .42. These were followed by buildings and facilities in third and profitability in fourth. Results of the second survey once again indicate that acreage or forage availability are primary constraining factors, but labor was ranked higher in this follow-up survey, possibly due in part to question structure and respondent perception in the earlier survey.

Factors Preventing Expansion

Respondents also were asked if they had considered but decided not to expand their sheep operations in the 1970s or 1980s. Forty percent indicated they had, while 60 percent said they had not considered such actions. Major factors influencing this decision pattern followed those of earlier questions. Labor was ranked first with a value of .67, followed by acreage constraints with a value of .39. Profitability was ranked third, followed by drought conditions, buildings and facilities, and predators in fourth, fifth, and sixth, respectively.

Table 4. Follow-up Survey: Factors Influencing Flock Size*

Factors	Calculated Value~
Influencing Contraction:	
Labor Costs or Availability	0.76
Drought Conditions	0.37
Profitability of Sheep	0.34
Limited Acreage Available	0.22
Predator Problems	0.18
Limiting Expansion:	
Limited Acreage Available	0.79
Labor Costs or Availability	0.42
Limited Buildings or Facilities	0.27
Profitability of Sheep	0.17
Limited Capital to Invest	0.17
Drought Conditions	0.12
Influencing Change of Decision:	
Labor Costs or Availability	0.67
Limited Acreage Available	0.39
Profitability of Sheep	0.35
Drought Conditions	0.22
Limited Buildings or Facilities	0.18
Predator Problems	0.11

*Calculation Procedure for rankings: $\text{Sum} [(\text{Factor Frequency within rank} / \text{Total \# Factors}) * \text{Rank Value}]$ where rank value is First = 3; Second = 2; Third = 1.

Source: Original Survey

Factors Influencing Change in Farm Type

The fourth of these similarly formatted questions was to determine if producers had shifted to part-time farming due to labor constraints. Almost 13 percent of producers had changed from full to part-time farming in the 1970s or 1980s. Since only a small number of respondents had actually changed their operation status, the ranking procedure used for previous questions was not applicable. Generally this decision, however, appeared to be most affected by age or health, retirement, or off-farm employment rather than labor considerations.

Price Incentives

Producers were queried about their current local lamb price and the price level for lambs required for them to expand, assuming wool prices remained constant. They were also asked to list the two primary constraints facing them should prices increase by the needed amount. The mean price increase needed for producers to expand their sheep flock was \$18.55 above the respondents' average price (in 1988) of \$66.72 per hundred pounds. Should prices rise by the needed amount, the three primary constraints facing producers were, in order of importance, acreage, labor, and facilities.

The \$18.55 average required increase in lamb prices may measure the returns needed to finance additional capital investment or to expand to full-time farming. Prices near \$85 per hundred are above those needed to cover variable costs and, according to published budgets, exceed the total costs (variable plus fixed) for most producers.

Competitive Enterprises

Producers also were asked what category and what specific enterprise in that category competed most with the sheep enterprise for the producer's time, efforts, and capital. Responses followed expectations with beef cattle ranked as the primary competitive enterprise by 43 percent of the respondents. This was followed in second by off-farm jobs as the primary competition for 16 percent of respondents and in third by small grain enterprises at 10 percent.

Labor Affordability

Over 76 percent of producers indicated they did not feel they could afford quality labor for their sheep enterprises. Some commented that this was due to the small size of their operations, while others indicated that worker's compensation and social security payments made hired labor cost prohibitive. Several also indicated they were unable to pay competitive wages and maintain profitability at the same time.

Solicited Comments

Solicited comments on producers' opinions regarding the influence of labor cost and availability on flock size generally followed results of both surveys. Most producers had adjusted their flock size based on the amount of labor that they and their families could supply. Seasonality of labor requirements, along with the scale required to justify hiring labor, further limited expansion by producers. Respondents also indicated a lack of knowledgeable laborers or persons willing to work with sheep for wages producers could afford to pay. Some producers stated they could expand, but profitability would decrease due to lower lambing rates or increased predator losses.

Overall Survey Implications

Results of the two surveys create an interesting portrait of the United States sheep industry. As expected, beef cattle are the primary competitive enterprise for sheep along with cropping enterprises. The large proportion of part-time sheep farmers and the inherent labor intensity of sheep provide evidence of competition from off-farm employment for producers' time. Not only is time a constraint, but also forage availability, acreage, and facilities are especially restrictive for part-time producers. Results further indicate that preference for the sheep enterprise, not just comparative profitability, plays an important role in sheep producers' decisions to expand.

The combination of these factors along with other problems associated with sheep, such as predators and breeding seasonality, create a picture of an industry that is inherently more prone to contraction than expansion. The use of sheep by many as supplemental income decreases constraints on contraction or liquidation, and also submits the sheep enterprise to additional constraints from other primary enterprises. There is much that is not clearly understood in terms of what motivates changes in the sheep industry, but the available literature and the survey results provide the base on which modeling efforts were built.

Model Development and Results

Modeling of supply response for livestock production is traditionally based on the assumption of profit maximization by managers. In theory, livestock producers attempt to maximize returns for a given set of capital resources given input prices, expected output prices, and opportunity costs. For livestock sectors, seasonal conditions and reproductive and genetic constraints also influence producer decisions. The estimation of a supply function therefore must incorporate these factors into a mathematical expression of the supply curve.

Resources usable for sheep production, primarily land and facilities, generally have usage limited to agricultural enterprises. Other major enterprises in the U.S. that can utilize the same land and facilities consist primarily of beef cattle and cash crops. A third resource that is not limited to agricultural use is the manager's labor. Off-farm employment therefore also competes with the sheep enterprise for labor resources. Theoretically, an increase in revenue for one of these enterprises, *ceteris paribus*, should result in investment in that enterprise and disinvestment in those enterprises for which resources can also be used. For livestock, this means increases or decreases in breeding inventories.

Breeding inventories dictate output of both lamb and wool. Though the amount of lamb produced can be increased or decreased slightly by changes in lambs saved at birth, replacement retention, and changes in slaughter weight, output is ultimately limited by breeding inventories. Modeling of inventories therefore separates longer term resource adjustment decisions from weekly or monthly management decisions. The general supply model is:

$$INV = f(P_o, P_c, P_i, G, S.)$$

where,

- INV = breeding inventory,
- P_o = price of outputs,
- P_c = price of competitive enterprises' outputs,
- P_i = price of inputs,
- G = genetic and physical constraints, and
- S = subjective factors.

In general, increased revenue for a given enterprise, either from higher output or lower input prices, should result in investment in more productive units, primarily the breeding inventory. Similarly, decreases in revenue should result in liquidation of some of the breeding inventory. Increases in output price and therefore increased revenue from an enterprise competing for similar resources should result in a shift in resource use to the competitive enterprise and a decrease in breeding inventories. Genetic and reproductive constraints associated with livestock enterprises restrict the rates at which producers can adjust resource use and inventories to match profit incentives and maximize revenue. Subjective factors such as changes in tastes and preferences may also affect producers' decisions to change inventories by shifting their perceived costs or returns.

Modeling of U.S. sheep inventories is hypothesized to be more accurate when done through regional models. As exhibited by survey results, operation type and production practices differ greatly from region to region. Some regions rely more on wool income, while others primarily depend upon lamb sales. Lambing rates and fleece weights and qualities along with producer attitudes differ greatly from region to region. Further complicating these differences is the payment calculation for the wool incentive program. Producers are paid a nationally constant percentage of their individual total returns from wool sales. Therefore, producers with higher wool yields and higher wool prices receive a larger incentive payment per ewe. Other factors varying by region which influence producers include seasonal conditions and predator concentrations. For this reason, regional supply models are estimated. Though a state by state model may be the most accurate estimation procedure, data limitations and the associated marginal improvements in accuracy of state-level compared to regional efforts rule out this option. Regional models based on the regions of the American Sheep Producer's Council used in the surveys were developed. A national model was also developed for comparison with the regional models.

For several variables, values from chosen representative states are used in each region due to data availability and collection requirements. Values for these states are used for all variables that are not aggregated for each region. The representative states used for each region are:

- East Coast and Southeastern region - Virginia
- Ohio Valley and Great Lake region - Ohio
- Midwestern Plains region - Iowa
- Northern Plains region - Wyoming
- Texas region - Texas
- Rocky Mountain region - Utah
- West Coast and Southwest region - California.

