Data Gathering Report for Insuring the Production of Lambs

Order Number: 12FPC423F0112

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Executive Summary

Watts and Associates, Inc. (the Contractor) was contracted to conduct a study to gather data and assess the potential for development of an insurance program for the U.S. Lamb industry. The research conducted under this effort is provided in this report, organized into six primary sections: Lamb Commodity Description, Review of Other Programs, Data Availability and Price Methodologies, Stakeholder Input, Risk Analysis, and Feasibility Recommendations.

The lamb industry has contracted, consolidated, and adapted considerably over the last 50 years. While the number of sheep and lambs is down from about 50 million head in the middle of the 20th century, to around 5 million head today, the production level has stabilized in recent years. Production systems have evolved to address important ethnic and seasonal consumption patterns through a declining number of operational commercial-scale dedicated lamb processing facilities. Imported product is perceived as a viable substitute for consumers and is viewed as a meaningful threat to the viability of domestic lamb production.

Several government and private programs are available to address aspects of the risks faced by lamb producers. In grazing production systems, there is widespread adoption of the Pasture, Rangeland, and Forage (PRF) - Rainfall Index (RI) insurance product to manage drought risk. Emergency feed, disaster relief, and trade-disruption oriented ad hoc programs have been well received by producers when they have been made available, but are seen as insufficiently consistent to offer 'bankable' risk mitigation.

There are a number of sources of information available regarding historical production and particularly pricing data from private and consistent government sources. While producers indicate there are large numbers of private sales that may not be accurately represented in publicly available data, auction market sales are reported regularly for major sales regions (typically weighted to the pricing received by smaller to medium-sized producers). Critically, despite strong efforts to do so, no pricing information regarding a market-based transparent measure of forward prices for lambs into any future period was identified.

Stakeholders are very interested in gaining access to improved risk management tools and provided voluminous feedback to the Contractor. In four on-site listening sessions, electronic on-line sessions, interviews, calls, and written comments, the industry opined strongly on the perils faced by their industry, the challenges to ongoing viability, and the specific types and designs of programs that each deemed most favorably for future offerings.

Based on available data, expert perspectives, and stakeholder input, the Contractor developed an analysis of the risks faced by producers. These prominently include predation, disease/morbidity, availability of grazing resources, consolidation and market power of buyers, threats from competing imported production, and strong (but not necessarily predictable) cyclical tendencies, the bottoms of which can threaten sustainability of operations.

The report concludes with a discussion of alternative program designs and their potential feasibility for further development. Based on the research conducted under this task order, there is strong and consistent perceived need for risk management tools for lamb producers and there is a reasonable expectation that participation would reflect that need. There are meaningful

challenges in underwriting any insurance program for livestock, which is why livestock-oriented designs have primarily focused on index programs oriented on measuring changes in price or rainfall. Consistent, independent, verifiable forward pricing data in the lamb industry was not identified and the varied, specialized, niche nature of the lamb industry exacerbates challenges to a broadly applicable design.

Feasibility standards are appropriately high as the interests of risk bearers, taxpayers, and potential participants must be carefully balanced. While the Contractor holds the industry as blameless for past program problems, safeguards must be put in place to assure any new design is not subject to the same vulnerabilities or shortcomings of previous offerings. Despite the clear role such a product could play in mitigating lamb producers' risks, the Contractor was unable to identify or devise a design for a Federal Crop Insurance product that met all the standards identified herein for feasibility. Alternatively, the Contractors would suggest that a risk management tool that would not be bound by constraints of actuarial soundness, strenuous underwriting and data reporting requirements, or responsibility to taxpayers, like those offered historically on an ad hoc basis (and perhaps formalized on an ongoing basis through a counter-cyclical price support) could better meet the needs of the lamb industry until a sustainable and viable source of forward looking instruments emerges.

I. INTRODUCTION

The Statement of Work (SOW) for Order Number 12FPC423F0112 identifies the objectives of the contracted work as: "to determine the feasibility of, and issues related to, insuring production of lambs.."[1] The SOW continues to describe the objectives of the first deliverable under the order: "The Contractor shall produce a data gathering report that determines the feasibility of developing an insurance program and recommends the most viable type of insurance program, if any is feasible."[2] This document is that data gathering report.

Despite decades of decline, the production of lambs in the United States remains a viable and regionally important component of the livestock industry. As per capita consumption of domestic lamb has fallen, the market has become more specialized; increasingly focusing on ethnic/cultural, seasonal, and regionally targeted consumer segments. Production, feeding, processing, and marketing systems and infrastructure have consolidated and adapted to support the evolving industry. These changes, paired with modest returns and frequently narrow (or even negative) margins have been disruptive for producers and driven strong interest in tools to support their operations and manage their risks.

Insurance based tools have been attempted previously for the lamb industry, with what might be gently described as mixed results. The Livestock Risk Protection (LRP) Lamb product was developed through the 508(h)/522(b) process and offered, with multiple revisions and temporary suspensions from 2009 until its final suspension in 2021. LRP Lamb offered price-based insurance coverage, setting guarantees based on an economic model that attempted to forecast prices in future time periods. If realized prices fell below forecast guarantees, producers would receive indemnities for the shortfalls. While the program was, at times, very popular among producers, the overall loss performance of the program was exceptionally poor and there was evidence of adverse selection or information asymmetries in the participation pattern of purchasers. Ultimately, its' owners elected to withdraw the LRP Lamb product and to emphasize their support of an alternative risk management tool to be developed as a potential replacement. In addition to LRP Lamb, lamb producers have been eligible to insure their grazing and haying risks through the PRF-RI product since its inception; in 2023 more acres were enrolled in PRF than any other Federal Crop Insurance Program.

Producers and industry stakeholders have expressed strong interest in providing information and expressing support for a viable risk management tool for lambs. In addition to dozens of one-on-one or small group calls, interviews, and expert contributions, the Contractor conducted four on-site listening sessions and one virtual listening session, each targeted specifically to solicit a strong cross section of interests, segments, regions, and perspectives. These sessions were very well attended and offered a surprisingly broad range of views and comments regarding the current status of this industry, the needs and risks of lamb producers, and the potential viability of various approaches to insurance-based tools.

Despite the small relative size of the lamb industry, the Contractor identified and obtained relatively rich and robust sets of historical production and pricing information from a number of trusted (USDA AMS, ERS, and NASS) sources reported on a reasonably consistent and reliable

[1] USDA FPAC Business Center, Eastern Section, AQD, 2015, Requisition 1107521, page 10 of 18.
[2] *Ibid*.

basis as well as a subset of proprietary data from industry sources that could potentially be used to corroborate and verify publicly available information. Unfortunately, no market-based indicator of future prices was identified; rueful past experience has harshly revealed the challenges of model-based price forecasting for insurance purposes. The identified data could indeed be usefully employed in the development of a risk management tool for lambs, but fail to meet feasibility criteria for a primarily price-based program, and face similar underwriting challenges for production-based coverage as are faced by other livestock sectors.

II. LAMB PRODUCTION DESCRIPTION

As is consistent with other data gathering reports, the SOW requires a high-level overview of the U.S. lamb industry to offer perspective on the scope and breadth of the production system. The reader will note these materials were created immediately prior to the February 12, 2024, release of the USDA NASS Census of Agriculture data and reflect the most current information available at the time of its creation. This section is organized to accommodate the specific language from the SOW:

> *"the data relative to lambs' economic importance, adaptation, stages of growth, classifications, important varieties and their characteristics, production requirements, susceptibility to insects, pests and diseases, marketing, utilization, and sources of feed. The Contractor shall also describe lambs' adaptation regarding environmental conditions (temperature, precipitation, seasonality, light, humidity, etc.). This description must note the 1) periods of growth when lambs can withstand named environmental stresses; and 2) periods of growth when named environmental stresses can cause damage that is not apparent in the growing season. The analysis of lambs' economic importance must include its U. S. and world production, leading U.S. states and countries, future expectations, and any expected changes in trade and economic policy that can affect this commodity. Description of the stages of growth must include a delineation of lambs divided into phases (such as growth, reproductive, slaughter). This description must note the approximate number of days in each stage and the effects of climate on each stage. Describe how prices are determined, recorded, and reported. If prices are determined by contract, copies of the entire contract shall be provided, if applicable."*

II.A. Economic Importance

U.S. and World Production

According to the most recent U.S. Census of Agriculture (CoA) Data from 2017, the total market value of sheep and lamb sales (farm gate estimate, not including wool revenue) was just above $700 million as shown in Table II.1.[3] The U.S. sheep industry has experienced a consistent decline in the number of head since it peaked at a record high of ~56 million in 1942. U.S. sheep numbers have largely stabilized at the most recent USDA estimate of 5 million. Sheep are a multi-purpose livestock animal that can, depending on the breed, provide two basic commodities: food and fiber. According to the 2017 Economic Impact Study released by the American Sheep Industry Association, the economic impact of sheep production generated an estimated $5.8 billion in 2016, including farm-gate revenue, processing and value-added revenue, wool, and retail sales.[4] Further, the study asserted that for every dollar put into the sheep industry, an estimated $2.87 is added to the economy as a whole.[5] In recent years, the ethnic market for lambs has emerged as a steady source of demand for on-farm slaughtered lambs, and this sector of the market is not reflected in the current USDA estimates shown below. As a result, it is reasonable to assume that USDA estimates are under reporting.[6]

[3] https://www.nass.usda.gov/Publications/AgCensus/2017/index.php#full_report.
[4] https://northernag.net/american-sheep-industry-adds-billions-to-u-s-economy/.
[5] https://www.wlj.net/top_headlines/sheep-industry-boosts-u-s-economy/article_c812ca3e-9327-11e7-a236-ff7992d3d12c.html.
[6] https://www.sheepusa.org/wp-content/uploads/2020/10/2020-Nontraditional-Market-Report_FINAL.pdf.

While flock sizes vary considerably, the majority of sheep operations are very small, 93 percent of all sheep farms reporting inventory for 2017 had a flock size of less than 100 head, however these farms only account for 32 percent of the total U.S. inventory on a per head basis.[7] In contrast, 42 percent of U.S. sheep are owned by less than 1 percent of the total farms with reported inventory, reflecting a trend of ongoing consolidation within the industry.[8]

Table II.1. Economic Importance of Sheep and Lamb in the United States

Year	Number of Operations	Sales in USD
2017	60,675	711,899,000
2012	53,754	663,620,000
Total	114,429	1,375,519,000

Source: The Developer after USDA NASS Quickstats Census Data for 2017, accessed October 2023.

Table II.2 shows the U.S. sheep and lamb sales in dollars by state for the most recent CoA years, 2012 and 2017.[9] As shown, all states recorded some level of sheep and lamb production with sales, however states such as Colorado, California, Texas, and South Dakota represent the highest dollar amount in sales as recorded by the CoA for both years combined, respectively.

Table II.2. U.S. Sheep and Lamb Sales in Dollars by State

State	2012 ($000)	2017 ($000)	Total ($000)
Alabama	2,399	1,600	3,999
Alaska	30	34	64
Arizona	7,970	5,492	13,462
Arkansas	1,250	1,599	2,849
California	84,816	60,702	145,518
Colorado	80,250	138,044	218,294
Connecticut	853	655	1,508
Delaware	91	178	269
Florida	1,473	1,239	2,712
Georgia	1,395	1,568	2,963
Hawaii	863	798	1,661
Idaho	38,109	36,844	74,953
Illinois	7,017	6,672	13,689
Indiana	6,128	6,743	12,871
Iowa	26,719	33,399	60,118
Kansas	7,143	10,754	17,897
Kentucky	4,663	7,052	11,715
Louisiana	1,877	688	2,565
Maine	2,117	3,510	5,627
Maryland	2,539	2,355	4,894
Massachusetts	1,208	1,280	2,488
Michigan	10,327	10,751	21,078
Minnesota	19,806	18,886	38,692
Mississippi	953	959	1,912
Missouri	8,144	9,541	17,685
Montana	26,962	29,078	56,040

[7] https://www.nass.usda.gov/Publications/AgCensus/2017/index.php#full_report.
[8] https://www.ers.usda.gov/webdocs/publications/41867/50712_ages9048.pdf.
[9] This report was prepared prior to the February 13, 2024 release of the 2022 Census of Agriculture.

State	2012 ($000)	2017 ($000)	Total ($000)
Nebraska	11,512	9,129	20,641
Nevada	9,136	9,447	18,583
New Hampshire	646	1,140	1,786
New Jersey	1,588	1,383	2,971
New Mexico	4,913	7,470	12,383
New York	10,378	12,194	22,572
North Carolina	1,983	2,446	4,429
North Dakota	6,815	9,058	15,873
Ohio	12,853	16,393	29,246
Oklahoma	5,973	6,433	12,406
Oregon	26,076	21,110	47,186
Pennsylvania	9,508	9,807	19,315
Rhode Island	176	233	409
South Carolina	650	791	1,441
South Dakota	39,732	38,605	78,337
Tennessee	3,172	5,423	8,595
Texas	64,420	52,593	117,013
Utah	31,908	38,338	70,246
Vermont	2,277	1,600	3,877
Virginia	6,980	8,259	15,239
Washington	6,047	5,493	11,540
West Virginia	3,158	3,280	6,438
Wisconsin	11,212	8,573	19,785
Wyoming	47,404	52,279	99,683
Total	663,619	711,898	1,375,517

Source: The Developer after USDA NASS Quickstats Census Data for 2012 and 2017, accessed October 2023.

However, according to the annual Sheep and Goat Report released by the USDA National Agricultural Statistics Service (NASS) for 2023, the states with the highest recorded sheep and lamb inventory were Texas, California, Colorado, Wyoming, Utah, South Dakota, and Montana, respectively.[10] Table II.3 shows the total number of head displayed in thousands for each state as of January 1, 2023. According to the same survey, Texas housed the largest breeding sheep inventory, while California holds the most market sheep inventory amongst the states. Texas, while it has the highest inventory of any state, does not produce the most wool. Instead, California is recognized as the state with the most wool production, followed closely by Colorado, Utah, and Wyoming. It should be noted the Texas sheep and lamb market is being driven by ethnic consumers that request smaller framed animals at lower weights than that of traditional, commercially grown lamb. As a result, Texas sheep production has undergone a shift from wool breeds to that of hair sheep because of their tendency to have a smaller frame in order to meet this ethnic demand. According to the Texas Farm Bureau, nearly 75 percent of the sheep and lamb production in Texas is now serving the ethnic market demand directly.[11] This is a significant amount of market production that is largely not being accounted for in the USDA NASS Survey numbers due to the unregulated nature of important components of the ethnic market. Producers in many of the top lamb producing states, especially those with or near high

[10] Sheep and Goats (January 2023), USDA, National Agricultural Statistics Service. https://downloads.usda.library.cornell.edu/usda-esmis/files/000000018/nc582026h/nv936d50f/shep0123.pdf.
[11] https://texasfarmbureau.org/texas-sheep-goat-prices-strong-despite-pandemic/.

ethnic populations, agreed that ethnic demand has become a large sector of the lamb market – potentially skewing the existing USDA NASS data. Unfortunately, at this time no other reputable source of data currently tracking the ethnic markets has been identified.[12]

According to data for 2016 from the Livestock Marketing Information Center (LMIC), and summarized in Thorne et al., 2021, an estimated 76 to 83 percent of farmgate revenue comes from lamb, while only 6 to 13 percent comes from wool.[13] This represents a large transition in the industry because lamb was considered the supplement to the main commodity, wool, historically.

Table II.3 Top Producing States by Inventory for U.S. Sheep and Lamb - 2023

State	Number of Head (1,000)
Texas	675
California	550
Colorado	415
Wyoming	335
Utah	280
South Dakota	250
Idaho	220
Montana	190
Total	2,915

Source: The Developer after USDA NASS Quickstats, accessed October 2023.

Trends in World Sheep Production

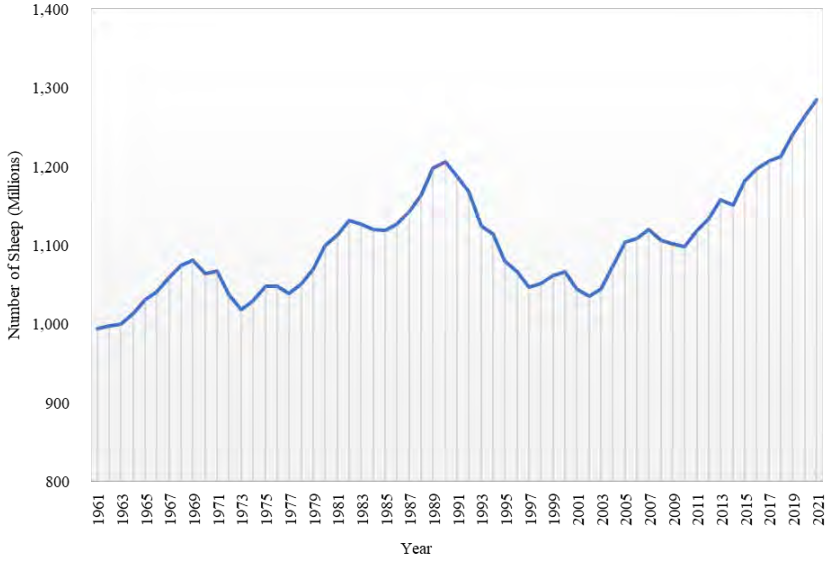
According to the Food and Agriculture Organization of the United Nations (FAO), there are more than 1.2 billion sheep in the world. As shown in Figure II.1, the world sheep population has shown more variation than that of the U.S. sheep population since 1961, however the significant decline in sheep numbers associated with the U.S. market since the 1940s has not been replicated on a global scale. By continent, Asia has the most sheep, with China alone accounting for just over 13 percent of the total world sheep population at 173 million head. India, the country with the second most sheep in the world, boasts just under six percent – less than half of China's sheep population. Australia follows closely behind with about five percent of the world's total sheep. With global sheep production seemingly variable and increasing in recent years, imports have become a topic of concern for U.S. sheep producers. A recent petition filed on behalf of U.S. lamb producers stated that 74 percent of lamb and mutton that is consumed in the United States is imported and, as a result, domestic production of lamb has been reduced by more than 60 percent, severely impacting the industry.[14] Between January and October of 2023, the United States imported more than 198 million lbs. (carcass weight) of lamb and exported only 529,000 lbs. (carcass weight).[15]

According to research released from the FAO in their Food Outlook for June 2023, total global ovine meat production is expected to increase by one percent, totaling approximately 17 million tons. This is expected to occur as a result of the production increases in Australia, China,

[12] https://nap.nationalacademies.org/resource/12245/SheepFinal.pdf.
[13] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8360125/.
[14] https://www.wttlonline.com/stories/lamb-producers-seek-import-relief,10917.
[15] https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/livestock-and-meat-international-trade-data/#Monthly%20U.S.%20Livestock%20and%20Meat%20Trade%20by%20Country.

Turkey, and the United Kingdom (UK). The increase in ovine meat output for these countries is predicted to outpace, or offset, the decline in production that is predicted in other countries, such as those within the European Union (EU), the United States, and Ethiopia. For others, such as New Zealand, the world's second leading ovine meat exporter, there is an anticipation of a reduction in overall flock size, however ovine production is expected to remain steady because of the increase in carcass weight on a per head basis which is predicted to compensate for the reduction in flock sizes. For Australia, the world's leading exporter of ovine meat; production, and therefore exports, are expected to increase by 9 percent to approximately 521,000 tons. The increase in the production of ovine meat in Australia, China, Turkey, and the UK is forecasted to increase global exports by 5.2 percent, largely due to the effects of the free trade agreement between Australia and the UK.[16]

Figure II.1. World Sheep Production 1961-2021



Year	Value	Year	Value	Year	Value	Year	Value
1961	994,209,218	1977	1,037,859,875	1992	1,167,594,321	2007	1,120,078,981
1962	997,148,601	1978	1,050,494,383	1993	1,124,269,366	2008	1,105,997,717
1963	999,647,639	1979	1,069,263,327	1994	1,113,806,439	2009	1,101,150,948
1964	1,013,436,306	1980	1,098,621,403	1995	1,079,239,390	2010	1,098,219,329
1965	1,030,824,625	1981	1,112,692,614	1996	1,065,888,013	2011	1,118,002,916
1966	1,040,628,062	1982	1,131,409,986	1997	1,045,893,064	2012	1,132,939,970
1967	1,059,085,182	1983	1,126,954,867	1998	1,050,444,037	2013	1,157,187,714
1968	1,073,968,517	1984	1,119,484,167	1999	1,060,944,037	2014	1,150,117,537
1969	1,080,656,610	1985	1,118,727,403	2000	1,065,588,133	2015	1,181,525,216
1970	1,063,210,662	1986	1,126,467,876	2001	1,043,611,810	2016	1,196,159,978
1971	1,066,432,803	1987	1,142,031,612	2002	1,035,433,055	2017	1,206,053,675
1972	1,037,727,724	1988	1,162,650,532	2003	1,044,360,747	2018	1,212,260,391
1973	1,017,647,247	1989	1,197,193,498	2004	1,073,010,830	2019	1,239,806,624
1974	1,028,834,301	1990	1,205,517,166	2005	1,103,519,998	2020	1,264,085,946
1975	1,047,873,202	1991	1,187,168,318	2006	1,108,510,164	2021	1,284,850,926
1976	1,047,986,435						

Source: The Developer after FAOSTAT, accessed December 2023.

[16]https://www.fao.org/3/cc3020en/cc3020en.pdf

In contrast, the U.S. sheep industry, as mentioned previously and shown in Figure II.2, has experienced consistent and significant declines on a per head basis since its peak in 1942. The decline in domestic production is attributable to many factors, however in recent discussions with U.S. producers, the most prominent issues that are currently facing U.S. sheep production are high imports, rising costs of production, changes in consumer demand for meat and fiber, unfavorable weather conditions, predation, and a lack or loss of infrastructure within the U.S. industry.

Imports were discussed extensively in listening sessions; many producers believe the amount of lamb that is currently being imported from Australia and New Zealand into the United States is decimating the domestic lamb industry. As of August 3, 2023, a petition "Protect American Lamb: Petition for Relief by America's Sheep Producers" was sent to the Office of the U.S Trade Representative (USTR) with a letter titled: "US Sheep Industry's Request for Immediate Relief from Injurious Imports of Lamb and Mutton from Australia and New Zealand." The petition, commissioned by the American Sheep Industry Association and presented by the R-Calf USA Sheep Committee, provides additional assertions to present their case. Their document states:

> *"Despite America's marked increase in lamb and mutton consumption that began in earnest a decade ago, all the increase has been captured by foreign supply chains while domestic production continually declines. These foreign supply chains have now captured 74% of the domestic market – away from full-time U.S. sheep producers."*[17]

Imported lamb has historically been significantly cheaper than that of domestically produced lamb.[18] This substantial cost difference is named in the petition as the primary factor responsible for the decline in domestic lamb production because (as stated): "Australian imports are delivered into the U.S. market at a significantly lower cost than what domestic lamb can be produced for in the United States." The petition lists the following factors as being the cause of these low-cost imports:

- U.S. producers are held to more rigorous production standards, these increase the cost of domestic lamb production.
- Predator control involving the use of Compound 1080 is heavily utilized in Australia and New Zealand – lowering their death losses to predation – and therefore significantly reducing their cost of production. The use of compound 1080 was banned in the United States in 1972.
- The U.S. lamb market is concentrated, with 53 percent of the market being controlled by four packers, with one of these being JBS, an Australian based vertically integrated packer that is "uniquely positioned to benefit from its Australian produced, low-cost lamb…"
- Australian prices appear even lower in the U.S. market due to the misalignment of currency exchange rates, the petition states that:

  > *"Australian exporters gain a profound pricing advantage over the U.S. sheep industry when the Australian dollar weakens relative to the U.S. dollar as this further lowers the price of Australian lamb and mutton*

[17] https://www.r-calfusa.com/wp-content/uploads/2023/08/230803-Combined-Cover-Letter-and-Sheep-Petition.pdf.
[18] USDA, ERS, Livestock Prices and Livestock and Meat International Trade Data, accessed Feb 2024.

imports, which greatly exacerbates the production-cost advantage Australia already enjoys."

The perspective on the assertions as presented in the petition above are consistent with the expressed views of U.S. lamb producers, especially those affiliated with the American Sheep Industry Association.

Despite the assertions of the petition to the USTR, some reports suggest low-cost imports are not the foremost cause of the decline in U.S. sheep and lamb production. An investigation into the "Competitive Conditions Affecting the U.S and Foreign Lamb Industries" was commissioned in 1994 by the USTR under Section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)) and Executive Order 12261. Amongst their many findings, they confirm that:

"...lamb meat production is generally lower in cost in New Zealand and Australia than in the United States, and likely reflect, at least in part, different management practices of live lamb growers."

"...Lower prices for live animals in Australia and New Zealand provide a cost advantage to packers in those countries relative to their counterparts in the United States."

"...model results suggest that increased imports displaced U.S. -produced lamb quantities to an extent that apparently falls between the range of opinions expressed by U.S. and foreign producer representatives. Results suggest that imports displaced some U.S.-produced lamb quantities, but such displacement typically has not significantly influenced price."

The infrastructure of the lamb industry has been a controversial topic for many years. It is referenced in the petition above that the decline in U.S. lamb production has also caused a reduction in the number of packers that slaughter lambs. Stakeholders within the lamb and sheep sector point to market concentration as an ongoing detriment to the lamb industries infrastructure.

In December of 2013, the USDA's Grain Inspection, Packers, and Stockyards Administration's Packers and Stockyard's program (P&SP) initiated another investigation into the lamb market after receiving multiple letters from industry advocates regarding market price volatility and manipulation and a host of other market-related concerns. As a part of this investigation, the P&SP measured the concentration of the slaughter sheep and lamb market in the United States using data from the Food Safety Inspection Service and annual reports collected from lamb packers and slaughter plants.[19] Their results, based on the Federal Trade Commission and Justice Department's Horizontal Merger Guidelines, indicated a Herfindahl-Hirschman Index (HHI) of 1,658 for 2012 meaning the industry is classified as *moderately concentrated*.[20] Additionally, a 2008 report from the National Academy of Sciences, "Changes in the Sheep

[19] Lamb Investigation, Public Report: USDA Grain Inspection, Packers, and Stockyards Administration Packers and Stockyards Program (PS&P): US Lamb Market in 2010, 2011, and 2012. https://www.r-calfusa.com/wp-content/uploads/sheep/131217LambInvestigationPublicReport.pdf.

[20] The Horizontal Merger Guidelines define a market with and HHI less than 1,500 as unconcentrated. Markets with an HHI of 1,500 to 2,500 are moderately concentrated. Markets with an HHI greater than 2,500 are highly concentrated.

Industry in the United States" stated that the "concentration in the US packing and feeding industries" has played a large role in the decline of the lamb industry.[21]

Unfortunately, there have not been any recent studies into the causes of the industry's continued decline. Regarding the infrastructure of the lamb industry, however; the USDA Agricultural Marketing Service Packers and Stockyards Division released their most recent annual report for 2020. According to this report, the number of plants that slaughter sheep and lamb increased from 65 in 2018 to 71 total plants in 2019. They do note, however, that while 71 seems like a considerable number of packers, it is likely the majority of these are small, multi-species slaughter plants that may process only a few lambs. In further analysis, the report shows the HHI for the federally inspected meat packing plants for sheep and lamb from 2015 to 2019, in which all years have an HHI under 1500, indicative of an *unconcentrated market.*[22]

The steep decline in sheep production has historically been a cause for concern for policymakers, producers, and those involved in the industry. Although there have been many factors attributable to this decline, no single primary cause has been definitively established. A 2008 study commissioned under the Agricultural Appropriations Act (P.L. 109-97) was funded through the USDA Economic Research Service (ERS) to "review the development and current status of the sheep industry in the United States and to examine challenges and opportunities for the future."[23] This study cites the following factors as key developments or changes that initiated the decline in U.S. sheep production:

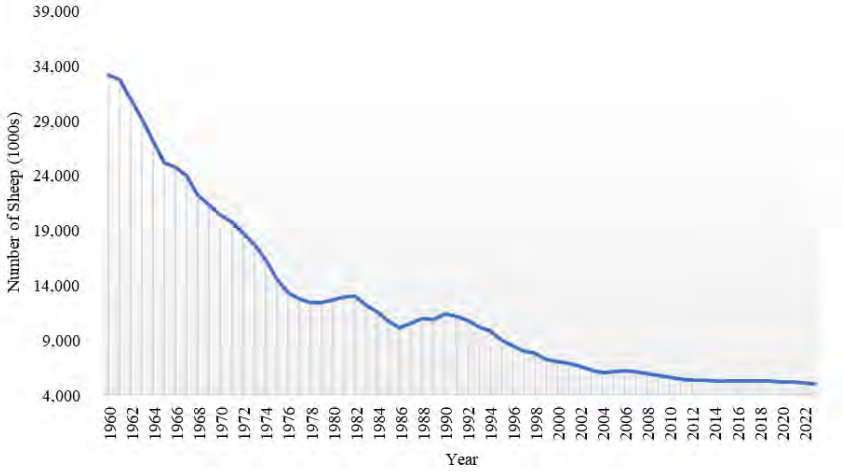
- World War II – Mutton (canned) was a key ingredient in a soldier's diet during the war, once the war was over, demand fell quickly, and a lot of the men who returned from the war did not want to raise or eat sheep.[24]
- Policy and Regulation Changes – Initially, wool was considered a "strategic" material used in wartime production and in WWII, which also initiated a labor shortage, the United States felt that wool was becoming scarce. At the time, being reliant on both food and fiber from sheep production, Congress initiated the National Wool Act in 1954. This policy change offered price support to producers that was based on the percentage of their own sales, meaning: the more "wool they produced, the more money they received." In 1993 the National Wool Act would be "killed" and by 1996 the payments received by producers via the National Wool Act funding were eliminated, and a significant number of producers exited the industry.[25] The study also cited changes in grazing permits and the increasing regulations on public lands usage since the 1960s being another large contributor to the decline in sheep production as producers have gradually lost access to public grazing lands, an issue that is left unresolved today. In the 1970s, legislation was added that prohibited or restricted the tools available to producers in dealing with

[21] https://nap.nationalacademies.org/resource/12245/SheepFinal.pdf.
[22] USDA AMS Packers and Stockyards Division, Annual Report 2020, accessed February 2024. https://www.ams.usda.gov/sites/default/files/media/PackersandStockyardsAnnualReport2020.pdf.
[23] Changes in the Sheep Industry in the United States: Making the Transition from Tradition. http://www.nap.edu/catalog/12245.html accessed January 2024 through: https://books.google.com/books?hl=en&lr=&id=JgacAgAAQBAJ&oi=fnd&pg=PT19&ots=eUF8BjxIel&sig=ZogSZubPeCksqhyrud844xzpGuY#v=onepage&q&f=false.
[24] https://www.npr.org/sections/thesalt/2019/11/26/781652195/after-wwii-mutton-fell-out-of-favor-in-the-u-s-can-it-make-a-comeback.
[25] https://www.sheepusa.org/blog/newsmedia-sheepindustrynews-pastissues-2018-october2018-remeberingthewoolact.

predation. These policies have been linked to the increase in predation losses, an additional large concern for current producers.[26]

- Imports and Global Competition – Other countries offered price support above market levels, creating a stockpile of wool on a global level, which then severely weakened wool prices, furthering the increase in producers exiting the U.S. industry. Concerns about the appreciation of the U.S. dollar against that of Australia and New Zealand currencies were also cited. Additionally, the competition of imports, particularly lamb, from Australia and New Zealand, reduced domestic production in response to consumers substituting imported lamb for U.S.-origin lamb.[27]
- Competition from other Meat and Fiber Sources – In the 1950s feed grains were relatively over-produced and very low cost, which ultimately lead to the introduction of feedlots, particularly cattle feedlots. The continued development of the cattle industry increased profitability for producers, incentivizing livestock producers to switch from sheep to cattle production. In the same manner, wool was also substituted for low-cost synthetic fibers such as rayon and polyester, and improved ginning reduced the relative cost of cotton fiber during this time, further displacing industry demand.
- Concentration in U.S. Packing and Feeding Industries – At the time of this study, 2005, the researchers reported that the top four lamb slaughter / packer plants in the market accounted for 57 percent of the total lambs slaughtered. This percentage had previously been up to 77 percent in 1988. Concentration in both the packers and the lamb feedlots leads to high transportation costs on the producer and those along the supply chain, therefore adding to production costs.

Figure II.2. U.S. Sheep Production (in 1,000s) 1961-2023



[26] Hawthorne, Donald W., "The History of Federal and Cooperative Animal Damage Control" (2004). Sheep & Goat Research Journal. 6. https://digitalcommons.unl.edu/icwdmsheepgoat/6.
[27] https://www.wttlonline.com/stories/lamb-producers-seek-import-relief,10917.

Year	Value	Year	Value	Year	Value	Year	Value
1960	33,170,000	1976	13,310,800	1992	10,797,000	2008	5,950,000
1961	32,725,000	1977	12,722,100	1993	10,201,000	2009	5,747,000
1962	30,969,000	1978	12,420,500	1994	9,835,700	2010	5,620,000
1963	29,176,000	1979	12,365,300	1995	8,989,300	2011	5,470,000
1964	27,116,000	1980	12,699,000	1996	8,464,600	2012	5,375,000
1965	25,127,000	1981	12,947,200	1997	8,023,700	2013	5,360,000
1966	24,734,000	1982	12,996,800	1998	7,825,100	2014	5,235,000
1967	23,953,000	1983	12,139,700	1999	7,247,000	2015	5,270,000
1968	22,223,000	1984	11,558,600	2000	7,036,000	2016	5,295,000
1969	21,350,000	1985	10,715,500	2001	6,908,000	2017	5,270,000
1970	20,423,000	1986	10,144,700	2002	6,623,000	2018	5,265,000
1971	19,731,000	1987	10,572,200	2003	6,321,000	2019	5,230,000
1972	18,739,000	1988	10,945,000	2004	6,065,000	2020	5,200,000
1973	17,641,000	1989	10,853,000	2005	6,135,000	2021	5,170,000
1974	16,310,000	1990	11,358,000	2006	6,200,000	2022	5,065,000
1975	14,515,000	1991	11,174,000	2007	6,120,000	2023	5,020,000

Source: The Developer after USDA NASS Quickstats, accessed October 2023.

Current and Expected Changes in U.S. Policy

Provided above is an examination of historical policy changes and their implications on the lamb market as it has evolved over time. It is apparent throughout the discussion that the lamb and sheep sector has been highly influenced by changes in both domestic and international trade policy. With that, an examination into current and expected policy changes may help to provide additional context regarding the future of the lamb industry.

Of foremost importance to lamb producers and industry stakeholders who attended listening sessions is the previously discussed initiative to receive relief from imports: "Protect American Lamb: Petition for Relief by America's Sheep Producers." This petition was formally filed with the Office of the United States Trade Ambassador, Katharin Tai, on August 3, 2023.[28] The website currently does not show any recent activity regarding the petition; however, some news outlets have reported the petition is "under review" and Australian government officials are aware of the petition and in discussion with the U.S. administration and trade officials. A spokesperson from the Australian Department of Agriculture, Fisheries, and Forestry commented on the matter, referencing the similar request that was announced in 1999 by the U.S. sheep industry to reduce lamb imports where the United States imposed tariffs that were ultimately deemed a violation to the World Trade Organization rules at the time, and thus, repealed. Given this existing context, Australia seems to remain confident that the "agricultural relationship with the US is strong" and they will "consider all options in responding to any developments on this matter."[29] For now, the American Sheep Industry Association representatives were advised against filing a trade case to fight Australian and New Zealand lamb imports.[30]

Discussions surrounding the possibility of an increase in the loan rates for the Wool Marketing Assistance Loan program have been in recent talks related to the upcoming Farm Bill. The Chief Economist for the House Committee on Agriculture, Justin Benavidez, mentioned they are hopeful there will be some increases in funding related to the Sheep Production and Marketing

[28] https://ustr.gov/.
[29] https://www.sheepcentral.com/say-nothing-r-calf-us-lamb-import-petition-is-under-review/.
[30] https://www.sheepusa.org/magazines/february-2024#campaign.

