Sheep and Lamb Industry Economic Impact Analysis, April 2008

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Abstract

Sheep industry production spurs a ripple effect throughout the economy, generating additional economic activity that was estimated using the IMPLAN (Impact Analysis for Planning) modeling software and dataset. An estimated $486.5 million in lamb, mutton, wool, sheep milk production, and breeding stock at the producer level supports an additional $1.2 billion in economic activity for a total of $1.7 billion. The sheep industry supports backward-linked industries that supply sheep production. It also supports local businesses through expenditures of sheep-industry generated income on goods and services. This study estimated a second model in order to quantify the value added to sheep products that were not captured in the first model. The sheep industry produces many and varied products from lamb chops served in fine dining restaurants to lanolin. Estimates of retail lamb and wool, wholesale pelts, variety meats, meal, tallow, and lanolin, and retail sheep cheese sales revealed that $785.6 million in production generates an additional $1.9 billion in multiplier effects, summing to a total economic impact of $2.7 billion.

I. Introduction

The sheep industry is an important economic component of our economy, but how important? Although sheep producers are found in every state, we don't know how significant their efforts are to our economy. From the lamb chops at Chéz Luis to wool blankets and hand lotion, the sheep industry produces a variety of products. To add to this, the sheep industry generates business for input supply companies, such as feed and sheep health supplies. In addition, sheep-industry generated income supports businesses of goods and services purchased. What is the total effect of the sheep industry, including these ripple effects?

The sheep industry has a long-standing history in the United States with sheep representing an integral part of rural communities and lamb showing up on dinner tables in every state of the nation. Although much has changed over the years, the sheep industry continues to provide a livelihood for many and contributes to the economic value of a myriad of agricultural and industrial products.

The U.S. sheep inventory is concentrated in the West, while sheep operators, with smaller flocks, are concentrated in the Midwest and Northeast. In general, the larger range flocks are found in the West, but flocks are scattered throughout the Northeast, Mid-Atlantic and Midwest. Texas, California, Wyoming, Colorado, and South Dakota represent the top five most populous states for total numbers of sheep and lamb.

Most sheep producers have relatively small flocks. Ninety-two percent of the total sheep operations have fewer than 100 head of sheep and lambs. In 2010, there were 81,000 sheep and lamb operations across the United States.

The largest lamb processing plants are found in the West – specifically in Colorado and California. The location of processing coincides with states with large sheep inventories and feeding operations.

The lamb and wool industry is an approximately $500 million dollar industry (farmgate receipts). About 2 percent of sheep operations account for one-half of sheep and lamb production in the United States.

II. Objective

The objective of this study is to estimate the economic impact of the U.S. sheep industry. The economic impact is a measure, a number, of how important the sheep industry is to our economy by capturing all the multiplier effects from producer expenditures on feed to income spent by lamb fabricators.

Thus, the initial production, the "direct" effect of production of lamb, mutton, wool, and the many byproducts, has an "indirect" or "multiplier" effect that echoes throughout the national economy. For every $1 of lamb produced, there is an amount that is used to support backward-linked industries such as pharmaceuticals and there is some amount that is spent on groceries and movies. This direct and indirect effect (or multiplier effect) sum to the total effect and is estimated using an input-output modeling technique and software called IMPLAN.

III. Previous Studies

There is no known study estimating the economic impact of the sheep industry in the United States. That is, there is no known study capturing the multiplier effect of the industry on the U.S. economy. There are estimates of the total production value of the sheep and goat industries combined. There are also estimates of the value of production of lamb, mutton, and wool production. This study is unique in that it will identify and quantify the total multiplier effect of the sheep industry.

Total farm cash receipts from livestock were estimated to have surpassed $120 billion annually since 2003, with beef, dairy, poultry, and pork representing well over 90 percent of this value.[1]

The value of beef production (including cull cows and steer calves from dairy herds) accounted for the largest share of livestock production. Dairy products represented the second largest animal-product sector. The third-largest sector was comprised of the poultry industry, including broiler, turkey, and egg production. Receipts from hog production represented the fourth-largest sector.