These states were chosen based on the proportion of regional sheep numbers in the state, geographical location, and other factors including production practices, wool type, and climate.

Profitability of Sheep

Any model explaining changes in breeding inventories must include some measure of returns for the sheep enterprise. Sheep are unique since they produce two outputs, meat and wool, which are inputs in two entirely different industries. Genetically, wool and meat production are competitive since those breeds that excel in meat production generally have poorer wool quality and yield and vice versa. Production levels of one output alone cannot be changed significantly without affecting the other. Production can also be complementary to some extent. Increased feed inputs increase both wool and meat output slightly and increased lambing rates increase both total lamb meat and lamb wool production.

Technological changes in lamb and wool production make the sole use of lamb and wool prices inadequate measures of the value of output from breeding inventories over time. Both average lamb weights and lambing percentages have shown significant increases over the past 30 years, while fleece weights have exhibited very little change in most regions. Further complicating measures of returns is the wool incentive program and its payment procedures. It is therefore assumed that a measure of total returns per ewe is the most appropriate method of accounting for changes in enterprise returns.

The sheep returns variable used in this modeling effort is designed to represent both changes in lamb and wool returns. The calculated variable is:

$$\text{Total Returns} = (\text{Annual Lamb Weight} \times \text{Annual Lambs per Ewe} \times \text{Lamb Price}) + (\text{Fleece Weight} \times \text{Wool Price}) + [(\text{Fleece Weight} \times \text{Wool Price}) \times \text{Incentive \%}]$$

The annual lamb weight used is the national average since average slaughter weights have exhibited few regional differences over time. National lamb prices are included under the assumption that changes in regional prices follow those of national markets. Constant representative values for regional fleece weights are used since weights vary between regions but have shown little change over time. Representative state values for annual lambing rates and annual wool prices from those states listed earlier were used in regional returns calculations. Lambing rates, which are actually lambs saved per ewe, were incorporated on a regional basis to account for genetic and technological lambing rate improvements and changes in predator losses. Representative state annual wool prices were used to account for quality and incentive payment differences. The returns-per-ewe variable for the national model is similar except lambing rates and fleece weights are based on national averages and the wool price is the national incentive level price. An increase in total returns per head should result in expansion of sheep inventories. Any positive changes in returns due to one output that are offset by decreased returns from the other output should therefore have no effect on producer decisions and resulting inventory levels.

Competitive Enterprises

Comparative profitability of alternative enterprises is also important in determining sheep numbers. As illustrated by both surveys, the primary competitive enterprise for sheep is beef cattle. Not only can cattle utilize similar forages and facilities, but they also require somewhat similar management skills and investment. Since sheep are better adapted to poor forage than cattle, combined grazing of sheep and cattle is a common practice. The combination of sheep and cattle enterprises is also encouraged by the added diversity of income that cattle and sheep provide. The presence of cattle on sheep operations also decreases restrictions on changes in inventories of both species. Brood cows are the primary beef enterprises competing with breeding ewes since both utilize primarily low quality forage. The price of a beef cow's output, the weaned calf, is therefore the most suitable proxy for returns for the competitive cattle enterprise. A national calf price was used under the assumption that regional changes follow those of the national markets. Increases in calf prices are hypothesized to result in a shift of resource utilization to cattle and a decrease in sheep inventories.

The secondary competitive enterprise revealed in the surveys that competes for resources used by sheep is cash crops. The type of crops that compete for land and labor resources varies greatly, however. Using a single commodity price as a proxy for returns from cash crops, even on a regional basis, would result in biased and inconsistent coefficients for other variables. If other crops also competed for resources, changes in inventories resulting from changes in the prices of those crops would be reflected in coefficients for other variables. The inclusion of several major crop prices, however, would result in decreased degrees of freedom in a time series

sample with limited observations. The most representative proxy for crop returns for major crops is therefore assumed to be the acreage of principal crops (grains, oilseeds, fibers, hay, etc.) harvested.

Acreage harvested should depict the actual level of resources designated for crop production rather than only the quantity of crops produced, and should reflect historical profitability of principal crops. Increases in crop acreage harvested should represent increased profitability of cash crops and decreased resources designated to sheep, other things equal, thereby lowering sheep inventories. Total regional harvested acreage estimates were used in modeling efforts to delineate regional differences. National principal crop acreage harvested was used in the national model.

Input Costs and Seasonal Conditions

Primary feed inputs for breeding sheep depend upon lambing season and production scenarios. Typically, ewes are fed good quality hay in seasons when pasture is unavailable, with grain supplemented for three to four weeks prior to and six to eight weeks after lambing. Some alternative feeds and winter pastures are also used, but feeds used depend mostly upon the season in which ewes are lambed. Most ewes are lambed in the spring and wintered on hay. Hay price is included in the model for several reasons. First, it serves as a proxy for feed input prices used in breeding ewe operations. Second, hay prices reflect seasonal conditions and forage availability. Pasture condition estimates do not include estimates of range condition in western regions in a consistent time series. As both surveys indicated, drought conditions and forage availability are key factors in decisions regarding flock size. Hay price is assumed to accurately reflect forage availability in a given region through valuation of feed resources. Season average hay prices from the representative states for each ASPC region listed earlier are used as a proxy of feed costs and seasonal conditions. An increase in hay prices indicates lower forage availability and higher feed prices and should result in decreased sheep inventories.

Subjective Factors

The United States sheep industry is unique. Both the historical background of the industry and the current attitudes of producers reflected in the surveys suggest that factors other than profitability affect producer decisions regarding flock size. The magnitude and duration of the decline in inventories in the 1960s and 1970s suggests that nonfinancial factors are important determinants of sheep numbers. Budgeted profitabilities for sheep and cattle for various Western regions showed returns for sheep and cattle to be similar in magnitude on an animal unit basis during the 1960s. National budgets for sheep and cattle estimate sheep to be more profitable than cattle for all but two years between 1971 and 1987. The decline of sheep inventories in the presence of positive budgeted profits suggests the presence of a non-financial cost of producing sheep. This "cost" may be a dislike for sheep, difficulty in finding labor, the need for more specialized management skills, or frustration with predators. This non-financial cost would effectively shift the marginal cost function up, creating a lower level of output for a given level of profitability.

Along with the presence of a non-financial cost, there is evidence suggesting the existence of a kinked or asymmetric sheep supply function. The magnitude of the decline in sheep inventories in the 1960s suggests a very elastic response, while the lack of positive response to the higher comparative profitability of sheep to cattle in the 1970s and early 1980s suggests a very inelastic response. This asymmetry in elasticity along with the survey results suggest that the sheep supply function may be characterized by the operation of asset fixity in reverse.

A hypothetical supply function depicting this concept is presented in Figure 1. In the survey, producers indicated that preference for the sheep enterprise was the primary factor in their decision to expand. This suggests that mainly those persons with a preference for raising sheep respond to positive incentives for production, thereby limiting industry supply response. Those producers who do respond are also limited by their individual resource constraints of labor, land, or capital. The combination of these resource constraints and limited response creates a very inelastic positive response depicted in Figure 1 by the segment A to S(A). If the industry is operating at point A, any response to positive price or profit incentives is very limited as suggested by the steep slope of the segment A to S(A).