Grant Program, the Wool Research, Development and Promotion Trust Fund, and the Foreign Market Development and Market Access Program.[31]

II.B. Environmental Adaptability

Adaptation in lamb production is recognized as the "level of tolerance to survive and reproduce under extreme living conditions."[32] Research has shown sheep are among the most diverse livestock species, with successful production occurring in a multitude of different environments and landscapes across the world.[33] With 50 percent of the world's small ruminant species (sheep and goats, primarily) being produced in arid climates, it is reasonable to infer sheep production is widely adaptable, and with the potential threat of rising global temperatures, sheep provide a strong example of successful adaptation to multiple environments.[34] Berihulay et al. shows that sheep adapt to each of these environments through multiple different behavioral, morphological, physiological and genetic mechanisms.[35]

Behavioral adaptations in sheep and lambs become noticeable once the animal has endured some level of stress for an extended period of time, or when an animal has been produced in a specific type of management system (intensive or extensive) for multiple generations.[36] For example, many studies show that in response to high ambient temperatures, sheep (and lambs) will reduce their feed intake as a way to reduce their metabolic heat.[37] Changes in grazing patterns have been examined in extensively managed ruminants experiencing heat stress, including sheep, where grazing time will be lower during the day and higher at night. Amongst other adaptations, sheep will increase their water consumption and drinking frequency during periods of extended heat stress if the water is available. In times where water is scarce, sheep are able to reduce their water loss through urine concentration.[38]

A study was conducted that examined the adaptability of extensively managed sheep (referred to as hill sheep) and intensively managed sheep (referred to as lowland sheep) in regard to lamb survival. Given that ewe and lamb mortality is the highest during the parturition and early neo-natal periods, the ability for the ewe to establish adaptive mechanisms can increase the chances

[31] www.sheepusa.org/magazines/february-2024.

[32] Berihulay H, Abied A, He X, Jiang L, Ma Y. Adaptation Mechanisms of Small Ruminants to Environmental Heat Stress. Animals (Basel). 2019 Feb 28;9(3):75. doi: 10.3390/ani9030075. PMID: 30823364; PMCID: PMC6466405. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6466405/#:~:text=Sheep%20and%20goats%20adapt%20to,with%20darker%20coats%20%5B8%5D.

[33] Schalk W P Cloete, Johan C Greeff, Cornelius L Nel, Ansie J Scholtz, Breeds and lines of sheep suitable for production in challenging environments, Animal Frontiers, Volume 13, Issue 5, October 2023, Pages 33–42, https://doi.org/10.1093/af/vfad053.

[34] G.R.Gowane et al., Climate Change Impact on Sheep Production: Growth, Milk, Wool, and Meat https://www.researchgate.net/publication/318168644_Climate_Change_Impact_on_Sheep_Production_Growth_Milk_Wool_and_Meat.

[35] Berihulay H, Abied A, He X, Jiang L, Ma Y. Adaptation Mechanisms of Small Ruminants to Environmental Heat Stress. Animals (Basel). 2019 Feb 28;9(3):75. doi: 10.3390/ani9030075. PMID: 30823364; PMCID: PMC6466405. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6466405/#:~:text=Sheep%20and%20goats%20adapt%20to,with%20darker%20coats%20%5B8%5D.

[36] Dwyer, K., Lawrence, A. A review of the behavioral and physiological adaptations of hill and lowland breeds of sheep that favour lamb survival. August 2005, Volume 92 (3): 235-260. Applied Animal Behaviour Science. https://www.sciencedirect.com/science/article/abs/pii/S0168159105001437?via%3Dihub.

[37] https://academic.oup.com/af/article/9/1/47/5168810.

[38] ChedidMabelle, JaberLina S., Giger-ReverdinSylvie, Duvaux-PonterChristine, and HamadehShadi K.. 2014. Review: Water stress in sheep raised under arid conditions. *Canadian Journal of Animal Science*. **94**(2): 243-257. https://doi.org/10.4141/cjas2013-188.

of survivability in the lamb and decrease lamb mortality. They found extensively managed sheep, such as those used in range production in the western United States, have developed behavioral mechanisms that differ from that of lowland or intensive sheep breeds, and these differences result in increased survivability of the lamb. They found extensively managed ewes have a higher likelihood of licking their lambs immediately after lambing and they "have a higher rate of low-pitched bleating" than intensively managed ewes, both of which are highly necessary for the ewe to develop an attachment with her lamb(s).[39] Furthermore, research shows this type of neo-natal behavior, and the development of the attachment between the ewe and the lamb is as important to lamb survivability as the ewe herself as it ensures early sucking and therefore the intake of colostrum, which is essential for lamb survival.[40] Behavior adaptations, unlike that of morphological and physiological adaptations, can be influenced by the producer's management decisions over a long period of time. Behavioral adaptations in the ewe are large factors in lamb mortality during neonatal development and because of the importance of colostrum and early nutrition in lamb production – can also be a significant influence on the economic viability of the lamb operation. Ewes lacking these behavioral adaptations as a result of intensive management could lead to a higher risk of lamb mortality in the flock.

Morphological and phenotypic adaptations occur slowly over many generations by natural and, in some cases, producer selection for certain physical characteristics that are more favorable for that given environment. Morphological adaptations can include the physical characteristics of a sheep such as "body size and shape, coat and skin color, hair type, and fat storage."[41] Sheep with lighter coated colors are better suited to withstand hotter temperatures because the light-colored wool and hair reflects solar radiation better than that of darker wool / hair breeds and light coated sheep absorb less heat. Additionally, larger sheep breeds have a lower metabolic rate than that of the smaller breeds, which aligns with the fact that hair sheep, which are smaller framed, are more suitable to the warmer environments of the southwest United States; while many of the sheep breeds that are utilized in the Western and Great Plains regions of the United States are larger framed wool or dual-purpose breeds with much higher finishing weights. Unique to sheep is the morphological adaptation for "fat tails" which occurred as an adaptive response to the depletion of energy resources occurring as a result of extreme environmental stress. The "fat tail" is defined as the "ability for accumulation and mobilization of body fat in the internal fat depots" when the animal is placed under extreme environmental stress. Fat tails are a morphological and phenotypic response to food scarcity and harsh environments, and an estimated 25 percent of the world's sheep population has evolved to maintain this adaptive response, however in a production scenario the thin tailed phenotype is considered more desirable and therefore thin tails are artificially selected for, resulting in sheep with different morphological characteristics.

[39] Dwyer, K., Lawrence, A. A review of the behavioral and physiological adaptations of hill and lowland breeds of sheep that favour lamb survival. August 2005, Volume 92 (3): 235-260. Applied Animal Behaviour Science. https://www.sciencedirect.com/science/article/abs/pii/S0168159105001437?via%3Dihub.

[40] Nowack, R., Murphy, T.M., Lindsay, D.R., Alster, P., Andersson,R.,Uyanas-Moberg,K. Development of a preferential relationship with the mother by the newborn lamb: Importance of the sucking activity. October 1997, Volume 62(4): 681-688. Physiology and Behavior. https://www.sciencedirect.com/science/article/abs/pii/S0031938497000796.

[41] Berihulay H, Abied A, He X, Jiang L, Ma Y. Adaptation Mechanisms of Small Ruminants to Environmental Heat Stress. Animals (Basel). 2019 Feb 28;9(3):75. doi: 10.3390/ani9030075. PMID: 30823364; PMCID: PMC6466405. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6466405/#:~:text=Sheep%20and%20goats%20adapt%20to,with%20darker%20coats%20%5B8%5D.

Similar to this, is the horned vs polled (hornless) sheep, where modern production practices have artificially selected for polled sheep and many sheep breeds are now considered "polled."[42]

Physiological adaptations in sheep are characterized by changes in heart rate, respiration, and rectal temperature.[43] The literature that currently exists on the topic of physiological adaptations in sheep are primarily concerned with the physiological adaptations to heat stress, and there is not substantial evidence of other physiological adaptations, though they exist. Panting is considered the first line physiological response as it is an increase in the lamb or sheep's respiratory rate with the purpose of thermoregulation.[44] Second to panting is an increase in sweating, reduced metabolic activity, and changes in the animal's endocrine system to reduce the loss of water.[45]

The genetic aspect of adaptation is defined by Niyas et al., as the "heritable animal characteristics which favor survival of a population."[46] While research has not yet identified the genetic link and patterns of expression of many sheep genetics, it is clear the further identification of these genetic variants will be a large factor in improving the production and welfare of sheep.[47]

As with any animal, a sheep's response to environmental stressors will vary based on characteristics such their breed type (hair vs wool breed), age, sex, and their stage of production or growth. Sheep are well renowned for their ability to adapt to multiple agroecological climates, and make productive use of arid, low quality range environments that would not otherwise be utilized. Additionally, Al-Hadeiry et al. (2012) stated sheep and goats perform and adapt "better than that of other domesticated ruminants."[48] Of the 200 breeds that exist worldwide, there are certain breeds that are more tolerant to environmental stressors than others.[49] Stress, as defined by Tüfekci H and Sejian V. (2023), is:

> *"a reflex reaction that occurs as a result of an animal's ability to cope with the negative effects of various factors and its inability to adapt and can have many negative results."*

Of the six stressors named in their research, cold stress, heat stress, nutritional stress, transportation and treatment stress, and shearing stress, three are of most importance from an

[42] Kalds, P., Zhou, S., Gao, Y. *et al.* Genetics of the phenotypic evolution in sheep: a molecular look at diversity-driving genes. *Genet Sel Evol* **54**, 61 (2022). https://doi.org/10.1186/s12711-022-00753-3.
[43] Dwyer, K., Lawrence, A. A review of the behavioral and physiological adaptations of hill and lowland breeds of sheep that favour lamb survival. August 2005, Volume 92 (3): 235-260. Applied Animal Behaviour Science. https://www.sciencedirect.com/science/article/abs/pii/S0168159105001437?via%3Dihub.
[44] . Gupta M, Kumar S, Dangi SS, Jangir BL (2013) Physiological, biochemical and molecular responses to thermal stress in goats. Int J Livest Res 3: 27-38.
[45] Dwyer, K., Lawrence, A. A review of the behavioral and physiological adaptations of hill and lowland breeds of sheep that favour lamb survival. August 2005, Volume 92 (3): 235-260. Applied Animal Behaviour Science. https://www.sciencedirect.com/science/article/abs/pii/S0168159105001437?via%3Dihub.
[46] Niyas PAA, Chaidanya K, Shaji S, Sejian V, Bhatta R, et al. (2015) Adaptation of Livestock to Environmental Challenges. J Vet Sci Med Diagn 4:3. http://dx.doi.org/10.4172/2325-9590.1000162.
[47] Kalds, P., Zhou, S., Gao, Y. *et al.* Genetics of the phenotypic evolution in sheep: a molecular look at diversity-driving genes. *Genet Sel Evol* **54**, 61 (2022). https://doi.org/10.1186/s12711-022-00753-3.
[48] Al-Haidary A.A., Aljumaah R.S., Alshaikh M.A., Abdoun K.A., Samara E.M., Okah A.B., Aluraiji M.M. (2012). Thermoregulatory and physiological responses of Najdi sheep exposed to environmental heat load prevailing in Saudi Arabia. Pak. Vet. J., 32: 515–519.
[49] https://pubs.nmsu.edu/_circulars/CR684/.

environmental management perspective: heat, cold, and nutritional stress. These can be directly related to environmental conditions and therefore can be examined as environmental stressors.

Cold Stress

Cold stress and resultant death rates of lambs are an important factor in successful lambing for many operations.[50] Lambs are very susceptible to cold, and hypothermia is an important cause of mortality in the early postnatal period.[51] Cold stress to neonatal lambs is attributable to heat loss resulting from one or more of the factors of low ambient temperature, wind, and evaporative cooling. The healthy newborn lamb has a good ability to increase its metabolic rate in response to cold stress by shivering and non-shivering thermogenesis (brown adipose tissue). The energy sources in the neonatal lamb are liver and muscle glycogen, brown adipose tissue, and, if it nurses, the energy obtained from colostrum and milk. The ingestion of colostrum can be essential for early thermogenesis in lambs, especially twin lambs.

Without quick intake of colostrum after birth, a lamb will lack energy, which is a common cause of hypothermia. Failure-to-ingest colostrum-caused hypothermia has three common causes. The first is the loss of sucking drive; severe cold stress and developing hypothermia can result in behavioral changes that cause low milk intake and subsequent depletion of energy reserves. In this case, management and labor can play a major role in keeping lambs alive. Lambs can be assisted with suckling on either an udder, with a bottle, or a stomach tube can be administered, delivering colostrum directly to the lamb. Additionally, recently chilled lambs can be warmed by drying them off if necessary and placing them in a warm sterile environment before returning them to their mother. Without constant supervision and immediate action during lambing in inclement weather in particular, a lamb's likelihood of survival is substantially decreased.

The second cause is poor mothering from the ewe. This can also sometimes be addressed through management, typically by assisting the ewe or, if that fails, grafting the lamb onto another ewe or designating the lamb a bum lamb and bottle feeding it without the assistance of any ewe. The third is related to birth injury. Birth-injured lambs, usually large single-born lambs that were stressed during birth due to their size, have depressed sucking and feeding activity. Note, the relationship between mortality of lambs and birth weight is a U-shaped curve, with both smaller and larger lambs at increased risk of death.[52] Birth weight is determined by genetics, nutrition, and litter size and is thus influenced by management, particularly in regard to nutrition. There is a significant association between the body condition score of late pregnant ewes and perinatal mortality. In other words, fatter healthier ewes tend to have larger healthier lambs. Note, prenatal nutrition is a complicated topic with significant micro and macro mineral requirements in the final development stages of a fetus. These are typically delivered through a mineral supplementation program after feed tests are performed. Feed quality also plays a significant role. Most well managed operations rely on their veterinarian or a nutrition specialist to develop a mineral and supplement program for their operation.

[50] Dwyer CM. Small Ruminant Research. 2008;76:31.
[51] Hinch GN, et al. Animal Production Science. 2014;54:656.
[52] Constable, Peter D., Kenneth W. Hinchcliff, Stanley H. Done, and Walter Grünberg. Veterinary medicine-e-book: a textbook of the diseases of cattle, horses, sheep, pigs and goats. Elsevier Health Sciences, 2016.

Most commonly, the selection of time of lambing is dictated by nutritional considerations and the seasonality of the ewes' sexual behavior, and lambing occurs at a time of year when cold stress is likely. The control of loss from hypothermia in newborn lambs requires supervision at lambing and protection from cold. Lambing in barns, wherein which the producer gathers either the "heavy" ewes (those that are close to lambing) or the ewes that have just lambed into a shelter to protect them from the cold, can reduce cold-stress loss by reducing wind, water, and temperature exposure. The availability of shelter in lambing paddocks can thus be effective at reducing mortality rate and reducing risk.[53] Some ewes will seek shelter at lambing, but many ewes in wool will not (this is usually influenced by breed). In some flocks, sheep are shorn before lambing in an attempt to force this shelter-seeking trait.

Multiple reports suggest that nearly half of all lamb mortalities which occur pre-weaning will occur on the day the lamb is born.[54] As referenced previously, data from APHIS shows that 85 percent of lambs are born in the months between January and May, with the exception of small producers that may practice some form of out of season or accelerated lambing practices, and those who alter the flock's polyestrous seasonality by producing in a confined production system. However, given the majority of sheep in the United States are seasonal breeders in a range production system, it can be reasonably inferred that most lambs in the United States are born in winter or early spring conditions. As a result, it has been shown that cold, wet and wintery conditions, especially those which include wind and moisture together, can result in a significant increase in lamb mortality. It is estimated that up to 50 percent of lamb losses at birth are a result of cold stress.[55] On the surface, cold stress is interpreted as losses due to hypothermia – a direct result of low temperatures and wet conditions upon lambing. Hypothermia is present if the lamb temperature is 100 degrees F or less, the normal body temperature should range between 102-103 degrees F at all times. Lambs that suffer from hypothermia will present themselves as lethargic, they will not be able to lift their head, and will likely lack a suckle response and therefore will not be able to ingest milk or colostrum, which eventually leads to starvation. Management and treatment of hypothermia in lambs is different depending on the number of hours that the lamb has been alive.

There are many indirect results of cold stress that may not be apparent – the lamb or ewe may survive – but other factors of production will be negatively affected and have been correlated with cold stress. Hypothermia can be a primary cause of death when the ambient conditions are too cold and/or wet for newborn lambs. It can also be a secondary cause of death when a lamb has been milk deprived over a few days during cooler weather. Nursing lambs will lack milk because of mastitis, poor genetics, udder/teat conformation, or inadequate ewe nutrition.

Exposure to winter environments can induce multiple impairments in sheep. To begin, ewes on range that lamb in the winter months will be in late gestation or lactation during the winter months, and as a result they will be in the stages of production that require the highest level of nutrition. Nutritional stress, related to forage availability is therefore a cause of concern when considering environmental stressors. Forage, especially in the western and central United States

[53] Young JM, et al. Animal Production Science. 2014;54:773.
[54] Dwyer, C. M. (2008). The welfare of the neonatal lamb. Small Ruminant Research, 76(1-2), 31-41.
[55] Tüfekci H, Sejian V. Stress Factors and Their Effects on Productivity in Sheep. Animals (Basel). 2023 Aug 31;13(17):2769. doi: 10.3390/ani13172769. PMID: 37685033; PMCID: PMC10486368.

will not be in its ideal growing season during the time that corresponds with lambing, this alone poses a problem, however cold stress during this time increases the energy requirement, but decreases feed utilization, therefore the ewe will lack the resources and the energy to provide for the young, nursing lamb. Seijan et al., reports that cold stress can have a negative impact on growth, adaptation, blood metabolites, and reproduction through the effects of nutritional stress.[56] Christopherson and Kennedy (1983) found that low temperatures decrease the digestibility and nutrient absorption of certain feed and forage sources.[57] For further context, Simeonov et al., reported that lambs which were born in 12.6 degrees Celsius (~55 degrees Fahrenheit) grew "significantly faster" than lambs born in 5.1 (~41 degrees F) or -3 degrees Celsius (~26 degrees F).[58] This reduction in digestibility coupled with a lack of available forage that is present during the time of lambing for range operations in the north and west central regions of the United States proves to be a significant source of stress occurring as a result of cold, wet, and windy weather conditions during lambing and in the production stages that follow. The increase in energy needed to sustain the lamb during periods of harsh environmental conditions, redirects that of which would have been utilized for growth and production, and many studies have shown that low birth weight lambs are much less vigorous than lambs with heavier birth weights.

Nutritional stress is likely to arise out of a lack of adequate forage, especially in the arid and semi-arid regions where range production is concentrated in the United States. Forage availability can vary widely from year to year, and producers may not have the resources to supplement with an additional feed source in years where rainfall or environmental conditions are poor. The availability of grazing land for sheep, as discussed, is rapidly declining – this has lead to producers looking to other sources of on-range feed. Often this consists of crop residues. Crop residues, typically, are very low in nitrogen (given that the mature crop was previously harvested), and high in crude fiber, often causing malnutrition or nutrition related stress.[59]

Heat Stress

Heat stress is not typically an immediate concern for mortality at lambing, due in part to the fact the majority of lambs, even out of season lambs, will not be born in the summer. However, heat stress is a factor to be considered once lambs have weaned and are on summer pasture assuming they have not been marketed previously. As a result, environmental stress associated with heat are more relevant to economic losses, given that the risks associated with heat stress can include: "… decreased growth, reproduction, production, milk quantity and quality, as well as natural immunity, making animals more vulnerable to diseases and even death."[60]

Heat stress causes indirect environmental stressors, especially in range production conditions. An animal experiencing significant heat stress while out on range, may have to walk a long distance (physical stress) to water or additional forage, while heat is the main trigger it is the

[56] Sejian, V., Kumar, D., & Naqvi, S. M. K. (2018). Physiological rhythmicity in Malpura ewes to adapt to cold stress in a semi-arid tropical environment. Biological Rhythm Research, 49(2), 215-225.
[57] R. J. CHRISTOPHERSON and P. M. KENNEDY. 1983. EFFECT OF THE THERMAL ENVIRONMENT ON DIGESTION IN RUMINANTS. Canadian Journal of Animal Science. 63(3): 477-496. https://doi.org/10.4141/cjas83-058.
[58] Simeonov, M. S., Stoycheva, I., & Harmon, D. L. (2022). Environmental Temperature Influences Diet Selection and Growth in Early-Weaned Lambs.
[59] Tüfekci H, Sejian V. Stress Factors and Their Effects on Productivity in Sheep. Animals (Basel). 2023 Aug 31;13(17):2769. doi: 10.3390/ani13172769. PMID: 37685033; PMCID: PMC10486368.
[60] Al-Dawood, A. (2017). Towards heat stress management in small ruminants-a review. Annals of Animal Science, 17(1), 59.

combination of effects at the same time that will promote additional stress, and lower productivity. Many range producers mentioned their sheep will often travel across multiple county lines throughout the summer, covering vast amounts of acreage in one season in order to maintain adequate forage and nutrition resources.

The initial consequence of heat stress that is most apparent during a lamb's growing seasons is a reduction in feed intake. This reduction is in itself an adaptation, meant to help lessen the bodies metabolic heat production that occurs via digestion.[61] However this decrease in intake then increases the likelihood of oxidative stress, linked, in part, to a reduction in reproductive performance of both the ewe and the ram. Additionally, the need to reduce overall body heat is met with the body's evaporation of water, or sweat, reducing the animal's overall water and mineral balance. It has also been found that higher temperatures are correlated with negative impacts and outcomes related to an ewe's milk production.[62] Some breeds of sheep can tolerate the impacts of heat stress better than others, and heat stress can often be tolerated in small amounts as long as it cools off at night. South Dakota State recommends the use of the Temperature Humidity Index (THI) as the most reliable tool for the measurement of heat stress, and sheep are characterized as heat stressed once the THI is near 82, meaning there are high temperatures paired with high humidity.[63]

Therefore, environmental adaptability is governed by factors such as genetic diversity and natural selection to develop breeds suitable for extreme climate conditions. Additionally, producers in various regions should choose the breeds most suitable to their production area. This may need to be discussed further in terms of insurability and moral hazard as there may be risks associated with producers opting to breed for certain production goals (ex: hair breeds for high meat production in cold environments) not suitable to their environment, and therefore create additional recorded losses associated with environmental concerns. The USDA and ASI have, throughout many years, introduced and recognized new breeds of sheep suitable to certain environments while maintaining attractive growth and production metrics. According to Sustainable Development Goal 2.5, and many other international agreements on the topic of sustainability, genetic diversity and the development of breeds that will withstand harsh environmental conditions is a priority among global leaders.[64]

Environmental Factors Affecting Lamb Mortality

Environmental factors influencing lamb mortality include a wide variety of variables which vary by area and topography. These include temperature, moisture (both humidity and rainfall), and wind speed. The influence of these variables varies based on the management system as well. In most U.S. production areas, the selection of lambing season is dictated by nutritional considerations, forage availability, and the seasonality of the ewes' sexual behavior (seasonality of the breed) or by the desire to increase productivity in the case of accelerated lambing. In

[61] Tüfekci H, Sejian V. Stress Factors and Their Effects on Productivity in Sheep. Animals (Basel). 2023 Aug 31;13(17):2769. doi: 10.3390/ani13172769. PMID: 37685033; PMCID: PMC10486368.
[62] Finocchiaro, R., Van Kaam, J. B. C. H. M., Portolano, B., & Misztal, I. (2005). Effect of heat stress on production of Mediterranean dairy sheep. Journal of dairy science, 88(5), 1855-1864.
[63] https://extension.sdstate.edu/heat-stress-small-ruminants#:~:text=Specifically%20for%20sheep%20and%20goats,%E2%89%A586%20degrees%20Fahrenheit)%20levels.
[64]https://www.un.org/sustainabledevelopment/hunger/#:~:text=2.5%20By%202020%2C%20maintain%20the,fair%20and%20equitable%20sharing%20of.

either a traditional or accelerated lambing system, the lambing season has the potential to occur at a time of year when cold stress is likely.

The care of the surviving lambs during lambing can have long repercussions on the rate of gain performance and even the mortality rates of the lambs. As discussed previously, lambs exposed to cold stress at birth may have lower rates of gain or compromised immune systems leading to higher mortality rates. This can have more obvious effects, such as damaged lungs or limbs from cold exposure or a compromised immune system from inadequate colostrum intake or subtler outcomes such as reduced vigor from significant stress endured early in the lamb's life.

II.C. Stages of Growth

Lamb stages of growth can be divided into periods of nutritional requirements as described in this section. This section also contains additional information regarding the nutritional requirements of sheep in a lamb production environment. Once pregnant, ewes will have an average gestation length of 147 days, varying based on a number of factors including breed. Meat breeds, such as those producing lamb, typically mature faster and therefore may average gestation lengths of 144 days.[65] After birth, growth can be separated into three stages, each one differing in nutrition and management requirements. The first is the nursing milk dependent stage, followed by a period during with the rumen is developed when grazing and feeding begins, and the last stage is the growing period during which the lamb is finished to a market weight. The nutrition requirements of lambs are highly variable and is influenced by multiple factors such as size and breed of the lamb, genetic potential of the lamb, the production environment and growth phase of the lamb, the type of market the lamb will be produced for, and so on. All producers will have and maintain different nutrition requirements, however the requirements as given below provide a baseline for the nutrition requirements of healthy and productive lambs in each growing phase.

The first stage, lasting between birth and 4-6 weeks, is when the lamb is mostly dependent on the milk they ingest from the ewe. Beginning in week two and three, a lamb will start to develop their rumen and are able to begin eating small amounts of forage, and it is recommended that lambs at this age (about two weeks old) should also be started on creep-feed. [66]/[67] After 4-6 weeks of nursing, the lambs require additional nutrition to maintain a healthy growth rate, and the ewe can no longer support the lambs' requirements. During periods of gestation and lactation, the climate can effect ewe and lamb shelter needs potentially resulting in lamb morbidity loss, as well as the availability of nutrients, such as through adverse weather conditions and late forage development.[68]

Assuming the lambs are in the range of 20-45 lbs. body weight, the target for daily gain in lbs. is 0.40 to 0.65 pounds per day for young nursing lambs in this growth stage. To maintain this targeted rate of growth, the energy and nutrition requirements are between 72 to 80 percent Total

[65] https://animalrangeextension.montana.edu/sheep/reproduction.html#:~:text=Gestation%3A%20Average%20gestation%20length%20or,from%20138%20to%20159%20days.
[66] Cottle, D.J. International Sheep and Wool Handbook. Nottingham University Press, 2010. (Chapter 11, Lactation and Lamb Growth by KG Geenty).
[67] https://www.merckvetmanual.com/management-and-nutrition/nutrition-sheep/feeding-practices-in-sheep.
[68] Castillo, D.A. & Gaitan, J.J. & Villagra, E.S. Direct and indirect effects of climate and vegetation on sheep production across Patagonian rangelands. Ecological Indicators. Volume l 124. 2021. 107417.

Digestible Nutrients (TDN). This is attainable with a diet that is 16 to 24 percent crude protein, 0.5 to 0.8 percent calcium, and lastly, 0.25 to 0.3 percent phosphorous according to the nutrition requirements for "Young Nursing Lambs" from Purdue. To reach these requirements, lambs at this age must begin supplementing their intake through grazing. However, since their rumen is not fully developed, the best way to reach the suggested energy and nutrition requirements is to provide them with small amounts of very high-quality forage or creep feed as mentioned previously. This must be considered in range operations so lambs at this stage of growth have access to adequate forage, whether it is grazed or supplied to them, at its most nutritious state. Included in this stage, if possible, is some formation of a creep feed system made up of grain, mineral, and a protein and is placed in feeders that the lambs can access. Creep feeding diet formulations are typically ground / cracked corn or soybean meal combinations balanced to provide the lamb a highly concentrated nutrition source. This is especially important if the producer opts to wean their lambs early, or when their flock has multiple ewes with multiple births because there is likely not enough milk from the ewe to supply for a multiple lamb birth. The final stage of growth occurs when the lamb reaches between 45 and 80 lbs. The availability of quality forage and pasture during this period can be limited by climate related effects, such as drought or excessive rainfall.[69]

This final stage may be a combination of the growth and finishing phases depending on one's intended market. If the lambs are intended for the nontraditional, or ethnic market as mentioned previously, then they are finished out between 60 and 80 lbs., and the consumer typically prefers a lean carcass meaning the finishing phase is very limited, if any.[70] In this case, the growth and finishing phase are essentially the same where lambs are left on pasture until they reach the optimum weight depending on the producers' target market.[71] On the other hand, if the lamb is being raised for the traditional market, then a period of "high grain feeding" is required to reach the ideal weight of 110 to 140 lbs., preferred by the processors. This high grain diet should have between 73 and 78 percent TDN, 12 and 14 percent protein, 0.5 percent calcium, and 0.25 percent phosphorous for at least 30 days, assuming a feeding rate of 3 to 4 percent of the lambs' bodyweight per day, and an average daily gain of 0.6 to 1.0 lbs.[72] This type of high energy diet is often supplied via a mixture of rations in various forms and feeding methods. In most cases, these lambs will be in feedlots with the intended market being the traditional consumer. In these scenarios, feedlots will have multiple types of feeding systems in place, ranging from perimeter feeding, or in some cases, lambs have access to a "self-feeding" system that is in place 24 hours a day rather than a scheduled perimeter feed that requires the labor needed to physically feed the lambs a set ration on a set schedule. According to a study by the Colorado State University Extension, lambs fed on a 24-hour system where they had free access to feed, gained and performed significantly better than those on a "hand-fed" schedule.[73] The amount of roughage included in a Total Mixed Ration (TMR) based finishing diet varies based on many factors, however, to avoid potential complications such as acidosis, there must be at least 10 percent.[74] Depending on the method of feeding systems each feedlot uses, the number of days for a lamb to

[69] Ibid.
[70] https://extension.sdstate.edu/direct-marketing-lamb-selling-ethnic-market.
[71] https://extension.psu.edu/marketing-lamb-and-goat-for-holidays#:~:text=If%20you%20want%20to%20sell,according%20to%20kosher%20dietary%20laws.
[72] https://ag.purdue.edu/department/ansc/sheep/_docs/feeding_the_lamb_crop.pdf.
[73] https://extension.colostate.edu/docs/pubs/livestk/01613.pdf.
[74] https://ag.purdue.edu/department/ansc/sheep/_docs/feeding_the_lamb_crop.pdf.

reach its finishing weight will vary. Research at the Ohio State University found the average days to market and the average daily gain in pounds changes based on the feeding system: grass fed, grass and finishing, grain-based confinement, or grain and hay. The grain-based confinement system had the highest average daily gain, 0.72 pounds per day, coupled with the least amount of time spent in the feedlot.[75] The availability of quality feed can be limited by climate related events during the previous growing season. When supplies are limited, such as following a drought, limited availability of nutritious feed may result in substitute less nourishing feed being fed that adversely affects the lamb weight of gain.

Sheep Nutrition Considerations

The five major categories of nutrients required by sheep are: water; energy; protein; vitamins; and minerals. During the summer season, sheep are typically able to meet their nutrient requirements from pasture with a salt and mineral supplement. Hay and grain are commonly provided in the winter months when forage is either unavailable, or low in nutrient density.

The main nutrient required, which is often the limiting factor in a typical ration for sheep, is energy.[76] Sheep with a shortage of energy intake will lose weight. This may happen with un-supplemented ewes grazing native range. The ewes cannot consume adequate amounts of forage due to low availability of forage or the slow rate of digestion of poor-quality forage. Ewes will respond to improved nutrition by gaining weight and/or presenting an improved body condition.

A ewe's body condition score tends to fluctuate throughout the year, depending on the stage of production and the availability and nutritional value of feed. Nutrient requirements are lowest for ewes during maintenance, increase gradually from early to late gestation, and are highest during lactation.

Access to clean water is required by both ewes and lambs. A sheep may drink between ½ to 4 gallons of water per day, however the typical amount is likely ½ to 1.5 gallons per day.[77] A simple way of estimating water requirements is to "double the weight of the air-dry feed intake" or, in other words, if a sheep consumes four pounds of dry feed, then the sheep would need a gallon (about 8.33 pounds per gallon) of water in total.[78] These requirements can change based on weather changes, dietary changes, and the sheep's stage of production. Inadequate water supplies or unclean water will decrease lamb rates of gain and increase instances of disease, and the presence of issues related to urinary calculi in a flock.[79]

Late Pregnancy Nutrition

The last 4 to 6 weeks of gestation is a critical nutritional period; due to at least 66 percent fetal growth occurring during this period. Inadequate nutrition during this stage results in lighter weight lambs at birth, unequal birth weights of twin and triplet lambs, reduced mothering instinct, lowered milk production, increased early lamb loss, and the heightened risk of pregnancy toxemia.

[75] https://u.osu.edu/sheep/2021/03/30/nutrition-and-feeding-systems-for-lamb-finishing/.
[76] https://u.osu.edu/sheep/2021/03/30/nutrition-and-feeding-systems-for-lamb-finishing/.
[77] https://extension.psu.edu/nutrition-throughout-pregnancy-for-sheep-flocks.
[78] https://extension.psu.edu/do-your-sheep-receive-optimal-nutrition.
[79] https://www.sheep101.info/201/nutritionreq.html.

Pregnancy toxemia is a metabolic disease that occurs at the end of gestation, and it is believed that nutritional deficiency due to the decreased ingestion of feed is the leading risk factor. It is most associated with late gestation because the fetus (or feti) begins to take up more space in the abdomen, and the ewe cannot physically ingest enough feed to supply the nutrition necessary to support both her and the fetus (or feti).[80] Ewes with more than one fetus are more prone to developing ketosis, and therefore pregnancy toxemia, than ewes carrying a single fetus.[81] According to Ji et al., 2023, ewes with pregnancy toxemia will display a multitude of symptoms including, but not limited to:

> *"Decreased appetite, depression, staggering gait, rough skin, blindness, muscle tremors, grinding teeth, convulsions, and eventually coma and death."*[82]

Avoiding pregnancy toxemia is possible, however it does require certain management practices that are implemented prior to breeding and during the early stages of gestation as well. Pregnancy toxemia is, systematically, the dam's body entering a state of ketosis. Ketosis occurs when there is not enough energy supplied to the body via nutrient-dense feeds, and the ewe (dam) will then metabolize her existing body fat. When fatty acids are metabolized at higher-than-normal rates, the body enters a state of ketosis. In order to avoid these, late gestation nutrition requires increased energy intake to allow for rapid fetal growth. Feeding higher-quality hay or grains that have increased concentration of energy and nutrients around six weeks prior to lambing is essential to lower the risk of pregnancy toxemia. Management practices such as fetal scanning, body condition scoring, and aging are utilized by some producers to ensure ewes carrying multiple lambs are fed a more nutrient dense ration, separate from the other ewes. Ewes with low body condition scores, and those who are overweight or underweight prior to breeding, pose a higher risk of developing pregnancy toxemia.[83] Additionally, ewes with low body scores at birth, as a result of pregnancy toxemia in the final stages of gestation, do not lactate well, regardless of nutrition during lactation. Thus, adequate nutrients to resolve or avoid pregnancy toxemia need to be provided well before the final lambing date.

Many congenital defects in sheep are known to be caused by deficiencies of specific nutrients in the diets of sheep and affect lambs both before and after birth. Many of these issues result in an increased probability of mortality in lambs or a decreased average daily gain. This may present a moral hazard issue, wherein a producer might decrease the quantity or quality of feed to pregnant ewes to reduce costs, which then could result in an insurable loss for an insurance product with yield as a measure of loss several months later after the lambs were born.

Lactation Period

The greatest nutrient demand for the ewe is during lactation. Twin rearing ewes require 50 percent more energy and protein to ensure adequate milk production for growth and survival of the lambs. Peak milk yield occurs around week four of lactation and begins declining after eight

[80] https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases.pdf.
[81] https://www.sheep101.info/201/nutritionreq.html.
[82] Ji X, Liu N, Wang Y, Ding K, Huang S, Zhang C. Pregnancy Toxemia in Ewes: A Review of Molecular Metabolic Mechanisms and Management Strategies. Metabolites. 2023 Jan 18;13(2):149. doi: 10.3390/metabo13020149. PMID: 36837768; PMCID: PMC9961611, Accessed February 2024. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9961611/#:~:text=Pregnancy%20toxemia%20is%20a%20nutritional,%2C%20abortion%2C%20or%20premature%20birth.
[83] https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases.pdf.

weeks of lactation. Nutrient requirements are drastically reduced in late lactation. Underfed lactating ewes will wean lambs with lighter weaning weights. Maximum lamb growth is achieved during this period by feeding the ewes a diet designed to maximize milk production.[84]

After reaching eight weeks of age, a lamb's energy intake is greater from roughage than from milk, so competition for roughage between ewes and lambs can reach a critical point depending on forage availability. Feeding programs vary for lambs depending on if the producer uses an accelerated or traditional lambing system. Spring or late winter born lambs are typically left on pasture with their dams over the summer and may or may not be put on a grain feeding program at weaning. Winter born lamb's feed programs vary, with many producers providing grain supplement in addition to roughage within several weeks of birth.