Other livestock and animal products — including sheep and lamb, wool, goats and mohair, and aquaculture products — produced farm cash receipts representing about 5 percent of the total value of animal products, or roughly $6 billion. Within this sum, a 2002 study found that the value of the sheep, goats, and their products was $541.7 million.[2]

The U.S. Department of Agriculture, National Statistics Service computes the gross income to sheep producers for lamb and wool annually. Gross income includes the value of home consumption as well as the cash receipts from marketed production. Sheep producer's gross income totaled $449 million in 2009. Colorado was the highest-ranking state for sheep and lamb cash receipts with $98 million (including feedlot sales), followed by California and Texas ($38 million each) and then Wyoming ($36 million).

IV. Method and Data

This analysis employed the use of the computer software and database package called IMPLAN. The IMPLAN economic impact modeling system, available from the Minnesota IMPLAN Group, Inc. (MIG), is the acronym for *Impact Analyses and Planning*.

IMPLAN is an input-output model. Within each industry, such as lamb production, there are sectors defining the stage of production such as carcass fabrication. Then, for a one-year production period, a transactions table reflects the value of goods and services exchanged between sectors of the economy.

[1] U.S. Department of Agriculture, Economic Research Service. Accessed at http://www.ers.usda.gov/Briefing/AnimalProducts/questions.htm
[2] U. S. Department of Agriculture, Bureau of the Census, 2002.

The economic data for IMPLAN comes from the system of national accounts for the United States based on actual data collected by the U. S. Department of Commerce, the U.S. Bureau of Labor Statistics, and other federal and state government agencies. Data are collected for distinct producing industry sectors of the national economy corresponding to the Standard Industrial Categories (SICs).

The model estimates the economic importance of the sheep industry by quantifying the linkages between input supply industries of the targeted industry as well as linkages between the incomes received in the targeted industry and expenditures on goods and services purchased. The model can quantify the direct effect, indirect effect, and induced effect from $1 value of production in any given sector. The direct effect, indirect effect and induced effect sum to the total effect.

The direct effect shows how output changes with a given change in final demand. For example, if lamb demand increases, the direct effect will show how lamb production is affected.

The indirect effects are the inter-industry purchases as they respond to the demands of the directly affected industries. Sheep production generates business for many contributing industries. From fencing to pharmaceuticals to feed, lamb production helps to support these backward linked industries.

The induced effects reflect spending from households from the income received from the targeted industry. Lamb producers most likely spend most of their income in their local economy on goods and services from new jeans to haircuts. The induced effect represents the impacts on all local industries caused by the expenditures of household income generated by sheep and wool production. That is, the induced effect captures all spending on goods and services by those contributing to sheep and wool production.

The induced effect includes spending by sheep producers as well as spending by all employees of all input-related industries contributing to sheep production. This may include employees of pharmaceutical companies, guard dog breeders, feedlot hands, shepherds, and part-time wool shearers.

This model used IMPLAN Sector 13 representing the average makeup of all non-cattle and non-poultry livestock and within which the sheep industry falls. The sector was defined to capture livestock industries that were found to have similar production functions. This means that the ratio of inputs to outputs is the same. Production functions show where an industry spends and in what proportion to generate each dollar of output. The production function generates the multipliers. For each sheep byproduct such as sheep cheese, the cheese manufacturing sector was used.

A multiplier is a single number that summarizes the total economic benefits resulting from production of a given industry. Multipliers measure the strength of ripple effects than can occur in an economy from $1 of production. Multipliers typically range between 1 and 3. The more inputs purchased locally and the more consumers shop at local shops, the higher the multiplier.

In order to estimate the impact from the sheep industry, the value of sheep products must be known. The model provides the multipliers that can compute the linkages and resulting indirect and induced effects, but it doesn't provide the initial direct

effect of production. IMPLAN estimates the value of sector 13 (non-cattle, non-poultry livestock), but not of the sheep industry individually.

The multipliers for the sheep industry were obtained through IMPLAN (Table 1). The output multiplier has a direct effect of 1.0, an indirect effect of 1.8, and an induced effect of 0.84, for a total effect of 3.65. This means that every $1 of lamb produced by a producer will yield $1.80 in extra product in backward linked industries such as at a local feed store, and $0.84 in extra spending in the local economy, perhaps for a haircut.