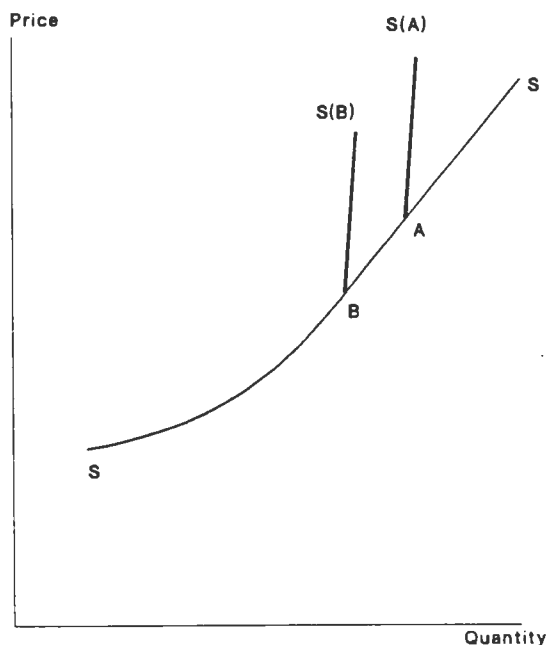


Figure 1. Proposed Shape of the Sheep Supply Function

Conversely, all producers tend to respond to negative pressures on the industry and contract, shifting production down the supply function from point A to point B when prices/revenues fall. If the industry is initially at point A, negative incentives can bring a substantial reduction in output. The segment of the supply curve from A down to B is much less inelastic than the segment A to S(A). During this contraction, some resources are shifted from sheep production to other uses. When positive incentives return, rather than shifting production back to point A, only those persons with a preference for raising sheep respond. These producers are once again limited by resource constraints and therefore create an inelastic response along the segment B to S(B). This "ratchet effect" places downward pressure on the industry over time and limits expansion in the short run.

Empirical modeling of this change in resources and possible changes in subjective costs is difficult. The use of dummy variables depends upon the ability to determine when production was in an inelastic or elastic portion of the supply function. Though a trend variable may explain a persistent decline in preference, an increase in subjective cost, or an increase in physical constraints, it fails to explain the actual changes in resources over time.

The large proportion of part-time sheep farmers leads to consideration of some measure in the change in numbers of part-time farms.

Part-time farmers are more limited by labor and acreage constraints (the primary limiting factors indicated in the surveys) than full-time producers because of farm location and size and the time constraints of off-farm employment. As the proportion of part-time farms increases, the proportion of sheep producers facing major constraints to expansion also increases. Increased numbers of constrained producers correlates to decreased resource availability among producers and lower sheep numbers. It is therefore hypothesized that as the proportion of part-time farms increases, sheep numbers should decrease due to increased labor and acreage constraints. The percentage of all farms that are part-time in farming was thus added as a potential explanatory variable.

Changes in the proportion of part-time farms may also have other implications. Part-time and small farms generally rely on off-farm income and have low or even negative farm incomes (Salassi). Part-time farmers should therefore be more nearly influenced by the "preference" dimension since they do not rely totally on farm income. Survey results also exhibited a higher influence level for the preference factor for part-time producers.

Whether or not a change in preference for raising sheep has occurred among full or part-time farms is impossible to determine. Preference for the sheep enterprise could have increased among part-time producers due to sheep's ease of handling or low initial investment, which would result in increased sheep inventories as the proportion of part-time farms increases. Preference for sheep among these producers, however, may have declined due to high labor requirements or predator losses which would result in lower inventories. Similar changes could have also occurred among full-time producers. Therefore, the effect on sheep supply of changes in preference cannot be linked to changes in the proportion of part-time farms. The proportion of part time farms does, however, measure changes in resource constraints on the sheep industry.

Supply Model Structure

The variables previously discussed are each given a lag structure and combined into a model for each region and the United States. The resulting model is as follows:

$$BEI_t = f(DTR_{t-2}, DCP_{t-3}, DHP_{t-1}, CAH_{t-1}, PPF_{t-1},)$$

where,

- BEI = January 1st breeding ewe and ewe lamb inventory, (1,000 head),
- DTR = deflated total returns per ewe, (\$/ewe),
- DCP = deflated calf price, (\$/cwt.),
- CAH = principal crop acreage harvested, (millions of acres),
- DHP = deflated season average hay price, (\$/ton), and
- PPF = percent part-time farms of total farms, (%).

Breeding inventory is the number of stock ewes and ewe lambs (in thousands of head) for each respective region and the U.S. on January 1st of each year as calculated from state estimates by the U.S. Department of

Agriculture. Total returns per ewe per year in dollars per head are calculated for each regional model and for the U.S. using the formula discussed earlier. Data used in returns calculations are USDA estimates for each year except for fleece weight. Fleece weights used are constant over the entire time series. They were estimated based on regional and national average fleece weights calculated from USDA estimates. Deflated calf prices are measured in dollars per hundred pounds and are annual average national prices reported by the USDA. National average calf price is used in both the national and the regional models. Hay price is the season average price per ton for all hay for representative states in regional models and for the entire U.S. in the national model. Crop acreage harvested is the sum of harvested acres of principal crops measured in millions of acres as reported by the USDA for each region and for the U.S. Revised data are used for the period prior to 1973 because the definition of principal crops was changed in that year. The percent of all operators who farm part-time is the number of farm operators working off the farm 200 or more days per year, divided by the total number of farm operators, and multiplied by 100. This information was obtained from the U.S. Census of Agriculture and was therefore not available in an annual series. Census year observations are used and values are interpolated for years between censuses. Again, regional values for part-time farms are used for regional models.

Lag Structure in Explanatory Variables

Variables are lagged under the assumption that producers base decisions upon historical profitability. A single lag structure is used because of the limited number of observations and the difficulty of determining a weighting scheme that accurately follows the weight each year's prices have on producers' decisions. Livestock cycles also generally create price trends that continue for several years thereby enabling annual changes to reflect past and future price levels.

Lags were determined through graphic comparison of trends and correlation matrices of lagged measures of the dependent and explanatory variables. Consideration is also given to previous modeling results and to expectations of producer behavior. Turning points of inventories generally follow turning points in total returns by two to three years. Correlation matrices exhibit a negative correlation for most lags between total returns and inventories for most regions. Total returns per ewe are therefore lagged two years under the assumptions that producers do not respond to incentives immediately and that ewe lambs enter the January 1 inventory the year after they are born. Producers will not retain ewe lambs in a given year of high prices due to their inherent value and to lagged responses prevalent in all agricultural industries. The following year, however, expansion will occur based on the previous year's prices.

A high negative correlation existed between calf prices lagged two, three, and four years and breeding ewe inventories. Comparison of turning points indicates similar lags of 3 to 5 years. Calf prices were lagged three years based on these findings.

Both hay price and crop acreage harvested showed high negative correlations when lagged one and two years. Hay prices were lagged one year in the models since forage availability and price in a given growing season will affect the number of animals carried through the winter. Negative correlations in later years are most likely the residual effect of producer decisions in previous years. Crop acreage harvested was lagged one year since it reflects past cash crop profitability and the acreage designated to crop production for the following year. The percent of part-time farms was lagged one year to represent the change in resources for the year prior to January 1st.

Model Estimation

Models were estimated for the period from 1953 to 1984. Preliminary model results varied by region, but variables generally exhibited hypothesized signs and were significant. All models had R^2 's above .95, but Durbin Watson statistics exhibited severe autocorrelation for all models, making t-tests unreliable.

Previous modeling research with other explanatory variables also encountered autocorrelation problems (Gardner, Whipple and Menkhaus). Changes in lag structure and the inclusion of several variables used in previous research in the hypothesized model did not remove the autocorrelation problems. The Cochrane-Orcutt iterative procedure was then used to estimate the unknown coefficient of autocorrelation, ρ . The coefficient ρ increased from around .5, depending upon the region, to 1.0 after five to six iterations. A value of 1.0 for ρ indicates the presence of perfect positive autocorrelation, or consistent underestimation or overestimation. Since livestock production and therefore expansion is limited by biological production constraints, present inventories have a direct dependence on previous inventory levels. Including lagged inventories as an explanatory variable should account for the consistent underestimation and overestimation tendencies. The estimated models under the autoregressive framework are of the form:

$$BEI_t = f(BEI_{t-1}, DTR_{t-2}, DCP_{t-3}, DHP_{t-1}, CAH_{t-1}, PPF_{t-1}).$$

Partial Adjustment Model

Including lagged inventories alters the linear model in several ways. The actual model estimated is a partial or stock adjustment model. This model assumes that the inventory level producers desire is dependent upon the current inventory. This is in fact the case with breeding ewe inventories since genetic and resource constraints do limit the amount of response possible in the short-run. Assuming BEI_t^* is the desired inventory level, the amount of actual adjustment in a given year, $(BEI_t - BEI_{t-1})$, is equal to the desired adjustment, $(BEI_t^* - BEI_{t-1})$, multiplied by P , where P is the fraction of desired adjustment obtained in a given year. In estimation of the partial adjustment model, the actual inventory level BEI_t is equal to:

$$P\alpha_0 + (1 - P)BEI_{t-1} + P\alpha_1DTR_{t-2} + P\alpha_2DCP_{t-3} + P\alpha_3DHP_{t-1} \\ + P\alpha_4CAH_{t-1} + P\alpha_5PPF_{t-1}$$

where,

P = an adjustment coefficient estimate, and
 α = a long-run parameter estimate.