A wide variety of issues can result from inadequate nutrient intake; examples include:

- Iodine – Can cause goiter and increased neonatal mortality, as well as prolonged gestation in ewes. Deficiency may result from a primary deficiency or be induced by nitrates.[85]
- Copper – Can cause enzootic ataxia in lambs. This can result from either a primary copper deficiency from low copper levels in the soil or a secondary deficiency in which the availability of copper is interfered with by other minerals (such as molybdenum and iron). Too much copper, however, can result in copper poisoning.[86]
- Manganese – Can result in chondrodystrophy and limb deformities.[87]
- Vitamin D – Can result in neonatal rickets.[88]
- Vitamin A – Common in lambs fed in feedlots. Can result in eye defects, reduced wool production, reduced ewe fertility, reduced immune response and white muscle disease.[89]
- Vitamin E and/or Selenium – More common in high rainfall areas, over 16 inches per year, such as the eastern United States. Can result in similar issues to those caused by deficiencies in Vitamin A, as well as congenital cardiomyopathy and muscular dystrophy.[90]
- Congenital cobalt deficiency is reported to reduce lamb vigor at birth and to increase perinatal mortality because of impaired immune function in the lamb. A similar effect on immune function in neonatal lambs has been found with copper deficiency.[91]
- Malnutrition in ewes can result in increased neonatal mortality, reduced lamb vigor, along with reduced probability of offspring surviving until weaning.

[84] Holst, P. J., Killeen, I. D., & Cullis, B. R. (1986). Nutrition of the pregnant ewe and its effect on gestation length, lamb birth weight and lamb survival. Australian Journal of Agricultural Research, 37(6), 647-655.
[85] Potter, B. J., Jones, G. B., Buckley, R. A., Belling, G. B., McIntosh, G. H., & Hetzel, B. S. (1980). Production of severe iodine deficiency in sheep using a prepared low-iodine diet. Australian journal of biological sciences, 33(1), 53-62.
[86] Suttle, N. F., Field, A. C., & Barlow, R. M. (1970). Experimental copper deficiency in sheep. Journal of comparative pathology, 80(1), 151-162.
[87] Anke, A., Hennig, A., Groppel, B., Dittrich, G., Grün, M., & Schellner, G. (1973). Manganese deficiency in ruminants. 4. Effect of manganese deficiency on the concentration of fat, protein manganese, ash, calcium, phosphorous, zinc and copper in newborn lambs. Archiv fur Tierernahrung, 23(3), 213-233.
[88] Bonniwell, M. A., Smith, B. S., Spence, J. A., Wright, H., & Ferguson, D. A. (1988). Rickets associated with vitamin D deficiency in young sheep. The Veterinary record, 122(16), 386-388.
[89] https://www.agric.wa.gov.au/livestock-biosecurity/selenium-andor-vitamin-e-deficiencies-sheep.
[90] https://www.agric.wa.gov.au/livestock-biosecurity/selenium-andor-vitamin-e-deficiencies-sheep.
[91] Vellema, P., Van den Ingh, T. S. G. A. M., & Wouda, W. (1999). Pathological changes in cobalt-supplemented and non-supplemented twin lambs in relation to blood concentrations of methylmalonic acid and homocysteine. Veterinary quarterly, 21(3), 93-98.

These examples illustrate the care with which insurance provisions for a lamb production insurance policy would need to be constructed. Producers wishing to cut costs or simply short on feed during a ewe's gestation period, with or without intent, could negatively impact the mortality rates or rates of gain of their lamb crop and thus trigger an insurance indemnity. The financial incentives to maintain adequate nutrition for ewes and lambs are likely significant enough to prevent this in the majority of cases, but additional evaluation of the moral hazard risks stemming from inadequate nutrition is recommended.

II.D. Classifications

The Contractor found two primary forms of classifications for lambs, slaughter delineated by quality and yield grading as well as classification by breed type. The following section on important varieties further delineates important breeds of lambs.

Slaughter Classification

The USDA has established standards for the "grades of slaughter lambs, yearlings, and sheep" under the Agricultural Marketing Act of 1946 (60 Stat. 1087; 7 U.S.C. 1621-1627).[92] These standards specify the classification of slaughter classes for market lambs and sheep as shown:

- Ram – uncastrated male ovine.
- Ewe – female ovine.
- Wether – male ovine castrated at a young age, before development of the secondary characteristics.
- Lamb – An immature ovine, under 14 months old, that has not yet cut its first pair of incisor teeth.
- Yearling – ovine between 1 and 2 years of age, that has cut its first pair of incisor teeth, but not the second pair.
- Sheep – ovine over 24 months of age, that has cut its first and second pair of incisor teeth.

Slaughter classifications for market lambs, yearlings, and sheep is further delineated by quality and yield grading. Quality grades are determined by carcass factors such as conformation and quality as related to fatness and maturity, indicators of palatability, of the animal. The finish of a lamb or yearling is graded by relating the quantity, distribution, type, and thickness of the fat in relation to the age and maturity of the animal. For each slaughter classification (slaughter lambs, slaughter yearlings, and slaughter sheep), there are four quality grade classifications:

- For slaughter lambs and slaughter yearlings.
  - Prime
  - Choice
  - Good
  - Utility
- For slaughter sheep.
  - Choice
  - Good
  - Utility
  - Cull

[92] https://www.ams.usda.gov/sites/default/files/media/Slaughter_Lambs%2C_Yearlings%2C_and_Sheep%5B1%5D.pdf.

In addition to quality grades, there are five yield grades that are applied across all sheep classifications. Yield grade 1 is representative of the "highest degree of cutability" while yield grade 5 represents the lowest. Additional information regarding slaughter classification of lambs can be found in the USDA United States Standards for Grades of Slaughter Lambs, Yearlings, and Sheep.[93]

Breed Classification

According to extension research from South Dakota State University, there are 47 recognized sheep breeds in the United States and each of these are grouped according to their use or certain characteristics into the following 6 classes; "meat, fine wool, long (course) wool, dual purpose, hair, and minor (specialty) breeds."[94] Most sheep breeds, with the exception of hair sheep, can be considered dual purpose; however it is not likely that sheep breeds will excel in both (and are even less likely to excel in all three types of production: meat, wool, and dairy).[95] In addition to the classifications listed previously, it is important to note sheep breeds are further characterized by their suitability to perform in the flock either as a terminal (ram) sire, or as a maternal (dam) sire.

Breeds classified for meat production (lamb or mutton) are selected for attributes related to carcass composition, muscle shape, performance, and size.[96] As a result of this selection, traits related to wool production, such as wool quality, are ignored. Over time, this has shaped breeds such as the Suffolks, Hampshires, Dorsets, Southdowns and others into sheep that excel in meat production but lack the qualities to efficiently succeed in wool and dairy production.[97] A large majority of meat breeds coincide with the medium wool breeds, including all breed types listed above.[98/99]

Breeds that are classified for use in fine wool include the Rambouillet (a common sheep breed in extensive range production in the Great Plains region), the Delaine-Merino, and the cross of these which is known as the Debouillet. Each of these breeds also have an extended breeding season, which is likely a result of many generations of selection and adaptation to harsh winter environments such as that of the Northern Great Plains.

Long wool breeds, also referred to as coarse wool breeds, include the Border Leicester, Lincoln, and Romney sheep breeds. Coarse wool breeds maintain traits for staple lengths that vary anywhere between 5 and 15 inches. Coarse wool breeds are suitable for cold and wet conditions, but they are considered to be only moderately prolific, and require more abundant feed resources to produce, and as a result they are not well suited to meat (lamb) production. They do, however, produce a heavy, long, and coarse fleece that is ideal for spinning.[100]

[93] https://www.ams.usda.gov/sites/default/files/media/Slaughter_Lambs%2C_Yearlings%2C_and_Sheep%5B1%5D.pdf.
[94] https://extension.sdstate.edu/sheep-breeds#:~:text=The%20American%20Sheep%20Industry%20Association,%2C%20hair%2C%20and%20minor%20breeds.
[95] https://www.sheep101.info/201/breedselection.htm.
[96] https://extension.sdstate.edu/sheep-breeds#:~:text=The%20American%20Sheep%20Industry%20Association,%2C%20hair%2C%20and%20minor%20breeds.
[97] https://www.sheep101.info/201/breedselection.htm.
[98] https://www.sheepusa.org/wp-content/uploads/2022/06/Wool_Grades_and_the_Sheep_that_Grow_the_Wool_Scan-1.pdf.
[99] https://smallfarms.cornell.edu/2023/01/introduction-to-sheep-breeds/.
[100] https://www.sheepusa.org/wp-content/uploads/2022/06/Wool_Grades_and_the_Sheep_that_Grow_the_Wool_Scan-1.pdf.

Research into the term "dual purpose" as it relates to sheep breeds provides two distinct, though relatable definitions. First, sheep breeds that are able to successfully produce a desirable wool and decently or well graded carcasses are classified as dual purpose. Early sheep breeds were likely all considered dual purpose; over time through the careful selection for certain traits, more specialized breeds have been introduced – these perform exceedingly well at a single form of production and are therefore more economical in terms of modern sheep and lamb production. In the United States specifically, "dual purpose" primarily refers to breeds that are produced for meat and wool. Breeds that are utilized for milk production in the United States are rare, and only two sheep breeds are referenced as dual-purpose milk breeds.[101] Secondly, the term "dual-purpose" is used to describe that a given breed is suitable to perform in the flock as either a terminal sire (ram) or maternal sire (ewe).[102]

Hair sheep breeds are quickly gaining popularity, especially in arid / temperate regions of the United States such as that in Texas. Hair sheep are characterized by their hardiness, heat tolerance, and the genetic adaptation of producing hair (similar to that of a goat) rather than wool. Hair sheep are utilized in extensive, low-input meat production and they do not require shearing. Most popular of the hair sheep breeds in the United States is the Dorper and the Katahdin.[103] Hair sheep tend to produce small framed, lower weight market lambs that than that of other meat breeds, but in recent years the demand for lean, small lambs has been driven by ethnic demand.

Examples of common breeds utilized in U.S lamb and sheep production are included in the following section. This list is compiled of breeds that are most commonly referenced in U.S production.

II.E. Important Breed Types in the United States

The USDA recognizes over 50 different breeds of sheep for U.S. production, however, there are certain breeds or crossbreeds that are more suitable for production than others.[104] With sheep, there is a significant amount of diversity between breeds, some are well suited for meat production in arid environments (hair breeds) while others are suited for wool and meat production in cooler environments (wool based breeds) and lastly, many breeds now in production are a result of a cross between the two. Sheep are primarily raised for meat, fiber, or a combination of the two. There are major categories that sheep breeds are categorized into based on their production purpose, physical characteristics, and breed performance. These categories include meat, long wool, fine wool, dual-purpose (meat and wool), triple purpose (meat, wool, and milk), hair, prolificacy, sires, and maternal traits. This diversity allows producers to identify a breed that is most applicable to their production scenario, which, as discussed previously, is highly variable from one producer to the next. A producer can choose the breed that most fits their environment, intended market, breeding season, lambing season, type of production, facilities, availability of labor, and so on. In general, a breed that has exceptional carcass traits and ideal rates of gain is likely not going to be as adaptable to harsh environments and climatic stress, whereas a highly adaptable breed may not produce a high-

[101] https://content.ces.ncsu.edu/pdf/sheep-and-goat-production-for-sm/2021-07-13/AG_sible_071221.pdf.
[102] https://www.sheep101.info/201/breedselection.htm.
[103] https://extension.sdstate.edu/sheep-breeds.
[104] http://www.fao.org/dad-is/en/.

quality carcass, but this diversity allows for a large pool of genetics to select from when producers are looking for a breed or looking to utilize a cross of breeds.[105]

Sheep are seasonal breeders, meaning that sexual activity is controlled by the ratio of daylight to dark. When days are shorter, fertility is highest because ewes' estrus increases in frequency, so ewes typically are bred in the fall (September through November). Gestation is, on average, 147 days (5 months), so lambs are born in the late winter and spring. Following lambing, ewes nurse lambs for about three months, so ewes are idle for about four months of the year. Some breeds have been developed to become accelerated breeders to increase the breeding frequency to three lamb crops in two years instead of the conventional once-a-year lambing.

In addition to seasonality, sheep breeds must be chosen based on their adaptability to the producer's environment and production system. The following breeds, discussed in detail below, will be described based on their ability to adapt to each environment or production region in the United States as well as their uses in regard to lambing and production systems. Given that large herds of sheep located in the western United States are typically commercial herds, it is likely that registered sheep numbers would not imply an accurate estimate of breed population in the United States.

Rambouillet

While they are suitable for multiple climates, Rambouillet sheep breeds are typically found on western U.S. range production systems. They are the largest framed sheep known for fine wool that excel in multiple forage or range conditions.[106] Additionally, this breed is recognized for their flocking behavior, which is ideal for navigation of mountain terrain and threats of predation.[107] They are known for their high-quality wool, however the breed has been crossed with other meat breeds to produce heavy, rapidly growing lambs for meat.[108] Rambouillets are known for their naturally long breeding season, and they are a breed that can be adapted to a fall or accelerated lambing program, however they are still considered seasonal and will naturally breed in the fall and lamb in the spring making them ideal candidates for range production in the western United States.[109]

Dorper

The Dorper is a cross between the Dorset Horn and Blackheaded Persian, with its main purpose being for meat. Dorpers have a mix of hair and wool that sheds on its own, and therefore they are considered low maintenance because there is no shearing needed. According to the American Dorper Sheep Association, the breed is meant to produce a "prime" version of lamb meat compared to other meat breeds, as a result it is often crossed into other breeds. Dorpers can be bred in accelerated or out of season production scenarios with the ability to breed every eight months, and they are known to have higher rates of twins at birth. Dorpers are known for their hardiness, and their ability to tolerate heat and therefore they are very popular in southwestern arid environments and are suitable for both intensive and extensive range production.[110]

[105] https://www.ars.usda.gov/ARSUserFiles/30400505/Publications/MARCCrossbreeding.pdf.
[106] https://www.britannica.com/animal/Rambouillet-breed-of-sheep.
[107] https://pubs.nmsu.edu/_circulars/CR684/.
[108] https://www.countrylovin.com/ARSBA/index.htm.
[109] https://sheep.extension.org/fall-lambing/.
[110] https://dorpersheep.org/about-dorpers/.

Katahdin

While this breed is considered a hair sheep which are typically suitable for warmer arid climates, Katahdin sheep are known for their adaptability and hardiness, and they will grow a thick winter coat in cold environments and are able to shed their coat in the summer. Depending on their environment they may not grow a thick coat and are therefore adaptable to both warm and cold climate regions. Katahdin sheep are not known for their size, but instead are recognized for their utility, their ability to consistently produce vigorous lambs across multiple production regions with little maintenance. According to Oklahoma State Extension, Katahdin sheep that are well managed can produce up to a 200 percent lamb crop, with most ewes producing twins and some producing quadruplets, and they typically can provide enough milk for their lambs as they are known for their milk production and maternal characteristics, as opposed to other breeds. They are known to have consistent, mid-grade, lean lamb carcasses and can be desirable for ethnic markets that prefer smaller framed, leaner lambs.[111] Given they are considered long seasonal breeders, and they mature quickly, Katahdin's can be utilized in accelerated or fall lambing with the right management.[112]

Dorset

Horned and Polled Dorset are recognized as two separate breeds. Horned Dorset were introduced to North America from Wales during the 1860s. Polled Dorsets were developed at North Carolina State College as a result of genetic mutation and accepted as a breed in 1956.[113] Dorset ewes weigh 150 to 200 pounds, and mature rams can weigh 225 pounds up to 275 pounds.[114] As a medium wool breed, Dorsets are primarily raised for meat and have desirable body length and muscle conformation. They are known for their higher lean meat yield, taste, and tenderness. Dorsets are capable of breeding year-round and adaptable to consistently performing in various climates. Multiple births of twins and triplets are common in this breed and average weaning of lamb crops is between 120 and 150 percent.[115] The ewes are known to be maternal due to their protective instincts and milk production.

Polypay

Polypay are a cross of four other sheep breeds, developed at the Sheep Experiment Station in Idaho during the 1960s. The new composite of breeds is a calculated mix of Finnsheep, Rambouillet, Targhees, and Dorsets, with each breed contributing in a different way. The initial goal came through frustration after the decline in sheep production, and profit, occurring in the 1960s. As a result of this, scientists wanted to create a new breed of sheep that met multiple primary goals, such as: "high lifetime prolificacy, large lamb crop at one year of age, ability to lamb more frequently than once per year, rapid growth rate of lambs, desirable carcass quality."[116] In comparative studies, Polypay sheep have shown to be superior on multiple factors of reproduction such as, earlier maturity, higher fertility, and they are more prolific when compared to that of other breeds in the United States. Wool is considered mid-grade; however,

[111] https://breeds.okstate.edu/sheep/katahdin-sheep.html#:~:text=Katahdin%20are%20hardy%2C%20adaptable%2C%20low,a%20variety%20of%20management%20systems.
[112] https://katahdinsheep.com/about.html.
[113] https://sheepbreeders.ca/charollais-dorset . Accessed February 2024.
[114] http://afs.okstate.edu/breeds/sheep/dorset/. Accessed February 2024.
[115] https://polldorset.org.au/about/our-breed. Accessed February 2024.
[116] https://breeds.okstate.edu/sheep/polypay-sheep.html.

carcass characteristics are more favorable than that of each breed that was used in development. While they are highly prolific and can raise multiple birth lamb crops, the nutrition considerations are higher than that of breeds which do not typically raise more than one lamb. As a result, they are not well suited to multiple production environments, for a Polypay to capitalize on the traits that are bred into them, they must be met with good management and sufficient resources. However, according to an economic evaluation comparing other popular U.S. domestic sheep breeds, the Polypay breed, in all production systems, is shown to increase profitability between 15 and 36 percent.[117]

Suffolk

This breed was initially the offspring of mating Southdown rams to Norfolk Horned ewes. It was recognized as a breed as early as 1810 and introduced to North America in the late 1880s. Suffolk are a large-framed meat breed with ewes weighing between 180 and 250 pounds and the rams ranging from 250 to 350 pounds. Due to their strong growth characteristics, Suffolk rams are often used as terminal sires (the females are not kept as replacement ewes) in commercial ewe flocks. They are known for their ability to thrive on poor range conditions and can be considered a dual-purpose breed for the production of meat and wool, however they are not known to produce fine wool.

As these descriptions help to illustrate, the differences in vigor, rate of gain, prolificacy, estrus cycles, value per pound, etc. can be significant between breeds. With sufficient historical data, these differences could likely be accounted for when developing premium rates for a variety of insurance programs. Ideally, individual histories for a farm would be available in order to account for complexities introduced by crossbreeding, which would somewhat nullify even good data on each breed as different crossbreeds will have different traits.

II.F. Production Requirements

Lamb production varies significantly across the United States. For each standard type of production environment there are several exceptions. For that reason, in this report, the Contractor discusses various production models and lambing systems.

Production Models

Throughout the United States, sheep production varies considerably depending on the region in which the operation resides and the producers' preferences. As mentioned previously, 93 percent of sheep farms that exist in the United States have a herd size of less than 100 head. The remaining 7 percent of farms have herd sizes anywhere between 100 head, up to 5,000 or more, according to the CoA for 2017. With that, it is reasonably inferred that sheep production systems and enterprise models vary considerably, and the niche markets that exist within sheep and lamb production are large contributors to the industry's total economic potential. With this level of variation in herd sizes, production models and lambing systems are highly variable both across and within regions across the United States.

[117] https://www.cambridge.org/core/journals/animal-genetic-resources-resources-genetiques-animales-recursos-geneticos-animales/article/abs/characteristics-of-the-american-polypay-a-review/AB7FA63E65BC3D6876B01B9F828FAC3E.

While there are a number of variations to this, most operations can classify as either "stock-sheep" or "feeder" enterprises.[118] Producers of stocker sheep can choose, based on their individual resources and preferences, to conduct their operations using a rangeland, shed, pasture or confined production model. Additionally, feeder enterprises will, in most cases, consist of some form of confinement production, however this can vary as discussed in greater detail later.

In the midwestern and western United States, where native rangeland and forage is more accessible, range production models for stocker sheep enterprises are more prominent. The objective of a typical stocker sheep operation is to breed, lamb, and maintain the health of lambs until they are weaned, at which point they are either finished and marketed on premises or sent to a feeder/feedlot enterprise to be finished out and sold to be slaughtered for meat. Depending on the location and producer preference of the range operation; things like breed, seasonality, and duration of growth may differ between operations. Over the course of a production year, range producers incorporate strategic movement of the sheep herd to optimize forage availability and adapt to seasonal changes. For a typical western state's operation, optimizing forage and range resources through the use of strategic seasonal management changes is key to a successful operation. When range lambing, it is common for breeds such as Rambouillet to be used in the northern great plains of the United States given they are a dual-purpose breed with a strong herd mentality and will they have extended breeding seasons allowing for producers to plan for breeding and lambing when the weather is most suitable in the spring. Lambing in the spring allows for ewes to lamb when conditions are more favorable for survival of the lambs in western range operations. Data collected in a 2011 USDA APHIS study shows that most lambs born across the United States were born in the months between February and May, however in larger operations, most likely those using range production models, the highest percentage of lambs were born in May. A very low percentage of range operations, only 5.6 percent will utilize any form of out of season breeding and lambing as this is not typically feasible given the lack of available forage, and the increased labor and inputs needed.[119]

Conversely, shed and confined lambing operations, which can be found in many production areas across the United States, are more popular among producers in the eastern region of the United States due to the lack of access to native range. The goal of a confinement production system is to intensify or increase production within a small area by supplying all inputs. Confinement operations vary, with some producers utilizing pastures to graze during certain times of the year, while others raise their herd in full and total confinement. Confinement production allows for better control over all inputs, therefore allowing for more successful accelerated or out of season lambing systems, however production and input costs remain much higher due to the need for the producer to supply a full ration feed and water system as well as attend to health issues that can be associated with confinement conditions.[120] Given that confinement production requires around the clock observation of the herd, on average, the number of lambs per ewe is the highest at 1.5, and little to no lambs are lost to predation or poisonous plants, two common risks associated with range production.[121]

[118] https://www.ers.usda.gov/topics/animal-products/sheep-lamb-mutton/sector-at-a-glance/.
[119] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep11/Sheep11_is_Lambing.pdf.
[120] https://www.agric.wa.gov.au/autumn/confined-paddock-feeding-and-feedlotting.
[121] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep11/Sheep11_is_Lambing.pdf.

Some producers may utilize a mixture of both systems, by utilizing forage on pasture when it is available and highly nutritious, and bringing ewes into some form of confinement, shed or pen, to lamb. This can be economically feasible when the producer has access to both range and confinement infrastructure.

Texas, the largest lamb producing state, and California, the second largest, utilize production models that differ from that of the Central and Intermountain West states described previously. In the Developer's discussions with producers in Texas, there are many exceptions or alterations to each production model, however most operations are still classified as "stocker-sheep" operations in each of these states. The majority of producers in Texas, for example, produce hair sheep which do not require as much labor in comparison to wool sheep breeds, but produce a smaller framed lamb that is ideal for the ethnic markets which prefer lean and small lambs. With the lack of harsh winters, Texas sheep producers using a range model will often leave rams out all year, along with the ewes and they will breed, and lamb based on an opportunistic lambing model. Depending on their target market, around half of Texas sheep producers will feed out and market their own lambs on premises to be sold to the ethnic, or nontraditional markets, but a small minority will send their weaned lambs to feedlots.[122]

In addition to Texas, California lamb production models differ slightly from that of the typical western range models described previously. The majority of sheep and lamb production is centered around the San Joaquin Valley, with operations being classified as small with less than 25 head, medium with 25 to 99 head, large with 100 to 999, or very large with 1,000 or more.

While there are multiple stocker sheep production models, the majority of lambs from each operation will be weaned and shipped at around 150 days old.[123] With the large majority of sheep being located in the west and west central United States, it is typical for a range operation to lamb in the spring, therefore lambs are weaned in the later part of summer and shipped to either a backgrounding or feeding facility for finishing. Depending on market fluctuations, some of these lambs will be kept and finished for market in the fall while others may be held until winter or spring of the next year. This practice has been controversial as processors and packers require additional labor to trim the excess fat that is accumulated over the lambs extended time in the feedlot. As with other livestock sectors, the feedlots are able to hold and supply lambs throughout the year as supplies change. Given the seasonality of the production models for large operations, it is difficult to maintain an even supply throughout the year, and feedlots work to mitigate this. USDA Agricultural Marketing Service (AMS) reports Colorado feedlot numbers in the report "Monthly Feeder Lamb Inventory Summary."[124] Numbers usually see a slight bump in the spring, then drop significantly through the summer and spike dramatically in the fall. Lamb feeding is concentrated in Colorado and the Great Plains.

Lambing Systems

Most sheep are seasonal breeders as a result of their sensitivity to the length of day and are most fertile in the fall as the days shorten. Sheep naturally will conceive in the fall when fertility is the highest (September – December) and thus, it is estimated that 85 percent of lambs in the

[122] https://www.lambresourcecenter.com/s/ALB-Seasonality-White-Paper-REVFINAL-07-11-18-1.pdf, accessed January 2024.
[123] https://www.lambresourcecenter.com/s/ALB-Seasonality-White-Paper-REVFINAL-07-11-18-1.pdf, accessed January 2024.
[124] https://www.ams.usda.gov/mnreports/lsmcolambfi.pdf.

United States are born between January and May.[125] Early (winter) lambing coincides well with the availability of labor as many lambing operations produce other commodities, since early lambing occurs in the months of January and February, which are generally less labor intensive for other farming operations.[126] Additionally, early lambing is, in most years, particularly lucrative for the producer because Easter and other religious holidays coincide well with early lambing given that lambs are born between January and February, then marketed in March or April for this type of production cycle.[127] However, early (winter) born lambs are more exposed to the elements and as a result, some form of confinement, shed, or housing is needed which can increase overall costs to produce. In these confined lambing conditions, lambs are able to escape environmental and predation risks, however; confinement also introduces a higher risk of disease and sickness such as mastitis, scours and pneumonia.[128] Ewes that conceive later in the fall and lamb later in the spring months of April and May (late or spring lambing) have the advantages of readily available and nutritious forage during times of late gestation and lactation, both of which have high nutrient requirements as discussed further below. In addition, the ewes can lamb on pasture without the added environmental risks associated with harsh winter temperatures and moisture. This can be more cost effective, as it decreases the overall cost of production by eliminating the need for confinement during lambing, as well as the cost of additional feed and labor required by confined lambing in the early months of January and February. There are tradeoffs, however, such as lambs born on range or pasture face a higher risk of falling victim to predation and parasites. Both early (winter) and late (spring) lambing are examples of the variation of an in-season lambing production model, because sheep are considered seasonally polyestrous with the estrous cycle being induced by changes in the photoperiod – as days get shorter in the fall, sheep enter estrus. Given they cycle every 16 – 17 days during their breeding season which typically occurs between September and December, in season breeding and lambing can vary between the first five months of the year depending on the production environment and producer decisions regarding management.[129]

Data also shows the lambing rate decreases as the operation size increases, likely due to multiple factors.[130] One being the operational practice used. The average size of an operation is larger in the west and central regions of the United States due to the increased availability of forage. With that, most operations are utilizing some form of pasture or range lambing management system and as a result, operations with 500 head or more averaged 1.2 lambs per exposed ewe, compared to that of 1.5 in the eastern regions where the operations are smaller and use confinement production systems.[131]

While fall conceived, spring born lambs mimic the natural breeding cycle of most breeds, some are less seasonal or have extended breeding seasons like the Rideau Arcott, Merino, Dorset, Polypay, Rambouillet, and most hair breeds.[132]

[125] https://static1.squarespace.com/static/64067687b84cb72537d80b9a/t/6495dc2086ccf603164fd4e7/1687542822713/ALB-Seasonality-White-Paper-REVFINAL-07-11-18-1.pdf.
[126] https://www.sheep101.info/201/lambingsystem.html.
[127] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep11/Sheep11_is_Lambing.pdf.
[128] https://u.osu.edu/sheep/2018/07/24/work-on-this/.
[129] https://www.merckvetmanual.com/management-and-nutrition/management-of-reproduction-sheep/reproductive-physiology-of-sheep, accessed February 2024.
[130] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep11/Sheep11_is_Lambing.pdf.
[131] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep11/Sheep11_is_Lambing.pdf
[132] https://extension.oregonstate.edu/animals-livestock/sheep-goats/out-season-lambing.

Breeds with extended reproductive seasons such as those listed previously are typically more easily adapted to fall lambing systems, which would be considered "out of season". Out-of-season breeding is typically used for the purpose of establishing an accelerated lambing program, because of the increased production costs and reduced fertility effects of breeding out of season, it is not cost effective to have an annual lambing program when implementing an out-of-season fall lambing system.[133] The schedule, while varying slightly based on region and producer preference, is designed to result in two lambing seasons with two different lamb crops which are managed and marketed separately.[134] Producers that manage a fall lambing system will have to do so through genetic selection of breeds with extended seasons as well as some method of inducing estrous, the most prominent and cost effective of these methods being the utilization of rams to induce the cycling of anestrous ewes. This is termed the "ram effect" where ovulation occurs within 50 hours of the introduction of the ram. After the initial ovulation occurs, ewes will resume out of season breeding activity around the 18th or the 24th day following the introduction of the ram.[135] While there are regional variances, a typical "out-of-season" or fall lambing system will involve breeding the first group of ewes in April and May, which will lamb between September and October (i.e. fall lambing) then lambs are marketed between March and April, and therefore they are not carried on pasture through the summer. The second group consists of whichever ewes did not conceive in the first breeding phase in April/May. These ewes will be grouped together and bred again in August of the same year, known as cleanup breeding. The ewes bred during the cleanup breeding phase will result in another lamb crop in January/February. Fall breeding systems will have lower fertility rates than that of seasonally bred ewes and in some cases, will have smaller birth weights depending on the location of the operation and the age of the ewe.[136] By separating the total lamb crop into two lambing periods, the producer can market their lambs during the "off season" when the market is less flooded with spring born, seasonal lambs, and this often results in higher prices per lamb. Additionally, it allows for the lambs to be sold before summer, which eliminates some of the risk associated with parasites which are more prevalent in the summer.[137] According to the previously referenced USDA APHIS study from 2011, 24.5 percent of operations bred either some or all their ewes in an out of season system between September and December.[138]

Given the variability in production practices, breeds, environmental conditions, and lambing systems across the United States, some producers manage their operations to produce outside of this natural cycle in order to maintain year-round production or sell to nontraditional markets. Across all U.S. regions, 75.5 percent of producers define a single breeding season per year, while 11.9 percent defined two breeding seasons, 10 percent reported that they do not define a single breeding season and lastly, 2.5 percent reported three breeding seasons.[139] For the western United States where range and pasture operations are more abundant, the majority of sheep producers have a single lambing season in the spring after turning out rams with their ewes in the fall so lambing coincides with the time at which feed resources are most abundant and nutritious.

[133] https://www.merckvetmanual.com/management-and-nutrition/management-of-reproduction-sheep/breeding-programs-of-sheep#:~:text=For%20example%2C%20in%20the%20northern,April%20to%20lamb%20in%20September). Accessed February 2024.
[134] https://extension.okstate.edu/fact-sheets/a-breeding-program-for-a-fall-lambing-program.html. Accessed February 2024.
[135] https://extension.oregonstate.edu/animals-livestock/sheep-goats/out-season-lambing.
[136] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7531163/.
[137] https://extension.okstate.edu/fact-sheets/a-breeding-program-for-a-fall-lambing-program.html, Accessed February 2024.
[138] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep11/Sheep11_is_Lambing.pdf.
[139] Ibid.

However, in order to serve a year around demand, producers in other parts of the United States, primarily the Northeast, utilize confinement production systems as a way to breed and market their lambs during the off season, while controlling all inputs and eliminating the risk of predation. For this reason, 46.6 percent of all lambs born in the eastern region of the United States are born in confinement (barn/shed), 26.8 percent are born in a specified lambing pen and less than 1 percent are born in on an open range.[140]

The variation in lambing and production practices examined across the United States are due, in part, to the producer's decision regarding the marketing of their lambs. The producer has the option to breed and market lambs that are either suitable for the traditional or nontraditional markets. The traditional market is defined by lambs that are range or pasture raised until weaning, then marketed through an auction or by direct sale to feedlots throughout the United States to be conditioned to finishing weight. Lambs are considered "traditional" if the use of auctions, order buyers, packer buyers, and commission sales representatives are utilized in marketing a lamb crop.[141] There is a small portion of the traditional market that may not enter the feedlots, some may be sent to Imperial Valley, California for backgrounding before being sent to the feedlots, and some will be finished on pasture and be marketed as grass-fed, however they are still sold to packers via the mechanisms listed above and therefore still considered traditionally marketed.

The nontraditional lamb market consists of ethnic and direct to consumer or "alternative" markets. The ethnic market encompasses lamb that is consumed for religious holidays or as part of a regular diet of the several ethnic groups that exist within the United States, such as those with "Middle Eastern, North African, Caribbean, southern European, and South Asian origins."[142] Most ethnic consumers, especially those with religious preferences, will require a different set of production and slaughter practices to meet their needs. For example, groups such as those with Muslim and Hispanic ethnicities require that the lambs be "young, unaltered males." Harvest and slaughter protocols that follow religious laws such as Kosher or Halal are typically a part of the ethnic demand, with some groups preferring to slaughter and process their own lambs. Additionally, unlike that of lamb in the traditional markets, ethnic markets primarily prefer leaner, smaller carcasses (between 50-100 lbs.) which reduces production costs.[143] In many cases, ethnic demand is met through direct-to-consumer marketing, which consists of "sales directly to the general public or niche markets" and includes the "freezer-market, ethnic religious markets, retail food stores and restaurants."[144]

One of the major obstacles facing both traditional and nontraditional U.S. sheep producers in their efforts to capture more of the domestic consumer market is the seasonality of the availability of finished lambs. Typically, demand for commercially raised traditional lamb is highest over holiday seasons such as Christmas and Easter for the U.S. consumer. This type of

[140] Ibid.
[141] A Niche Marketing Guide for Lamb Cooperatives, USDA, Rural Business and Cooperative Development Service, Research Report 142 (1996). https://ucanr.edu/sites/nichemarketing/files/341787.pdf . Accessed February 2024.
[142] National Research Council. 2008. Changes in the Sheep Industry in the United States: Making the Transition from Tradition. Chapter 7, Alternative and Emerging Markets. Washington, DC: The National Academies Press. https://doi.org/10.17226/12245. Accessed February 2024.
[143] https://extension.sdstate.edu/direct-marketing-lamb-selling-direct-consumer.
[144] https://www.sheepusa.org/wp-content/uploads/2022/06/Nontraditional_Lamb_Market_Study_Feb__12_2010-1.pdf Chapter 4, Accessed February 2024.

demand aligns well with the fall conceived; spring born lambing system. Given these are traditionally produced, it is likely they will have gone through a feedlot to be finished, fattened, and slaughtered between the ages of 8 to 12 months to fit the traditional consumer demand.

Nontraditional lamb, produced to meet ethnic demand, requires a much different set of consumer needs. Ethnic demands for nontraditional lamb are often dependent on religious holidays which typically occur in the summer, varying slightly each year; and are therefore outside the traditional U.S. lamb marketing season. Additionally, these religious beliefs often require "unblemished lamb" insisting the lambs be intact, slaughtered, and dressed in a specific manner that is not conducive to the traditional market and commercial processor as discussed previously. Typically, when dealing with the ethnic markets, an intact lamb brings a premium price. [145] Lastly, the preferred slaughter weight for nontraditional lambs is much smaller (60-80lbs), nearly eliminating the need for a feedlot or finishing stage, while traditional lambs are fed in feedlots to slaughter weights of 120-160lbs.

In order to address this, some producers in the United States have adopted a different lambing system called accelerated lambing. Accelerated lambing refers to ewes lambing more frequently than once per year. Such intensive reproductive management can also reduce maintenance costs of breeding stock per offspring reared, increase total lambs marketed over a period of years, and can provide a more uniform supply of lamb throughout the year. It does, however, introduce the complication of seasonal restrictions (mostly due to weather). These systems usually require increased resource and management inputs due to the complications of lambing at varying times of the year and the additional nutrition requirements to keep ewes in breeding and lambing condition throughout. For pasture and range-based systems, this aseasonal lambing system is difficult due to the high nutritional requirements of pregnancy and lactation for the ewe, which may fall in times such as late summer through mid-winter when traditional forage sources do not have sufficient nutrition to support this gestational demand. Depending on the location of the operation and the ability of the operation to supplement forage availability, different variations of accelerated lambing systems can be maintained. Forms of accelerated lambing practices are mostly applied to confinement production, or in cases where both confinement and pasture production are feasible.