Table 1. Sector 13 multipliers

	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output Multipliers	1.0	1.80	0.84	3.65
Employment Multiplier	25.2	10.3	6.2	41.7

The employment multiplier tells us that for every 25 jobs created in the sheep industry, 10 jobs will be created in backward-linked industries, and 6 jobs will be created as a result of increased consumer spending by sheep-industry related persons (Table 1).

Two models were estimated in this analysis. The first model captured the value of the sheep industry at the farmgate, or the producer level. The second model captured the value added in the industry. For example, it will be shown that lamb sales at the farmgate were about $265 million in 2010; however, retail and foodservice lamb sales were estimated at $544 million, 105 percent more. The additional $279 million was paid to transporters, meat cutters, lamb packers, grocers, and restaurant owners in order to turn the live animal into retail-ready lamb chops. There is a cost to adding value to products. The first model would miss the positive ripple effect throughout the economy of a fabricator's expenditures.

The effects of lamb, mutton, wool, purebred production, and sheep milk production were first estimated. This gives us the direct effect (gross value to sheep producers), the indirect effect (the economic boost to backward linked industries), and the induced effect (the expenditure of sheep-related incomes). The second model incorporated products such as lanolin and retail sales to capture value added in the industry.

The sheep industry's products and byproducts are far reaching, showing up in everyday products from baseballs, medications, hot dogs, to fine china. Estimating the value of all byproducts is a challenge because in many cases, the portion of production, such as the sheep intestines used for hot dog casings, is small. This analysis used publicly available data and estimates from many in the industry to cover as much industry production and value added as possible.

V. Model 1, Economic Impact of Producer Production

The IMPLAN model provided multipliers as well as the resulting indirect and induced effects of production. However, to arrive at the total effect of the sheep industry, production values had to be estimated and inputted into the model. To capture value added, the value of sheep products and the various stages of production were inputted into the model in order to estimate the total economic impact of the sheep industry. The values used are delineated in Table 2.

The first model estimated the economic impact of lamb, mutton, wool, sheep milk, and purebred breeding stock production at the farmgate.

Lamb and Mutton Production

The value of the sheep industry for meat production at the farmgate was estimated at $453 million in 2010 (Table 2). Lamb and mutton production captures lamb slaughtered in federally inspected plants, non-federally inspected plants, the ethnic market, as well as on-farm slaughter.

Table 2. Direct effects of farmgate production

Commercial Lamb	$264,919,540
Nontraditional Lamb Market	$155,178,510
Mutton	$8,277,360
Live Sheep Export	$8,170,000
Wool	$35,288,000
Sheep Milk	$3,375,000
Registered Purebred Breeding Stock	$11,300,000
Total	**$486,508,410**

Slaughter lambs are sold through public auctions as well as through private, direct trade with packers, often called formula trades and negotiated sales. Different marketing methods employ different pricing mechanisms and as a result, different average prices emerge. A weighted average price, based upon marketing method utilized, was used in this analysis.[3] Prices may also be a function of the weight of the animal, the quality, the time of year, or nature of the relationship between producer and packer. Commercial lamb production was valued at $265 million, a function of commercial production and weighted-average prices. In 2010, lamb prices ranged from $124/cwt. for formula trades to $127/cwt. in auction sales.[4]

Live sheep are primarily exported to Mexico and Canada. In 2010, the total value of live sheep was $8 million.

The value of mutton production was estimated by taking the non-lamb portion of federally inspected slaughter and multiplying it by the slaughter ewe average price. In 2010, 156,000 adult sheep were slaughtered with an average price of $53.06/cwt.

[3] Derived from U.S. Department of Agriculture, Agricultural Marketing Service, 2010.
[4] U.S. Department of Agriculture, Agricultural Marketing Service, 2010.

Ethnic Lamb Market

The ethnic lamb market is a significant and growing component of the sheep industry that mostly falls outside the mainstream, commercial market, yet it is not well documented. Lamb is common in the diets of many people of ethnic origins, particularly from the Middle East, Africa, and the Mediterranean region, Latin America, Caribbean, and Asia. In addition, lamb is popular in religious observations for many ethnic groups. As will be explained, the nontraditional market was estimated at $155 million in 2010.