Parameter estimates obtained for explanatory variables during regression on actual inventories are short-run estimates. Long-run estimates can be obtained by dividing coefficients by P .

Conventional Durbin Watson measures of autocorrelation are not valid for partial adjustment models because the d value tends toward 2, indicating truly random error terms. Durbin d statistics in partial adjustment models therefore are biased against finding first order autocorrelation. For large samples, the Durbin h test is a valid measure of autocorrelation. A revised statistic, the Durbin h statistic, is:

$$h = (1 - .5*d)[N/(1 - N*\text{var}(1-P))]^{.5}$$

where,

h = Durbin h statistic,

d = Durbin d statistic,

N = Sample size, and

var(1-P) = variance of lagged dependent variable coefficient.

Testing procedures for the Durbin h statistic follow those of a normal distribution and are strictly valid for large samples. Since no exact limitations of sample size exist, the sample used in model estimation is assumed to be adequate for valid results. Inclusion of lagged inventories corrected autocorrelation problems in the national model and most of the regional models based on the Durbin h test.

Model Results

Regional and national models and their results are presented in Table 5. In general, variables exhibited expected signs for all regional models, and Durbin h statistics and R²'s were also generally within acceptable ranges. Significance of variables varied from region to region. Only crop acreage harvested varied consistently from its hypothesized sign, having a positive rather than negative influence on sheep numbers for most regions and for the national model.

The model of Region 1 inventories had a high R², but the hypothesis of no autocorrelation was rejected. The lagged inventory variable was statistically significant with a coefficient of .898. Returns per head had the hypothesized sign but was not significant at the 10 percent level. Calf price and percent part-time farm variables also had expected signs but were not statistically significant. Hay price had a positive coefficient and was insignificant, but due to the wide diversity of this region, the chosen state hay price may not be truly representative. Crop acreage harvested had a positive sign and was significant. East Coast and Southeastern region forecast errors ranged from -.9 to 25.6 percent with 25.6 percent being the highest percent error of any regional model.

Ohio Valley and Great Lake region results were consistent with hypothesized signs, but several variables lacked statistical significance at the 10 percent level. Lagged inventories, returns per ewe, and part-time farm variables were all significant. Calf price, hay price, and harvested acreage variables had hypothesized signs, but none were significant. The Durbin h statistic of .635 indicated that autocorrelation was not present in the model. Region 2 had the highest R² and F-value of all regional models and out-of-sample forecast errors ranged from -16.2 to 11.1 percent.

Modeling efforts for Region 3, the Midwestern Plains region, exhibited encouraging results. Only the harvested acreage variable had a sign inconsistent with the hypothesized model. Its coefficient was positive and significant, which may reflect increased feed availability. Returns per ewe had a positive sign but was not significant. All other variables exhibited hypothesized signs and were significant at the 5 percent level. Autocorrelation was not observed and the R² was once again high. Forecast errors ranged from -17.0 to 6.8 percent.

Lagged inventories, calf price, and hay price were all significant and had hypothesized signs in the model for Region 4, the Northern Plains states. Returns per ewe and percent part-time farms had hypothesized signs but were not significant at the 10 percent level. Once again harvested acreage had a positive coefficient, but was not statistically significant in Region 4. The model had the lowest F-value of all regions. Its Durbin h statistic of .316

Table 5. Regional and National Supply Model Estimates, 1953-1984

ASPC REGIONS	1 East Coast	2 Ohio Valley	3 Midwestern Plains	4 Northern Plains	5 Texas	6 Rocky Mountain	7 West Coast	United States
VARIABLE	PARAMETER ESTIMATES							
BEI (t-1)	0.898** (16.40)	0.922** (14.76)	0.864** (12.03)	0.924** (10.88)	0.812** (12.90)	0.973 (18.39)	0.988** (20.63)	0.845** (13.24)
DTR (t-2)	0.872 (1.20)	3.038** (3.80)	1.152 (0.83)	3.269 (1.35)	1.298 (0.59)	2.896** (2.24)	4.175** (2.32)	19.608** (2.58)
DCP (t-3)	-1.166 (-1.64)	-0.309 (-0.57)	-2.805** (-3.02)	-3.806** (-2.41)	-2.398* (-1.78)	-2.588** (-3.10)	-1.760 (-1.7)	-17.12** (-4.12)
CAH (t-1)	9.150** (3.45)	-3.028 (-0.73)	8.699** (3.18)	26.31 (1.07)	55.34** (3.99)	75.98** (2.64)	44.088* (1.72)	16.729** (3.74)
DHP (t-1)	0.172 (0.23)	-1.213 (-0.97)	-3.725** (-2.27)	-5.497* (-2.06)	-15.84** (-5.06)	-2.890* (-1.74)	-1.144 (-0.67)	-43.27** (-3.63)
PPF (t-1)	-10.91 (-1.70)	-15.24* (-1.75)	-29.88** (-2.28)	-26.92 (-1.01)	-37.77** (-3.04)	-16.04 (-1.41)	3.262 (0.23)	-200.06** (-2.62)
CONSTANT	-147.78 (-0.57)	555.83 (1.09)	196.33 (0.30)	343.95 (0.29)	2021.44** (2.30)	-208.53 (-0.36)	-979.58 (-1.42)	5867.91 (1.33)
R2 =	0.995	0.996	0.994	0.987	0.988	0.993	0.992	0.997
Durbin h =	2.162	0.635	1.124	0.316	0.515	2.964	0.147	0.256
F(6,25) =	798.92	941.83	688.42	321.52	349.74	592.05	546.06	1265.97
FORECAST PERCENT ERROR ~, OUT-OF-SAMPLE TESTS								
1985	-0.9	11.1	-9.7	-20.4	13.2	-16.3	-1.1	-15.4
1986	4.6	-7.3	-17.0	0.9	-23.1	-4.1	0.04	-9.9
1987	25.6	-0.1	6.8	-4.1	-3.5	-2.8	0.07	-1.2
1988	16.3	-16.2	5.8	-1.0	-1.8	7.1	12.4	3.1

* = Significant at 10% confidence level

** = Significant at 5% confidence level

~ Forecasts generated for each year from re-estimated models for the previous year.

failed to reject the hypothesis that autocorrelation was not present. Forecast errors ranged from -20.4 to .9 percent.

The model for Texas exhibited significance at the 10 percent level for all variables except returns per ewe. All explanatory variables exhibited anticipated signs except harvested acreage. Hay price had a higher t-value than in any other region, possibly reflecting the higher variability and importance of seasonal conditions in Texas. Region 5 had a Durbin h statistic of .515 indicating no autocorrelation at the 5 percent level. Forecast errors ranged from -23.1 to 13.2 percent.

Region 6, the Rocky Mountain region, had a lagged inventory coefficient of .97 with a highly significant t-value of 18.39. Returns per ewe, calf price, and hay price variables all had hypothesized signs and were significant at a 10 percent confidence level. Harvested crop acreage again had a positive sign and was significant. The model exhibited positive autocorrelation with a Durbin h statistic of 2.964. Forecast errors for this model ranged from -16.3 to 7.1 percent and the model had a F-value of 592.05.

The model of the West Coast and Southwestern states (Region 7) exhibited the lowest forecast error of all regions. Lagged inventories, however, had a coefficient of .988 which is very high for a partial adjustment model. Returns per ewe was the only other variable exhibiting both the hypothesized sign and statistical significance. Calf price had a negative sign but was not significant. Hay price had a negative coefficient but was not significant, while harvested acreage had a positive sign and was significant at the 10 percent level. The model for Region 7 was the only regional model which exhibited a positive sign on the part-time farm variable but it also had an insignificant t-value. As mentioned earlier, the model exhibited the most accurate predictions with a percent error ranging from -1.1 to 12.4 percent with a low of .04 percent. The model had a Durbin h statistic of .147, indicating autocorrelation was not present.