One of the most commonly used accelerated systems allows for three lambing's in two years with four fixed mating periods during the year, known as the "8-month" system. This system is generally characterized by a fixed breeding and lambing schedule such as May breeding/October lambing, January breeding/June lambing, and September breeding/February lambing. Ewes that did not conceive during a breeding period are typically exposed at the next possible period. Ewes that manage to conceive at every opportunity would have lambing intervals of 243 days.

Some producers have developed a variation of this system that provides for a more continuous lambing schedule. The flock is divided into four groups on a staggered eight-month lambing interval schedule. If the ewe fails to conceive with her group, she is moved into a different group and has a second chance to breed two months later.

[145] https://extension.psu.edu/marketing-lamb-and-goat-for-holidays#:~:text=If%20you%20want%20to%20sell,according%20to%20kosher%20dietary%20laws.

Another accelerated lambing system, the "five lamb crops per ewe every three years" system was developed by Cornell University and is often called the STAR system. It was developed to maximize production of market lambs on a continuous, year-round basis. The calendar year is divided into 5 segments that each represent one-fifth of a year, or 73 days. Each segment is representative as a point of a star, and thus it is named the STAR system. The STAR can be rotated to result in the most suitable dates for each operation. Two-fifths of a year is 146 days, which is approximately the gestation length of a mature ewe. There are thus five lambing periods in each year. There are always three groups in the flock: breeding and pregnant ewes and the rams, lambing and/or lactating ewes and their lambs, and growing lambs (market and replacements). These three groups are kept and managed separately in the STAR system.

In this system, out-of-season breeding techniques are used. These techniques assist in the shortening of the lambing period and allow the ewes to come into heat out of season so they can be bred for an accelerated lambing program. In general, the nutritional requirements of accelerated production are higher as animals are in a more productive state a greater proportion of the time.[146] This system adds significant complication to the potential development of an insurance program. The complication is linked to the added variability of both the rate of gain and mortality variables, as the lambing season changes.

The traits of these accelerated lambing systems have a significant impact on insurance risk. These include:

- Incidence of mastitis is often increased and more careful monitoring is required.
- Parasites and diseases must be monitored more carefully.
- Ewes must be replaced more frequently.
- Breeding is more difficult than with spring lambing. Out-of-season breed up rates tend to be poor and variable. Producers may struggle to achieve consistent breeding success during the spring. With sufficient data showing typical breed up rates during each season, this would not be an insurmountable barrier to insurance.[147]
- Nutrition: Since those utilizing an accelerated lambing system are lambing and breeding more often and at varying periods of the year, management requirements and feed inputs needed are increased in order to ensure an adequate plan of nutrition prior to and during the breeding season. As with many facets of livestock agriculture, optimal nutrition plays a significant role in both the breed up rates of ewes and the health outcome of the lamb,[148] with nutrition being important beginning at the time before conception and continuing to be particularly relevant to a lamb's future performance during the fetal stages.[149]

In addition to increasing insurance risk, accelerated lambing programs also significantly increase the rating complexity and required provisions of any insurance policy as they affect nearly every aspect of production. Rather than insuring a "season" as with traditional field crops, insuring accelerated lambers would require the insurance to attach at any time. This means additional data would be required to evaluate variance in conception, rate of gain, and mortality during and

[146] https://lambboard.com/s/Accelerated_Lambing_LC_Fact_Sheet_05_25_20171.pdf . Accessed February 2024.
[147] https://lambboard.com/s/Accelerated_Lambing_LC_Fact_Sheet_05_25_20171.pdf . Accessed February 2024.
[148] https://lambboard.com/s/Accelerated_Lambing_LC_Fact_Sheet_05_25_20171.pdf . Accessed February 2024.
[149] https://lambboard.com/s/Optimum_Nutrition_LC_Fact_Sheet_05_25_20171.pdf. Accessed February 2024.

in between different lambing and weaning periods over the course of a year. For example, stakeholders indicated conception rates vary significantly when turning rams out for breeding during different parts of the year. During hotter or colder times of the year, ewe estrous cycles are affected, resulting in fewer ewes bred and therefore lower conception rates. This same concept also transfers to lambing, where cold weather can have a significant negative impact on mortality rates in the first ten days, as well as requiring exponentially more labor and management. Lambing during such periods has the most notable impact on lamb mortality during the first ten days (further discussion of this early-life mortality is included in Section III. Review of Other Programs of this report). For example, lambs are particularly susceptible to cold stress during the first five days of life.[150] Lambs that suffered from cold stress or sickness early-on are more vulnerable to disease and other health issues long after the initial cause of those issues has passed. These issues result in lower rates of gain and higher mortality rates; effectively representing greater risk to producers, and potentially to insurers.

Thus, since an accelerated lambing program can theoretically lamb at any time of the year, a robust dataset illustrating the short and longer run effects on lamb mortality and rate of gain would be required to support insurance offers for these systems. Ideally an adequate dataset would also include control variables such as facilities, health protocols, number of ewes lambed, specific type of accelerated lambing protocol, and feed program, among many others.

II.G. Susceptibility to Insects, Pests, and Disease

There are many different kinds of pests and diseases that can affect lamb production. However, the concern from an insurance stand point is not just the potential severity of one of these damaging problems, but the likelihood as well. In this part, the Contractor discusses the role insects, pests, and diseases have on lamb susceptibility.

Insects and Pests

Sheep are highly susceptible to issues related to the presence of insects, pests, and parasites. Management for the following insects can reduce the incidence of infection, irritation, disease, malnutrition, and other insect related risks. The most common insect of concern is known as the sheep ked *Melophagus ovinus*, or in plain terms, the sheep tick. It is described as a tick because of its resemblance to the common tick, however it is known as a "wingless fly." If present on the ewe, a sheep ked will relocate to the lamb once it has been born. A sheep ked's six-month lifecycle is entirely lived in the wool or on the skin of a sheep or goat, and reproduction is continuous, with several generations born within a single year. They bite through the skin, and feed on blood capillaries similar to a mosquito, which causes intense irritation and stress to the sheep or lamb, while considerably damaging the wool and skin. In addition to physical irritation, keds can cause anemia in the sheep which also increases the animal's susceptibility to disease.[151] Lice, of which there are multiple species prevalent in sheep, survive by the same mechanism as sheep keds, and are treated similarly with sprays, pour-ons, and dusts.

[150] Constable, Peter D., Kenneth W. Hinchcliff, Stanley H. Done, and Walter Grünberg. Veterinary medicine-e-book: a textbook of the diseases of cattle, horses, sheep, pigs and goats. Elsevier Health Sciences, 2016.

[151] https://ccetompkins.org/resources/pest-management-recommendations-for-sheep-goats-and-swine#:~:text=Sheep%20and%20goats%20are%20susceptible,and%20mange%2C%20or%20itch%20mites.

Sheep Nose Bot Flies, or *Oestrus ovis*, are flies that deposit larvae in the nostrils of sheep, primarily in the spring and summer. The larvae will migrate and cause intense irritation, and can cause infections as a secondary result, however the primary sign of infestation in sneezing, labored breathing, head banging, and in cases where the sheep are severely infested and weak, it can cause death. From a production and risk management perspective, studies have shown that a sheep nose bot infestation can cause weight reductions in the sheep or lamb of up to four percent.[152] Management of pastures infested with bot flies is crucial, as well as an oral drench formulated as a systemic insecticide when treatment is required.

Scabies, caused by "scab mites" or *Psoroptic ovis*, is a contagious skin disease caused by mites that bite and infect the skin of sheep. This causes significant stress to the animal, and infestations can be deadly. Federal and state quarantine regulations apply, and a veterinarian is responsible for detection and eradication should a producer suspect scabies.[153]

While referred to in many different terms, wool maggots define a collective species of "blow flies" that are known to infest soiled wool. The occurrence, or infestation of the larvae is termed "Blowfly Strike" or Cutaneous myasis. Blowfly strike is caused by female flies, whom of which are attracted to and lay their eggs in wounded or decomposing tissues. The larvae, once hatched (approximately 12 hours after laying), will then feed on the wounded tissue of the sheep creating larger flesh wounds that will then attract more flies and therefore more maggots. The infestations are rapid, and once a considerable amount of flesh has been lost or infected the sheep is at risk of developing infection, which can result in death. Given that the flies are attracted to the foul smell of wounded skin and tissues, it is imperative that producers minimize the risk of flesh wounds by eliminating the physical hazards in the sheep's environment such as that of barbed wire fencing. Foot rot is a common attractant for blow flies, so prompt treatment is imperative. Additionally, in lambs, wool maggots are a concern when castration and tail docking occur as these are open wounds and the smell of the wounded tissue places the lamb at risk of Blowfly Strike. There are many forms of treatment using insecticide in the form of sprays, foams, and dusts. Tail docking is sometimes used as a form of preventative treatment to reduce the incidence of soiled wool.[154]

Generally, goats are believed to be more susceptible to internal parasites than sheep, however, susceptibility is considered highest in sheep that are either young (lambs), lactating, in late gestation, or around the time of lambing. Parasites can be detrimental to a flock, and have been shown to:

> *"…damage the gastrointestinal tract, and result in reduced reproductive performance, reduced growth rates; less productive animals in terms of meat, fiber and milk; and even death."*[155]

Parasite infections are characterized by diarrhea, reduced rate of gain or weight loss, reduced appetite, and an impairment in reproductive performance. It has been shown that susceptibility to internal parasites is slightly variable amongst sheep, with some having a higher genetic-

[152] https://entomology.ca.uky.edu/ef503.
[153] https://ccetompkins.org/resources/pest-management-recommendations-for-sheep-goats-and-swine#:~:text=Sheep%20and%20goats%20are%20susceptible,and%20mange%2C%20or%20itch%20mites.
[154] https://entomology.ca.uky.edu/ef503.
[155] https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases.pdf.

induced resistance. Listed by many sources as the most "deadly," the gastrointestinal roundworm formally known as *Haemonchus contortus*, and informally known as the "barber pole worm" is a blood sucking parasite that can consume up to 1/10 the animals total blood volume within 24 hours, causing anemia, protein loss, and death. The susceptibility to parasitic infection, as previously mentioned, is variable. Genetic resistance and resilience to parasitic infections can be inherited and selected for, and therefore producers can reduce their risk associated with the losses that are incurred as a result of parasitic infections by opting to select for breeding stock that exhibits this resistance. Sheep have varying levels of susceptibility to parasites depending on their age and stage of production. For example, a young lamb that has been recently transitioned to grazing on pasture would be highly susceptible until about six to eight weeks old when they will begin to develop a natural immunity. Ewes in late gestation and directly after parturition will be the least resistant to parasites and therefore pose an increased risk to the producer because much of their resistance to parasites is lost due to the effects of hormonal and photoperiod changes. As with most parasites, the eggs are typically found on blades of grass. It is recommended that good pasture management is the most effective way to manage the risks associated with parasites, in addition to treatment when necessary. A good rotational grazing strategy, ample resting (three to six months since previous grazing), allowing horses and cattle to graze the same area, and if necessary, tillage or burning ensures a reduced parasitic load. Lastly, sheep tend to graze closely to the ground where the larvae live on the blades of grass, so planting or allowing for forages that can be grazed at shoulder height is ideal.[156]

Susceptibility To Disease, Insects, and Pests

Prevention of livestock diseases is an integral part of a comprehensive livestock operation's Bio-Security plan. There are two broad categories that diseases may be classified under. One method that animals become infected is through communicable diseases that are transferred from one animal to another and can occur across species. Animals may also carry genetic diseases that offspring inherit from their parents' DNA. Livestock can also develop diseases/disorders related to extreme weather conditions and inadequate nutrition. Transmissible diseases are preventable when sheep producers implement biosecurity practices. To help prevent the spread of disease, a two-week quarantine of newly purchased sheep, those returning from a show or from being bred elsewhere should be enforced.[157] Currently, APHIS lists practices for the management and response of aspects related to biosecurity in sheep.[158/159] Consultation with these resources in addition to sheep industry experts to establish acceptable bio-security practices for all types of sheep operations would be a basic requirement for any production policy providing coverage for disease risk as part of a production insurance program.

Medications

Currently, there are 68 FDA approved drugs for the management of various disease and parasitic risks available in the United States. Some of these, about 1/3 are able to be purchased "OTC" or "over the counter" by a producer, while the remaining, including all antibiotics, must be prescribed via a veterinarian.[160]

[156] https://www.extension.purdue.edu/extmedia/as/as-573-w.pdf.
[157] https://lambboard.com/s/Disease_Prevention_LC_Fact_Sheet_05_25_20171.pdf. Accessed February 2024.
[158] https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa_animal_disease_information/sheep-goat/biosecurity.
[159] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheep01/Sheep01_is_Biosecurity.pdf.
[160] http://www.farad.org/vetgram/Sheep.asp.

Chronic Diseases
Major diseases that negatively affect lamb crop can be chronic in nature and result in ewes or rams with poor body condition scores (BCS), thus producing fewer embryos, fetuses, and ultimately, the birth of fewer live lambs and/or less vigorous lambs. Examples of chronic diseases that can influence flock productivity include foot scald, foot rot, and foot abscesses.

Gestation Diseases
During pregnancy, contagious, infectious agents can cross the placental barrier and infect the gestating fetus, resulting in late term abortion. If infected earlier in pregnancy, the fetus can be resorbed, and the infected ewe appears open during ultrasound scanning or at lambing. The three most common agents that cause abortion in sheep are Campylobacter spp., a bacterium; Toxoplasma, gondii, a protozoan parasite; and Chlamydophila abortus, a rickettsia bacterium. These agents are transmitted through sheep's oral consumption. Toxoplasmosis is spread by young, immunologically naïve cats eating infected rodents and those cats defecating on feed, including stored grain, hay, or pasture. The remaining two agents are spread by infected sheep via feces or aborted material. Thus, preventative measures are required as part of a bio-security program to decrease the likelihood of a flock contracting these diseases.

Metabolic diseases of late gestation include pregnancy toxemia, which is also referred to as ketosis, and hypocalcemia. Pregnancy toxemia can affect multiple ewes in a flock that are usually pregnant with two or more lambs. It is typically induced by a long period, or chronic, malnourishment or by a short period of time where the sheep does not eat or drink which induces physiological stress that causes metabolic diseases such as this. Prevention is the first line of treatment, management of the ewe's nutritional needs in late pregnancy is key. When prevention fails and toxemia is present in the ewe, it is recommended that high energy concentrates such as oral propylene glycol, or corn syrup, should be fed at high rates of 200 ml, four times per day in addition to ample water and electrolytes to bring the ewe out of this "shock-like" state.[161]

Pre-weaning Disease
The most common pre-weaning lamb health issues are hypothermia, starvation, naval infections, pneumonia, and diarrhea. The prevalence of these diseases is affected by the health status and BCS of the ewes and adequacy and management of the lambing facilities.

Naval infections result from exposure to a wet environment prior to umbilical cords drying and falling off. Insufficient colostrum intake may be a risk factor in these infections. Pneumonia in neonatal lambs is often the result of inadequate ventilation and deficient tissue mineral levels necessary for immune function. Diarrhea in young and newborn lambs can result from different infectious agents where contamination levels become higher because of overcrowding, poor sanitation, and poor colostral intake and absorption.

Post-weaning Disease
Common post-weaning diseases include acidosis, enterotoxemia, and various respiratory diseases. Acidosis occurs in cases where lambs consume large amounts of starch from grain and often results in death. It is typically preventable using sound management and well balanced

[161] https://extension.colostate.edu/topic-areas/agriculture/pregnancy-toxemia-ketosis-in-ewes-and-does-1-630/#:~:text=Treatment%20of%20pregnancy%20toxemia%20in,designed%20for%20dehydration%20in%20livestock.

TMR that includes at least 10 percent of forage. Enterotoxemia is caused by a bacterium, Clostridium Perfringens Type D, and can be vaccinated against.[162] Most respiratory diseases require observation and quick treatment using antibiotics that are prescribed via a veterinarian.

Communicable Disease Transmission

There are five major ways in which communicable cross-species diseases and zoonotic diseases are transmitted. These routes are: aerosol, direct contact, vector, oral, and fomite.

- Aerosol: Disease transmission via aerosol occurs when pathogenic agents within aerosol droplets are passed from one animal to another whereby the susceptible animal inhales the disease pathogen.[163] These disease-carrying agents typically do not survive for extended periods of time when contained in aerosol droplets; therefore, close proximity is typically required for disease exposure from an infected animal to a susceptible animal.
- Direct Contact: A common route of disease transmission, particularly when animals are cohabitating in confined areas and during reproduction. A healthy animal can become exposed when a pathogenic agent on a diseased animal directly touches an open wound, mucous membranes, or the skin through blood, saliva, nose-to-nose contact, rubbing, or biting.[164] Reproductive disease transmission is also considered a type of direct contact.
- Vector: Diseases communicated through vector-borne exposure also require contact but are not directly shared between the diseased animal and the susceptible animal. Rather, the diseased animal transmits the disease to a vector (typically a type of bug or parasite, common vectors include fleas, ticks, mosquitoes) after which the vector then transfers the disease to infect the susceptible animal.[165]
- Oral: This route of transmission requires the animal to consume a pathogenic agent from contaminated feed, water, or other objects in their environment and frequently are caused from the presence of feces or urine on the consumed objects that carry disease agents.[166] Common environmental objects include equipment, feed bunks, water troughs, mineral blocks, or other items that livestock may lick or chew.
- Fomite: The final type of disease transmission and is unique in that it usually involves a secondary route of transmission. Fomite exposure occurs when an inanimate object, such as a vehicle, shovel, clothing, clippers, boots, carry a pathogen from one susceptible animal to another.[167] A subtype of fomite disease transmission is traffic transmission where a pathogenic agent is carried on a vehicle or trailer to multiple susceptible locations.

General Disease Treatment and Prevention

An integrated approach to disease prevention is utilized by sheep producers to improve flock health, profitability, and decrease the risk of animals becoming affected by compromising diseases or disorders. When monitoring sheep health, producers regularly assess overall flock health including vital signs, body condition, and fleece condition, as well as looking for

[162] http://www.omafra.gov.on.ca/english/livestock/sheep/health.html. Accessed February 2024.
[163] http://www.cfsph.iastate.edu/Infection_Control/Routes/aerosol.php. Accessed February 2024.
[164] http://www.cfsph.iastate.edu/Infection_Control/Routes/direct_contact.php. Accessed February 2024.
[165] http://www.cfsph.iastate.edu/Infection_Control/Routes/vector-borne.php. Accessed February 2024.
[166] http://www.cfsph.iastate.edu/Infection_Control/Routes/oral.php. Accessed February 2024.
[167] http://www.cfsph.iastate.edu/Infection_Control/Routes/fomite.php. Accessed February 2024.

behavioral indicators of unhealthy animals such as vocalization, abnormal eating habits, teeth grinding, and scours.[168]

The most basic method of disease control is implementing a biosecurity plan to avoid introduction of diseases. These plans consider all modes of disease transmission, quarantine plans for infected animals, sanitation, and restriction of traffic around the animals.[169]

One of the most common methods of prevention for common communicable diseases is the development of a vaccination program specific to each individual sheep flock. Although the vaccines used will vary in each flock, clostridial vaccines are recommended for all sheep as they are endemic to all sheep operations, specifically for *Clostridium perfringens* Types C and D, as well as tetanus.[170] Combination vaccines are also used to prevent other clostridial diseases including blackleg and malignant edema.

Prevention programs include major factors such as vaccination, antibiotics, facilities, and nutrition. To prevent transmissions, most operations have some level of bio-security protocols in place. For insurance purposes, a common basic bio-security protocol would likely need to be reviewed and implemented as part of the insurance provisions as a requirement for insurance.

II.H. Marketing

Producers typically market lambs through auction sales, forward contracts and spot sales to feedlots and packers, and direct sales to consumers. USDA AMS lists 38 different auction markets selling lambs and sheep in 17 different states.[171] Lamb auction sales are typically less frequent than cattle sales and often occur on a weekly basis. Lamb are also sold through video auctions.

Lamb feedlots and brokers also purchase direct from producers. Some of these purchase are made through forward contracts, while it is also common for producers to make spot sales to lamb purchasing agents. Price discovery for these spot sales is often based off recent auction estimates from nearby auction houses while forward contract offers are priced by the purchaser based on market projects adjusted for transportation, number of head, and historic consistency and reliability of the individual producer. The basis effect can be significant if the producer is a large distance from any nearby feedlot or packing operation and can also adversely affect the price if the number of head does not match an efficient transportable load. A producers offer may also be lower if they have a history of delivering injured, diseased, or inconsistently weighted lambs. Because of the personalized nature of these contracts, the Contractor was not able to acquire any for this report.

Sales direct to consumers are also a popular way to market lambs. Producers the Contractor spoke to about this form of marketing were cautious to discuss the details of this type of marketing. What the Contractor was able to learn is they typically are able to capture a larger premium, in some cases as much as $2 over auction sales, and want to protect established

[168] https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases.pdf. Accessed February 2024.
[169] Ibid.
[170] https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases.pdf. Accessed February 2024.
[171] https://www.ams.usda.gov/market-news/sheep-auction-reports.

relationships with the buyer consumers. This form of sale is particularly common among immigrant populations who want the ability to choose a live animal and are accustomed to personally slaughtering and butchering lamb. This process allows them to ensure the means of slaughter, whether halal or kosher, produces final cuts that meet their expectations and needs.

II.I. Utilization

Lamb are primarily utilized for meat production. Wool lambs and ewes also produce wool that is a fiber used in textiles to produce cloth for such things as clothing and upholstery as well as can be used for products such as insulation and bedding.

Lambs are slaughtered for a carcass that can be cut and prepared into various meat products. These include such meat products and cuts such as lamb chops, rack of lamb, leg of lamb, lamb shank, kabobs, gyros, lamb collar, and ground lamb. There are many other parts of the lamb that are also prepared for consumption such as tongue, heart, offal, and flank, though these cuts are typically less desirable than cuts such as ribs or loin.

Secondary products include fleece used for wool production in textiles, clothing, and insulation; skins which are tanned and processed into leather; lanolin, a wax extracted from wool for use in cosmetics, pharmaceuticals, and industrial applications; bones which are processed into bone meal for fertilizer or gelatin for food and industrial uses.

II.J. Sources of Feed

The most important sources of feed for young lambs vary depending on their age and stage of development:[172]

Newborn lambs (up to 2 weeks old)
Milk: Their primary source of nutrients is their mother's milk, which provides essential protein, fat, and antibodies for growth and development.

Early weaning (2-8 weeks old)
Creep feed: Lambs can start nibbling on specially formulated creep feed alongside their mother's milk. This high-protein, high-energy feed helps them transition to solid food and promotes rumen development.

Forage: If good quality forage is available, lambs can start grazing alongside their mothers.

Weaned lambs (8 weeks old and above)
Forage: Once weaned, lambs rely primarily on good quality pasture or hay as their main source of roughage and fiber.

Some specific examples of good quality forage for lambs are
Legumes: Alfalfa, clover, and birdsfoot trefoil are all high in protein and minerals, making them excellent choices for young lambs.

[172] Forage Quality in Sheep and Goat Production by Alabama Cooperative Extension System: https://agrilife.org/westtexasrangelands/files/2023/03/targeted-grazing-with-goats-and-sheep.pdf. Accessed February 2024.

Grasses: Timothy, orchard grass, and ryegrass are all digestible grasses that provide energy and fiber.

Mixed blends: Many commercially available seed mixes are specifically formulated for sheep and lambs, offering a balanced blend of grasses and legumes.

It is important to note that the best forage for lambs will vary depending on factors such as age, breed, climate, and pasture conditions. Consulting with a veterinarian or experienced sheep producer can help you choose the most suitable forage for your lambs.

Depending on their growth rate and desired finish, lambs may also be fed grains and concentrates to provide additional energy and protein.

III. REVIEW OF OTHER PROGRAMS

In this section, the Contractor provides information in relation to the SOW requirements:

> *"Review of Other Programs – The Contractor shall list and summarize the provisions and benefits of all state and federal programs that currently support or subsidize these producers. The Contractor shall also research and describe any private insurance program that is available to these producers. The Contractor shall note any gaps in coverage and constraints of the private insurance programs, if applicable."*

Unlike other livestock sectors, the U.S. lamb industry has witnessed consistent and considerable declines in the number of sheep and therefore the overall size of the industry since its peak in the 1940s. While there are a number of factors that pertain to its decline, the industry has been particularly affected by changes in government programs and legislation over the past few decades. When it comes to risk management, there are state, federal, and very few private insurance programs that cover aspects of sheep and lamb production. These are discussed in detail in this section.

III.A. Federal Programs

Lamb producers have a limited number of existing FCIC endorsed programs which can be used to manage risks associated with their enterprises. Since its final suspension in 2020, LRP Lamb is no longer available to lamb producers as an insurance option which leaves them with two remaining risk mitigation insurance choices – Whole Farm Revenue Protection (WFRP) and Pasture, Rangeland, and Forage (PRF), though neither are specifically tailored to the industry itself.

First, WFRP is ideally suited for farms that produce two or more commodities. WFRP encourages producers to diversify, and with every additional approved commodity added to the policy (additional terms apply), the subsidy rate for the insured is increased. WFRP is available for sheep producers assuming the two commodities used are lamb and wool AND each individually generate at least 1/3 of the total farm revenue and the producer has the required documentation to prove this.[173] During the course of listening sessions hosted by the Contractor across U.S. lamb production areas, it became apparent producers were mostly unaware of WFRP as an available option. Aside from the general lack of awareness, producers also mentioned that wool prices are set too low, and they typically do not make enough from wool revenue alone to qualify it as a separate commodity, therefore it still would not be economically feasible for them to participate unless the farm had multiple other commodities that gained revenue. In most cases, the larger producers in the west are range producers and with herds of 1,000 or more, it is not likely operations of this size will have multiple other commodities that would qualify as a revenue stream for WFRP. Additionally, for small enterprises of 50 head or less, most producers who participated in the listening sessions with operations of this size either had off-farm jobs for income support, or they were retired from a previous career and now raised a small flock as a hobby. This leaves the mid-size operations (51 to 999 head) as the only potential candidates for the existing WFRP, and, as shown for the top producing sheep/lamb states; Texas, California, Colorado, Wyoming, Utah, South Dakota, Idaho, and Montana, respectively; there were 495

[173] https://www.rma.usda.gov/en/Policy-and-Procedure/Insurance-Plans/Whole-Farm-Revenue-Protection.

WFRP policies earning premiums and 16 indemnities for the 2023 crop year.[174] No further information was provided as to which commodities these policies were insuring.

The other product which may be available to lamb producers to help offset some of their revenue risk is the PRF program. In larger operations, such as those operating in a western range based extensive production model, forage is their main or only feed source. While indirect, PRF can be applied to lamb production through the management of risks associated with losses in forage and rangeland that occur as a result of a lack of precipitation, as long as the insured can prove insurable interest in the flock and legal access to the rangeland/forage. The program is administered through a system that utilizes a grid to decipher the covered area rather than a county line that dictates the coverage area parameters for most area programs. Each grid is set as 0.25 degrees latitude by 0.25 degrees longitude (roughly 12 miles by 17 miles in most of the United States). Any pasture, range, and hay fields that lie within each grid can be insured based on the precipitation data from the National Oceanic and Atmospheric Administration's Climate Prediction Center that is detailed for that grid. While it is not a program that is aimed at the production of lambs, it is aimed at the management of one risk– a lack of precipitation that lowers forage production, that can, in some cases, be associated with lamb production risk. This program is not going to be applicable to operations in all regions of the United States, nor is it applicable to small intensive operations such as feedlot or confined production. In any operation where the forage is purchased from outside the operation and the sheep are fed a set ration, PRF would not be applicable.[175]

Separate from the crop insurance umbrella are the following USDA/FSA assistance programs that are directed at sheep and wool producers. The Wool and Mohair Marketing Assistance Loan (MAL) and the Loan Deficiency Programs (LDP) are meant to provide "interim" financial assistance to wool and mohair producers so they are not forced to sell their commodities at harvest when market prices are lowest. Ideally a producer would use this as a source of cashflow and hold their wool and/or mohair until prices are more favorable. The MAL is either repaid upon the timely sale of the wool or mohair or can be repaid by using the commodity as collateral and delivering the commodity to the Commodity Credit Corporation. While helpful, this does not pertain to lamb production unless the producer is utilizing a dual-purpose breed. In many cases, this is not economical and in the largest producing state, Texas, where hair breeds are predominant and wool is no longer produced as sheep are used primarily for meat production.

The other option, administered in lieu of the MAL, is the LDP. The LDP is defined as the "difference the producer would have received if a loan was repaid at the lower market price, a direct benefit that does not need to be repaid." However, neither the LDP nor MAL have lamb listed as an eligible commodity, so it would not be accessible to lamb producers unless they also produce revenue via wool or mohair, which in today's production system is unlikely.[176] Most lamb producers that are still using wool based breeds find it is more costly to shear, produce, and market the wool than what they receive for it. Wool breeds are sheared when necessary for the management of flock health rather than for the extra revenue that wool could potentially bring to the operation.

[174] The Contractor via the RMA Summary of Business Report Generator, accessed January 2024.
[175] https://www.rma.usda.gov/en/Policy-and-Procedure/Insurance-Plans/Pasture-Rangeland-Forage.
[176] https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/mal_ldp_fact_sheet.pdf.

Other programs include the Livestock Forage Disaster Program (LFP), Livestock Indemnity Program (LIP), and the Emergency Livestock Relief Program (ELRP). However these are administered by the FSA as disaster aid programs and are not considered risk management and may not be applicable to all lamb producers. LIP indemnifies losses due to predation or weather events. Payments in LIP are 75 percent of the market value as determined by USDA for sheep. This payment rate in 2023 was $233.35 for ewes, $183.33 for lambs, and $554.78 for rams. ELRP assists lamb producers when their losses are a result of drought and wildfire and utilizes the LFP data. LFP assists producers by administering up to 60 percent of the replacement cost of feed during eligible periods. Lastly, FSA also administers the Emergency Assistance for Livestock, Honeybees and Farm-Raised Fish Program which provides assistance for losses not covered by the other disaster programs due to disease or adverse weather including blizzards and wildfires.

III.B. State Programs

Beyond the predator trapping services provided by USDA Wildlife Services, a number of states maintain livestock depredation programs to mitigate lamb losses caused by wildlife predators or compensate for experienced loss. Wyoming has an Animal Damage Management Board (ADMB)[177] that is tasked with mitigating damage by predatory animals and birds. The Minnesota Department of Agriculture[178] compensates up to $20,000 per livestock owner per year for livestock destroyed by wolves. Colorado maintains a Game Damage Program[179] administered through the Colorado Parks and Wildlife Department that provides prevention materials such as fencing and reimburses for losses caused by big game animals. In Montana, the Montana Livestock Loss Board (LLB)[180] manages a mitigation and reimbursement program for livestock lost to predation by wolves, grizzly bears, or mountain lions. Idaho has designated Wolf Conflict Funding[181] to compensate livestock losses due to wolf depredation. Utah's Division of Wild Resources compensates[182] for damages to livestock by mountain lion, black bear, wolf, or eagle.

The state programs that offer compensation for losses due to predation are inconsistent with regards to type of predator, although many include compensation for wolf predation. The amount of compensation also varies between states with limitations on appropriated funds. Producers do not contribute funds to enroll in the programs as these are not insurance-styled programs, but rather apply for compensation by proving losses through documentation, such as photographs.

III.C. Private Programs

Private insurance programs are available to cover named peril losses that include sheep production. The Westfield Insurance Farm and Agribusiness Network[183] identifies sheep as covered under a suite of farm and business-specific coverages. Nationwide[184] has available

[177] https://www.wyadmb.com.
[178] https://www.mda.state.mn.us/business-dev-loans-grants/wolf-depredation-compensation.
[179] https://cpw.state.co.us/aboutus/Pages/GameDamage.aspx.
[180] https://liv.mt.gov/Attached-Agency-Boards/Livestock-Loss-Board/index.
[181] https://species.idaho.gov/programs/wolf-conflict-funding/.
[182] https://wildlife.utah.gov/hunt-tables-and-maps/49-hunting/index.php.
[183] https://www.westfieldinsurance.com/insurance/farm-and-agribusiness/agribusiness-network.
[184] https://www.nationwide.com/business/agribusiness/farm-insurance/agrichoice/.

Agrichoice, AgrichoicePlus, and Country Choice policies to cover livestock. American Family Insurance offers Livestock Insurance[185] both blanket and scheduled coverage for sheep. Higginbotham has Ranch and Livestock Insurance[186] with coverage available for sheep. Hub Financial[187] can provide insurance for bankruptcy or livestock business-related losses.

In discussions with lamb producers, private and named peril insurance policies were seldom mentioned. Many producers are unaware of the existence of such policies and do not pursue this coverage for lack of awareness and understanding. Producers have also explicitly expressed a desire for price insurance a form of protection the Contractor was not able to identify as currently available through private programs. Most of the private insurance is schedule or blanket coverage that protects sheep as an intermediate asset.

[185] https://www.amfam.com/insurance/farm-ranch/coverages/livestock-cattle-insurance.
[186] https://www.higginbotham.com/business-insurance/specialties/farm-and-ranch-insurance/ranches/.
[187] https://www.hubfinancial.com/life-insurance/.

IV. DATA AVAILABILITY AND PRICE METHODOLOGIES

In this section, the Contractor provides information in relation to the SOW requirements

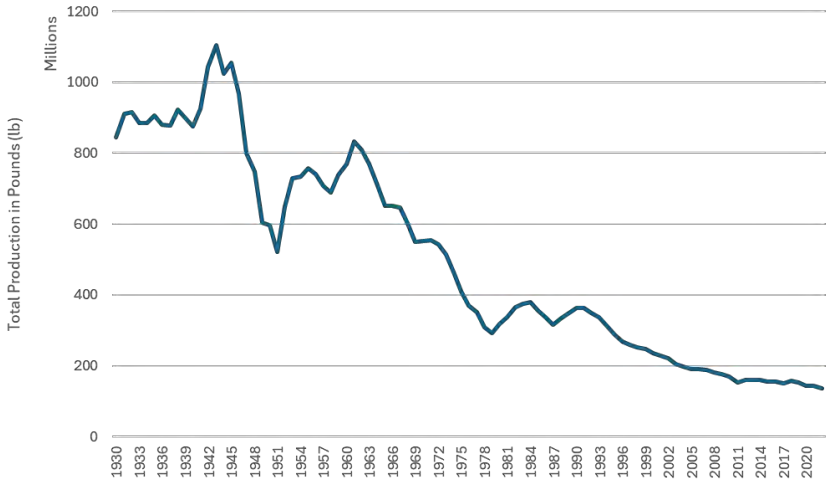
> *"Data Availability and Price Methodologies – The Contractor shall conduct a search for price and yield data at the national level and by the homogenous regions identified by the Contractor, as applicable. Identify viable data series and formulate all reasonable alternative methods other than contract price to develop expected prices for each commodity, including costs for feed used for lambs. These methods shall include determinations of farm-gate prices and the effects of quality deficiencies on prices. The Contractor shall also formulate methods to construct a series of yields for prospective insureds who have an insufficient number of yields to determine an Actual Production History (APH) yield, if applicable."*

There are a number of data sources relating to lamb production, slaughter, and economic factors. The following identifies viable data sources that characterize lamb production. These include historic production and import quantities, Livestock Mandatory Reporting data, such as carcass and cutout values, and historic price series for live-weight lamb.

IV.A. Domestic Production and Imports

Domestic production of lamb has seen significant historic reductions. USDA NASS survey data indicates record high production in 1943 with over 1.1 billion pounds of lamb and mutton slaughtered to just over 130 million pounds in 2022 the lowest recorded amount. Figure IV.1. shows this decline since the 1930s.