The volume of lamb going into the ethnic market is not known for certain, so an estimate was used in its valuation. An estimated 1,159,000 head were sold into the ethnic trade in 2010. This number was derived from a statistical discrepancy between the 2010 commercial slaughter volume and the reported lamb crop (less 5% for losses). It is thus assumed that most lamb slaughter in the ethnic market occurs outside of the federally inspected "commercial" market. Slaughter may occur in non-federally inspected, or state plants, or even in slaughtering facilities that are not captured in national databases.

Sheep producers across the United States sell direct into the ethnic or nontraditional market at average weights ranging from 80 lbs. to 124 lbs.[5] The ethnic lamb market is unique in its demand for lambs lighter in weight than the 140-lb. commercial market. As an example, milk-fed 40- to 55-lb. lambs are in demand for the celebration of the Eastern, or Greek, Easter. Heavier, 60- to 80-lb. lambs are in demand for the Muslim observation of Ramadan, a month of fasting.[6] White, or Caucasian, buyers prefer lambs from 85 lbs. to 124 lbs.[7]

Prices received by producers in the nontraditional market are not known, but it is known that prices received are often a premium to that in the commercial market. Prices of feeder lambs at auction in the 40-lb. to 115-lb. weight range were used as a proxy for direct slaughter lamb sales in the nontraditional market. The average auction price was $133.89/cwt. in 2010.[8]

Producer lamb and mutton production accounts for an estimated 90 percent of total farmgate sales (listed in Table 2). Wool accounts for 7 percent of the total farmgate value, purebred stock accounts for 2 percent and sheep milk sales account for 1 percent.

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[5] Shiflett, J., Williams, G., and Rodgers, P., "Nontraditional Lamb Market in the United States: Characteristics and Marketing Strategies," Prepared for the American Sheep Industry Association, 2010.
[6] Larson, A. and E. Thompson. No date. "Direct Marketing Lamb to Niche and Ethnic Markets," University of Illinois Extension.
[7] Shiflett, J., Williams, G., and Rodgers, P., "Nontraditional Lamb Market in the United States: Characteristics and Marketing Strategies," Prepared for the American Sheep Industry Association, 2010.
[8] U.S. Department of Agriculture, Agricultural Marketing Service, 2010.

Wool Industry

The U.S. wool clip was valued at $35.3 in 2010 at the farmgate.[9] The average price of wool was $1.15 per lb. greasy and total production was 30.6 million lbs. with 4.215 million head shorn.

The U.S. wool industry produces wool across each micron (average wool fiber diameter) category with the finer wools with a lower micron reading receiving price premiums. However, the volume of each micron produced is unknown. U.S. wool is characterized from the very fine to the coarsest wool. Roughly 28 percent of the wool clip is 22 micron and finer. About half of wool production is the mid-micron wools from 22 micron to 31 microns, with the remaining 4 percent being the coarsest wool. "This makes American wool suitable for a wide variety of products including fine worsted suiting, knitwear, woolen velours and coatings, upholstery, bedding materials for futons, mattresses and comforters, and industrial products."[10]

Dairy Sheep

The sheep dairy industry is a small, but growing segment of the sheep industry. Sheep milk at the farmgate was estimated at 3.375 million lbs. in 2010.[11] Dairy sheep production is primarily found in the northeastern United States (Vermont and New York) and in the Midwest (Wisconsin and Minnesota). Dairy sheep are neither typical U.S meat nor wool breeds, but East Friesan and Lacaune sheep.

There were an estimated 69 dairy farms in the U.S. with a total of 9,000 milking ewes. With a conservative estimate of 500 lb./ewe/year, 4.5 million lbs. of milk are produced annually. Given an estimated farmgate price of $0.75 per lb. this equates to $3.375 million in milk production.[12]

The sheep dairy industry faces stiff competition from imports, but this is a good sign there is solid demand to support the expanding domestic industry. Imported prices are generally lower and volumes imported far surpass domestic production. A sheep milk cooperative in Wisconsin reported, "With current estimates for U.S. imports of sheep milk products at more than 72 million lbs. annually (equivalent to 360 million lbs. of milk), there is a great deal of room for cooperative growth between producer and processors."[13]