Regional vs. National Models

Regional models exhibited substantial variation in t-values, Durbin h statistics, and in forecast errors. No consistent overestimation or underestimation patterns were observed in forecasts. R²'s and F values were high for all models. Returns per ewe had a positive sign for all regions, though statistical significance was marginal. The calf price variable had the hypothesized sign for all regions and was found to have higher t-values in the western regions. The acreage harvested variable generally exhibited a positive rather than negative sign and was usually significant among regional models. This implies that total regional crop acreage is complementary to sheep production or is correlated to some unknown variable that is not included in the model. Even though crops may compete with sheep on individual operations, total crop production increases feed availability and lowers feed costs. The positive coefficient on crop acreage harvested is assumed to reflect the effect of increased feed availability on sheep inventories. Hay price had a negative coefficient for all but Region 1. Similar to calf price, hay price exhibited higher t-values in western regions. The percent of part-time farms variable was generally negative and significant except in the model for Region 7, where it exhibited a positive sign.

Correlation matrices for the regional variables exhibited high partial correlation coefficients between the lagged inventory and part-time farm variables and between total returns and crop acreage harvested variables. Correlation was also high between deflated hay price and the percent part-time farm variable. The multicollinearity which appears to be present results in large standard errors but does not bias

coefficient estimation. The low t-values for various variables in models with high R²'s along with high correlation coefficients tends to confirm that multicollinearity is a problem in the regional models.

The model for the United States exhibited more desirable statistical properties than the regional models. Though the possibility of multicollinearity exists, all variables except crop acreage harvested had hypothesized signs and were statistically significant at the 5 percent level. Like the regional models, the coefficient for crop acreage harvested was positive and statistically significant. The model's R² was .997 and the Durbin h statistic of .256 indicates that autocorrelation was not present. Forecast errors ranged from -15.4 to 3.1 percent.

Regional models were hypothesized to be more accurate predictors of inventory levels because of regionalization of production practices, seasonal conditions, and enterprise competition. Models were re-estimated for the period from 1953 to 1988 and root mean squared errors (RMSE) were calculated over that period to determine if regional or national models should be used for forecasting and elasticity calculations. The RMSE for the sum of regional predicted values versus actual national inventories was 377.65. The RMSE for the national model's predicted values was 401.27. This difference in error of 23.62 thousand head is relatively small. This difference in accuracy cannot justify the added costs and limitations of data collection for regional forecasting. Therefore, the national model was used for elasticity estimates and inventory projections.

Elasticity and Inventory Estimates

The national model was re-estimated with data through 1988 to obtain elasticity estimates and make inventory projections through 1993. Coefficient values changed slightly from the previous model, which may result from the industry's movement toward expansion in 1987. In the sample period prior to 1987, the industry had experienced expansion only three times; in 1955, from 1958 to 1960, and from 1979 to 1982. The re-estimated model is:

$$\begin{aligned} BEI_t = & 1416.8 + .928 BEI_{t-1} + 24.132 DTR_{t-2} - 14.125 DCP_{t-3} \\ & (.460) \quad (21.087) \quad (3.565) \quad (-3.387) \\ & - 28.42 DHP_{t-1} + 12.357 CAH_{t-1} - 113.674 PPF_{t-1} \\ & (-3.452) \quad (3.043) \quad (-1.99) \end{aligned}$$

$$R^2 = .996 \quad F = 1443.207 \quad \text{Durbin } h = .8081$$

Variable t-values (in parentheses) were similar to the previous model and other statistical properties of the model exhibited change.

Sheep Industry Supply Elasticities

The partial-adjustment model framework used in this modeling effort allows calculation of short-run intermediate, and long-run supply elasticities. Short-run, five year, and long-run elasticity estimates are presented in Table 6. Short-run response to all factors is relatively inelastic which is consistent with survey results and elasticity estimates from prior studies (Gardner, Whipple and Menkhaus). The short-run elasticity of breeding inventories with respect to returns per head of .126 indicates only a small response to increased returns. The 5-year elasticity is lower than Whipple and Menkhaus' estimate of stock sheep inventory elasticity with respect to lamb price (5-year) of 1.38, but is similar in magnitude to their wool price elasticity of .59. Long-run elasticity with respect to returns is 1.74, much lower than Whipple and Menkhaus' 30-year lamb price and wool price elasticities. The overall low elasticity of breeding inventories with respect to gross returns has strong implications for industry groups attempting to stimulate production. Higher gross returns will not result in large increases in inventories in the short or long run.

Table 6. Stock Elasticity Estimates for the U.S. Sheep Industry

Elasticity of Breeding Inventory w.r.t.	Time Horizon		
	Short-run	5 Years	Long-run
Total Returns	0.126	0.546	1.754
Calf Price	-0.067	-0.290	-0.939
Hay Price	-0.132	-0.572	-1.839
Part-time Farms	-0.200	-0.866	-2.788
Crop Acreage	0.234	1.014	3.256

Inventory response to changes in calf prices is the lowest of all factors with a long-run elasticity of -.939. A low elasticity of breeding inventories in sheep with respect to calf price suggests that competition from beef cattle may be primarily a long term stimulus for change in sheep inventories. Since sheep and cattle are both faced with genetic limitations which hamper rapid changes in production, a relatively low cross elasticity of sheep inventories with respect to calf prices is not unexpected.

The elasticity of sheep inventories with respect to hay price is similar in magnitude to that of total returns. On a national level, the elasticity of inventories to hay price is hypothesized to more nearly reflect the input cost of hay than changes in seasonal conditions. The variation in hay price significance in regional models suggests that elasticities for hay price in the national model cannot reflect the actual

changes in seasonal conditions on national inventories. Furthermore, variation in pasture conditions between major sheep producing areas may be so localized that it has no significant effect on national hay prices.

Sheep inventories exhibit the most elastic response to changes in the proportion of part-time farms and to changes in harvested crop acreage. The long-run elasticity of sheep inventories with respect to the proportion of part-time farms is -2.788. Changes in resource constraints portrayed by this variable should have a large short and long-run effect on flock size under the hypothesized notion of fixed assets or an asymmetrical supply function. Consideration should be given, however, to the possibility of a more inelastic response to a decrease in the proportion of part-time farms. Earlier arguments suggest resources can be more easily shifted out of sheep production than they can be brought back into the industry. This suggests the possibility of a less elastic response to the part-time farm variable during periods of decline in the proportion of part-time farms.

Crop acreage harvested exhibits the highest elasticity and is positive, which does not follow the hypothesized sign or the expected magnitude of influence compared to other variables. In the surveys discussed earlier, crops were the secondary competitive enterprise for sheep producers, therefore a high (positive) elasticity was not expected. The possibility, introduced earlier, that the crop acreage harvested variable reflects changes in feed availability rather than competition for resources is further supported by this high positive elasticity. The high elasticity of sheep inventories with respect to crop acreage harvested indicates a relatively large response by sheep producers to changes in feed availability and costs.

Elasticity estimates for sheep inventory response have many implications for the industry. Estimates are smaller than those of Whipple and Menkhaus but agree with the inelastic response of the hypothesized supply function. Any industry strategy must take into account the largely inelastic response of sheep producers and the resource constraints present in the industry and must recognize that only in the long run are most supply elasticities greater than 1.0 in absolute value.

Inventory Projections

The sheep industry, like most agricultural industries, is affected by many unpredictable factors. Seasonal conditions, domestic and foreign policy, fashion trends, and changes in competitive products all play a role in determining producer returns and breeding inventories. The combination of these factors makes long term industry projections difficult and subject to error.