Figure IV.1. Lamb and Mutton Slaughter Production in Pounds

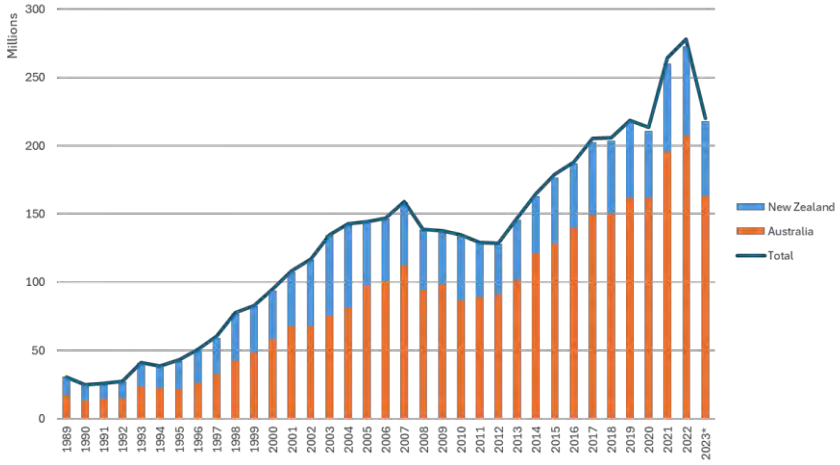


Year	Value	Year	Value	Year	Value	Year	Value
1930	845,000,000	1954	734,000,000	1977	351,000,000	2000	236,000,000
1931	910,000,000	1955	758,000,000	1978	309,000,000	2001	228,000,000
1932	916,000,000	1956	741,000,000	1979	293,000,000	2002	222,200,000
1933	885,000,000	1957	707,000,000	1980	318,000,000	2003	203,700,000
1934	885,000,000	1958	688,000,000	1981	338,000,000	2004	198,600,000
1935	906,000,000	1959	738,000,000	1982	365,000,000	2005	191,500,000
1936	881,000,000	1960	768,000,000	1983	376,000,000	2006	189,800,000
1937	878,000,000	1961	832,000,000	1984	380,000,000	2007	188,900,000
1938	923,000,000	1962	809,000,000	1985	357,000,000	2008	180,100,000
1939	898,000,000	1963	770,000,000	1986	337,000,000	2009	175,400,000
1940	876,000,000	1964	715,000,000	1987	316,000,000	2010	168,300,000
1941	924,000,000	1965	651,000,000	1988	335,000,000	2011	153,300,000
1942	1,043,000,000	1966	650,000,000	1989	348,000,000	2012	160,800,000
1943	1,104,000,000	1967	646,000,000	1990	362,000,000	2013	161,100,000
1944	1,024,000,000	1968	602,000,000	1991	362,000,000	2014	160,700,000
1945	1,054,000,000	1969	550,000,000	1992	349,000,000	2015	155,600,000
1946	968,000,000	1970	551,000,000	1993	337,000,000	2016	155,400,000
1947	799,000,000	1971	554,000,000	1994	310,000,000	2017	150,200,000
1948	747,000,000	1972	543,000,000	1995	288,000,000	2018	158,200,000
1949	603,000,000	1973	514,000,000	1996	269,000,000	2019	153,200,000
1950	597,000,000	1974	465,000,000	1997	260,000,000	2020	143,100,000
1951	521,000,000	1975	410,000,000	1998	252,000,000	2021	142,800,000
1952	648,000,000	1976	371,000,000	1999	247,000,000	2022	136,200,000
1953	729,000,000						

Source: After USDA NASS Survey, accessed from Quick Stats database January 2024.

As lamb production in the United States has decreased, recent years have seen a significant uptake in lamb imports as shown in Figure IV.2. from Livestock and International Trade Data published by USDA ERS.

Figure IV.2. Lamb and Mutton Carcass Weight Imports



Year	Australia	New Zealand	Total	Year	Australia	New Zealand	Total
1989	17,469,924	13,227,947	30,749,945	2007	112,843,367	45,582,700	159,271,481
1990	13,414,512	11,508,382	24,927,555	2008	94,144,380	44,169,085	138,962,217
1991	14,723,219	11,160,781	26,022,023	2009	98,548,164	38,709,506	137,546,652
1992	14,960,484	12,526,353	27,488,067	2010	86,831,183	47,362,230	134,602,428
1993	23,632,212	17,339,021	40,978,293	2011	89,473,723	39,363,281	129,369,607
1994	22,761,913	15,910,656	38,682,803	2012	91,238,808	36,777,206	128,639,633
1995	21,567,668	21,106,449	43,284,216	2013	101,429,371	44,348,028	146,927,225
1996	26,423,264	23,969,933	50,701,133	2014	121,310,798	41,844,843	164,504,389
1997	32,968,678	26,416,988	60,428,038	2015	128,323,159	48,276,280	178,740,224
1998	42,437,519	34,798,864	77,813,463	2016	140,144,264	46,613,842	187,895,911
1999	48,587,489	33,984,277	83,045,668	2017	149,374,305	53,365,464	205,222,168
2000	58,400,460	35,348,516	95,201,846	2018	150,421,113	52,921,159	205,677,956
2001	67,784,939	39,576,228	108,214,833	2019	161,958,122	54,664,105	218,510,063
2002	68,072,979	48,565,399	117,046,709	2020	161,988,904	48,459,911	213,633,521
2003	75,319,560	59,158,621	134,830,033	2021	195,652,176	64,399,966	264,241,059
2004	81,255,692	60,749,000	142,748,103	2022	207,835,830	64,953,344	278,002,800
2005	97,393,229	46,245,841	144,239,511	2023*	163,519,128	54,153,143	220,158,498
2006	101,035,406	45,563,590	147,129,847				

Source: After USDA ERS, accessed from Livestock and International Trade Data January 2024.

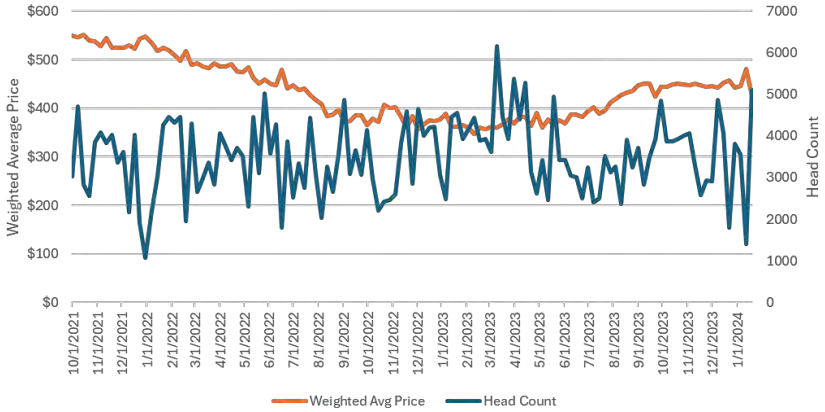
IV.B. Carcass and Cutout Reports

As part of the Livestock Mandatory Reporting (LMR) packers are required to report purchases of lambs, sales of carcasses and boxed lamb cuts.[188] USDA AMS publishes daily the National 5-Day Rolling Average Boxed Lamb Cuts (LM_XL500), for both fresh and frozen plant basis negotiated sales. This report includes total weight of cuts and a weighted average price. The report has been published since August 2001 providing over 22 years of historic data. Both Australian and New Zealand imports of Lamb Carcasses and Lamb Cuts imported are also reported by AMS in the National Weekly Lamb Carcass and Lamb Cuts – Imported Product (LM_XL552). This report is available from January 2005 and provides the number of trades, pounds, and weighted average price.

Carcass Reports from AMS include the daily Estimated National Lamb Carcass Cutout Report (LM_XL502) which provides the weighted average Free on Board (FOB) processing plant prices. This report provides both the gross carcass value and net carcass value after process/packaging costs. Historic data exists dating back to May of 2012, comprising just under 12 years of daily carcass values. The head count of Negotiated, Formula, and Forward Contract sales are also reported by weight class in the USDA AMS National Weekly Comprehensive Lamb Carcass Report (LM_XL555) for delivery within 14 calendar days. This weekly report does include a weighted average price. From October 2021 to present, this price is the average across all weights and is shown in Figure IV.3. From June 2017 to October 2021 no prices were published. From August of 2001 to June of 2017, the average price was published for each weight class.

[188] https://www.ecfr.gov/current/title-7/subtitle-B/chapter-I/subchapter-C/part-59.

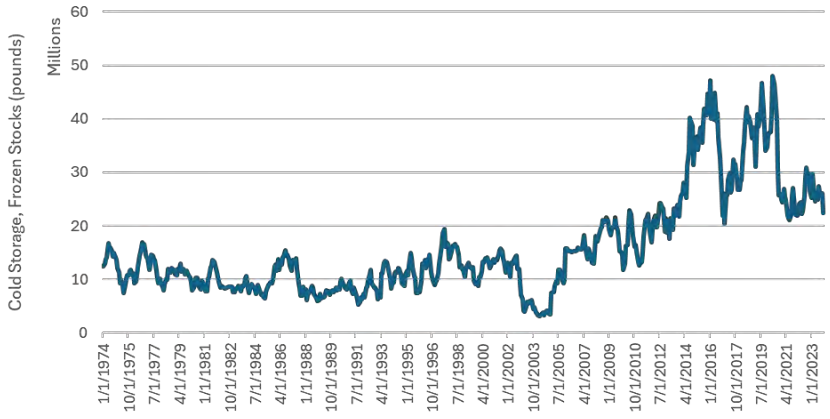
Figure IV.3. Contract Sales Average Price and Head Count



Source: After USDA AMS (LM_XL555), accessed January 2024. Data Table in Appendix A.

The USDA NASS reports survey data on Lamb and Mutton Stocks by total pounds in the monthly Cold Storage report dating back to 1917. Figure IV.4. shows cold storage stocks over the last 50 years. Stocks remain relatively high compared to historic levels with a significant reduction that occurred during the period of COVID-19 shutdowns. During the listening sessions, the Contractor was informed that while consumers were in lockdown at home, many chose to try cooking lamb resulting in increased demand from retailers. While initially in March of 2020, the U.S. dollar was at an all-time high against the Australian dollar, the strength of the dollar decreased by 2021 to levels lower than pre-pandemic until the middle of 2022 when imports increased.

Figure IV.4. Lamb and Mutton in Cold Storage, Frozen



Source: After USDA NASS Survey, accessed January 2024. Data table in Appendix B.

IV.C. Production Pricing

There are several livestock auction barns and video auctions that sell lamb. Table IV.1. shows a list of those whose sales are recorded by AMS. Three of these livestock auctions are viewed by the industry as representative for feeder and slaughter lambs. These are the Centennial Livestock Sheep and Goat Auction in Fort Collins, Colorado (AMS_1899), the Producers Livestock Sheep and Goat Auction in San Angelo, Texas (AMS_2014), and the Sioux Falls Regional Livestock Auction in Worthing, South Dakota. These auction sales give a representative price for lamb to

producers. There are other sales, but transportation to feedlots and packers from these auctions is more likely to affect the sale price. USDA Market News from AMS has historic data back to 2000 for prices paid for lamb. Starting in 2019, the Market Analysis and Reporting Services (MARS) database contains weekly auction reports.

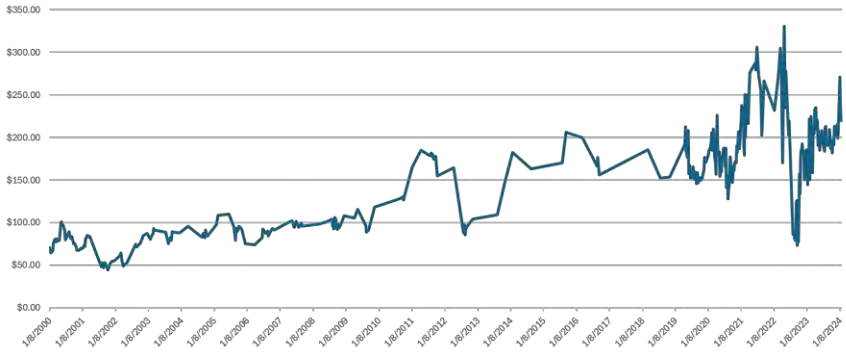
Table IV.1. Auction Data Collected by USDA AMS

Report (Slug) Name	Report Title	Market Type
AMS_1772	Public Auction Yards Sheep & Goat Auction - Billings, MT	Auction Livestock
AMS_2153	Kalona Sheep and Goat Auction - Kalona, IA	Auction Livestock
AMS_1833	Missouri Weekly Sheep/Goat Auction Summary	Auction Livestock
AMS_2016	Sioux Falls Regional Livestock Auction - Worthing, SD	Auction Livestock
AMS_2014	Producers Livestock Sheep and Goat Auction - San Angelo, TX	Auction Livestock
AMS_1899	Centennial Livestock Sheep and Goat Auction - Fort Collins, CO	Auction Livestock
AMS_2922	Equity Cooperative Sheep & Lamb Video/Internet Auction - Baraboo, WI	Video Auction Livestock
AMS_3453	Northern Livestock Sheep Video/Internet Auction - Billings, MT	Video Auction Livestock
AMS_3454	Western Video Sheep Video/Internet Auction - Cottonwood, CA	Video Auction Livestock
AMS_3411	Superior Livestock Auction	Video Auction Livestock

Source: After USDA AMS, accessed January 2024.

The Contractor combined these data sources to construct a time series for lamb prices (Figure IV.5.) for the average price per pound of choice and prime shorn slaughter lambs sold at the Fort Collins, Colorado auction.

Figure IV.5. Average Price Paid at Fort Collins, CO Auction for Choice and Prime Shorn Slaughter Lambs



Source: After USDA AMS Market News, accessed January 2024. Data table in Appendix C.

The veracity of auction price data, particularly for video auctions, was brought into question among stakeholders. The Contractor was made aware that it is not uncommon for a lot of lambs to be 'no sale' after an auction is completed, yet not reported as such, resulting in an artificially inflated price. This occurs when either the auction house or seller bid up the price well beyond any legitimate buyers. For example, a buyer may stop bidding at $1.50 per pound on a lot; however, the bid continues to $2.15 per pound. After the auction, the buyer may be contacted,

told it was a 'no sale', and asked if they still wanted to make a purchase at $1.50. Nevertheless, the false price of $2.15 is published.

Price data exists for auctions and, regionally, the four auction houses in San Angelo, Texas, Sioux Falls, South Dakota, Greeley, Colorado, and New Holland, Pennsylvania. These datasets provide regional estimates of producer prices. An average of the first three would produce a reasonable estimate for a national price. The Contractor did not receive any complaints about these specific auction houses reporting false prices.

Quality issues exist for lambs that are excessively heavy at time of sale. Weights in excess of 160 pounds are less desirable and will likely sell less per pound than weights in the 120 to 140 pounds range. Low weights have historically been discounted; however, recent changes in demand, particularly from the ethic markets, have significantly increased the prices of light weight lambs.

Stakeholder feedback indicated that Australian and New Zealand lamb cuts are a consistent product produced at a lower cost than U.S. lamb production. As a substitute product, packers and grocers have a clearer picture of market dynamics than producers. One of the concerns the industry faces is overpricing their product and losing retail shelf space. Following the COVID-19 lockdowns as supplies were depleted, the Contractor was informed that retailers took losses to keep the product affordable and that after this, to compete for shelf space against a more affordable imported product, packers took losses. In turn this resulted in lower contract prices for producers.

Feedlots have a grasp on price expectations based on cost projections. However, it is the packers who have the clearest grasp on price expectations based on retailer contracts and the ability of U.S. lamb to infiltrate the market. For this reason, packer forward contracts are likely the best available data source for price expectations. However, these contracts are not consistent with national price expectations but incorporate basis effects with historic performance such as producer and/or feedlot expectations. Nevertheless, the Contractor found that this is the only financial instrument where the lamb industry is putting its own money on the line around a price expectation.

Stakeholders indicated during the listening sessions that the price to retailers is the most appropriate form of price risk faced by lamb producers. Based on these findings, the Contractor believes the best way to establish price expectations is through packer forward contracts. Using feed costs as a proxy is an alternative method to establish price expectations based on commodity price expectations; however, the value of lambs is not only affected by direct costs but also by trade dynamics which result from currency risk in conjunction with packer and retailer behaviors. The Contractor spoke to industry stakeholders who readily admitted that based on these dynamics, it was very evident to them when the projected price in the LRP Lamb contract was incorrect. When mispriced in favor of indemnity, they purchased as much of the LRP product as allowed and received indemnities. For this reason, feed costs, seasonal dynamics, and currency exchange projections, may not be enough to reasonably develop an alternative method for expected prices.

Nevertheless, some alternative price protections to the value of lamb may provide some risk protection to producers. Feedlots experience feed cost risks and a protection against the rising cost of feed may provide some relief during periods of tightening margins. Lamb producers experience challenges during periods of drought and rising demands for labor, as such, providing risk protection against the cost of hay or the adverse effect of wage rate increases was also viewed favorably.

For any Actual Production History (APH) calculations, lamb yields are recorded by weight and by head. In certain locations, such as the northeast region of the United States where terminal sales occur in light weight lambs, producers maximize based on quantity of lambs and not weight. In most all other parts of the United States and in the majority of lamb sales, weights are determined by scale on trailer weight tickets. Auction sales will indicate the total number of head by weight class. To calculate a yield estimate, an average weight for each range can be used. Lamb growth rates vary by region, time of year, and production environment. Establishing a projected APH for insureds who do not have historic performance would require a significant amount of data from extremely similar highly standardized operations. Because it is uncommon to find similarly structured production environments in livestock operations, estimating an APH for insureds who do not have yield history is likely to introduce a form of moral hazard.

V. STAKEHOLDER INPUT

This section of the data gathering report contains a discussion of the results from the efforts on the part of the Contractor to gather lamb production information from lamb industry stakeholders in the primary lamb production regions within the United States. The SOW instructed the Contractor to:

> *"Interviews/Listening Sessions Data – The Contractor shall contact leaders representing lamb producers at the state and national levels to determine the potential interest in a crop insurance program. Identify what insurance programs they are interested in and why. Examine their perceptions of any potential conflicts, difficulties, and risks. The Contractor shall analyze, summarize and interpret the data gathered. The Contractor shall not conduct questions and listening sessions in such a manner that they could be construed as a survey. Contact must be made electronically and via in-person listening sessions at up to three locations representative of the lamb industry. When pertinent, the outreach must reference this contracted product, use visual aides to enhance communication, clearly articulate purpose of engagement, and provide Contractor's information in the presentation. Any information that will be made available to the public regarding the listening sessions must be approved in advance by RMA."*

During the course of five listening sessions, the Contractor collected input from industry stakeholders and lamb producers across multiple states and production areas. These listening sessions served as a platform for the Contractor to listen to the needs and concerns of producers and gain insights into potential conflicts, difficulties, and risks within the lamb industry. Throughout four in-person listening sessions, one national virtual listening session, and numerous one-on-one interactions with stakeholders, the Contractor is confident the feedback received and compiled herein accurately reflects the input of stakeholders within the lamb industry.

To ensure stakeholders were informed about the time, location and focus of the listening sessions, the Contractor circulated flyers (see Appendix D) that contained additional information regarding the project and details about each listening session. These flyers were circulated amongst producer groups across the U.S. lamb and sheep industry via email. One version of the flyer was replicated using the RMA template for listening sessions, this was sent to the RMA for their records and dispersal. Another flyer, with additional context on the project and event details for each listening session, was created by the Contractor to circulate amongst producer groups and industry stakeholders. The Wyoming, South Dakota and Montana sheep and lamb producer groups recreated and circulated their own combined flyer to announce the Belle Fourche, South Dakota lamb listening session to all their members.

All circulated flyers included a link to the Contractor's online registration form, developed and used to track interest and anticipated participation (Appendix E). In addition to tracking interest from the industry, the form also enabled the Contractor to contact interested parties when changes were made to the listening session information. The online form was programmed to send automatic emails to the registrant providing details of the specific listening session they

indicated interest in and additional contact information for each event. The response email template for each session can be found in Appendix F.

V.A. Locations and Results

The Contractor conducted four on-site and one virtual listening session with stakeholders. The on-site sessions were in Boise, Idaho; Belle Fourche, South Dakota; San Angelo, Texas; and Denver, Colorado. The Contractor requested and was granted authority from the RMA Contracting Officer's Technical Representative to add the fourth location when it came apparent that the national organization, the American Sheep Industry Association (ASI), representing the lamb industry would be able to provide far greater participation in the session were it to be held in conjunction with the ASI Annual Convention held in January 2024. The Contractor attempted to host a listening session in the northeastern United States lamb production region, however, the sheep and lamb organizations in this region had limited capacity to organize a session given the time constraints of the contract. Furthermore, many of the state representatives for the producer groups in the region stated a local session was not necessary given that other locations, such as San Angelo, Texas, service the northeast part of the country. The contacted state groups who responded indicated that an in-person listening session would not be of interest to their producer group members given the scale of operations and the type of production in the region. However, to ensure the northeast region's sheep and lamb production and risk management needs were represented in this data gathering report, the Contractor made additional efforts to collect stakeholder feedback through calls and virtual meetings. In addition to the "one-on-one" discussions with various producers and producer representative groups, the Contractor encouraged producers and stakeholders from the region to attend the virtual listening session hosted by the Contractor. Efforts were made by the Contractor to identify industry representatives from the northeast region during the virtual session. The following discussion addresses the results of each of the on-site sessions, respectively.

Boise, Idaho

The first listening session was held in Boise, Idaho in collaboration with the West Central States Wool Growers Convention on November 4, 2023. Out of the 35 individuals who participated, 77 percent of them were directly associated with sheep and lamb production. Given the overwhelming majority of participants were producers, it is reasonable to assume producer level concerns were accurately represented in the session.

Over the course of the session, it became increasingly clear producers were primarily interested in a price-protection type of insurance program, much like the previously discontinued LRP Lamb program. Other programs of interest, such as those that would cover losses due to predation and poisonous plants were discussed as well, though not preferred over a price program. Additionally, some attendees commented that any policy or program developed must be flexible enough to accommodate multiple different production practices. Several various practices were mentioned, such as barn and shed lambers, pasture and range lambers. Participants also opined as to the possibility of it being necessary to embark on the development of two or more distinct policies based around the different production types. Some producers expressed skepticism in any program working well from a "one size fits all" approach given that production practices in the lamb industry vary considerably more than that of the beef or dairy industry.

There was a lot of interest in the topic of input cost coverage, primarily for those who use shed and barn lambing production systems because they generally require more inputs than that of range lambing systems which may only require a program that indemnifies based on a weather event, such as multi-peril type coverage. Additionally, there was some interest in margin-based coverage, particularly in the sense that their main concern is the stability of their operations for years to come. A Utah-based sheep rancher advocated for a product that considers the lamb market prices, input costs and other market fluctuations that may impact overall revenue.

The consensus among a proportion of attendees being that if they had a price protection program that established a price floor, they could use that financial stability to improve overall liquidity of their operation and ultimately make better and more informed decisions on investments for future production years – thereby stabilizing the industry by reducing the need for imports, and reliance on foreign sheep and lamb. Others, however, were more interested in a catastrophic level of price protection to protect or "shield" them from the intense volatile swings that the market has been experiencing.

There were some comments regarding the assumption that the previous LRP Lamb program was discontinued due to confidentiality issues that occurred when the third processor stopped reporting their prices to RMA, and, if this was the case, it should be feasible to use a different publicly traded USDA index for lamb prices and resurrect the same policy they had before. There were mixed feelings among producers regarding the type of program they wanted to see. Some believed the previous LRP Lamb program should be offered again, while others recognized it may be pulled again, believing maybe a different approach might have more longevity, such as offering coverage through margin, input costs, and multi-peril plans. Protection for predation, poisonous plants, weather events and other quality or quantity risks were identified as other possible perils the program could cover.

After price and market related risks, predation emerged as the second greatest peril of concern. Numerous producers mentioned predators as being the second most prominent factor affecting lamb and sheep mortality, immediately following lambing losses at birth. After acknowledging the current existence of the Livestock Indemnity Program (LIP) and similar state administered programs discussed in Section III. Review of Other Programs, producers still felt they did not have adequate coverage for losses due to predation. In large part, according to the participants, this was due to the failure of federal program verification standards to confirm losses in an efficient manner. Also, producers mentioned that losses due to eagle predation are not being compensated because the eagles are federally protected. One producer provided anecdotal evidence mentioning a fellow sheep rancher in his area who was able to successfully get compensated for their losses of lambs to eagle predation, but the compensation was insignificant. The neighboring rancher lost around three-hundred lambs and got compensated for only ten.

Some states, such as Wyoming, apply factors to increase compensation beyond a 1:1 ratio for predator losses. Producers in these states acknowledged this is useful to their operations because not only does the compensation cover the initial cost of losing the animal to predation, it also helps mitigate the unknown downstream costs not readily evident at time of loss. Some of these related downstream losses were mentioned by the participants; added stress to the herd, added stress to the ewe resulting in future lamb abortions, weight loss, higher susceptibility to disease, etc. In addition to the downstream losses, sometimes sheep or lambs are carried off by the

predator to be consumed elsewhere, so there is no visual evidence to confirm a kill. The participants felt this multiplier also helped to account for additional undocumented kills.

On a similar note, many comments suggested the current system in place for confirming kills for LIP has proven to be less than favorable for the producer. There were discussions regarding the inability to get an adjuster to confirm a kill in the timeline allotted by the program. In some cases, producers mentioned adjusters for LIP were scheduled too far out and by the time adjuster arrives the lamb or sheep is too decomposed to confirm a kill. Others mentioned they are far too remote for an adjuster to reach, which means they don't get compensated for predation losses for which they otherwise should have been compensated. Multiple suggestions were made supporting a system where the producer could take a picture of the kill and submit it virtually. While this helps to solve the problems associated with adjusters coming to the kill site, it does not necessarily help when animals are carried off, missing, or simply never found, which would be the most likely case for range and pasture lambing operations. It also introduces an opportunity for additional moral hazard risks in the program, with the possibility of producers filing inaccurate evidence.

The peril of poisonous plant consumption was referenced a few times, while significantly less than the price and predation perils. Plants such as Halogeton, Death camas and Locoweed were mentioned specifically. Bloat was a minor concern as well, however it cannot always be traced back to a poisonous plant because bloat can also occur for other non-plant related reasons. There is interest in poisonous plants being included in a multi-peril policy as a qualifying cause of loss for both morbidity and mortality related risks, however it is not likely there would be overwhelming interest in a policy that only accounted for poisonous plants.

Belle Fourche, South Dakota

The Contractor partnered with the surrounding state sheep associations to host the Belle Fourche Listening Sessions; the South Dakota Sheep Growers Association, Wyoming Sheep and Wool Association, and the Montana Wool Growers Association were represented. The session was held in Belle Fourche, South Dakota on December 7, 2023, with a total of 55 attendees present, with nearly everyone in attendance noting they were a lamb and sheep producer.

Price protection was the main topic of concern for lamb producers in the northwest central region as well. With the 2022 lamb prices still fresh in their mind, producers are feeling the pressure on multiple fronts. One producer mentioned they received $112 per head for their 100-pound lambs last year and they should have been receiving at least $150 or $170 per head, on average, for that size lamb. To most, this 34 percent price reduction represents a catastrophic loss. Catastrophic price loss coverage was discussed prominently throughout the session, referring to a set price level that is not based on market fluctuations, but instead provides an artificial floor price that would trigger an indemnity in the event that the real market prices fall below this predetermined floor price. With imports becoming the largest threat to the industry, there was discussion about factoring in exchange rates to account for the risk that high imports impose on the lamb industry.

In regard to price protection, other than that of catastrophic, some producers mentioned prices needed to be calculated on a more regional or localized basis, as the auction yards such as San Angelo or New Holland do not accurately represent the price they receive in Montana, Wyoming, and South Dakota. Furthermore, producers claimed that lamb sold direct to ethnic

market consumers does not correlate well with lamb prices received at auction and are not being documented and accounted. With the ethnic market's considerable growth in recent years, there is a large segment of lamb and sheep production prices that are not well-documented. Lastly, several producers recognized that the price received by U.S. lamb producers is heavily influenced by global markets, specifically that lamb production in New Zealand and Australia results in a highly competitive retail substitute. Consequently, market price fluctuations often result in a lower retail price than can be supplied through domestic packers, feeders, and producers, requiring at least one of these segments of the domestic supply chain to take losses in order to keep the product on retail shelves.

Preferences regarding price protection seemed rather split amongst the group, with some mentioning that catastrophic price protection is all they felt was necessary, while others felt that a price protection program with buy-up coverage would be needed. In all cases, there was a general consensus that a price protection program is their highest priority. There was general acknowledgement that imports are the root of the problem, and price protection, while it may help save the industry in the short run, would be a "band-aid" to a much larger scope of issues that need to be addressed on a political level.

As with the feedback received during other western U.S. listening sessions, predation is a large concern. It was mentioned slightly fewer times than price protection, likely because there are federal and state level compensation programs that currently exist. While producers do want to see these programs improve, it is also understood that these programs do not fall under the reach of the FCIC.

Lamb production in the western United States differs from the confinement production model that is used in the eastern region because sheep graze freely in a vast area of rangeland and thus predators are a significant risk. One producer mentioned they have lost 40 percent of their lamb crop to predation in past years and given the vast area of range that sheep and lambs will cover, there is no way to find the carcass and confirm the predation kill in all instances. Without confirmation, which is at times impossible, the current programs do not provide enough assistance. There was additional discussion about how a future lamb predation-based insurance program would need to be developed in a way addressing the documentation of every kill concern as this is not feasible for producers in the western and west central regions. Another producer mentioned he often has a 150 percent lamb crop, however with predation becoming a consistent problem, yields are averaging down to about 100 percent. With an already strained market, losing 40 percent or more of a crop can be detrimental to an operation, not including the costs associated with predation that occur in addition to the loss of the animal. Predation accounts for only one of the mortality events that may result in a death loss, however producers in the Belle Fourche session did not acknowledge any others.

There was a great deal of interest in policies that were individual based, with many producers outright opposing the idea of an area-based program. This predisposed opposition originates from previous experiences that attendees have had with different programs, such as PRF and NAP. They felt that a county line approach did not reflect their losses, and therefore didn't pay out indemnities in accordance with those losses. Additionally, the variation in lamb production amongst operations is far too broad, and the yield differences are significant. The weight in which lambs are marketed is variable across and within operations, there are no industry set

standards such as those in the cattle markets, imposing a need for flexible insurance periods such as that of PRF. Lambing, as with all other aspects of production, occurs at different times, and likely multiple times per year. Many producers felt that the only fair representation would be an average of the individual producers' yield data because of the variance in lambing, yield per lamb, and production practices.

San Angelo, Texas

The San Angelo listening session was held on December 9, 2023. The session was held in conjunction with the Texas Sheep and Goat Raisers Association annual winter meeting. Producers Livestock Auction based out of San Angelo is consistently recognized as the leading auction house for lambs in the country and, as the Contractor was informed, is the primary source of national sales into the eastern U.S. market. Lamb production in Texas differs greatly from other U.S. regions with most of the production being hair sheep breeds targeted for sale into the kosher and halal meat markets. In the session, the producers were mostly involved in hair breed production.

Changes in the breed from wool to hair sheep requires very different management and production models from that seen in other regions of the United States. For example, as discussed in the listening session, hair breeds are not seasonal breeders, while wool sheep are. With that, most Texas production models have lambs all year around, and follow an opportunistic lambing approach, where rams are left with ewes all year around and conception/lambing is not scheduled.

Lamb production in Texas differs from other parts of the country also with regards to the production environment. Producers in Texas tend to monitor ewes and lambs less frequently with some large producers expressing uncertainty over the total number of ewes on pasture. Large tracts of land and limited availability of forage, particularly during drought years, result in sheep being spread across vast areas. Lambing and marketing are often done over a continuous cycle. Predation is a major concern with some producers acknowledging potential lamb losses may range from 50 percent to 80 percent of total lambs born. As result, producers may only know of lamb loss from pregnancy tests and are not able to generate physical evidence. Crested Caracara birds were sighted as one of the leading predators of lambs. Guardian dogs do help limit losses, particularly from coyote predation; however, the amount of brush cover and terrain can limit the ability of guardian dogs to prevent predation. Because lambs that are killed by predators cannot be found and, in some cases, may not be documented to begin with, it is very difficult to track these losses within the guidelines of current FSA and LIP programs. Additional comments regarding the 20 percent deductible on LIP being too high were recorded. The predators mentioned in the session were mountain lions, coyotes, and the Crested Caracara, a federally protected migratory bird species. This imposes yet another problem for Texas producers as they are not allowed to manage these predators and may not be reimbursed, via government predation programs, for losses that are a result of a Crested Caracara attack.

Producers were interested in the idea of revenue and price protection, however acknowledged they feel the local ethnic market into which their hair sheep breeds are marketed have insulated them from the larger effects of price volatility mentioned in other sessions. Producers also acknowledged a disconnect between the price received for live lamb sales and the price sold at

the grocery store. Retail price movement is not correlated with the price lamb producers receive and so producers feel they are insulated from increases in demand for lamb, largely due to imports.

Because of the production environment being very hands-off during lambing, producers believed insurance should attach at pregnancy scanning. As well, with hair sheep producers, lambing occurs all year round. Nine of ten lambs sold through the auction house are hair sheep. Wool sheep production runs on seasonal trends, but hair production typically does not.

Producers expressed a favorable experience with PRF insurance, particularly because of the simplicity of an index policy and also that it was tied to weather which correlated with their production gains. The largest interest, however, was regarding the potential for a revenue type of insurance product for lamb, being price received times yield gained from pasture.

Concern over the cheaper lamb imports from Australia and New Zealand was expressed. One stakeholder stated that, having seen overseas operations in these countries in person, that they are highly efficient production environments. The participant expressed concern that U.S. lamb producers need to be incentivized to improve and not be tempted to continue with less successful practices because of the availability of insurance indemnities. These producers also expressed an interest in insurance options for goats.

Denver, Colorado

The Denver, Colorado listening session was held in conjunction with the American Sheep Industry Association Annual Convention. The listening session for lamb was held on January 12, 2024, with 78 people in attendance from various states and production regions across the United States. Being that Colorado is the state with the most lamb feedlots, comments regarding a program directed at feeder production, rather than stocker sheep, were mentioned. While most participants in other sessions were unaware of the Whole Farm Revenue Insurance program, those in Denver seemed to be more aware of it, inquiring about how the program could be used to develop a future lamb product and if insurance agents would be reluctant to sell due to complexity. Concern over complex designs were discussed with the consensus being that any new policy should be simple to explain to any producer.

When discussing mortality insurance, many producers confirmed that ultrasound would be the most ideal way to track and confirm losses because the herd is out on range when lambing and they do not have the labor or facilities to track losses at or after birth related to lambing mortality. Many producers went so far as to mention that they do not know when their “lambs hit the ground” so mortality insurance that attaches at lambing would not be ideal for their production systems. Mortality risks included predation, but also highlighted blizzards as a major cause of lamb and ewe loss.

On the topic of price protection, many producers advocated for a price index that is tied to the carcass cutout value of lamb. Throughout the listening session, many producers felt that during periods of high retail prices, these are not being passed down to the producer level, and the difference between the retail price of lamb on the shelf and the price they receive from the processor for their lambs is significant. Participants were especially interested to know if a

formula could be used that incorporates the live-weight auction price and the retail price. As input prices have risen, live-weight sales are relatively unchanged, leaving the producers to operate on tight margins. Concern was expressed that cheaper imports are filling retail demand leaving U.S. lamb producers in a position where they feel they are not able to capture higher retail prices.

The primary risk of concern was that of price insurance. Numerous producers expressed a desire for price protection and highlighted cutout values as something that captures price movement risk. Price discussions also centered around LRP Lamb, with concerns raised over the pilot areas and limitations in the number of sales. The producers acknowledged that current price movements are closely tied to imports and suggested price insurance protect against imports.

National Virtual Session

On December 14, 2023, the Contractor hosted a virtual listening session. While there was significant interest generated via the online registration form, attendance and engagement was low in comparison to the in-person sessions. A total of 18 people logged in to attend the meeting, 3 of which were RMA personnel and 3 were Contractor staff. Of these 18 participants, only a handful of people engaged in discussion, and as a result, there was not a significant amount of feedback collected during this session.

Price protection was not as prevalent in the virtual discussion, but there was mention of input costs being a large concern, specifically due to recent changes to labor laws. In contrast to comments received at other listening sessions, one producer mentioned that predation was too narrow in scope, and they did not believe a policy aimed at predation alone would be significant enough to make a difference in the industry. However, on the topic of predation, another producer proposed the idea of federal or state trappers serving as insurance adjusters, or submitting documentation that could act as proof of predation being the cause of loss in the area.

Additionally, in alignment with the feedback received at other sessions, there were comments regarding a policy that would be built around age classes rather than yield in pounds per lamb, because of the variation in yield parameters, terminal capacities, birth weights and weaning weights amongst breeds.

Additional Feedback

As mentioned, the Contractor spoke to lamb producers in the northeastern United States during individual phone calls and meetings. Production environments varied across these states with small scale range and barn lambing to total confinement and solar grazing operations. Due to the high demand for low weight lambs, and the increased input costs of confinement production, producers are incentivized to run accelerated lambing programs. This is most efficiently done through total confinement barns with feed and lambing programs occurring in an environment similar to a dairy operation, and often with the use of some form of out of season breeding and lambing protocols. Predation is not a risk that producers in the northeast region are particularly concerned with, given the majority of production is some form of a confinement system. These producers typically utilize some form of direct marketing to consumers and restaurants in addition to selling through local auction houses.