Breeding Stock

Another important segment of the sheep industry that generally isn't accounted for by lamb or cull lamb sales is sheep breeding stock. There are 47 breeds and types of sheep in the United States from Suffolk or Dorset, to Katahdin hair sheep, to the rarer Coopworth. Purebred sheep are represented by at least 33 official registry

[9] U.S. Department of Agriculture, National Agriculture Statistical Service, 2010.
[10] American Sheep Industry Association, www.sheepusa.org accessed 1/2008.
[11] Mikolayunas, Claire, Ph.D., Small Ruminant Extension Specialist, Department of Animal Sciences, University of Wisconsin-Madison, E-mail correspondence 3/2011.
[12] Ibid.
[13] Wisconsin Sheep Dairy Coop Accessed on 10/26/07 at http://www.sheepmilk.biz/about.html.

associations.[14] Purebred sales occur throughout the year, often at county and state fairs and not at livestock auctions.

The Banner -- the nation's largest all-breeds sheep magazine -- covers all major sheep sales and produces sale reports of registered purebreds. Most purebred sheep are registered, but they do not have to be registered by law. In 2010, the estimated value of breeding stock was $11.3 million. An estimated 25,000 head of registered breeding stock sold in 2010 for an estimated weighted average of $452 per head.[15] Breeding stock and show sheep may sell for $150 per head to $2,600 per head, with the premium given to show sheep.[16]

Model 1 Results

Impacts are usually measured in terms of gross output (sales), income, employment, and value added. Output is the value of production, or sales, in a given year. Employment includes full-time and part-time wage, salaried, and self-employed jobs.

The value-added impact encompasses employee compensation, proprietor income, other property income, and indirect business tax. Employee compensation includes wages, but also health and life insurance, and retirement payments. Proprietary income is income by self-employed individuals. Other proprietary income includes payment from interest, rents, and dividends. Lastly, indirect business tax is tax paid by individuals to businesses.

The direct effect of lamb, mutton, and wool production at the farmgate, or the value to the producers was $464 million in 2010 (Table 3). The value that this production produces in backward-linked industries such as feed was $836 million. The value that this production created in the United States on consumables, goods and services, was $392 million. The total effect of lamb, mutton, wool production, and breeding stock was $1.7 billion in 2010 at the producer level.

The value-added effect summed to $596 million. The value-added indirect effect accounted for $330 million and the induced effect accounted for $214 million. The direct effect was $53 million. The direct effect may be low relative to the value-added impact from the indirect and indirect effects because there are relatively few hired hands in sheep production relative to other enterprises.

[14] *The Banner Sheep Magazine*, www.bannersheepmagazine.com accessed 3/11/08.
[15] Deakin, G., The Banner Sheep Magazine, Editor/Publisher. Phone correspondence 3/2011.
[16] The Banner Sale Management Service, 2010.

Table 3. Effects of lamb, mutton, and wool production at the farmgate

	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Total Output Effect	$463.6 mill.*	$835.7 mill.	$391.7 mill.	$1,691 mill.
Value-Added Impact	$52.8 mill.	$329.5 mill.	$213.8 mill.	$596 mill.
Employment Impact	11,698	4,767	2,866	19,331

*****Some of the direct effect is lost in the modeling effort from converting 2010 values to the model's 2006 base and back again.

The total employment effect was 19,331 jobs. The indirect and induced employment effect is added to the current number of 81,000 sheep and lamb operations for a total 97,970 sheep-industry related jobs.[17] For every 11,698 jobs created in the sheep industry there are 4,767 jobs created in backward-linked industries and 2,866 jobs created as a result of sheep-industry produced income related expenditures.

VI. Model 2, Value Added in the Sheep Industry

The economic impact of the sheep industry was also estimated at the wholesale and retail levels, where possible, to capture value added in the industry. When estimating impacts at the wholesale and retail level, it is important to split the retail price into the appropriate producer values. For example, a portion of the value of a lamb chop at a fine dining restaurant will be given to the restaurateur, but a portion will also be allocated to the producers, packers, and transporters. IMPLAN can thus capture all linkages along a supply chain.

The added value of the sheep industry is estimated at $775 million compared to $487 at the farmgate, at least an additional $288 million. This is an underestimate: It does not capture all lamb and wool byproduct sales at the wholesale and retail levels due to data constraints.