Industry projections using the national model developed from the surveys all indicate a general and long-term decline in inventories. World sheep inventories reached record highs in 1989 of 1.15 billion head. U.S. breeding inventories increased from a historic low of 7.87 million head in 1986 to 8.51 million by 1989. Total U.S. lamb and mutton production was projected at 340 million pounds for 1989, its highest level since 1985. Deflated total returns per head (1982-84 base) for 1988 as estimated for the national model of inventories are \$83.92 per head, \$14.14 below 1987 levels. Estimates based on preliminary prices and production for 1989 indicate a further decrease in total returns to approximately \$77 per head (deflated). Calf prices have trended up since 1986 and cattle inventories have shown signs of expansion for 1990. Harvested crop acreage estimates based on plantings show a 12 million acre increase of harvested acreage to 302.1 million acres for 1989. Hay price for 1989 is expected to decrease by 2.5 percent from 1988. The proportion of part-time farms is expected to follow its current trend and increase

by 0.5 percent per year. Based on this preliminary information, breeding inventories are predicted to decrease by 420,000 head to 8.09 million head in 1990. Annual patterns in breeding inventories and in total lamb and mutton production since 1979 support these model results. Expansion in 1990 would be a fourth consecutive increase in breeding inventories, while previous expansion periods have lasted only 1 to 3 years. Increased calf prices and decreases in actual and deflated total returns for 1988 and 1989 further support a decrease in breeding inventories in 1990.

Projections for 1991 through 1993 indicate a continued decline in the national breeding flock. Projections are run under several different scenarios. For all scenarios, the proportion of part-time farms is assumed to continue its current trend. Lamb weights and lambing rates are maintained at their 5-year averages, and fleece weights remain the same. The consumer price index is assumed to increase at an inflation rate of 5.0 percent through the period. Table 7 contains the projection from each scenario used.

Scenario 1 projects inventories under the assumption that current annual nominal price levels for lambs and calves remain constant through the projected period. Nominal hay price and harvested acreage are maintained at their respective 5-year average levels. The wool incentive price is adjusted down 1 cent per pound per year based on the current trend. Under these assumptions, breeding inventories are projected to be 7.89, 7.67, and 7.49 million head for 1991, 1992, and 1993, respectively.

Scenario 2 assumes that prices keep pace with inflation which is assumed to continue at 5 percent per year. Hay price is maintained at its 5-year average deflated level, and lamb and calf prices are kept at current real or deflated levels. Wool incentive price and harvested acreage remain the same as in the first scenario. Though deflated returns are higher for sheep in scenario 2, higher deflated calf and hay prices resulted in inventories falling to 7.01 million head by 1993.

Though many changes can occur over the next four years, projections for Scenario 3 are made using current trends and expected changes in variables affecting the sheep industry. Increasing lamb and mutton supplies through 1991 from higher domestic production and ewe slaughter are expected to place downward pressure on lamb prices with actual nominal annual prices falling to approximately \$.65 per pound. A continued trend of increasing lamb and mutton imports may also add to downward pressure on lamb prices. Demand for lamb is assumed to remain relatively stable. The wool incentive price is assumed to continue declining slowly to \$1.75 per pound by 1991 based on current USDA policy. Though long term trends in lambing rates indicate an annual increase of .01 lambs per ewe, lambing rates are again held stable due to the high annual fluctuations and limited short-run effect on total returns. Lamb weights are expected to remain stable at 117 pounds due to increased industry pressure to reduce sales of overweight lambs. Deflated returns per ewe fall substantially under these assumptions since wool price and lamb price are projected to decrease in real or deflated terms.

The beef cattle industry is considered to be entering an expansionary phase, therefore calf prices are assumed to increase at or above the assumed 5 percent inflation rate through 1990 due to decreased heifer and cow slaughter (USDA). Decreased grain stocks and higher prices in 1988 and 1989 are expected to increase harvested acreage in 1990 to around 315 million acres (USDA). Acreage harvested is then assumed to return to its 5-year average of 305 million acres. Hay price is assumed to remain at its 5-year average real level, and the proportion of part-time farms is assumed to increase at its current rate. Under these assumptions, January 1st inventories of ewes and ewe lambs are projected to fall to 6.55 million head by 1993. A decrease in imports due to higher domestic production and lower retail prices may help bolster returns per ewe. Increased lambing rates and resulting higher returns could also reduce inventory liquidation.

Table 7. U.S. Breeding Ewe Inventory Projections, 1990-1993

	1990	1991	1992	1993
Scenario 1:				
Deflated Total Returns*	\$83.92	\$79.15	\$75.32	\$71.67
Deflated Hay Price	\$68.40	\$55.05	\$52.43	\$49.93
Deflated Calf Price	\$69.08	\$75.40	\$74.80	\$71.22
Crop Acreage Harvested	302.1	304.8	304.8	304.88
Percent Part-time Farms	35.8	35.9	36.1	36.2
Projected Inventory (million head)	8.09	7.89	7.67	7.49
Scenario 2:				
Deflated Total Returns	\$83.92	\$82.49	\$81.85	\$81.24
Deflated Hay Price	\$68.40	\$63.25	\$63.25	\$63.25
Deflated Calf Price	\$69.08	\$75.40	\$75.40	\$75.40
Crop Acreage Harvested	302.1	304.8	304.8	304.88
Percent Part-time Farms	35.8	35.9	36.1	36.2
Projected Inventory (million head)	8.09	7.73	7.37	7.01
Scenario 3:				
Deflated Total Returns	\$83.92	\$76.16	\$72.47	\$73.43
Deflated Hay Price	\$68.40	\$63.25	\$63.25	\$63.25
Deflated Calf Price	\$69.08	\$75.40	\$75.40	\$75.40
Crop Acreage Harvested	302.1	315.0	304.8	304.8
Percent Part-time Farms	35.8	35.9	36.1	36.2
Projected Inventory	8.09	7.71	7.12	6.55

* Values for explanatory or independent variables are actual lagged values used in calculating each year's projected inventory.

Survey results of producers plans through 1990 indicated that inventories should continue to expand. These decisions, made in 1988, will most likely change since returns for sheep have declined in 1988 and 1989 and since calf prices have shown significant increases over the same time period. Without substantial increases in returns, which are unlikely with world sheep numbers at an all-time high and decreasing government support, the sheep enterprise will be unable to compete with rising beef cattle inventories for producer resources. Breeding sheep inventories will decline and more resources will be lost from the industry. Though model projection indicate inventories as low as 6.5 million head by 1993, allowance for error and consideration of survey results suggest breeding inventories may fall to between 7.2 and 7.4 million head in the next four years.

Conclusions and Implications

The U.S. sheep industry faces many challenges over the next several years. Results of this study indicate that the industry is more prone to contraction than expansion and that breeding inventories could fall below 7.4 million head by 1993. Lamb and mutton will face continued competition with other red meats, fish, and poultry for consumer market share. Domestic wool will face continued competition with synthetic fibers and foreign textiles. Increased returns for beef cattle in the U.S. will lure resources out of sheep production. Competition from record-large world sheep inventories and decreased government support will place downward pressure on lamb and wool prices.

Based on these conditions and survey results, any industry strategy to increase or at least maintain industry production should center on three main goals:

1. Maintaining producer returns,
2. Increasing producer preference for the sheep enterprise, and
3. Maintaining market share.

Though elasticities of inventories with respect to total returns are low, lower prices for lamb and wool from increased world production and decreased government support will have a negative effect on inventories. Thus, maintaining or improving producer returns will be important.

Producer returns are more responsive to changes in lambing rates than to any other output factor. Lambing rates also show the most potential for improvement and are more controllable than lamb price. Import restrictions have been shown to increase lamb prices and inventories (Whipple and Menkhaus), but they would also lead to decreased product availability and possible loss of market share.

Research towards developing economical increases in lambing rates and dissemination of this information is one primary way to maintain returns. Increased wool quality and resulting increases in value is another way to bolster returns per head. Survey results indicate the need for a consistent wool grading system and for incentives to increase wool cleanliness and quality. Both of these alternatives would help maintain producer returns during periods of declining inflation-adjusted selling prices.

The second area of concern that an industry strategy should address is producer attitudes and preferences. A more positive perception of sheep by current and future producers will help keep resources in the industry. Survey results indicated that most growth in sheep numbers in recent years has occurred among mid-sized, diversified farmers in the Midwestern and Northern Plains states. With increasing returns for beef cattle, keeping resources in sheep production may depend on these and other producers being made

more aware of the advantages of combined cattle/sheep grazing and of the more stable income that sheep can provide. Also, research to reduce the labor requirements of sheep and to reduce predator losses would help change producer perceptions. Another factor influencing producer attitudes is the increased seasonal variations in lamb price in recent years. Concern over price variability was evident in the survey. Increases in price variation directly increase producers' risks. Consideration should be given to production/marketing strategies which would help stabilize prices throughout the year.