Besides price risk, conception rates, feed, and labor costs are items of concern. Solar grazing is also increasing in popularity. It is generally recognized as an operation that moves sheep or lambs between fields of solar panels to increase the utilization of the land that the solar panels occupy. The producers the Contractor spoke with stated many of the solar grazing operations are less focused on lamb production and more on solar farm upkeep, with solar being the main revenue source. Additional information regarding lamb production in the northeast region is documented in Section II (Commodity Description) of this report.

V.B. Summary of Feedback by Topic

The listening sessions provided feedback on the lamb industry as it relates to production risk management experienced by lamb producers. A number of issues were raised which consistently centered around a certain type of production environment, a type of peril, and past experiences with federal crop insurance. The following summarizes the Contractor's findings.

Lamb production varies considerably by location and region across the United States. While there are exceptions, it is typical for a producer in the western and Great Plains states to utilize a range production system, which includes the use of dual-purpose sheep breeds to produce both lamb and wool given the sheep are raised entirely on range or pasture and need to withstand a more harsh environment. When on range, the flock is continuously moved throughout the year to maintain adequate forage availability, because the primary source of feed is provided through grazing. This type of production requires access to vast expanses of grazing land and very large flocks (typically 1,000 or more head of sheep) to be profitable, and thus it is not suitable for the northeast region of the United States where access to land is often the determining factor to the production system selection. The producers in the southwestern region of the United States, such as Texas, also utilize a similar range production scenario to that of the western and Great Plains regions. However, the southwestern region industry is not typically using dual purpose breeds. Production in Texas and the surrounding states are primarily of hair sheep breeds, which grow and shed hair year around rather than producing wool. These sheep are allowed to graze continuously over large tracts of land with minimal interaction, and reproduction is managed using either opportunistic lambing, or some form of accelerated lambing because the climate is more suitable to year-round production. Large scale production is found primarily in the western states, however much of the feedlot capacity is in the Midwest, with some being in the San Jaquin Valley in California. Lastly, the northeast region utilizes barn and shed production systems on small tracts of land typically supplemented or supplied with feed, with some of the larger operations utilizing total confinement systems. Breeds in the northeast region vary between smaller framed hair sheep, dual purpose, and specialty breeds.

Different production environments result in different sets of risks. However, most producers expressed price risk as the number one concern. After price risk, mortality risk due to predation and weather was the next highest issue of concern. Feedlots expressed concern about weight gain, but this issue was not frequently discussed among lamb producers.

Experiences with LRP Lamb insurance was frequently discussed. Producers looked favorably on the product as a tool for price support but expressed various frustrations such as limited number of sales and failure to precisely capture expected prices. PRF was highlighted as a tool many producers rely on and appreciate for its simplicity and correlation with lamb pasture gains.

V.C. Analysis of Feedback from Sessions

In listening to the issues facing lamb producers, the Contractor found that while many of the risks could be addressed through insurance, other forms of risk management policy may better address concerns raised by participants. Listening session participants expressed a strong desire for price protection, particularly as was offered through the LRP product. Producers also expressed a significant concern over price risk as a result of retail imports. While U.S. lamb producers continue to differentiate their products, at this time it appears imported lamb is a direct competitor which can be produced, transported, and marketed at prices well under that of domestically produced lamb. The industry also recognizes that during periods of excessive demand and low domestic supply, imports are necessary to keep lamb affordable and on retail shelves. As a result, U.S. lamb producers are typically unable to capture increases in domestic demand for lamb. Unfortunately, as the market fluctuates, this also results in periods of depressed live-weight prices paid to lamb producers. Any insurance product developed using forward instruments will likely project coverage below a price support the producers expect. For this reason, it appears producers are, more so, in need of an insurance-styled income support program with counter-cyclical behavior than an insurance program. In a similar way, mortality losses where they have occurred in high numbers as a result of predation, particularly from protected species, are unlikely to be covered to the extent producers need through an insurance program. As many producers needing this coverage are in locations experiencing high mortality losses, an insurance plan would project an expectation of high loss resulting in either large premiums or very large deductibles. Consequently, it appears producers may experience better service through improvements to existing federal indemnity programs than through new forms of insurance.

V.D. Interpretation of Feedback

The risks and concerns that lamb producers and stakeholders have over the state of the sheep industry are real and substantial. Historically, these producers own all the price risk with their only experience of support being through the LRP Lamb program. As stakeholders expressed to the Contractor, many of the large operations had a better sense of projected prices than did the LRP Lamb pricing model resulting in either lots of insurance sales with many indemnities or few sales with no indemnities. The industry experienced favorable price support, but enrollment and price protection was not consistent across the industry and across production timelines.

The effect of the COVID-19 pandemic on lamb prices caused a significant uptake in consumers who were cooking more at home and opting to experiment with different foods, one of which was lamb, which resulted in a moderate increase in demand. However, the COVID-19 pandemic caused many restaurants to shut down operations, which essentially eliminated an entire market overnight, causing producers to hold their lambs and thereby increasing the available supply. This appears to be a win-win for the lamb market, but the, for all intents and purposes, complete shutdown of transportation and the processing facilities by the government in their COVID-19 response effectively closed access to the excess supply demanded by the populace resulting in very high prices for the very limited product on the shelf. As high retail lamb prices can result in a loss of grocery shelf space, packers and retailers took large losses until government international trade protections were eased and imported cuts were able to fill the production supply gap as the domestic transportation resources slowly came back online. Packers and feedlots typically contract with growers in advance of delivery. This establishes a consistent

supply of lamb; however, as retail demand fluctuates through seasons, it is customary for lambs to be held back until slaughter timing aligns with expected retail demand and hopes of higher prices.

The behavior of this market and responsiveness to retail demand and import market supply results in U.S. lamb producers having very little control over not only the price they receive for live lambs, but also the information needed to accurately project market price movements. As a result, the average lamb producer knows little about the future state of the lamb market while large vertically integrated producers have a better perception of market expectation than everyone else.

Mortality risks are faced by producers and can be addressed through an insurance program. However, documenting lamb births and deaths is a challenge for many of the producers who operate a range production system for their lamb operation. The rangeland covered by most lamb producers is vast and rugged. While some producers can track and monitor during distinct lambing seasons by bringing their ewes into a barn or pasture for lambing; there are a significant number of producers who run their sheep across areas that would be difficult to traverse and facilitate loss adjustment through a mortality insurance program.

Yet, in light of these challenges, the listening sessions were highly interactive, and mostly well attended. Participants actively discussed the challenges and deeply expressed a desire for some form of risk protection. As a result, the feedback received was genuine and the Contractor believes the industry will continue to advocate for additional forms of risk protection.

VI. RISK ANALYSIS

This section provides a discussion addressing the requirements from the SOW:

> *"Risk Analyses – The Contractor shall define the economic perils; collect data to identify and quantify these perils; identify data that are unavailable, but necessary to quantify these risks; estimate the frequency and severity of the most important perils that currently are uninsured, classify each of the perils as insurable or uninsurable and justify the classification of the risk. The Contractor shall also identify manmade or created perils that can affect the production of lambs and describe when and how these perils can occur. The Contractor shall also identify state, county, and regional grading standards and USDA grading standards; determine the identity and independence of the grading agency and entity that performs the grading evaluation and what impact this may have on any viable insurance programs; and provide a copy of the most recent grading standards. The Contractor shall also report any history of disaster program payments, including NAP, as a result of any action for the past ten years of available data. The data shall be from acceptable and appropriately cited sources and report the data."*

VI.A. Economic Perils

The Contractor found that the perils associated with lamb production are similar to other livestock production systems. Goat production risk is most closely related to lamb production. However, there are also many similarities to cattle production; yet, depending on the production environment and lambing practice, lamb production is more sensitive to mortality losses and less exposed to rate of gain risk, such as experienced in cattle and swine production. Generally, perils in agriculture can be identified through price (market), financial, institutional, and human (personal) sources of risk. The Contractor addresses each of these sources herein.

VI.B. Production Risk

Mortality and Production Risks

The risks associated with lamb production affect two main outcome variables; production/market weight per lamb and number of lambs weaned per ewe. Many of the potential risks can affect both these outcomes and thus they can be highly correlated. Factors affecting lamb mortality and production are varied and begin well before a lamb is birthed.

Lamb mortality is one of the major factors impairing revenue and profitability in sheep operations, and nearly half of all pre-weaning lamb deaths occur on the day of birth.[189] Mortality significantly varies with the management system (intensive versus extensive lambing, high labor input versus low labor input, differences in the availability and quality of shelter, month in which lambing occurs, etc.) and according to whether there is a particular disease problem in a given flock. Nonselective mortality surveys have shown population mortality rates in lambs, from birth to weaning that vary from 10 to 30 percent, and there are flocks that may exceed this higher figure in the face of a major problem. In well-managed flocks, neonatal mortality can be less than ten percent and in rare cases below five percent.[190] Unsurprisingly, many sheep

[189] Dwyer CM. Small Ruminant Research. 2008;76:31-41.

[190] Constable, Peter D., Kenneth W. Hinchcliff, Stanley H. Done, and Walter Grünberg. Veterinary medicine-e-book: a textbook of the diseases of cattle, horses, sheep, pigs and goats. Elsevier Health Sciences, 2016.

producers strive to reduce lamb crop mortality associated with late gestation and newborn lambs. Sheep respond to management (i.e., labor inputs) more than any other domestic species, which is apparent during the critical periods that effect lamb mortality.[191] This fact requires careful consideration in the insurance context. It is inherently difficult to monitor and affirm that appropriate management practices have been subscribed to minimize mortality and the presence of an insurance guarantee can substantially alter grower incentives to maximize lamb survival.

Major lamb mortality causes fall into several major categories including failure of neonatal adaptation to postnatal life, infectious diseases, exposure to elements, functional disorders, management and labor errors, and predation. The distribution of these varies by stage and is broken up in the following discussion.

Prenatal Mortalities

Infectious abortion can cause considerable fetal, parturient, and postnatal mortality in infected flocks. In contrast to other large animal species, abortion storms in sheep are often accompanied by significant mortality in lambs surviving birth. Many agents associated with abortion in ewes produce placentitis and cause abortion in late pregnancy. This frequently results in the birth of lambs that are born growth-retarded and weak with a high likelihood of death during the first few days of life. Any investigation of perinatal mortality in sheep should also consider the presence of agents causing abortion, although abortion and the birth of dead lambs is always prominent in abortion outbreaks.

Preventative flock health care and a sound nutrition management plan promote higher lamb vigor and increased lamb survivability and reduce pregnant ewe death. Based on studies on lamb mortality, stillborn births can often account for 25 percent of losses that occur at or near the time of lambing. Stillbirth occurs largely as a result of prolonged birth and fetal hypoxemia. Prolonged birth and dystocia are particular problems in large single lambs. Higher rates of stillbirth can also occur in flocks that are in poor condition. Prolonged birth is a major risk factor for subsequent postnatal disease. Stillborn mortality can be divided into two categories: pre-term and full-term delivery.

- In many flocks, the majority of pre-term losses are associated with abortion diseases. The top three abortion diseases include: Campylobacter, Chlamydia, and Toxoplasmosis. In most flocks, the incidence of pre-term delivery associated with natural causes, non-bacterial, is expected to be two to four percent.
- For full-term stillborn mortality, both nutrition and health are important, along with lamb delivery abnormalities. A full-term stillborn delivered in a litter of triplets or resulting from a backward presentation at birth are common.[192]

Postnatal Mortalities

The majority (up to 80 percent) of all lamb crop mortality (including full-term stillborn) occurs in newborn lambs under 2 weeks of age. For live newborn lambs, the primary causes of mortality can differ by the type of production system. In production systems using a shed lambing facility, the primary challenges to newborn lambs are starvation and hypothermia, as

[191] https://lambboard.com/s/ReduceLambLossLCFactSheet05252017.pdf . Accessed February 2024.
[192] Berger, Y. M. (1997). Lamb Mortality and Causes. A nine-year summary at the Spooner Agricultural Research Station. mortality, 10, 9-5.

well as respiratory diseases, scours, and injury. Lambs born in pasture or range lambing systems are also threatened by weather conditions and predators.[193]

Starvation and hypothermia are common causes of death that can result from decreased vigor, pain or trauma after a difficult delivery, failure to adapt to postnatal life, or infectious disease. In examining data from the USDA in 2019, there were approximately 232,530 lambs lost to "nonpredator" related causes. The top three reported causes were; weather-related with 22.1 percent, internal parasites with 15.5 percent, and lambing problems with 9.9 percent.[194]

A number of studies have consistently identified low birth weight as the single most important factor associated with lamb mortality.[195,196] Other common factors associated with the mortality rates of neonatal lambs are litter size (which is associated with, but cannot entirely be attributed to lower birth weights for twins), lamb gender (with males having higher mortality rates than females), and lamb behavior.[197] Management practices that have been found to most effectively reduce lamb mortality include winter feeding of pregnant ewes and providing shelter from the elements during lambing season.[198]

Other Factors

Lambs found dead or missing may account for significant losses in some management practices, such as extensive range production. Predation, or predation injury, is an important cause of loss in the United States and, depending on the region, can occur from domestic dogs, coyotes, birds, mountain lions, bears, or other wildlife such as seen in Texas with the Caracara. According to USDA data, in 2019, predation alone accounted for 32.6 percent of sheep losses, and 40.1 percent of lamb losses. These numbers have remained close to these rates, with the exception of marginal increases in predation losses found between 2014 and 2019. In lambs, there were 155,470 recorded predation losses, and 59 percent of them were attributed to coyotes, 15 percent attributed to domestic dogs, and 4.3 percent attributed to mountain lions.[199] Additional context is needed, however, to understand and utilize predation data.

As discussed in many of the listening sessions, predation is very poorly recorded given the lambs are typically carried off by the predator, and as a result this loss to predation is either not recorded, or they are not able to verify the predator. In cases where predation is recorded, it is likely in some form of intensive, or pasture production management where the producer is able to monitor the herd consistently and the predator was not able to get away with the lamb. This represents a small minority of the U.S. sheep herd, and therefore predation is likely severely underestimated in these reports.

Poor mothering and an inability of the ewe to gather and bond to both lambs in the case of twins can be a problem and can cause permanent separation of lambs from the ewe and subsequent death from starvation. Management at lambing can also influence the patterns of mortality.

[193] https://lambboard.com/s/ReduceLambLossLCFactSheet05252017.pdf . Accessed February 2024.
[194] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheepdeath/sheep-death-loss-trends-us-2020.pdf.
[195] Dwyer CM. Small Ruminant Res. 2008;76:31.
[196] Bleul U. Livestock Science. 2011;135:257-264
[197] Dwyer CM. Small Ruminant Research. 2008;76:31.
[198] Hinch GN, et al. Animal Production Science. 2014;54:656.
[199] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheepdeath/sheep-death-loss-trends-us-2020.pdf.

Intensive stocking at the time of lambing allows increased supervision and tends to reduce the incidence of stillbirths and lamb mortality related to parturition. It can furthermore ensure the early feeding of colostrum to weak lambs. On the other hand, it can result in a greater occurrence of mismothering associated with the activities of "robber" ewes and may increase lamb mortality related to infectious disease.[200] Mortality rates can differ between breeds, and lambs from crossbred dams may have higher survival rates.

Mortality rates are a function of management and environment. Weather issues are a true risk and when taken alone offer a clear context for insurability, but how well equipped an operation is to deal with that risk can have a significant impact. Minimal mortality rates might ideally be achieved by managerial factors such as intermediate lamb birth weights and proper nutritional management of pregnant ewes, provision of adequate shelter, and good animal husbandry practices particularly during lambing. Further steps can be taken, for example, ewes carrying multiple lambs in utero can be selected using ultrasound and fed separately from those with singles due to their higher nutrition requirements. Pregnant maiden ewes should also be fed to their separate requirements (maiden ewes are still growing in addition to carrying a fetus thus increasing their energy and protein requirements). As each farm is operating under different circumstances, mortality rates will vary accordingly. These factors contribute to the need for historical mortality data for each operation type in order to model mortality risk based on the factors discussed. In the absence of these data, there can be no basis for evaluation and establishment of premium rates for insurance coverage.

Selected Academic Study Findings

Due to the paucity of production data available, relevant academic research regarding lamb production and mortality was also reviewed. The Spooner Agricultural Research Station analyzed data for causes of mortality encompassing a total of 5,425 lambs born (alive or dead) over 9 years (1989 through 1997). The data evaluated in this study is from a university farm with ample labor resources that had lambs and their ewes under close supervision in relatively well-developed facilities. Other types of operations, such as those that pasture lamb or have limited labor, are likely to see different results.[201]

A total of 5,425 lambs were born (alive or dead) over the nine-year period. Five hundred thirty-six lambs (9.9 percent) were born dead or died before weaning. Mortality ranged from 8 percent to 13.7 percent annually. Effects of gender, ewe breed, year, age of ewe, type of birth, lambing season, sire breed, and birth weight were reviewed. Causes of death were also categorized by number of days of age of the lambs.[202]

Only 16 percent of all death occurred between 8 days of age and weaning. The causes of death are more difficult to diagnose without a full necropsy of the lambs. Therefore, the number of pneumonia and overeating problems may be underestimated. In this age group, metabolic disorders and diseases were the prevalent causes of death. The mortality rate increased as the number of lambs in the litter increased. Lambs born single or twins have little reason to die as

[200] Holmoy IH, et al. Preventative Veterinary Medicine. 2012;107:231-241.
[201] Berger, Y. M. (1997). Lamb Mortality and Causes. A nine-year summary at the Spooner Agricultural Research Station. mortality, 10, 9-5.
[202] Ibid.

long as reasonable care is provided. The mortality rate increases in lambs born as triplets or greater. However, there wasn't a significant difference between triplets, quadruplets, and quintuplets in the herd, due to the factor that the surplus lambs were raised separately on milk replacer.[203] This is only likely to be the case in well managed intensive lambing operations.

Based on their records, more than 75 percent of all mortality over the nine-year period had a base cause in faulty or inadequate management of either ewes, lambs, or facilities. Improvements or modifications in the overall management of the flock before, during and after lambing may have significantly reduced the number of deaths.[204] Other studies estimate that 70 percent of lamb mortality between birth and weaning occurs in the first 48 hours,[205] or 80 percent in the first 2 weeks after birth.[206]

In a different study on a large pasture-based operation in western Montana, times and causes of mortality suffered by domestic sheep were documented for one year at the sight of death. This operation had less supervision and labor available, in addition to being spread out over considerably more acres making supervision impractical.[207] The total mortality in this study consisted of 66 (12.5 percent) natural deaths, 449 (85.2 percent) predator kills, and 12 (2.3 percent) undetermined deaths. Predators killed 425 (20.8 percent) of the original herd and 355 (29.3 percent) of the 1974 lamb crop exposed to predation. Pneumonia related deaths caused 42.2 percent of the natural field mortality. Necropsies were performed on all carcasses possible and 75.3 percent of the sheep killed by predators were healthy; 73.3 percent of the 15 lambs shot for comparison were healthy.[208]

A New Zealand research station tracked mortality for the first 25 days for single, twin, and triplet births. Mortality rates were 14.1, 14.7, and 33.0 percent for each group, respectively. Ninety-four percent of all deaths occurred within 72 hours of birth. Dystocia accounted for 50.4 percent of all single deaths and starvation/exposure for 45.0 percent of all multiple deaths.[209]

USDA NASS and APHIS Mortality Data

The USDA APHIS and NASS partner to publish a report every five years using U.S. state level survey data. The data tracks losses for all states in which sufficient responses were collected. In the eastern United States, the losses surveyed are of "lambs born", which would include most lambing and post-lambing losses with the likely exception of mortalities such as stillbirths. In the western United States, surveys request mortality statistics after lambs have been branded, docked, or marked, with the exception of four states which also track pre-docking mortalities. This is due to the prolificacy of pasture lambing in the western United States and accompanying lack of supervision for data collection during lambing. This would thus indicate most of the mortalities tracked occurred after the lambing season since docking, branding, and marking

[203] Ibid.
[204] Ibid.
[205] https://extension.psu.edu/use-birth-weight-as-a-selection-tool#:~:text=Lifetime%20Wool%20from%20Australia%20notes,the%20last%20third%20of%20gestation.. Accessed Febraury 2024.
[206] https://lambboard.com/s/ReduceLambLossLCFactSheet05252017.pdf. Accessed February 2024.
[207] Ibid.
[208] Henne, D. R. (1975). Domestic sheep mortality on a western Montana ranch.
[209] Scales, G. H., Burton, R. N., & Moss, R. A. (1986). Lamb mortality, birthweight, and nutrition in late pregnancy. New Zealand journal of agricultural research, 29(1), 75-82.

typically occur 2 to 12 weeks after birth. The report is published every five years based on the prior year's survey results.[210]

The most recent APHIS report was published in 2020 based on the 2019 survey. Sheep death loss due to non-predator causes accounted for 32.6 percent of adult sheep inventory and 40.1 percent of lamb inventory. The top three causes of non-predator death loss in adult sheep were: old age (18.4 percent of losses), internal parasites (15.9 percent), and lambing problems (10.1 percent). The top three causes of non-predator losses in lambs were: weather-related causes (22.1 percent of losses), internal parasites (15.5 percent), and lambing problems (9.9 percent).[211] Table VI.1 displays the 2019 NASS survey data for the western U.S. states that track pre-docking losses. Combined, the total pre-docking mortalities as a percentage of total mortalities was 56.6 percent. These results agree with the Spooner Agricultural Research Station analysis which indicated that a significant percentage of lamb deaths occur at birth or shortly following birth.

Table VI.1. NASS 2019 Pre-docking and Post-docking Mortality Percentages

State	Pre-docking	Post-docking	Total	Pre-docking Losses as a Percentage of Total Losses
AZ	5,470	4,000	9,470	57.7
CA	15,600	14,000	29,600	52.7
CO	13,000	17,000	30,000	43.3
ID	7,280	9,000	16,280	44.7
MT	18,000	17,000	35,000	51.4
NV	10,720	7,000	17,720	60.5
NM	9,300	3,500	12,800	72.7
OR	9,730	6,000	15,730	61.8
UT	17,000	15,000	32,000	53.1
WA	1,690	2,000	3,690	45.8
WY	22,500	12,000	34,500	65.2
Total	138,820	106,500	245,320	56.6

Source: Contractor after USDA APHIS Sheep Death Loss in the United States 2020 – NAHMS. Accessed February 2024. https://www.aphis.usda.gov/aphis/dashboards/tableau/sheep-death-dashboard

Table VI.2 displays the survey results at the national level for lambs by mortality type and by size of operation. Total per head losses for each cause and the percentage of each type of loss composed of total mortalities for operations of that size are displayed. While ideally this data would include a more specific indicator of the age of the lamb at the time of death, it does provide useful insight into the major causes of loss in sheep operations across the United States.

Reviewing the table, the highest percentages of death loss in lambs were attributed to weather-related causes (22.1 percent), internal parasites (15.5 percent), and unknown non predator causes (13.9 percent) ignoring operation size. On the smallest operations, lambing problems contributed to a higher percentage of lamb death loss (17.6 percent) than on the largest operations (0.9 percent). This is likely due to the part-time nature of small lambing operations.

[210] https://www.aphis.usda.gov/animal_health/nahms/sheep/
[211] https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheepdeath/sheep-death-loss-trends-us-2020.pdf

Additionally, in the largest operations, lambing is done on range, and in many cases unsupervised. This could mean that while the death wasn't recorded at lambing, there could be a portion of lambs that had lambing problems but were instead marked under "unknown non-predator causes" or under "other disease problems" given that it has been previously established that issues at lambing can impact the immune system and reduce overall vigor in lambs that survive the first 48 hours. On the largest operations, most of which are likely pasture based non-intensive operations, other disease problems, weather, and unknown were the main causes. With these risks, it is understandable that they would be most present in a large operation, because these are related to production types that require little to no labor or supervision. Weather is the main concern, because the herd is not typically kept near barns or shelters in range based extensive production. In the same sense, the second highest cause of lamb mortality in large operations of 1,000 head or more is "other disease problems". Again, provides an example of the higher risk associated with the larger operations because they are not able to supervise and doctor the herd as much as other operations of smaller sizes, likely why "other disease problem" is not a significant cause of lamb mortality in any other operation sizes (less than 2.5 percent). Note the midsize operations had the fewest "unknown" and "other non-predator causes", likely because those operation sizes have the most time devoted to the management and supervision of each ewe. This data shows how risks associated with lamb mortality vary based on a producer's decisions regarding production management and reflect the common belief that a "one size fits all" approach to an insurance product may not be feasible for lamb production.

Table VI.2. U.S. NASS Number and Percentage of Lamb Mortalities, by Non-predator Cause and by Size of Operation

Size of Operation (Number of Sheep and Lambs)	1–24		25–99		100–999		1,000 or more		All operations	
Non-predator cause	Number	percent	Number	percent	Number	percent	Number	percent	Number	percent
Enterotoxemia	880	2.3	1,660	2.6	3,780	4.7	3,480	6.7	9,800	4.2
Internal parasites	5,130	13.7	13,460	21.3	14,990	18.7	2,560	4.9	36,140	15.5
Other digestive problems	1,380	3.7	2,920	4.6	3,920	4.9	2,280	4.4	10,490	4.5
Respiratory problems	2,260	6.0	3,440	5.5	9,240	11.5	4,560	8.8	19,490	8.4
Metabolic problems	30	0.1	220	0.3	340	0.4	440	0.9	1,030	0.4
Other disease problems	890	2.4	1,460	2.3	1,110	1.4	9,490	18.3	12,950	5.6
Weather related	6,550	17.5	11,980	19.0	21,590	27.0	11,160	21.5	51,280	22.1
Starvation	690	1.8	1,890	3.0	2,730	3.4	2,100	4.1	7,420	3.2
Lambing problems	6,600	17.6	10,760	17.0	5,230	6.5	490	0.9	23,080	9.9
Neonatal Disease	290	0.8	520	0.8	850	1.1	300	0.6	1,960	0.8
Being on back	120	0.3	30	0.0	80	0.1	100	0.2	330	0.1
Poisoning	690	1.8	350	0.6	1,320	1.7	1,250	2.4	3,610	1.6
Theft (stolen)	90	0.2	290	0.5	150	0.2	780	1.5	1,310	0.6
Other non-predator causes	900	2.4	1,330	2.1	1,190	1.5	1,110	2.1	4,530	1.9
Found dead	3,690	9.9	5,400	8.6	4,290	5.4	3,470	6.7	16,850	7.2
Unknown non-predator causes	7,270	19.4	7,420	11.8	9,250	11.6	8,310	16.0	32,260	13.9
Total	37,460	100	63,130	100	80,060	100	51,880	100.0	232,530	100.0

1: Such as bloat, scours, or acidosis. 2. Such as milk fever 3. Such as mastitis or foot rot. 4. Such as chilling, drowning, or lightning. 5. Such as by nitrate, noxious feeds, or noxious weeds. 6. Such as lameness. 7. With cause undetermined.

Source: Contractor after USDA APHIS Sheep Death Loss in the United States 2020 – NAHMS. Accessed February 2024. https://www.aphis.usda.gov/aphis/dashboards/tableau/sheep-death-dashboard

Common Disease Perils

Scrapie

A highly prolific disease throughout the sheep industry is Scrapie. As one of the several transmissible spongiform encephalitis (TSE) that is related to bovine spongiform encephalopathy (BSE or "mad cow disease), it is a fatal, degenerative disease that affects the nervous system in sheep.[212] There is not a known link between Scrapie and any effect on human health, but other TSEs, such as mad cow disease, do affect humans. The exact cause of the disease is not known, but it is associated with the presence of an abnormal protein called a prion.[213] Because of this, there is no treatment or vaccine available for the disease. Any known animal infected with Scrapie is not allowed to enter the food chain.

Scrapie usually takes more than a year to develop to the point where symptoms become present and may even take several years to present itself. Most cases occur in animals between two and five years of age, and these animals will die within one to two months after showing signs of the illness. Symptoms displayed by animals that develop this illness may vary greatly and include behavioral changes such as aggression or apprehension, noise sensitivity, biting at limbs or sides, wool pulling, tremors, and incoordination or an abnormal gait, while other animals simply have a poor wool coat or will be found dead. Wasting and debility are the most prominent symptoms of Scrapie found in sheep flocks.[214]

The USDA has a national control program targeted at eradicating Scrapie. According to information posted on the National Scrapie Eradication Program (NSEP), there have been two reported cases found at slaughter in 2021 and in 2019, both of which were not able to be traced back to the farm level. In addition to calling on producers to report any of their sheep with noticeable symptoms, and relay them for testing, the NSEP also implements a surveillance program at slaughter. They also have a Scrapie Free Flock Certification Program that requires producers to submit samples of their sheep that had been previously found dead or euthanized.[215]

Johne's Disease

This disease is caused by the bacteria *Myobacterium aviumi*, subspecies *paratuberculosis* and affects domestic ruminants and wildlife ruminants by wasting and, terminally, by diarrhea.[216] This bacterium invades the intestine and lymph nodes, interfering with nutrient absorption.[217] There is a cattle strain, a sheep strain, and an intermediate strain.[218] Sheep typically only contract the sheep strain, but can also succumb to the intermediate strain. In the United States, it was found that 68 percent of U.S. cattle dairy herds have at least one cow that it infected, however it is thought to be less prevalent in sheep in the United States.[219] It is considered a major infectious disease in sheep in New Zealand and Australia.[220] There has been some

[212] https://scrapiecanada.ca/about-scrapie/. Accessed January 2024.
[213] Ibid.
[214] Ibid.
[215] https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/sheep-and-goat-health/national-scrapie-eradication-program.
[216] https://www.ontario.ca/page/johnes-disease-sheep. Accessed February 2024.
[217] https://www.ontario.ca/page/johnes-disease-sheep. Accessed February 2024.
[218] Ibid.
[219] https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/nvap/NVAP-Reference-Guide/Control-and-Eradication/Johnes-Disease.
[220] https://www.ontario.ca/page/johnes-disease-sheep. Accessed February 2024.

speculation in recent years regarding the relationship between Johne's Disease in livestock and Crohn's Disease (autoimmune disease with intestinal ulceration), but there remains no confirmed causal relationship between the two diseases to date.[221]

Sheep may become infected with Johne's Disease at any age, and if an animal is infected in the fetus or as a lamb, the disease will manifest when the infected animal is as young as 18 months old.[222] Environmental stresses in a sheep's life cycle can also hasten the onset of the disease, such as lambing or mastitis infection in ewes. This disease is difficult to identify until a sheep is terminally ill and can be mistaken for other wasting diseases. This difficulty in diagnosing Johne's Disease often leads to sheep flocks being exposed to the bacteria in large doses over multiple generations before the disease is identified which can constitute major negative impacts in a flock's productivity.

Because Johne's Disease is an intestinal disease, the most common method of transmission of this disease is ingestion of fecal matter through consuming contaminated feed (fecal-oral route). Johne's bacteria have a thick cell wall and can survive in the environment for up to a year as they are resistant to disinfectants and to drying by the sun.[223] This resistance allows for infected sheep to contaminate pasture, feeders, waterers, and other spaces where the flock cohabitates with the disease. Infected sheep do not shed the bacteria when they first become infected but typically begin to do so between one to five years and more commonly two to three years.[224] Infected sheep will shed the disease without displaying any symptoms for a year or so and can remain highly productive during this time.

Tillage of pastures can help to dilute and kill Johne's bacteria. Snow cover helps survival of the bacteria, but drying or exposure to intense cold will reduce the size of the population in a pasture. Johne's bacteria are resistant to most disinfectants, so disinfectants specific to killing mycobacteria must be used to control Johne's bacteria.[225] Most sheep producers use a variety of methods to prevent the introduction of the disease into their flock, including purchasing sheep from reputable disease-free flocks, maintaining the sheep flock separately from other ruminants, maintaining a closed flock, and closely evaluating body condition on each individual animal. However, even these combined prevention efforts could still allow Johne's Disease to become present within a flock.[226]

The United States has developed the Johne's Disease Control Program that combines education and monitoring via fecal, tissue, and blood sampling, however, there is no licensed sheep vaccine for the disease in North America, but countries where it is a major infectious disease including New Zealand, Australia, and Spain utilize vaccination as a means to control losses.[227/228]

[221] Ibid.
[222] Ibid.
[223] Ibid.
[224] Ibid.
[225] Ibid.
[226] https://www.canr.msu.edu/news/johne-s-disease-in-sheep-and-goats. Accessed February 2024.
[227] https://www.ontario.ca/page/johnes-disease-sheep. Accessed February 2024.
[228] https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/nvap/NVAP-Reference-Guide/Control-and-Eradication/Johnes-Disease Accessed February 2024.

Spider Lamb Syndrome

Ovine hereditary chondrodysplasia, commonly known as Spider Lamb Syndrome (SLS), is a simple autosomal recessive genetic disease that can be lethal in lambs. The gene for this trait is autosomal recessive for the disease, and this is especially challenging for sheep producers as it is difficult to identify and cull animals that carry the disease but do not express it phenotypically. In cases of this disease, affected animals have severe skeletal abnormalities which cause their legs to be greatly bowed-in and/or bowed-out or otherwise deformed.[229]

SLS was first observed in the 1950s and increased in prevalence in the 1970s and 1980s. It is most common in Hampshire and Suffolk breeds and is generally not considered a concern for white-faced breeds.[230] Because this is a genetic disease, the prevention protocol that Hampshire and Suffolk sheep producers can utilize is to breed the disease out of their flock through purchasing of pedigreed sheep and culling of any sheep that may be carriers of the disease.

Chronic Copper Poisoning

Sheep are more prone to Chronic Copper Poisoning, or CCP, than other domestic animals. This is a nutritional disease that occurs when livestock absorb copper from their diet in levels that are inconsistent with the actual amount of copper needed to be absorbed to meet the animal's nutritional needs.[231] Most often, this disease becomes present due to a mistake in the nutritional mix to the feed, and a flock's feed mix has higher copper levels than are required for the sheep. This can occur with custom mineral mixes for individual sheep operations, especially if there has been an issue with copper deficiencies in the past or if the sheep are run in a mixed operation with cattle where they may have access to cattle mineral mixes, or the mixes have been confused.

Excess copper is stored in the liver and will eventually reach toxic levels over a matter of months or years. When the liver reaches its copper storage capacity, the copper is released into the bloodstream, causing liver damage, jaundice, and the destruction of red blood cells as the copper circulates.[232] Up to 60 percent of the red blood cells in circulation can be damaged, compromising their ability to carry oxygen to tissues in the body.[233]

Common symptoms of the onset include affected animals becoming increasingly weak and may begin wandering aimlessly or head-pressing. As the disease progresses, the affected animal will develop jaundice, and breathing typically becomes shallow and rapid as they become anemic. Jaundice can be seen in the yellowing of the eyes, the roof of the sheep's mouth, and sometimes skin discoloration can be seen if the sheep is shorn.[234] Sheep with CCP will typically experience a period of recumbency as the final terminal stage of the disease.

Copper poisoning is diagnosed based on the clinical symptoms observed prior to death, the feeding history, and dark discoloration of the liver and kidneys found in a necropsy of the affected animal. Typically, only a few animals die from CCP in a flock, but the remainder of the flock should receive treatment even if they aren't showing symptoms of the disease. Treatment

[229] http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2148/CR-3902web.pdf. Accessed February 2024.
[230] Ibid.
[231] https://www.ontario.ca/page/chronic-copper-poisoning-sheep. Accessed February 2024.
[232] https://www.nadis.org.uk/disease-a-z/sheep/copper-poisoning-in-sheep/. Accessed February 2024.
[233] https://www.ontario.ca/page/chronic-copper-poisoning-sheep. Accessed February 2024.
[234] https://www.nadis.org.uk/disease-a-z/sheep/copper-poisoning-in-sheep/. Accessed February 2024.

as a response to animals showing acute symptoms of this nutritional disease is generally unsuccessful. Hence, producers need to focus on identifying the cause of the disease and implementing a treatment plan for the rest of the flock that may be at risk as well as a prevention plan for the future.

Treatment of the at-risk livestock include oral dosing or injections of ammonium tetrathiomolybdate that strip the copper from the liver; although, this is an expensive treatment for animals. Another option is to add copper antagonists, such as molybdenum or sulfur to the mineral ration to prevent further excess absorption of copper. Some sheep breeds may be more susceptible to absorbing higher levels of copper than others.