Pelt Market

Once a sheep or lamb is slaughtered, the pelt is removed and sold. The U.S. pelt market was valued at $18.4 million in 2010 (Table 4). The U.S. sheep industry produces pelts of varying quality and thus prices. The U.S. Department of Agriculture records pelt prices and volumes sold under formula, negotiated and contract trades -- about 44 percent of the commercial market -- but not pelts sold from lambs and sheep purchased at auctions. Therefore, the entire pelt market was valued based

[17] U.S. Department of Agriculture, National Agricultural Statistical Service, "Sheep and Lamb Operations, 2010," 2010.

upon an extrapolation of the value breakdown from known, recorded prices and quality.

Wooled pelts, which comprised 58 percent of total pelts in 2010, received $8.21 per pelt; No. 1 pelts brought $6.76 per piece (39 percent of total), and No. 2s received an average $4.46 per piece (3 percent of pelts).[18]

Table 4. Value added direct effect of model 2

Wholesale Pelts	$18,426,205
Wholesale Variety Meats and Rendered Products	$19,294,544
Retail Lamb Sales	$298,383,076
Food Service Sales	$245,337,196
Retail Sheep Cheese	$18,675,000
Retail Wool: Military Purchases	$172,299,355
Value Added Wool Exports	$11,001,000
Wholesale Lanolin	$2,192,873
Total	**$785,609,247**

Variety Meats and Rendered Products

The U.S. sheep industry produces sheep and lamb variety meats and rendered products, which were valued at $19.3 million in 2010. After the lamb or mutton is marketed, the other edibles, such as livers, are often marketed to ethnic markets where they are considered a delicacy. Other edibles and non-edibles are marketed into the rendering process as feed ingredients for items such as pet food and tallow. Roughly 74 percent of the value from sheep byproducts comes from marketed edible products while the remainder comes from rendered products.

Lamb processors market variety meats, cheek meat, kidneys, brains, livers and hearts, to ethnic grocers domestically and overseas. In 2010, 3.2 million MT in offal, entrails and internal organs were exported with an annual value of $4.5 million.[19] According to lamb packers, sheep and lamb variety meats are generally valued at approximately $2.50 per head. Thus, the value of variety meats is an estimated $6.1 million.

The major packers in the sheep industry also market whole frozen sheep heads for up to $2.50 each. Sheep heads are primarily exported to Mexico, but ethnic markets also exist in Los Angeles, the San Francisco Bay Area and Texas. The estimated value of heads was $6.1 million in 2010.

Hooves are discarded at some plants but not all; bones are sometimes sold or otherwise rendered. Sheep and lamb blood also has value. Dried blood is used in blood meals for fertilizers for plants or applied directly to roses. Blood is sometimes sold as a separate item, but often sold with other rendered products.

The ability and portion of lamb byproducts sold as consumables or rendered differs widely by plant. Plants that don't have good markets for some variety meats sell

[18] U.S. Department of Agriculture, Agricultural Marketing Service, 2010.
[19] U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Statistics. Data accessed 2/18/08.

them to rendering. Typically, all non-edibles would be sold to rendering -- bones, stomachs, some intestines (except natural casings), lungs, fat, etc. Not all packers are able to sell rendered products from sheep; some small plants have to pay to have products that would otherwise be marketed for rendering discarded.

The rendering process also typically produces lamb meal and tallow. It was estimated that about 37 percent of a live sheep are sent to rendering, roughly 65 percent of this volume is water, and the remainder is half tallow and half meal.[20]

A common use of lamb meal is for pet food, such as Iams "Lamb & Rice" dog food brand. As Iams reported, "Lamb meal is rendered lamb tissues such as skeletal muscle, some bone and internal organs that have been dried and ground. Skeletal muscle and internal organs are sources of high-quality protein and fats. Bone, in small amounts, is an excellent source of minerals such as calcium."[21] The value of the lamb meal market in 2010 was estimated at $3.2 million.