The third area on which an industry strategy should concentrate is on maintaining market shares (and therefore prices) for lamb and wool. Consumers ultimately decide the demand for both lamb and wool, but lamb is more directly subject to consumer preferences since it involves less further processing. Problems with overfat and overweight lambs, as experienced in the spring of 1988, need to be addressed before they substantially affect consumer demand. Respondents to the surveys also indicated confusion over what type of lambs were desired. Most concerns revolved around discounts for heavy lambs that were not overly fat. Industry standards and incentives for acceptable carcass size, quality, and yield based on consumer demands would help clear up this confusion and reduce waste. New product development should be pursued if it will improve demand for lambs. Finally, the effects of product promotion on both lamb and wool consumption should be evaluated and product advertisement pursued if it proves cost effective.

The strategies suggested may still not be enough to bolster returns over the next few years and maintain inventory and resource levels. Consideration of these and other possibilities should be incorporated into the development of any industry programs. Though the results presented herein are not the final word on sheep supply response, they do provide insight into the current industry situation and prospects for the future.

Implications for Future Research

Several problems still exist with the supply models presented in this study. Multicollinearity, especially in regional models, may need to be corrected in order to obtain smaller confidence intervals and to increase forecast accuracy. Further research and more sophisticated modeling of the hypothesized asymmetrical supply function may also increase regional and national model accuracy. The use of weighted regional values rather than those of representative states may increase regional model effectiveness and accuracy. More accurate measures of seasonal conditions and forage availability may also prove beneficial. More data observations, particularly observations outside of the downward trend in inventories, might increase the accuracy of the estimated models.

In any case, future modeling efforts must include some measure of the change in resources that has occurred within the industry and account for the technological changes that have occurred in lambing rates and lamb weights. Consideration must also be given to the actual proportion of income received from lamb and wool outputs and its change over time. Future models must also include some measure of the profitability of cattle and of forage or pasture availability and cost.

Controlled experimentation could be used to determine the elasticity of the short run supply function and the magnitude of the increase in profit incentives that would be required to stimulate production. The follow-up survey indicated that, on average, lamb prices would have to increase by \$18 per hundred pounds (from the \$66 area) before producers would expand. A representative set of sheep producers, placed in a controlled setting, could be presented with alternative scenarios to determine when expansion

would occur. If the resource constraints are indeed so severe that a lamb price increase of 20 to 30 percent or a similar increase in returns per ewe would be required to bring in additional capital investment and labor, the industry faces a severe barrier to growth. Controlled experiments to elicit producer responses would help to determine the magnitude of the needed incentives and would provide guidance to development of strategies by industry groups.

On a final note, changes in government policy, including import restrictions or suspension of the wool incentive program, may result in significant changes in the projected inventories and in the supply models presented in this study. Further work to estimate the net impact of the wool incentive program during a period of downward trending inventories is needed.

Appendix 1. Major Survey Form

PLEASE REMEMBER, ALL ANSWERS ARE STRICTLY CONFIDENTIAL

Circle the appropriate answer, please, or answer as directed.

1. How many years have you been in the sheep business?
 - a. 1-5 years
 - b. 6-10 years
 - c. 11-20 years
 - d. Greater than 20 years
2. How do you consider your farming operation?
 - a. Full-time (major source of household income)
 - b. Part-time
3. What percent of your total farm receipts come from your sheep enterprise?
 - a. Less than 10%
 - b. 10-25%
 - c. 26-50%
 - d. 51-75%
 - e. Greater than 75%
4. Please indicate all of the other enterprises other than sheep that accounted for more than 10% of your total farm receipts in 1987.
 - Beef Cattle
 - Dairy Cattle
 - Other Livestock (hogs, poultry, horses, goats, etc.)
 - Cash Crops (grain, hay, vegetables, Christmas trees, etc.)
5. Do you hire labor for the daily operation of your sheep enterprise?
 - a. Yes
 - b. No
6. How many breeding sheep were in your operation as of Jan. 1, 1988?
 - a. None, I operate a feedlot
 - b. 1-50 Head
 - c. 51-299 Head
 - d. 300-599 Head
 - e. 600-999 Head
 - f. 1,000-2,499 Head
 - g. Greater than 2,500 Head

IF YOU ANSWERED NONE, PLEASE SKIP TO QUESTION #11.

7. When are your lambs born? (Circle all that apply)
 - a. Winter
 - b. Spring
 - c. Summer
 - d. Fall
8. Where are most of your lambs born? (Circle one)
 - a. In barn or shed
 - b. On range
 - c. On pasture

9. What was your lambing percentage in 1987?
- Less than 100%
 - 100-125%
 - 126-150%
 - 151-180%
 - Greater than 180%
10. Approximately what percent of your total lambs in 1987 were
- Sold as:
- Slaughter Lambs _____ (e.g. 60%)
- Feeder Lambs _____ (e.g. 30%)
- Kept as Replacements _____ (e.g. 10%)
11. How do you sell your lambs? (Circle all that apply)
- Electronic Marketing
 - Stockyard
 - Direct to Packer
 - Order Buyer
 - Feeder Buyer
12. Approximately how many total pounds of wool were shorn from your flock in 1987?
- _____ Total Pounds
13. Do you currently receive a wool incentive payment for wool or unshorn lambs?
- Yes
 - No
14. Please indicate how you feel about the following statement: "The wool incentive program is a major factor in my decision to continue my sheep enterprise."
- Agree
 - Tend to Agree
 - Tend to Disagree
 - Disagree
15. What was the percent death loss for all sheep on your operation in 1987?
- 0-5%
 - 6-10%
 - 11-15%
 - 15-20%
 - Greater than 20%
16. Please rate the following causes of your death loss as to their seriousness.
- Major Moderate Minor None
- Lambs lost to starvation/exposure
- Lambs lost to infectious disease
- Lambs lost to predators
- Ewes lost to disease
- Ewes lost to predators
- Unknown causes
17. How many acres (excluding public lands) of rangeland/pasture (owned and rented) do you use for sheep?
- _____ Acres
18. How many AUM's (Animal Unit Months) of public land do you use for sheep?
- _____ AUM's

19. Compared to 1988, how many sheep do you expect to have (check one answer on each line):

	Greater than 10% More	1-10% More	1-10% Same	1-10% Fewer	Greater than 10% Fewer	None
Next year						
In 5 years						

20. Do you have more sheep than you had five years ago?

a. Yes b. No

IF NO, PLEASE GO TO QUESTION #22

21. To what extent have each of the following factors influenced your decision to expand your sheep flock?

	Influence			
	Strong	Moderate	Weak	None
Had excess labor available	1	2	3	4
Amount of predation decreased	1	2	3	4
Had unused facilities available	1	2	3	4
New lamb markets developed	1	2	3	4
Had underutilized range/pasture	1	2	3	4
More profitable than other enterprise	1	2	3	4
Wanted to stabilize income	1	2	3	4
Had available capital to invest	1	2	3	4
Able to obtain financing	1	2	3	4
Added partner to operation	1	2	3	4
Personal preference for sheep	1	2	3	4

IF YOU ANSWERED QUESTION #21, PLEASE SKIP QUESTION #22

22. To what extent have each of the following factors influenced your decision to not expand your sheep flock?

	Influence			
	Strong	Moderate	Weak	None
Lack of suitable fencing	1	2	3	4
Lack of quality labor	1	2	3	4
Increased predation	1	2	3	4
Increased grazing fees	1	2	3	4
Limited range/pasture acreage	1	2	3	4
Limited number of lamb markets	1	2	3	4
Limited number of wool markets	1	2	3	4
Nearing retirement	1	2	3	4
Drought conditions	1	2	3	4
Excessive debt load	1	2	3	4
Shortage of replacement ewes	1	2	3	4
High death loss from disease	1	2	3	4
Requires too much capital investment	1	2	3	4
Other enterprises more profitable	1	2	3	4
Personal preference for other enterprise	1	2	3	4

23. Over the long term, do you think sheep are more, less, or equally as profitable as cattle?

- a. More Profitable
- b. Equally Profitable
- c. Less Profitable
- d. Don't Know

IF YOU DO NOT HAVE CATTLE AS AN ALTERNATIVE ENTERPRISE,

PLEASE GO TO QUESTION #25

24. For each of the following comparative levels of profits between sheep and cattle (returns above all labor, feed, and capital costs), please indicate whether you would *increase, decrease, or maintain* the number of sheep in your flock.