Additionally, younger sheep absorb copper more efficiently, so copper antagonists should be consistently provided in the flock's diet, which can help influence the amount of copper that will be absorbed. Another method of prevention is to avoid providing feeds with relatively high concentrations of copper to sheep flocks. These feeds include silage or pasture where large quantities of pig or poultry manure have been spread as fertilizer, cattle minerals, and distiller grains from distilleries that use copper stills. Since CCP is a nutritional disease, careful management of a sheep flock's diet can easily control the prevalence of this disease.

Soremouth

This is a viral skin disease, also known as contagious ecthyma, caused by Pox virus entering the body of a sheep through a break in the skin. Signs of this disease include scabs and blisters on the nose, mouth, udders, teats, and sometimes around the hoof and skin on the lower leg of the infected animal. Because this disease affects the mouth of the infected animal, a common symptom is loss of body condition due to reduced feed intake, decreased growth rates, increased susceptibility to other diseases, and death from starvation if the infection persists. When a lactating ewe contracts the disease, the lesions on their teats can make it painful to nurse leading ewes to prematurely wean their lambs, reducing growth rates in lambs.

Soremouth is contracted by ewes through direct contact with objects in their environment such as fences, equipment, feed, and bedding that have been exposed to the virus. Sheep are able to recover from the virus when the symptoms are not so acute that the sheep starve themselves, and symptoms can be treated by applying topical iodine on the affected area. However, it is easy to spread the infection to adjacent areas of skin when applying the topical solution, so it is usually best to allow the lesions to heal on their own. The infection will typically last four weeks after which time the animal will become immune. Commercial vaccines are also available for the prevention of soremouth in sheep.

The vaccine is a live vaccine that causes a localized infection of the disease wherever the sheep producer chooses to scratch and infect the skin so that the sheep will build an immunity to the infection.[235] The area will usually be a hairless area such as the inside of the thigh, inside of the ear, or under the tail. Once a flock contracts soremouth, susceptible animals, such as offspring or purchased sheep, will likely contract the disease. Closed flocks should not have to vaccinate for soremouth if it is not present.

[235] Ibid.

Footrot/Foot Scald

Footrot is a virulent bacterial infection caused by the coexistence of two anaerobic bacteria, *Fusobacterium necrophorum* and *Dichelobacter nodosus*. Livestock become infected with these bacteria when they are habituating in warm, moist conditions.[236] The bacteria enter the hoof and digest the hard, horny tissue on the sole that protects the fleshy tissue within the foot. *D. nodosus* has a lifespan in the soil of 10 to 14 days but can survive in the foot for extended periods of time with the appropriate anaerobic environment.[237] In order for the bacteria to enter the skin between the toes to start the infection, there needs to be irritation on the skin and hard frozen ground in dry lots provides an environment that can cause irritation to that soft tissue. Once the ground warms to mud, the sheep are then in an ideal environment to develop footrot. It is most contagious when the soil has high moisture and temperatures between 50° and 70°F.[238] Footrot commonly develops when an infected sheep is added to the flock, but *D. nodosus* can also be carried by cattle, deer, and horses and brought into the flock. Some sheep can become chronic carriers of footrot. In addition to environmental factors, the flock's nutrition, genetics, age, and physical conformity can influence susceptibility to developing footrot.[239]

Foot scald is also a bacterial infection but is not as compromising to animal health because it only infects and inflames the area between the toes without undermining the horny tissue in the hoof.[240] *F. necrophorum* is present in the intestine of ruminants, so it is always present in pastures where ruminants graze and defecate, and it is the bacteria that can cause foot scald in cold, wet conditions where mud and manure have been able to accumulate.[241]

Virulent footrot can create huge economic losses due to the extenuating symptoms that the disease causes, particularly lameness that leads to decreased reproductive capabilities and weight loss and body condition from lack of feeding as well as decreased milk and wool production. Other clinical signs include redness and inflammation between the toes and a foul odor. Progressive cases can cause the hoof horn to separate from the hoof wall. Other costs associated with the disease include efforts for treatment and prevention, culling, decreased value upon sale of infected animals, and decreased lamb growth if the ewe has low milk production. Once a herd is infected with footrot, it can be difficult to eradicate.

When virulent footrot becomes prevalent in a flock, the infected animals need to be separated from the at-risk animals, and the animals that cannot be cured are culled. Infected animals can be treated by hoof trimming, irrigating the feet, vaccination, and antibiotic treatments to control the symptoms.[242] Footrot is a preventable disease by the same measures as well as dedicated surveillance of animal health, routine hoof checks and maintenance, quarantining new animals for 30 days before joining the flock, and moving feed and water troughs to reduce the likelihood of creating moist conditions for footrot to develop.

[236] https://www.extension.purdue.edu/extmedia/As/As-596-footrot.pdf. Accessed February 2024.
[237] Ibid.
[238] Ibid.
[239] Ibid.
[240] https://www.extension.purdue.edu/extmedia/as/as-595-commondiseases.pdf. Accessed February 2024.
[241] https://www.canr.msu.edu/news/foot-rot-and-foot-scald-in-goats-and-sheep. Accessed February 2024.
[242] https://www.extension.purdue.edu/extmedia/As/As-596-footrot.pdf: Accessed February 2024.

Bluetongue

Bluetongue is a viral disease that affects ruminants including sheep, cattle, deer, goats, and camelids, sheep being the most severely infected.[243] There are several strains of Bluetongue, so if an infected animal recovers from Bluetongue but is subsequently infected with a different strain, then that animal will become infected again as it is only immune to the strain that it was originally infected with. The disease is transmitted by biting midges which can travel long distances on the wind and have peak populations during warm months of late summer and early fall.[244] Historically, Bluetongue was most prevalent in tropical and subtropical areas including Central Africa and Southeast Asia, but outbreaks in other continents began spreading in the mid-2000s.[245] The United States does not currently have any programs related to the surveillance or mitigation of bluetongue.[246]

The main symptoms of Bluetongue are changes to the mucous membranes of the mouth and nose as well as on the coronary band on the foot (top of hoof); these are especially pronounced in sheep. Specifically, the infected animals will experience salivation, nasal discharge, ocular discharge, inflammation of the coronary band, and swelling of the face and ears. Sheep will also experience a fever and appear depressed and reluctant to move. Their tongues may also become swollen, and the lack of oxygen can make the tongue and mucous membranes appear blue. This disease can cause pregnant ewes to abort their pregnancies and impact their ability to return to estrus at regular intervals. These symptoms present themselves after an incubation period of 12 days.[247] Most flocks only experience a small percentage of losses from Bluetongue, but some flocks that are severely impacted can have deaths massing 70 percent of their flocks.[248]

Treatment of Bluetongue is limited. Antibiotics can be used to control secondary bacterial infections but not actually treat the Bluetongue disease. It is difficult to control because there are numerous potential hosts that can contract the disease and several strains that can be transmitted. There are some pour-on insecticides available to control midges that are expensive, but the primary prevention of the disease is through vaccination which are mostly used in Africa, Asia, and the United Kingdom.[249] The current vaccines are attenuated and killed vaccines, and some multivalent vaccines are available to protect against multiple strains.

Cache Valley Virus

This virus is mosquito-borne and endemic to North America. The mosquitos work as vectors for the virus and transmit the disease to sheep, cattle, and horses, resulting in reproductive losses in sheep. When Cache Valley Virus, or CVV, infects a fetus in a pregnant ewe between day 28 and day 48 of gestation, then fetal death and abortion or malformations at birth occur.[250] Infection up to day 28 results in fetal reabsorption and no apparent malformations have been observed after day 48. Most of these birth defects affect the brain and nervous system, as well as the skeleton

[243] https://www.nadis.org.uk/disease-a-z/cattle/bluetongue-in-cattle-and-sheep/. Accessed February 2024.
[244] Ibid.
[245] Ibid.
[246] https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/cattle-disease-information/bluetongue-disease-info.
[247] https://www.nadis.org.uk/disease-a-z/cattle/bluetongue-in-cattle-and-sheep/: Accessed February 2024.
[248] Ibid.
[249] Ibid.
[250] https://jvi.asm.org/content/87/10/5586: Accessed February 2024.

and muscle. Specific malformations include fused joints, twisted spines, and thin and underdeveloped muscles.[251]

Flocks that are infected with the disease typically experience a low percentage (less than 5 percent) of their lamb crop affected, but see overall lower ewe reproductive efficiency, decreased lambing rates, and higher numbers of open ewes.[252] Lambs with extreme deformities are stillborn, and lambs born alive with deformities from CVV generally have a very high mortality rate.

There is currently no vaccine for CVV and no treatments because it is a virus. Sheep that contract the virus gain some immunity to the disease, but the disease prevalence is in where it is regionally manifested, so flocks will lose their immunity over time which increases the clinical symptoms when the flocks become infected again.[253] Diseases such as CVV constitute a classic insurable peril, due to producer having little control over whether their flock is infected. Regarding indemnification of such a peril, maximum liability would need to be established and the lack of the presence of the disease initially would need to be proven.

VI.C. Price Risk

As the Contractor learned during the listening sessions, lamb price risk is considered by many producers to be one of the biggest perils facing their operations. The price of lambs is largely affected by retail demand for lamb meat products and total supply. Supply of lamb meat cuts can be significantly altered by import markets. These import effects are a result of lamb market dynamics and currency risk. Exchange rates, particularly with Australia and New Zealand, play an additional factor in the amount of lamb cuts being sold into the U.S. market, at times driving prices below the cost of production of many U.S. lamb producers. The role of these markets and data sources are discussed in Section IV. Data Availability and Price Methodologies.

The frequency of price loss events has increased in recent years. Table VI.3 shows the average price received over the previous five years as calculated from a time series shown in Figure IV.5 that was compiled from USDA AMS Market News auction data for prices paid at Fort Collins, CO for Choice and Prime Shorn Slaughter Lambs in $/lb. The average deviation calculated from a time series of prices indicates years with sustained periods of low prices while the largest deviation column shows the magnitude of these price losses.

[251] https://www.wlj.net/top_headlines/vet-warns-of-effects-of-cache-valley-virus-during-lambing/article_56bbe452-0856-11e8-9b1d-fbebf00712d1.html: Accessed February 2024.
[252] Ibid.
[253] Ibid.

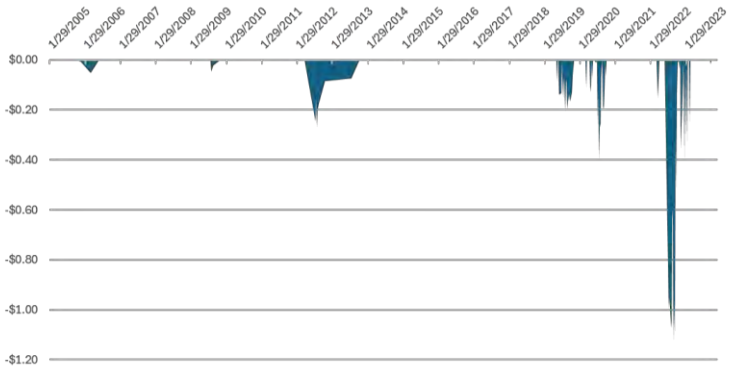
Table VI.3. Price Deviation Below the Previous 5-year Average History

Year	Previous 5-year Average	Average Deviation Below	Largest Deviation Below
2005	$0.76	$0.00	-$0.01
2006	$0.79	$0.00	-$0.05
2007	$0.85	$0.00	$0.00
2008	$0.90	$0.00	$0.00
2009	$0.93	-$0.01	-$0.05
2010	$0.94	$0.00	$0.00
2011	$0.98	$0.00	$0.00
2012	$1.12	-$0.16	-$0.27
2013	$1.17	-$0.04	-$0.07
2014	$1.21	$0.00	$0.00
2015	$1.35	$0.00	$0.00
2016	$1.47	$0.00	$0.00
2017	$1.54	$0.00	$0.00
2018	$1.41	$0.00	$0.00
2019	$1.66	-$0.07	-$0.21
2020	$1.67	-$0.05	-$0.39
2021	$1.71	$0.00	$0.00
2022	$1.86	-$0.35	-$1.12
2023	$1.83	-$0.03	-$0.39

Source: USDA AMS Market News, accessed January 2024.

Both the frequency and severity of price loss can be seen in Figure VI.1. The price loss of 2012-2013 was largely driven by high retail prices and heavyweight carcasses caused by delayed animal marketing. With steadily increasing imports going into the COVID-19 pandemic, a loss of supply due to changes in consumer demand for lamb and food consumption during the pandemic played a large role in the price collapse of 2022 as domestic supplies fell and import sales flooded the market. The data behind this is cited in Section IV. Data Availability and Price Methodologies.

Figure VI.1. Price Loss Frequency and Severity for Choice and Prime Slaughter Lambs Sold in Colorado



Date	Price Loss	Date	Price Loss	Date	Price Loss	Date	Price Loss
1/29/2005	-	9/24/2011	-	4/15/2020	-	8/10/2022	(0.94575)
2/19/2005	-	10/1/2011	-	4/22/2020	-	8/17/2022	(0.99340)
6/18/2005	-	10/15/2011	-	4/29/2020	-	8/24/2022	(1.04453)
8/13/2005	-	4/14/2012	-	5/6/2020	-	8/31/2022	(1.07214)
8/27/2005	-	8/4/2012	(0.24432)	5/13/2020	(0.12914)	9/7/2022	(0.63448)
9/3/2005	-	8/11/2012	(0.14682)	5/20/2020	(0.10271)	9/14/2022	(0.59541)
9/10/2005	-	8/18/2012	(0.26932)	5/27/2020	-	9/21/2022	(1.11988)
9/17/2005	-	8/25/2012	(0.20182)	6/3/2020	(0.07161)	9/28/2022	(0.96660)
9/24/2005	-	9/8/2012	(0.17432)	6/10/2020	-	10/5/2022	(1.08490)
10/1/2005	-	11/10/2012	(0.08432)	6/17/2020	-	10/12/2022	(0.28258)
10/8/2005	-	8/10/2013	(0.07457)	6/24/2020	-	10/19/2022	(0.50953)
10/15/2005	-	11/2/2013	-	7/15/2020	(0.01276)	10/26/2022	(0.13030)
10/22/2005	-	1/25/2014	-	7/22/2020	-	11/2/2022	(0.00574)
11/12/2005	-	8/23/2014	-	7/29/2020	(0.25610)	11/9/2022	(0.00833)
12/17/2005	(0.00619)	8/1/2015	-	8/5/2020	(0.12277)	11/16/2022	-
4/1/2006	(0.05252)	9/12/2015	-	8/12/2020	(0.39470)	11/23/2022	(0.03664)
6/24/2006	-	3/12/2016	-	8/19/2020	(0.26793)	11/30/2022	(0.01156)
7/1/2006	-	8/20/2016	-	8/26/2020	(0.25680)	12/7/2022	(0.35313)
7/22/2006	-	8/27/2016	-	9/2/2020	(0.06632)	12/14/2022	(0.25222)
7/29/2006	-	9/17/2016	-	9/9/2020	-	12/21/2022	(0.15510)
8/12/2006	-	3/10/2018	-	9/16/2020	(0.03522)	1/4/2023	-
8/19/2006	-	7/28/2018	-	9/23/2020	(0.18547)	1/11/2023	(0.38985)
8/26/2006	-	11/3/2018	-	9/30/2020	(0.19834)	1/18/2023	(0.01447)
9/23/2006	-	11/10/2018	-	10/7/2020	(0.11709)	1/25/2023	(0.29652)
10/7/2006	-	4/24/2019	-	10/14/2020	(0.01246)	2/1/2023	-
10/14/2006	-	5/1/2019	-	10/21/2020	(0.06207)	2/8/2023	(0.32642)
11/4/2006	-	5/8/2019	-	10/28/2020	-	2/15/2023	-
5/5/2007	-	5/15/2019	-	11/4/2020	-	2/22/2023	-
5/19/2007	-	5/22/2019	-	11/11/2020	-	3/1/2023	-
6/9/2007	-	5/29/2019	-	11/18/2020	-	3/8/2023	(0.24852)
6/16/2007	-	6/5/2019	(0.08532)	11/25/2020	-	3/15/2023	-
6/30/2007	-	6/12/2019	-	12/2/2020	-	3/29/2023	-
8/4/2007	-	6/19/2019	-	12/9/2020	-	4/5/2023	-
8/11/2007	-	6/26/2019	(0.13910)	12/16/2020	-	4/12/2023	-
9/1/2007	-	7/17/2019	(0.13418)	1/6/2021	-	4/19/2023	-
9/8/2007	-	7/24/2019	(0.00547)	1/13/2021	-	4/26/2023	-
3/15/2008	-	8/7/2019	(0.14901)	1/20/2021	-	5/3/2023	-
6/7/2008	-	8/14/2019	(0.06696)	1/27/2021	-	5/10/2023	-

Date	Price Loss	Date	Price Loss	Date	Price Loss	Date	Price Loss
8/2/2008	-	8/21/2019	(0.10018)	2/3/2021	-	5/17/2023	-
8/9/2008	-	8/28/2019	(0.20548)	2/10/2021	-	5/24/2023	-
8/16/2008	-	9/4/2019	(0.09164)	2/17/2021	-	5/31/2023	-
8/23/2008	-	9/11/2019	(0.07668)	2/24/2021	-	6/7/2023	-
8/30/2008	-	9/18/2019	(0.19633)	3/3/2021	-	6/14/2023	-
9/6/2008	-	9/25/2019	(0.16548)	3/10/2021	-	6/21/2023	-
9/13/2008	-	10/9/2019	(0.13472)	3/17/2021	-	6/28/2023	-
9/27/2008	-	10/16/2019	(0.16604)	3/24/2021	-	7/19/2023	-
10/4/2008	-	10/23/2019	(0.15578)	3/31/2021	-	7/26/2023	-
10/18/2008	-	11/6/2019	(0.12711)	4/7/2021	-	8/2/2023	-
10/25/2008	-	11/13/2019	(0.06146)	4/14/2021	-	8/9/2023	-
11/22/2008	-	11/20/2019	(0.02996)	6/9/2021	-	8/16/2023	-
12/13/2008	-	11/27/2019	-	6/16/2021	-	8/23/2023	-
4/11/2009	-	12/4/2019	-	6/30/2021	-	8/30/2023	-
5/16/2009	-	12/11/2019	-	7/21/2021	-	9/6/2023	-
6/27/2009	-	12/18/2019	-	8/11/2021	-	9/13/2023	-
8/15/2009	-	1/8/2020	-	8/25/2021	-	9/20/2023	-
8/22/2009	(0.04680)	1/15/2020	-	9/15/2021	-	9/27/2023	-
9/12/2009	(0.02180)	1/22/2020	-	1/12/2022	-	10/4/2023	-
11/21/2009	-	1/29/2020	-	2/23/2022	-	10/11/2023	(0.01589)
9/4/2010	-	2/5/2020	-	3/16/2022	-	10/18/2023	-
10/2/2010	-	2/12/2020	-	3/30/2022	-	10/25/2023	-
10/9/2010	-	2/19/2020	-	4/13/2022	(0.15260)	11/1/2023	-
10/23/2010	-	2/26/2020	-	4/27/2022	-	11/8/2023	-
1/8/2011	-	3/4/2020	-	5/4/2022	-	11/15/2023	-
4/16/2011	-	3/11/2020	-	5/11/2022	-	11/22/2023	-
7/30/2011	-	3/18/2020	-	5/18/2022	-	11/29/2023	-
8/13/2011	-	3/25/2020	-	6/15/2022	-	12/6/2023	-
8/20/2011	-	4/1/2020	(0.10845)	6/22/2022	-	12/13/2023	-
8/27/2011	-	4/8/2020	-	8/3/2022	(0.99520)	12/20/2023	-
9/3/2011	-						

Source: USDA AMS Market News, accessed January 2024.

Price loss is an insurable peril for lamb producers as experienced at sale. Protection against government policy or import quantities is not insurable under the act. The lamb market expectation of price is, unfortunately, not available in any public data sources. Packers and retailers maintain contracts, many of them forward contracts with negotiated price; however, this contract data is not currently accessible. In discussions with stakeholders, the Contractor learned that releasing this pricing data represents negotiated sales which contain dynamics related to other factors such as transportation and quality. On a large enough scale, such data sources could be privately analyzed to derive a market expectation of price movement. While establishing a market price would be essential to any insurance development, deriving the perceived volatility of that price would be difficult and require a high degree of estimation.

A study was conducted in 2014 by Paul Peterson entitled "Necessary and Sufficient Conditions for a New Futures Contract on Slaughter Lambs"[254] This study found eight conditions necessary for successful futures contracts with four of them identified as serious problems. The cash

[254] Peterson, P. E. Necessary and Sufficient Conditions for a New Futures Contract on Slaughter Lambs. American Sheep Industry Association. August 2014.

market size and cash market concentration of the lamb market was found to be insufficient. There was also criticism at the time that the LRP Lamb program would potentially interfere, a problem that does not exist today. The other major issue was the lack of price volatility as previously mentioned. The reports final conclusion was that a lamb futures contract would be unlikely to succeed, and exchanges would not develop such a product. As this report was completed ten years ago and the lamb market has undergone changes since then, it may be worthwhile to revisit some of these issue; however, in discussions with the lamb industry the general sense is that many of the same concerns exist today.

VI.D. Financial Risk

Revenue generated by lamb sales is an important source of income for a number of operations in the United States. According to the U.S. Census of Agriculture the number of operations generating more than $50,000 in total market value from sheep fell from 12,335 in 2012 to 11,694 in 2017.[255] However, the recent Census of Agriculture shows a slight increase to 11,849 operations in 2022.[256] Lamb producers rely on this income to pay for such things as family living expenses, to maintain rural infrastructure, and to support communities with limited access to economic resources. The total number of operations at these higher revenue levels show production is steady maintaining current levels and a mainstay for many individuals. The Contractor was not able to find data pertaining to the extent to which communities and individuals rely on revenue generated by lamb production as a primary source of income. The loss of this economic impact is a peril that would, however, affect many individuals in some capacity. The frequency of this loss is also not well understood; however, recent reductions in the prices received for lambs did significantly affect producers net farm income as the Contractor was informed during listening session data collection. This loss of economic impact and living expenses is not an insurable peril.

VI.E. Institutional Risk

Regulatory actions taken, particularly with respect to import and export markets would present a major source of institutional risk to lamb producers. Such actions by the government such as tariffs or trade agreements that would make lamb imports more or less feasible for foreign producers would severely impact the U.S. supply of lamb cuts and result in potentially a significant fall in prices. Such actions are unlikely to occur. While price protections are insurable under the act, policy and decisions of state are not.

Many lamb operations graze large tracts of public land, particularly in the western states. Loss of publicly leased land could have major ramifications on these operations. The Bureau of Land Management (BLM) administers about 18,000 permits for livestock to graze as much as 155 million acres of public land. This resource is of very high value to lamb producers and if lost would result in significantly higher costs of production and would likely put a significant number of lamb operations out of businesses. The frequency of loss of permits is low, these permits usually cover a ten-year period and are renewable if certain conditions are met. Changes in rulemaking or policy that limits livestock grazing is not insurable under the act.

[255] USDA NASS Quick Stats data, accessed February 2024.
[256] Ibid.

VI.F. Human or Personal Risk

According to data and research from the National Institute for Occupational Safety and Health (NIOSH), the agricultural industry, which is grouped with data from the forestry, fishing and hunting sectors, represented one of the highest fatal injury rates when compared to all other U.S. industries. For 2022, the fatal injury rate was 23.5 fatalities per every 100,000 full time workers employed in the agricultural, forestry, fishing and hunting industries.[257/258] For additional context, the average fatality rate for all U.S. industries combined in 2021 was 3.6 deaths per 100,000 workers, and a total of 5,190 fatal injuries recorded in all U.S. industries for 2021.[259] Agricultural production is one of the only industries where family members are also at risk for work related injuries due to the fact that families of agricultural workers reside, and in most cases, are required to help on the farm. While these estimates remain some of the highest across all industries, the NIOSH also states they believe these figures are severely under-reported since the survey methodology excludes self-employed workers, which constitute the majority of agricultural producers. Additionally, with agricultural production occurring in rural areas of America, barriers to healthcare are a large concern. The Rural Health Information hub lists the following as barriers to healthcare access – all of which lead to a significant under-representation of injury and fatality rates in the agricultural sector: "…workforce shortages, health insurance status, transportation issues, health literacy, and stigma in rural communities" and "…access issues for specific populations and healthcare services."[260]

A 2019 study analyzed data pulled under the query for "farm" and other relevant key words from the U.S. Consumer Product Safety Commission and the National Electronic Injury Surveillance System databases to estimate the number of people who were treated for agricultural related injuries in an emergency department. They found that 62,079 people were treated for farm related injuries that occurred in people between the ages of 1 and 95 years old, and approximately 30 percent of the injuries found were in youth patients.[261]

Understanding that the agricultural industry experiences one of the highest rates of injury and fatality, and is severely under-reported, provides context for the following discussion of human and personal risk in sheep and lamb production.

According to Oregon State's Occupational Health Program for Animal Handling and Cornell College of Veterinary Medicine Animal Health Diagnostic Center there are several human and personal risks that can be associated with sheep production. Zoonotic diseases, one subset of human risk to sheep production, consists of diseases such as rabies, Q-fever, contagious echthyma (referred to as Soremouth in sheep), ringworm, chlamydiosis, brucellosis, listeriosis, salmonella, campylobacteriosis, coccidioidomycosis, cryptosporidiosis, giardiasis and

[257] https://www.cdc.gov/niosh/topics/aginjury/default.html.
[258] https://www.bls.gov/news.release/cfoi.nr0.htm.
[259] https://www.bls.gov/iif/fatal-injuries-tables/fatal-occupational-injuries-table-a-1-2021.htm.
[260] https://www.ruralhealthinfo.org/topics/healthcare-access#:~:text=Barriers%20to%20care%2C%20including%20workforce,specific%20populations%20and%20healthcare%20services.
[261] Serap Gorucu, Judd Michael & Kelly Chege (2022) Nonfatal Agricultural Injuries Treated in Emergency Departments: 2015-2019, Journal of Agromedicine, 27:1, 41-50, DOI: 10.1080/1059924X.2021.1913271.

anthrax.[262/263] Zoonotic diseases are contracted through either direct or indirect contact with an infected animal, consumption, inhalation, and vectors such as flies, ticks, mosquitoes, and other pests.

Another subset of human risk associated with sheep and lamb production is the risk of physical injury in the management or handling of sheep and lambs. Activities such as shearing, drafting, mustering, and drenching are common amongst those listed as the cause of injury in emergency departments for accidents that occur as a result of sheep and lamb production.[264] Sheep are well known for their docility; however, they are very gregarious and function as a flock unit. As a result, when they are separated from their flock can become rather dangerous to handle.

Jumping, head butting, charging, are a few incidences of physical risks that can occur in sheep management and production. Sheep are strong enough to cause the incidence of fractures and broken bones in certain circumstances.

Pesticides, fungicides, bactericides, and biological control agents are utilized in sheep and lamb production and the handling of these substances can pose additional risk to the producer. Human exposure to these agents via the skin, lungs (inhalation), mouth, and the eyes can be toxic depending on the level of toxicity of the agent, the chemical concentration, and the duration of time exposed to the agent.[265]

VI.G. Man-Made Risks

Influence of Management and Labor

Labor tasks and management decisions both can have significant impacts on mortality. Labor tasks such as evaluating the lambs and ewes every few hours for general health and vigor, checking a lamb's ability to suckle and ensuring adequate colostrum is ingested, and artificial rearing can have major impacts on the mortality rates of a ewe flock. Trained labor can also help to prevent problems such as Central Nervous System (CNS) injury which can occur through a number of ways including dystocia (a stuck lamb that requires birthing assistance) and the lesser-known hypoxia (oxygen deprivation/stress). These commonly affect heavy weight lambs enduring longer or more difficult births, and small lambs which are more prone to hypoxia despite normal birthing lengths. These can be somewhat managed by keeping bred ewes at proper body condition scores and by good genetic selection. Thus, accurate nutrition management of the ewe using body condition scoring is important to ensure the ewe is in the right condition to achieve optimal birthweight of lambs. In addition, whether lambing occurs in a building or on pasture, management can make a difference on the percent lamb crop reared. For pasture lambing, choosing a lambing time that has more favorable weather and ensuring proper nutrition can be key steps in reducing lamb mortality.

This presents a potential issue from an insurance development standpoint as these lambs will often eventually die from secondary causes – such as predation, starvation, or cold exposure.

[262] https://www.vet.cornell.edu/animal-health-diagnostic-center/programs/nyschap/modules-documents/zoonotic-diseases-sheepgoats.
[263] https://occupationalhealth.oregonstate.edu/sheep.
[264] https://aghealth.sydney.edu.au/wp-content/uploads/2019/05/ohs_risk_sheep_wool_production_aus.pdf.
[265] Ibid.

Birth stressed lambs or lambs that failed to ingest adequate colostrum will have compromised immune systems and are much more likely to contract fatal illnesses later in life. Other managerial factors, such as too many ewes in the lambing mob or too many ewes per hectare can also increase the risk of hypoxia by increasing birth time.

Lambing mortality preventative factors and techniques directly influenced by management include, but are not limited to:

- Ensuring adequate knowledgeable labor and supervision available to perform duties such as daily health observations and adequate colostrum intake.
- Well-designed facilities to avoid overcrowding, accidents, and to provide a relatively sterile healthy environment more easily.
- Use of good animal husbandry techniques, such as artificial rearing of some lambs to reduce the mild demands on some ewes and ensuring adequate bonding time between a ewe and her lambs.
- Genetic selection of ewes for ease of lambing, good udder structure and milk supply, and strong maternal instincts.
- A good nutrition plan.
- Established procedures to maintain hygiene.
- An established health protocol developed with a veterinarian.

VI.H. Grading Standards

A USDA enforced and administered grading system exists for lamb after slaughter at the national level. Grades are determined by USDA employees who work independently from both packers and producers. The grade of an ovine carcass is based on separate evaluations of two general considerations. The first is palatability, which indicates characteristics of the lean and conformation and the estimated percent of closely trimmed (0.10-inch fat or less), semi-boneless and boneless, as well as major retail cuts to be derived from the carcass. For lamb, there are four quality grades within each class: Prime, Choice, Good, and Utility.[266]

Yield grades reflect the "quantity" of retail cuts that can be expected from a lamb carcass. Yield grades in lamb refer to a classification system used to assess the amount of lean meat present in a lamb carcass relative to its fat content. These yield grades provide information for both producers and consumers, assisting in determining the quality and market value of lamb carcasses.

Yield grades are 1, 2, 3, 4 and 5 with yield grade 1 being more desirable than a yield grade 5 in the amount of retail cuts from the leg, loin, rib and shoulder. Adjusted fat thickness of the carcass is the only factor used to determine lamb yield grades.

The yield grade of an ovine carcass is based on the amount of external fat present. The amount of external fat for carcasses with a normal distribution of this fat is evaluated in terms of its actual thickness over the center of the ribeye muscle.

[266] https://www.ams.usda.gov/grades-standards/lamb-grades-and-standards.

Some packers have a system set up, known as "the grid", where the owners of the lambs (often a feedlot by the time a lamb is slaughtered, producers that retain ownership all the way to slaughter, or the packers themselves) are paid premiums or discounted based on the average carcass grades and yield grades a group of lamb receives.

VI.I. Disaster Program Payments

Lamb producers have received several ad hoc disaster program payments over the last 10 years. The most notable and largest of these was the Coronavirus Food Assistance Program (CFAP), which was a relief initiative implemented by the USDA in response to the COVID-19 pandemic. The primary objective of CFAP was to provide financial assistance to agricultural producers who faced market disruptions and financial losses due to the pandemic.

CFAP offered direct payments to eligible farmers, ranchers, and other agricultural producers who suffered price declines and additional marketing costs as a result of COVID-19. These payments aimed to help offset some of the financial hardships experienced by producers across various sectors of the agricultural industry. CFAP had multiple rounds of funding, with adjustments and expansions made over time to address evolving needs within the agricultural sector. For sheep producers, the first round of payments for lambs totaled (CFAP 1): $50,092,263.36.[267] The second round of payments to sheep producers, CFAP 2, totaled: $91,999,177.[268]

Another ad hoc program that made payments to lamb producers was the Emergency Livestock Relief Program (ELRP), which was a livestock ad hoc disaster relief program designed to assist producers with losses incurred during the 2021 crop year drought. The bill allotted $750 million to assist producers of livestock for losses incurred during calendar year 2021 due to qualifying droughts or wildfires. The livestock producers who suffered losses due to drought are eligible for assistance if any area within the county in which the loss occurred was rated by the U.S. Drought Monitor as having a D2 (severe drought) for eight consecutive weeks or a D3 (extreme drought) or higher level of drought intensity during the applicable year.

In addition to ad hoc programs, the 2014 farm bill permanently authorized four agricultural disaster programs for livestock that apply to lamb producers: the Livestock Indemnity Program (LIP); the Livestock Forage Disaster Program (LFP), the Emergency Assistance for Livestock, Honey Bees, and the Farm-Raised Fish Program (ELAP). Producers do not pay a fee to participate in these programs and advanced sign-up is not required. They are all administered through the Farm Service Agency (FSA) and funded via the Commodity Credit Corporation (CCC). In fiscal year 2021, $544 million was paid through LFP, $76 million was paid through ELAP, and $16 million was paid through the LIP.

LIP provides payments to eligible livestock owners and contract growers for livestock deaths in excess of normal mortality caused by extreme or abnormal damaging weather, disease, and attacks from wild animals reintroduced or protected by the federal government. The program also compensates producers when an animal is injured as a direct result of an eligible loss condition but is not killed and is sold at a lower price.

[267] https://www.farmers.gov/data/cfap1.
[268] https://www.farmers.gov/data/cfap2.

The LFP makes payments to eligible producers who have experienced grazing losses on drought-affected pastureland or on rangeland managed by a federal agency due to a qualifying fire. Producers must own, cash or share lease, or be a contract grower of covered livestock during the 60 days prior to the beginning date of a qualifying drought or fire. They must also provide pastureland for livestock that is physically located in a county affected by a qualifying drought during the normal grazing period for the county or is managed by a federal agency where grazing is not permitted due to fire. For drought, payments are 60 percent of the estimated monthly feed cost. Payment frequencies are dependent on drought intensity levels published weekly for a specific county by the U.S. Drought Monitor.

ELAP provides payments to producers of livestock, honeybees and farm-raised fish and compensation for losses due to disease, adverse weather, feed or water shortages, or other conditions (such as wildfires) that are not covered under LIP or LFP. In 2021, the USDA updated ELAP to cover feed transportation costs for drought-impacted ranchers. Many ranchers who transported livestock to new feed sources were left out in the original policy, so transporting livestock to feed was added in a later version. The policy allows reimbursements of 60 percent (90 percent for socially disadvantaged, beginning, or veteran farmers or ranchers) of feed transportation costs above what would have been incurred in a normal year. This rate is then multiplied by the national average price per mile to transport a truckload of eligible livestock or livestock feed, multiplied by the actual number of additional miles the feed or livestock was transported by the producer in excess of 25 miles per truckload of livestock or livestock feed and for no more than 1,000 miles per truckload of livestock or feed during the program year.

VII. FEASIBILITY ASSESSMENT AND RECOMMENDATIONS

This section of the report responds to the following statement in the SOW:

> *"Feasibility Recommendations, Possible Design Options and Impact Analyses – The Contractor shall make recommendations on the feasibility of new product development for the production of lambs. The Contractor shall provide a comprehensive discussion of crop insurance alternatives with an overall recommendation and explanation of why it is recommended. For any recommended program, the Contractor shall include an outline of the model or methodology used for the basis of the guarantee, preliminary premiums, expected prices, and determining yields. The Contractor shall also recommend a year for implementation, units of exposure, types, practices, insurance dates, initial insurability requirements, pilot counties, insured causes of loss, uninsured causes of loss, a description of what triggers a loss and how indemnities will be calculated, and loss adjustment procedures. The Contractor shall identify and evaluate the potential impacts on producers, taxpayers and the market of any crop insurance programs in which producers express an interest. The Contractor shall identify the risk of program fraud, abuse, adverse selection, and moral hazard faced by the government.*
>
> *The Contractor when recommending a possible insurance program needs to keep in mind the following criteria:*
>
> - *It must conform to RMA's enabling legislation, regulations, and procedures that cannot be changed;*
> - *The insureds and their agents must be willing to pay the appropriate price for the insurance;*
> - *The insurance product must be effective, meaningful, and reflect the actual risks of the producers;*
> - *The perils affecting production must be identified and categorized as insurable and non-insurable;*
> - *Be ratable and operable in an actuarially sound manner;*
> - *Contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions;*
> - *There must be an appropriate geographic distribution of production to ensure a sound financial insurance program;*
> - *There must be enough interest for the risk to be spread over an acceptable pool of insureds;*
> - *Customers must not be able to select insurance only when conditions are adverse;*
> - *Moral hazards must be avoidable or controllable;*
> - *There must be no change of beneficial gain; and*
> - *There must be no change in market behavior or market distortions that change the quantity supplied or shift the supply curve."*

The task of this report is to collect information and data to analyze the potential development of new risk management tools for lamb producers in the United States. This section is intended to provide a discussion and conceptual overview of alternative crop insurance products that could offer this protection and evaluate their potential feasibility for further development. The

discussion is based on producer feedback regarding their risk management needs garnered from statements made during the listening sessions and individual conversations with the Contractor.