Another byproduct of sheep production is tallow. Lamb and mutton fat, or suet, is extracted from lamb offal and rendered into tallow. Rendering suet involves the repeated process of melting, simmering, straining, and cooling. Tallow may be edible or inedible. Edible tallow is often used in baked goods such as packaged cookies and crackers, ready-made pie crusts, or in fried goods. Inedible tallow was originally used to make candles, but is now used in a myriad of industrial uses from animal feed to art supplies. Lamb tallow parallels the beef tallow market so the average 2010 beef tallow price of $34/cwt. was used in this analysis.[22] The value of tallow was an estimated $3.8 million in 2010.

Retail and Foodservice Sales

Much of the value added in the lamb industry stems from transforming live animals into lamb cuts. Lamb packers and meat cutters, transporters, and butchers all play a role making lamb cuts ready to set out in a supermarket meat case or feature on a menu.

It is estimated that 37 percent of lamb sold "retail" is sold in the food service sector.[23] Hotels and restaurants are increasingly placing lamb on the menu and fetching at least a 40-percent premium to do so. It was estimated that the unit price of lamb in the food service sector was $8.53/lb. in 2010 while the retail average was $6.09/lb. The U.S. Department of Agriculture, Agriculture Marketing Service reports lamb prices for featured product across the U.S. This average was used, plus 2.5 percent, to estimate full price.

The estimated value of lamb sold at retail was an estimated $298.4 million while the value in the foodservice sector was $245.4 million.

[20] Dr. David Meeker, National Renderers Association, phone conversation 3/25/08.
[21] IAMS report accessed at us.iams.com on 3/11/08.
[22] U.S. Department of Agriculture, Agricultural Marketing Service, 2010.
[23] American Lamb Board. January 2007. *Analysis of Lamb Demand in the United States.*

Value Added Wool Market

The U.S. adds value to its wool clip by processing a portion into wool top and wool textiles while the remainder is exported as raw wool. The further processing that occurs in the United States includes textiles such as wool yarn, thread and fabric, wool apparel, wool home furnishings, and wool floor coverings. Many retail products are produced using 100-percent wool; however, many of the products are blended with other natural and non-natural fibers so it is difficult to value total wool retail sales. We can quantify value-added wool exports, however, as well as wool sales to one customer, the U.S. military.

Value Added Wool Exports

Roughly 80 percent of the U.S. wool clip is exported. Within this, 74 percent of U.S. wool exports was in the greasy form in 2010, before any further processing. The U.S. also adds value to its wool through scouring (cleaning), carding and producing wool tops. Ten percent of wool exports by volume was degreased or cleaned. Wool is wet washed (scoured) to remove grease (unrefined lanolin), vegetable matter and other impurities which gather in the wool from the range, feedlot, or shearing floor.[24] Seventeen percent of wool exports was carded wool tops and 0.2 percent was carded wool exports. The carding process passes the clean and dry wool through a system of wire rollers to straighten the fibers and remove any remaining vegetable matter.[25] Wool tops are a grouping of the washed, combed, and sorted longer fibers. Wool tops are ready for spinning. By value, $1.7 million of all wool exports was exported as degreased wool, $9.2 million as carded wool tops and $136,000 as carded wool for a total $11 million.

Military Wool Purchases

Of the 20 percent of the U.S. wool clip that is processed domestically, most is used to fulfill military contracts for wool and wool-blended products. Annual military purchases of wool products equal approximately $172 million.[26] Ninety-eight percent of this value is wool and wool-blended clothing. The military also purchases wool blankets worth about $24 million annually. All branches of the military and both enlisted men and women as well as officers wear wool. In 2010, there was a significant return to 'organizational/protective' clothing items, particularly “Fire Resistant” garments. The garment value for those items is approximately $25 million.

Lanolin Market

Lanolin is a wool byproduct. Wool grease, the precursor to lanolin, is a yellow substance extracted from wool. Wool grease is obtained by squeezing wool between rollers. The water-repellent properties of lanolin mean its uses are varied and

[24] American Sheep Industry Association, 2010.
[25] Ibid.
[26] Driggers, Mitch. ASI Wool Consultant, E-mail correspondence, 1/2008.

widespread. Common commercial uses include cosmetics, lubricants, and rust-preventative coatings.