Compared to Cattle:	Number of Sheep		
	Increase	Decrease	Maintain
Sheep are 75% less profitable	1	2	3
Sheep are 50% less profitable	1	2	3
Sheep are 25% less profitable	1	2	3
Sheep are equally profitable	1	2	3
Sheep are 25% more profitable	1	2	3
Sheep are 50% more profitable	1	2	3
Sheep are 75% more profitable	1	2	3

25. In what state is the majority of your sheep operation located?

26. What is your age?

- a. 30 and under
- b. 31-40
- c. 41-50
- d. 51-60
- e. 61 and over

WE WOULD NOW APPRECIATE YOUR RESPONSE TO THE FOLLOWING THREE QUESTIONS. IF YOU HAVE NO COMMENTS OR SUGGESTIONS, HOWEVER, PLEASE RETURN THE SURVEY IN THE PRE-PAID ENVELOPE.

27. Please briefly list and explain any changes in lamb pricing, grading, etc. that you feel are needed or that would be beneficial to the lamb marketing system in your region.
28. Please briefly list and explain any changes in wool pricing, grading, etc. that you feel are needed or that would be beneficial to the wool marketing program in your region.
29. Please use the remainder of the page to list and explain any other factors influencing your decision to maintain or discontinue your sheep enterprise that have not been mentioned in this survey.

SURVEY ON LABOR ISSUES IN SHEEP PRODUCTION

1. Was the last change in the size (5% or more) of your sheep operation during the 1970s or 1980s a reduction?

Yes _____ No _____

If yes, was labor (costs or availability) of labor the primary reason for that reduction?

Yes _____ No _____

If labor was not the primary reason, list the top 3 reasons in order of importance including labor if it was one of the top 3.

- a. _____
- b. _____
- c. _____

2. Have you changed from full-time to part-time farming during the 1970s or 1980s?

Yes _____ No _____

If yes, was labor (costs or availability) in your sheep program the most important reason?

Yes _____ No _____

If labor was not the most important reason, list the top 3 reasons in order of importance, including labor if it was one of the top 3 reasons.

- a. _____
- b. _____
- c. _____

3. Was the last change in the size (5% or more) of your sheep program during the 1970s and 1980s an expansion of the size of your sheep program?

Yes _____ No _____

If yes, was labor (costs or availability) the primary constraint that stopped the expansion at a certain level?

Yes _____ No _____

If labor was not the primary constraint, list the top 3 reasons in order of importance, including labor if it was one of the top 3 reasons.

- a. _____
- b. _____
- c. _____

4. During the 1970s or 1980s, did you consider expanding your sheep program and then decide not to?

Yes _____ No _____

If yes, was labor (costs or availability) the primary factor that stopped you from expanding?

Yes _____ No _____

If labor was not the primary reason for not expanding, list the 3 top reasons you decided not to expand, including labor if it was one of the top 3 reasons.

- a. _____
- b. _____
- c. _____

5. Do you feel you can afford to pay what it takes to get good help in your sheep program?

Yes _____ No _____

Comments: _____

6. At the current time, what would you estimate the price for slaughter lambs to be in your market area? \$ _____/cwt. (If you produce only feeder lambs, enter your estimate of feeder lamb prices.)

Given your price listed and assuming that wool prices (selling price plus incentive payment) will stay constant, what price for lambs would be needed for you to expand your sheep operation significantly? \$ _____/cwt.

If lamb prices were to increase that much and you considered expanding, what would be the two most important constraints or problems facing you as you try to expand?

- a. _____
- b. _____

7. For your most recent sale, what was your total wool price (sales price plus wool incentive payment)?

_____ cents per pound

Assuming lamb prices will remain constant at the current price you estimated above, what net wool price (selling price plus incentive payment) would be required for you to expand your sheep operation significantly?

_____ cents

8. What is the most important competition for your time, efforts, and money as you consider expanding in the sheep area? Choose one of the following:

____ Competition from other livestock
List which livestock: _____

____ Competition from crops
List which crops: _____

____ Other competition
Explain: _____

Please tell us briefly how you think the labor cost and availability issue influences producers decisions on size of operation and decisions to cut back or expand.

THANKS FOR YOUR HELP!

Appendix 2. The Producing Regions

American Sheep Producer Council Regions

REGION 1	EAST COAST & SOUTHEAST	REGION 3	MIDWESTERN PLAINS
	Alabama		Iowa
	Arkansas		Kansas
	Connecticut		Minnesota
	Delaware		Missouri
	Florida		Nebraska
	Georgia		North Dakota
	Kentucky		Oklahoma
	Louisiana		
	Maine		
	Maryland	REGION 4	NORTHERN PLAINS
	Massachusetts		Montana
	Mississippi		South Dakota
	New Hampshire		
New Jersey			
	New York	REGION 5	TEXAS
	Pennsylvania		Texas
	Rhode Island		
	South Carolina	REGION 6	ROCKY MOUNTAINS
	Tennessee		Colorado
	Vermont		Idaho
	Virginia		Utah
	West Virginia		
REGION 2	OHIO VALLEY & GREAT LAKES	REGION 7	WEST COAST & SOUTHWEST
	Illinois		Alaska
	Indiana		Arizona
	Michigan		California
	Ohio		Hawaii
	Wisconsin		Nevada
			New Mexico
			Oregon
			Washington

Appendix 3. Response Rates for Major Survey
 Total Responses - 530 Response Rate 59.8%

REGION 1:	Mailed -	73
	Usable Responses -	43
	Uncompleted -	4
	Improper Address -	0
	Refusals -	1
	Response Rate -	64.4%
REGION 2:	Mailed -	78
	Usable Responses -	39
	Uncompleted -	9
	Improper Address -	2
	Refusals -	0
	Response Rate -	63.2%
REGION 3:	Mailed -	103
	Usable Responses -	62
	Uncompleted -	5
	Improper Address -	2
	Refusals -	0
	Response Rate -	66.3%
REGION 4:	Mailed -	166
	Usable Responses -	93
	Uncompleted -	8
	Improper Address -	1
	Refusals -	0
	Response Rate -	61.2%
REGION 5:	Mailed -	152
	Usable Responses -	76
	Uncompleted -	9
	Improper Address -	2
	Refusals -	2
	Response Rate -	56.3%
REGION 6:	Mailed -	137
	Usable Responses -	75
	Uncompleted -	10
	Improper Address -	2
	Refusals -	1
	Response Rate -	63.0%
REGION 1:	Mailed -	291
	Usable Responses -	142
	Uncompleted -	11
	Improper Address -	10
	Refusals -	2
	Response Rate -	54.4%

Appendix 4. Response Rates for Labor Survey

Total Responses - 121

Response Rate 24.0%

REGION 1:	Mailed -	47
	Usable Responses -	11
	Uncompleted -	2
	Improper Address -	0
	Refusals -	0
	Response Rate -	27.7%
REGION 2:	Mailed -	48
	Usable Responses -	12
	Uncompleted -	2
	Improper Address -	0
	Refusals -	0
	Response Rate -	29.2%
REGION 3:	Mailed -	67
	Usable Responses -	14
	Uncompleted -	0
	Improper Address -	0
	Refusals -	0
	Response Rate -	20.9%
REGION 4:	Mailed -	101
	Usable Responses -	22
	Uncompleted -	1
	Improper Address -	0
	Refusals -	0
	Response Rate -	22.8%
REGION 5:	Mailed -	85
	Usable Responses -	15
	Uncompleted -	3
	Improper Address -	1
	Refusals -	0
	Response Rate -	17.9%
REGION 6:	Mailed -	85
	Usable Responses -	19
	Uncompleted -	6
	Improper Address -	1
	Refusals -	0
	Response Rate -	29.8%
REGION 1:	Mailed -	151
	Usable Responses -	28
	Uncompleted -	4
	Improper Address -	3
	Refusals -	0
	Response Rate -	21.6%