Lanolin is increasingly popular in the cosmetic and pharmaceutical industries for it provides moisture and therefore prevents skin from drying and chapping. Common uses range from lipsticks to sunscreen to band-aids. The lanolin market is increasingly producing higher purity products such as Medilan (medical grade lanolin). Price premiums are received as the purity of lanolin increases.

It is unknown how much wool grease and lanolin is sold retail in the United States. For this study, the estimated value of wholesale lanolin is used to represent one wool value added byproduct. Without an officially-published lanolin production figure, some assumptions and estimates were made to value the market. Finer wool clips produce about 4.5 kg. of wool grease per 100 kg. of clean wool while the coarser wools may produce about 2 kg.[27] An average 3.5 kg was used in this analysis. After the volume of wool grease is estimated, it was assumed that another 2 percent is lost in processing wool grease into lanolin. An estimated price of $4.50 per lb. was used for wholesale lanolin sales. This brings the value of lanolin at wholesale to $2 million.

Retail Sheep Cheese

An estimated 83 percent of all sheep milk is used for cheese production with the remainder going into yogurt, ice cream, and soap and lotion production (derived from Thomas, D., 2004). Thus, in 2010, an approximate 3.7 million lbs. of milk were used in cheese processing. It takes approximately 5 lbs. of sheep milk to produce 1 lb. of sheep milk cheese so an estimated 747,000 lbs. of cheese were produced. Domestic sheep milk cheeses can retail for $22 per lb. to $52 per lb., with a weighted average of $25 per lb. (derived from the online sales of Wisconsin Sheep Dairy Cooperative cheeses). The estimated value of the U.S. sheep cheese market is thus $18.7 million.

Model 2 Results

The economic effects presented in the first model only captured the total impact of the sheep industry at the farmgate. They represent the total effect to the economy triggered by live sheep, lamb and mutton sales, sheep milk production and breeding stock sales. The estimates don't capture value added to sheep products. The model results presented below estimated the economic effect of adding value to products estimated in the first model.

The total effect of the sheep industry is estimated at $2.7 billion (Table 5). The direct effect of production, or sales, is $749 million, the indirect effect of supporting backward-linked industries is $1.4 billion and the induced effect of household spending is $633 million.

The value-added impact totaled $963 million with $532 million attributed to the indirect effect and $345 million attributed to the induced effect. The direct value added effect from the sale of sheep products and byproducts totaled $85 million.

[27] Paullier, Diego. Chargeurs Wool USA. Phone conservation 1/30/08.

The total employment effect from additional lamb, wool, or sheep byproduct sales at the retail level is up to 18,890 jobs created. For every 18,890 jobs created in the sheep industry, there are 7,698 jobs created in backward-linked industries and 4,628 jobs created as a result of sheep-industry produced income-related expenditures.

Table 5. Total effects of byproduct production and wholesale/retail sales

	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Total Output Effect	$748.6 mill.*	$1,350 mill.	$632.5 mill.	$2,731 mill.
Value-Added Impact	$85.2 mill.	$532.1 mill.	$345.2 mill.	$962.5 mill.
Employment Impact	18,890	7,698	4,628	31,216

*Some of the direct effect is lost in the modeling effort from converting 2011 values to the model's 2006 base and back again.

VII. Conclusion

Sheep industry production in the United States spurs a ripple of activity throughout the economy, magnifying its contribution in the United States in additional revenue and employment gains. Officially-published data as well as correspondence with industry partners enabled the estimation of the value of sheep-related production at the producer level and then value added at the wholesale and retail levels, where possible.

The IMPLAN modeling software and dataset was employed to estimate the additional revenue and employment generated from producer-level production and value-added production. In 2010, an estimated $486.5 million in lamb, mutton, wool, sheep milk production, and breeding stock at the producer level supported an additional $1.2 billion in economic activity for a total of $1.7 billion. The sheep industry supports backward-linked industries that supply sheep production. It also supports local businesses through expenditures of sheep-industry generated income on goods and services.

A second model, which quantified the value added to sheep products that were not captured in the first model, revealed an additional billion in U.S. revenue generated. Estimates of retail lamb and wool, wholesale pelts, variety meats, meal, tallow, and lanolin, and retail sheep cheese sales revealed that $785.6 million in production generated an additional $1.9 billion in multiplier effects, summing to a total economic impact of $2.7 billion.

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