A variety of potential insurance programs were considered. Producers consistently requested one particular form of insurance, namely price insurance, with the intended outcome being a product they could utilize to protect against market price volatility. This requested form of insurance most closely resembled the previously available LRP Lamb product with many producers suggesting variations of this product that might enable it to be offered again. As discussed in Section VI. Risk Analysis and again in this section, reinstating a similar product presents certain challenges. As this study was not restricted to price insurance, but all forms of protection, additional considerations such as for production or revenue insurance are also herein considered. The findings of this report, while of limited certainty in a potential successful development, do find that as industry awareness and demand increase for insurance that is not price-only, certain avenues of development may become moderately feasible.

The Contractor also found some level of interest among producers during the course of the listening sessions in some form of wool protection. In a sense, for most producers, (there are a few exceptions) the market wool is to lamb as cotton seed is to cotton lint – a coproduct that can have value but is not typically the driver of basic production economics. While wool insurance is technically outside the scope of this report, the interest in insuring that revenue source should be noted, particularly if the development of a revenue type product was to be pursued.

Given the large number of risks and concerns raised during the listening sessions, the Contractor evaluated the feasibility of a variety of alternative insurance types, beginning with the most basic and moving to the more complex. These include Mortality Insurance, Lamb Production Insurance, Price Insurance, and Revenue Insurance.

VII.A. Crop Insurance Alternatives and Feasibility

The following are alternative crop insurance options for lamb producers including a discussion about the potential of successfully implementing an insurance development.

Mortality Insurance

Producers in the listening sessions mentioned predation losses, disease, and lambing losses as causes of concern and potential risks. As discussed in Section III. Review of Other Programs, many states have predation programs and the LIP program offered through the FSA offers some mortality coverage at what equivocates to a low coverage level policy.

A mortality insurance policy for lambs could be constructed to function similarly to the LIP administered by FSA. Though not an insurance program in the strict sense of the term, this program provides reimbursement for mortality losses in livestock to producers. For this product concept, producers would ideally keep track of and submit documentation annually to their insurance provider or government-based guarantor verifying the size of their flock and expected lamb crop through documentation and pregnancy scanning before lambing or by verifying their lamb crop size post lambing.

An insurance value factor is used to peg the correlation between weight and market value. While it can be generally assumed the value of market lambs increases as they near and pass the time of weaning, accounting for the various values of lambs of different ages presents significant challenges to insurance. In addition, producers sell different groups of lambs at different weights and prices due to a variety of factors. Based on stakeholder input during the listening sessions, lamb producers in different parts of the country may hold or sell lambs in the fall depending on demand for various lamb weights (this is much more common in ethnic markets where different sized lambs are desired at different times during the year). During the listening sessions, the Contractor learned producers around the San Angelo, Texas and New Holland, Pennsylvania regions will continue to hold and feed their lambs or choose to sell them immediately after weaning depending on whether the price for heavier lambs rises relative to lighter lambs.

The most straightforward solution to this approach is that employed by the LIP program in which livestock are given a static value regardless of their age before weaning. The data to determine such a value is readily available using the pricing data tracked by the AMS and thus presents little barrier to insurance if used statically similarly to a Yield Protection program. The consequence of this simplicity, however, is that many producers will be over or underinsured relative to the current value of the lost stock at any given time.

Mortality Insurance Example

Assume *Example Farm Mort* lost lambs due to a covered cause of loss such as an adverse weather event in June 2024. *Example Farm Mort* followed all reasonable operating practices listed in the insurance provisions. *Example Farm Mort* provided the following verifiable beginning inventory ewe records for the following calendar years:

Table VII.1. Mortality Insurance Example Historical Live Ewe Drop Rates – *Example Farm Mort*

Year	Verifiable Beginning Calendar Year Inventory of Ewes	Verifiable Lamb Sales	Final Live Ewe Drop Rate
2023	1,195	1,950	163%
2022	1,175	1,820	155%
2021	1,156	1,865	161%
2020	1,010	1,606	159%
Average Final Live Lamb Percentage			160%

Source: Example generated by The Contractor

For 2024, *Example Farm Mort* provided a verifiable beginning inventory of 1,000 ewes. *Example Farm Mort* insured their lamb crop at an 80 percent coverage level. Assume lambs are valued at 80 pounds and the AMS average sale barn price was $1.90 per lbs. The liability calculation would be:

*(Cov. Level) * (Average Live Lamb Percentage) * (# of Ewes) * (Lamb Value)*

Where the Average Live Lamb Percentage is the simple average of the Final Live Ewe Drop Rate for each reported year rounded to the nearest whole percentage point and Lamb Value is the published covered sale weight of lambs (80 pounds for this example) multiplied by the AMS average sale barn price ($1.90).

Example Farm Mort would thus have a total liability of:

0.80 * 1.60 * 1,000 * 152 = $194,560

Following the loss, *Example Farm Mort* submits documentation of a loss of 400 lambs (note this loss is in excess to 'historically typical' losses). The *Example Farm Mort* then markets 1,200 lambs in the fall and submits documentation of the sales.

The formula for final harvest revenue is:

*(Actual Live Lamb Percentage) * (# of Ewes) * (Lamb Value)*

Example Farm Mort final harvest revenue is:

1.20 * 1,000 * 152 = $182,400

To calculate the indemnity, the actual harvest revenue is subtracted from the liability:

$194,560 - $182,400 = $12,160

Thus, *Example Farm Mort* would receive an indemnity of $12,160 in the above scenario.

A standard mechanism in crop insurance to control liability and risk is that of a maximum coverage level. This mechanism essentially serves the same purpose as a minimum deductible on a standard insurance policy. This limit accounts for the expected normal loss or mortality experienced by farms which is not considered insurable risk. In the case of lambs, normal mortality rates range from 12 percent to 16 percent though pre-weaning mortality can normally range anywhere from 10 percent to 30 percent.[269] The maximum coverage level should be set at a point lower than/outside the range of normal mortality losses in order to provide true risk management, but so as not to indemnify poor animal husbandry or operational management. As both these factors are exceptionally difficult to monitor, coverage levels would have to be set at a level under which only truly egregious failures of management could artificially trigger losses, and these could be assessed by loss adjusters.

The value of the lambs also needs to be set at a level so as to deter moral hazard regarding mortality losses from poor management or reduced inputs. For the LIP, this is done by effectively reimbursing farmers and ranchers at an effective rate somewhat less than 50 percent of the real final value of the animal (it should be noted: the premium rate for LIP is essentially 0 and producers are not required to sign up beforehand). This theoretically should provide producers with enough incentive to maintain inputs and animal husbandry practices in order to avoid making an insurance claim, while providing them with coverage should disaster strike. It may be useful to think of this reduced valuation as a co-pay for losses once the deductible has been met. In developing such a program, an overt co-pay to maintain production and management incentives for producers may be appropriate.

[269] Dwyer, C.M. 2008. Genetic and physiological determinants of maternal behavior and lamb survival: Implications for low-input sheep management. J. Anim. Science 86:E246-E258.

Feasibility

There was minimal interest in a pure mortality type policy during the listening sessions and during individual conversations with the stakeholders, indicating possible low uptake.

For this insurance concept, the number of pregnant ewes or ewes with lambs would need to be third party verified. Discussions with producers revealed regular pregnancy scanning to be relatively uncommon, but some listening session participants agreed they might be willing to perform the task annually for insurance purposes. However, based on feedback obtained during individual producer conversations, many large western state producers may be uncertain of the precise number of ewes they take from the lambing ground in the spring to summer pasture (often on BLM permits or state or national forest permits) in the fall. They may be even less sure of the number of lambs that accompany those ewes, having limited opportunities to obtain a precise count (this is more likely in cases where producers are running several thousand ewes and base their stocking rates on estimated numbers). Also, in those regions where lambing is continuous on open range (Texas), tracking successful live births and pregnancy testing year-round would be virtually impossible and very costly. As a matter of practice, it is generally undesirable to change the industry being insured so it can accommodate the needs of the insurance policy.

Another potential issue is the question of moral hazard regarding the animal husbandry and care of the flock (crop), which has a substantial effect both on the mortality rates and the rate of gain of the lambs.

Additionally, rating crop insurance ideally requires access to substantial historical data on the frequency and severity of losses. While this ideal is rarely met, in the case of lamb, the variance in production models, environments, and management styles coupled with the lack of currently available records or data documenting the economic results of those differences to calculate expected loss differences by operational style and region presents a substantial obstacle to premium calculations. The Contractor was unable to identify a long-term, time series database containing the necessary observations, diversity in geography, frequency of loss, and severity of loss information delineated by enough production practices to construct a data driven rating model of rates of gain by practice for lamb.

With the collection of additional data, a moderate coverage mortality policy attaching sometime after 10 to 50 days of age on the lambs and extending until the sale date of the lambs appears feasible for some types of operations in some areas. This policy would need to account for the lambing conditions if the policy attached before lambing, such as barn or pasture lambing among a number of other factors. Ideally, over a period of years, a participating producer would maintain mortality records through the insurance program which may then allow for increased coverage options or rating adjustments (reduced premium) based on loss ratios.

As discussed in greater detail in earlier sections, there are innumerable potential causes of lamb mortality and ways these are influenced by labor and management decisions. It is fundamentally challenging to monitor and confirm appropriate management practices have been incorporated to (which differ depending on the context) minimize mortality. The presence of an insurance guarantee can substantially alter grower incentives to maximize lamb survival. The two main

barriers to this type of insurance can thus be summarized into two topics. The first is moral hazard related to the influence of management decisions on mortality rates (which in many cases is nearly undetectable, such as inadequate prenatal nutrition resulting in immunocompromised lambs the following spring). The second is the issue of loss adjustment. Confirming losses and whether they fall under insurable causes of loss is a challenge yet to be addressed to the satisfaction of all parties in the currently available programs providing some relief to producers for herd and/or flock mortality losses. Both these issues might be somewhat negated by calculating liability as a function of historical production on an operation and by capping liability at a level that only insures lambs to a point where a portion of input costs are covered. Such a system would deter moral hazard and enable a potentially simpler program where the number of surviving lambs need confirmation, but individual mortalities do not (though for larger losses, some dated photographic evidence might be recommended).

Such a system might present its own challenges in that producers may not deem it worthwhile, thus some sort of balance would need to be found between administrative burden and the viability of the program.

Based on the data gathered, listening sessions, review of the scientific literature available, and the Contractors assessment, a mortality policy insurance product is deemed infeasible.

Lamb Production (Weaned Lamb Crop) Insurance

Some interest was expressed during listening sessions in an option to insure total pounds of weaned lambs. Theoretically, a rate of gain policy could be implemented on a simple model. The majority of producers sell either their lambs at auction barns or over private scales on contract (although a significant number of larger producers discussed maintaining ownership of their lambs to slaughter, wintering them either on feedlots or on grass in warmer climates) and receive a receipt recording the number of lambs, weight and price per pound of each group of lambs sold. If the dates of birth of the lambs were known (or a lambing calendar window was specified), with the correct records, it would be straightforward to calculate an average rate of gain per day for a lamb crop or simply track the average lamb. Total lamb crop weight might also theoretically be insurable (except for numerous comments received from producers/stakeholders indicating they sell at different weights at different times each year depending on prices as discussed elsewhere in this report, confounding the meaningfulness of past performance as a predictor of future outcomes). This is where an average daily gain estimate becomes relevant, since regardless of when a producer sells the lamb crop, total weight can be divided by number of days of age to establish an average daily rate of gain (ADG) for the lamb crop as a whole or in contemporary groups (provided the necessary data are maintained). Thus, in theory, a rate of gain production insurance could be relatively easy to implement.

Using sale records, the sale dates and average weights could be used to estimate days to market and ADG on lambs sold in the past. Ideally, days to market and ADG would be calculated for each individual animal. This would provide a more accurate picture of the performance of the animals in the flock. However, using lambing dates and market receipts would provide a reasonable estimate of the ADG it takes a farm's lambs to reach the marketplace using information already available.

Production Insurance Example

Table VII.2. shows an example of two groups of lambs from two different contemporary groups. The first group is assumed to be pasture finished and the second group is assumed to be supplemented with grain and feedlot finished.

Table VII.2. Lamb Average Daily Gain Estimation

Group	Lambing Start Date	Sale Date	Head Sold	Avg. Birth Weight	Avg. Sale Weight	Weight Gained	Days to Market from Lambing Start Date	Avg. Daily Gain
Feedlot Finished: Group 1	20-Apr	10-Oct	100	6 lbs.	100 lbs.	94	173	0.54 lbs./day
Pasture Finished: Group 2	20-Apr	20-Nov	100	6 lbs.	100 lbs.	94	214	0.44 lbs./day

Source: Example Generated by The Contractor

Example Farm Prod experienced a reduction in final sale weights on its 100 pasture raised lambs (Group 2) due to an eligible cause of loss such as an adverse weather event in June and July 2024. *Example Farm Prod* followed all reasonable operating practices listed in the insurance provisions.

Example Farm Prod has an established 5-year historical ADG of 0.44 lbs./day for its pasture-raised lambs, which it normally markets at an average of 100 pounds. These lambs are insured under a different Practice than the farms' feedlot raised lambs (Group 1) and are thus insured separately with a different ADG. The Group 2 lambs are insured at an 85 percent coverage level at a target sale weight of 100 pounds with an average birth weight for the breed used of 6 pounds for an effective insured ADG of 0.374 lbs./day.

The liability calculation would be:

*(Cov. Level) * (Historical ADG) * (Target Sale Weight) * (# of Lambs Insured) * (Lamb Price/lb.)*

Example Farm 2 would thus have a total liability of:

0.85 * 0.44 * 100 * 100 * $2.00 = $7,480.00

The formula for final harvest revenue would be:

*(Actual ADG) * (Target Sale Weight) * (# of Lambs Insured) * (Lamb Price/lb.)*

Their actual harvest revenue is thus:

0.35 * 100 * 100 * $2.00 = $7,000.00

To calculate the indemnity, the actual harvest revenue is subtracted from the liability:

$7,480 - $7,000 = $480

Thus, *Example Farm Prod* would receive an indemnity of $480 in the above scenario.

Note, the Target Sale Weight in the above equations is essentially an inflation factor that could be selected by the producer and changed to adjust their liability, though it would result in a change in their premium based on the size of the adjustment to their liability.

Feasibility

The difficulty with an ADG insurance policy presents itself when the number of factors influencing a lamb's rate of gain are evaluated and it becomes clear many of those factors are heavily influenced or indeed wholly determined by management. To begin with, a lamb's growth rate is affected by the animals' own ability to grow, breed of ewe, fetal programming (having to do with the ewe's gestation period nutrition), hybrid vigor (crossbred lambs have hybrid vigor and thus tend to grow faster), type of feed available, mineral program, weather, gender (intact rams grow faster), and a number of environmental influences and stressors. Up to weaning, the main environmental influences are: birth weight (determined by genetics/breeding rams chosen), ewe milk supply (determined by genetics and feed quality and quantity, more protein typically correlates with more milk), weather (cold wet weather reduces rates of gain significantly in addition to causing more sickness), health (influenced by facilities, cleanliness of barn, pens, or pasture, mineral program, and health protocols), and creep feed available. After weaning, the main environmental influences are lamb health, weather, and feed quantity and quality. Growth rate can vary significantly, based on genetic and environmental factors.

The effect of different feeding systems also must be accounted for as these can produce very different lamb growth patterns. Systems that promote rapid lamb growth usually achieve greater feed efficiency and require fewer days for lambs to reach market weights but also require use of more expensive feeds to achieve high rates of gain and efficiency. Forage-based production systems are usually associated with slower lamb gains, but total cost of gain may be less than for dry lot production systems.[270] These differences might be accounted for by setting up the insurance product with options where a producer could select the type of feeding system they utilize, or by simply having the producer provide their records so a normal average daily gain could be calculated.

Additional difficulty is present in that farms selling different weight groups of lambs and varying the size (# of head) and timing of their sales each year introduces additional variance into their ADG, as we can assume that lambs weight gain fluctuates by their age to some degree (lambs at different stages of growth likely gain weight at different rates). Even farms that intend to market lambs at the same time each year may experience some variance as lambs are also marketed on fat levels (yield grades). Buyers prefer certain scores that may or may not coincide with weight classes and lamb producers may find it more profitable to feed their lambs to those preferred scores.

[270] Notter, D.R., R.F Kelly, F.S. McClaugherty. 1991. Effects of ewe breed and management system on efficiency of lamb production: ll. Lamb growth, survival and carcass characteristics. J. Anim. Sci. 69:22-33.

Even more so than mortality, the question of moral hazard regarding the animal husbandry and care of the flock. For example, a producer could purchase lower quality feed or simply reduce the daily amount of feed provided to ewes or lambs and significantly reduce their rate of gain and final weight. This could be discouraged with a lower coverage level limit, but would likely significantly reduce the uptake of the insurance. Based on the Contractors' assessment, a rate of gain insurance product is thus deemed infeasible without fundamentally new and invasive monitoring processes to limit the potential for adverse behaviors.

Price Insurance

Livestock price insurance, particularly LRP for cattle, dairy, and swine has seen tremendous growth in recent years largely due to the simplicity of the product offering and flexibility of options for sales closing. Lamb producers are familiar with this product and had a favorable experience using it. As such, during listening sessions producers consistently stated they were interested in a similar policy. That producers are facing price risk is a very real issue of concern. Market price dips have become an increasingly concerning feature of lamb production as discussed in Sections VI. Risk Analysis and IV. Data Availability and Methodology. The frequency and severity of these price falls has increased in recent years.

The challenge of implementing a similar product for lamb is that the development will require establishing not only expected prices, but also price volatility. Expected prices need to be established off of an instrument that the industry is willing to put its own money down on with respect to what it believes the future price of lamb will be. More challenging than this is that price volatility needs to also be calculated, which is a measure of the market's perception of variance (i.e. the amount of certainty the market appears to have in that price) at time of sales closing. For example, high uncertainty on currency exchange rates would drive up the amount of variance/volatility and consequently should increase the insurance premium. Right now there are no publicly available financial instruments that the Contractor was able to identify that capture this data.

Some of the suggestions that were made regarding a price insurance product were a version of LRP where the projected prices were set based on historical prices. The hope was that a floor could be established that would at the very least provide coverage for when the price plummets well below most typical coverage levels. A model such as an autoregressive integrated moving average (ARIMA) that takes into account seasonal trends in the data and historic performance, while it may be able to establish a reasonable floor will likely fail to account for asymmetric information with the industry and will not enhance any understanding of a price volatility. Issues with basing a model on historical prices, rather than forward looking prices such what is with forward contract prices under the Dry Pea and Dry Bean Revenue Endorsements or futures contract prices based on specific delivery months and contract specifications such as the LRP policy for feeder cattle, are discussed in the following section.

Feasibility Issues

Regression to the Mean

Commodities that have experienced exceptional positive or negative price performance in the past may revert to their long-term average returns over time. This phenomenon, known as regression to the mean, suggests that past outperformance does not guarantee continued success

in the future. Commodity producers often can predict or recognize these situations at their extremes. Livestock in particular take time to adjust to market prices (thus the concept of the cattle cycle), which means that even when producers recognize a market is at a high, it takes time to adjust to take advantage of it. However, price insurance based on historical prices allows producers an immediate opportunity to take advantage, presenting moral hazard issues. These are further discussed in the following sub-section.

Overvaluation or Undervaluation
Commodities such as lamb can become overvalued or undervalued relative to their fundamentals, leading to corrections in prices over time. Just because lamb prices have risen in recent years to new highs does not indicate lamb prices will continue to increase and vice versa.

Past Attempts at this Model
Numerous requests were made during the listening sessions regarding developing a price insurance product similar to the LRP Lamb product available to producers in the past. In a sense, the industry has been down this road before and the same factors that made a model-based pricing approach infeasible before continue to present meaningful challenges today.

The LRP Lamb product was developed under the 508(h)/522(b) process and offered from 2007 until 2021. The program was plagued with persistently high loss ratios, inconsistent participation, and suspension by FCIC to address identified issues. The intention of this study is to focus on the potential future feasibility of new programs to serve the lamb industry and therefore only a brief summary of the challenges and issues faced in the previous program is provided here. It is worthy to note the Contractor performed a detailed evaluation of the LRP Lamb product in 2013; while revisions were made subsequent to the delivery of the evaluation, the program continued to endure challenges consistent with those encountered in its initial years of offering.

The overall loss performance of the LRP Lamb program fell outside administrative mandates. The total indemnities paid during the 2008-2012 crop years were particularly high; indemnities totaled $36,672,000, resulting in a loss ratio of 3.31 (331 percent) and a loss cost ratio of 0.0781 (7.81 percent). The 13-week endorsement, easily the most popular term offered, performed worse than other (longer) endorsement lengths in most years and only the 39-week endorsement had a loss ratio under 1.00, experiencing sparse participation for those extended offers. Over the course of the LRP Lamb program offer, roughly 75 percent of all lambs insured were covered under the 13-week endorsement.

Purchase behavior implies the program was subject to information asymmetries which may have supported adverse selection. Prices demonstrated a significant amount of variation during the years LRP Lamb insurance was offered. In the Contractors' 2013 review, the analysts constructed a measure that is unobservable on the date of sale (the effective date). This measure is the ratio of the actual ending value observed at the end of the coverage period to the expected ending value predicted at the beginning of the coverage period (the effective date). Over the life of the pilot, the simple average of this ratio for the 13-week endorsement was 1.023, just slightly higher than the expected 1.00. But, the weighted average of the ratio for insured lambs was 1.117 which indicates that purchases were concentrated on effective dates when the

(unobservable) ratio was highest. The simple average of the ratio for the intervals when lambs were insured was 1.054, and when no lambs were insured was 0.962, a (statistically significant) nearly 10 percent difference in outcome. The weighted average ratio was over 15 percent higher for effective dates when insurance was purchased. In the absence of information asymmetries, these ratios can have been expected to have been the same whether coverage was purchased or not.

The LRP Lamb model consisted of seven variables of which five were reported by USDA's AMS during the week prior to the sales timeframe (i.e. Monday) and two were internally generated variables. Model variables sourced and/or estimated from USDA AMS reports were released on Thursday and Friday afternoons prior to the Monday effective date of the LRP Lamb offer. The evaluation of model performance found that, while the model performed better than alternatives in-sample during the time period it was originally developed, performance was not favorable in an out-of-sample framework or over the term of the pilot. The central and critical component of LRP Lamb was its price forecasting model, and despite sustained serious attempts to hone and shape an effective model to project prices, the evidence strongly suggests market participants collectively had access to more or better information, which they used to shape their insurance participation decisions. This outcome strongly reinforces the importance of market-based price discovery for forward pricing, which is the central feature of every other price-based coverage offered for livestock.

Thus, the Contractor in summary does not recommend the reimplementation of LRP-lamb and has identified no fundamentally new or improved data sources, modeling techniques, or insurance schemes that would effectively and predictably preclude similar problems in a future offering.

Forward Contract Based Price Insurance

The Contractor participated in individual level discussions with three different packer representatives on the possibility of developing a price insurance policy based on averaging forward contracts for feeder lambs. The concept might be set up to insure lambs at a per head level using a price set by averaging forward contract prices from multiple lamb buyers/packers. Packer/lamb buyer buy in and willing participation would be critical to this concept and in discussions with the Contractor the buyers indicated neutrality on whether they might be willing to commit to participate in a program of this type and provide the USDA RMA with their contract data on a consistent annual basis.

Feasibility

Without a reliable commitment from the largest packers/lamb buyers, this concept would be entirely infeasible, particularly due to the industry concentration with just a few large lamb meat packers composing accounting, depending on the type of commitment they were willing to make.[271,272] However, even with reliable commitments to provide forward contract data for feeder lambs, issues exist due to the wide variance in quality and size specifications, as well as wide disparities in delivery dates. Unlike field crops, which in the United States are almost

[271] Brester GW, Mustek DC. The Effect of Market Concentration on Lamb Marketing Margins. Journal of Agricultural and Applied Economics. 1995;27(1):172-183. doi:10.1017/S1074070800019714.
[272] https://www.ams.usda.gov/sites/default/files/media/PackersandStockyardsAnnualReport2020.pdf.

always planted with a regular set growing season, ewes can lamb at any time during the calendar year, as is discussed further in previous sections. Even western range operations, which typically lamb in the spring, may lamb at varying different times in the spring resulting in different shipping dates, both due to lambing date as well as depending on how quickly their lambs reach feeder lamb age, which once again varies depending on nutrition, genetics, and even the preference of the feeder lamb buyer on when they would prefer to receive the lambs.

Revenue Insurance - Weaned Lamb Revenue Protection (WLRP)

In lieu of a price insurance program, producers expressed interest in a revenue insurance product. The Contractor provided some educational material and an overview of the currently existing Whole Farm Revenue Program (WFRP), which might meet many of the criterion mentioned by producers regarding managing risk in years wherein they experience a significant price decline for lambs. Lamb producers were seemingly wholly unfamiliar with the program in every instance in which the subject came up (a slide on WFRP was shown and discussed at each of the four listening sessions); thus, little can be inferred from their feedback regarding any potential issues with the program.

Given the lack of a lamb futures market contract or the existence of a reliable pricing data source, options to insure lamb producers' revenue or current lamb prices are extremely limited. As a potential alternative to WFRP, the Contractor discussed the development of a potential revenue program based on the number of ewes a producer is currently running and an average of their historical revenue per ewe. The concept being similar to the Actual Revenue History (ARH) concept applied to livestock, while also bearing some similarities to the Weaned Calf Risk Protection (WCRP) program being offered as a pilot for the first time in 2024.

Essentially, this concept utilizes the precedent and underwriting conceptualization already developed under the ARH model for pricing and adapts it, on the yield coverage side, for many of the WCRP pilot provisions, to the lamb industry. The intent of such an approach would be to analyze the potential of providing lamb producers with a potentially viable form of revenue coverage based on their own pricing (in the absence of viable broader market pricing data).

Unlike WCRP, there would be no projected price discovery period. Instead, the producer's expected price would be set using a similar methodology as that established under ARH/PRH programs. That is, the annual revenue per ewe would be equal to the total revenue reported by the producer for their flock divided by the number of ewes in the producer's flock. Flock numbers would need to be confirmed using pregnancy scanning records and/or total taxable head counts reported to state departments of agriculture/livestock. A minimum record history of at least five years would likely be adequate as a baseline. This record history would need to include total ewe flock size (ideally proven with pregnancy scan records and sales records if any additional ewes were bought or sold during a year), total revenue from lambs sold, and total number of lambs weaned. These records, once provided, would allow for the establishment of an expected benchmark annual revenue per ewe.

This concept would also not utilize a harvest price, nor therefore a harvest price discovery period. Instead, this approach would use the final harvest revenue from the producer's fall sales to potentially trigger an indemnity, as shown in the example below.

This feature of an ARH/PRH or WFRP style program (though unavoidable based on the nature of the design) does present an important drawback relative to the WCRP pilot, in that producers that choose to not sell their lamb crop in the fall, but instead choose to retain ownership, would be rendered ineligible for indemnification as they have no final harvest revenue. The WCRP pilot avoids this issue by ending the insurance period when calves are weaned and multiplying their final weight by the final harvest price based on the November feeder cattle futures contract.

Another important drawback to this approach is that the midsize and large scale Western and Midwest lamb producers to whom this model might be most applicable are the same lamb producers who most commonly retain ownership. Insurance coverage would end when the lambs were weaned and sold, not simply weaned or because the insurance period ended. This is due to the ARH side of the program, which would require producers to actually sell their lambs and retain weight and price receipts in order to substantiate any claim (and establish an ARH history for future years).

The ARH/PRH or single-commodity WFRP approach does has a number of potential advantages to alternatives; the ARH style revenue guarantee per ewe is specific to an individual operation. In the WCRP pilot, the price must be adjusted by the applicable regional adjustment factor to reflect differences in prices paid per pound for calves in different regions due to basis and perceived quality differences. The price is then further adjusted by the price adjustment factor, which is used to account for the significant differences in per pound prices paid for calves based on their sale weight. (i.e., heavier calves typically sell for a lower per pound price than light calves and vice versa.)

This difference in price per pound paid due to variance in live weight at the time of sale also exists in the lamb industry, with lighter lambs usually bringing a higher per pound price. This creates an additional difficulty in applying the ARH mechanics to livestock due to the fact that livestock producers can change their sale date and thereby change the average weight of the lambs they are weaning/selling. Even if the sale date is at a consistent time each year, lamb weights will vary somewhat due to differences in average daily gain from year to year which are often weather related. The lamb industry often handles this by utilizing what is referred to as a "sliding scale" in their contracts. Since producers cannot precisely predict what weight their lambs will be on the date of shipping/sale, sales contracts will include a sliding scale to be applied to the agreed upon sales price. These sliding scales vary, however, typically they adjust the price upward in the case that lambs come in lighter than expected and downward when the lambs are heavier.

These differences in weight seem unlikely to present a significant barrier to insurance; this is analogous to the normal expected variance in most crop yields from year to year. That is presuming, however, that the producer sells/ships their lambs at roughly the same time each year (i.e. a one-to-three-week sales window in any given year).

Given the often significant difference in per-pound-prices that selling lambs at different weight ranges result in, limits would need to be set on how much the annual sale date could vary. This would disqualify yet another subset of producers, those who have sold their lambs at different times in previous years or may sell at a different time in the insured year. Note however, that

given enough years of historical data, one or two exceptions could potentially be dropped from their ARH history (akin to a yield exclusion). The WCRP pilot requires four to ten years of historical weaning weight records, typically sales tickets, in order to be eligible for insurance coverage. After which, self-certification using third-party verified records is expected to be acceptable. The Contractor expects that a similar record requirement would be acceptable for lamb producers based on this precedent.

The WCRP pilot does offer T-yields when cattle producers do not have adequate historical weaning records. Actual annual weight records are capped at 125 percent of the T-Yields. Examining the applicability of T-yields to the lamb industry presents several hurdles to underwriting beyond those presented by the cow-calf industry. The main one being the tendency of ewes to birth multiple lambs, with each producer weaning a varying ratio of lambs. These range widely depending on operation type, location, and management often anywhere from 1 to 1.2 lambs per ewe on the low end to as many as 2 lambs per ewe on the high end. Additional research and data collection is needed to evaluate whether an average ratio and weaning weight might be applicable in certain areas.

Participants in the WCRP pilot must provide a calf report proving the number of live calves that have been born the earlier of the date on which the final calf is born or 60 days after the date calving begins. This requirement would likely also be applicable to lamb producers. This requirement would present little issue to some lamb operations, however some western midsize and large range lambing and hybrid lambing operations may find this to be a significant/difficult requirement to confirm the precise number of lambs born and surviving in the first 60-day period.

The WCRP pilot requires a Producer Pre-Acceptance Worksheet (PAW), which explains the details of an operation and notifies the insurance companies when significant changes in a producer's production practices or methods are expected to occur. When this is the case, or a producer is signing up for the insurance for the first time, a Pre-Acceptance Inspection Report (PAIR) is required. A PAIR must be completed within 30 days of the SCD and evaluates pasture conditions, changes in livestock numbers, expansion, management practice changes, and other changes to an operation that may have an effect on the number of head weaned or their final weaning weights.

Revenue Insurance (WLRP) Example

For this concept, *Example Farm WLRP* is based in Wyoming with a typical range lamb production model and purchases 70 percent coverage level insurance. *Example Farm WLRP* has an average revenue per ewe of $200. *Example Farm WLRP* pregnancy scans 1,000 ewes before lambing and ships 950 lambs. The lamb market drops and *Example Farm WLRP* receives a price of $1.50/lb. for their lambs. Note that many operations keep replacement females from their lamb crop to maintain their flock size for which the policy would need to account. Replacement females are included in the final total to account for year-to-year variance in replacement female numbers.

The liability calculation would be:

*(Cov. Level) * (Historical Average Revenue/Ewe) * (# of Ewes)*

Example Farm WLRP would thus have a total revenue guarantee of:

0.70 * 200 * 1,000 = $140,000

Following the loss, *Example Farm WLRP* submits documentation of revenue of $100,000.

The formula for final harvest revenue (value of production to count) is:

*(# of Lambs) * Actual weaning weight * Harvest price = Value of production to count*
Their actual harvest revenue is thus:

950 * 75 * $1.50 = $106,875

To calculate the indemnity, the actual harvest revenue is subtracted from the liability:

$140,000 - $106,875 = $33,125

Thus, *Example Farm WLRP w*ould receive an indemnity of $33,125 in the above scenario.

Feasibility

The most significant hurdle to this potential insurance type is producer records. Based on conversations held with producers, many producers do not keep detailed records of lambing nor do many operations engage in regularly conducting pregnancy testing. In many cases, producers during conversations had during the listening sessions stated they may have no records. Lamb losses are typically more significant than calf losses in cattle and it is more difficult to track or confirm a cause of loss for each individual lamb in many midsize-large range operations for a number of reasons. These reasons include, but are not limited to, a greater number of potential predators (birds of prey and coyotes for example, are a much more significant threat to lambs than to calves), as well as much higher percentage rates of starvation due to mismothering and weather exposure.[273] The tendency of ewes to birth up to as many as four lambs further complicates and increases the difficulty of tracking live lambs and lamb losses in a pasture lambing situation.

Further record keeping/data availability issues exist with some range sheep operations lacking records on the number of ewes they run (see earlier discussion in the section). These operations may not confirm how many saleable lambs they have until shipping.

Further complicating the issue is the practice of many western producers retaining ownership of their lambs while they are fed out in feedlots. These lambs are commonly fed out over the winter in a separate locale and typically slaughtered at some point during the spring or summer.

[273] Johnston WS, Maclachlan GK, Murray IS. A survey of sheep losses and their causes on commercial farms in the north of Scotland. Vet Rec. 1980 Mar 15;106(11):238-40. doi: 10.1136/vr.106.11.238. PMID: 7361390.

For example, many Montana lamb producers ship their lambs to feedlots in Colorado with the feedlot charging them a daily rate per lamb for feed and care if they choose to retain ownership. Some years these operations may rotate between retaining ownership (potentially higher risk higher reward) and selling their lambs to a feedlot or a packer to feed out. They may also retain partial ownership, for example, the lamb producer might retain ownership of 50 percent of the value of a group of weaned lambs, while the feedlot owns the other 50 percent. The lamb producer and the feedlot in this case would split feed and care costs at roughly 50 percent each.

Other western producers also reported retaining ownership of their lambs after weaning and pasturing their weaned lambs on grass over the winter (typically in warmer climates such as certain valleys in western Oregon or southern California). Discussions between the representatives/buyers of the packing companies and the Contractor revealed that the staggered varying production and maturity times seen in the lamb industry are in part by design. It may be worth noting this system is reportedly the result of a concerted effort by lamb buyers representing the packers to stagger the lamb supply, rather than receive a rush or glut of lambs all at once.

In order to reduce moral hazard incentives for the management factors mentioned related to mortality and rate of gain, as well as the issues associated with using historical prices, a low coverage level limit might be in order. The added complexity of the increased difficulty tracking lamb numbers, lack of applicability to many types of lamb operations, higher normal lamb loss relative to normal calf loss, and the lack of an available futures market contract for lamb for a price trigger mechanism all add further challenges to building on the WCRP model for application to lambs.

VII.B. Recommendations

There are several potential products or tools with varying challenges to feasibility that were explored for the lamb industry. The Contractor engaged with stakeholders to collect data on the potential of a development and as part of that information collection process, concluded that producers will likely exhibit a greater sensitivity to participation for products they currently lack interest in. This, naturally, creates a challenge in recommending a non-price protection product, which is the primary need and request for insurance. Additionally, the Contractor is concerned about various potential products with regard to the chance of moral hazard due to the nature of lamb production and reliance on good husbandry practices.

For a product to service all lamb producers across the United States, it would need to be robust enough to allow for variations in production practices, feeding systems and marketing procedures. In light of that, the Contractor believes that an ARH- or WCRP-styled product is likely the closest to being feasible for the entire lamb industry; however, the Contractor cannot, at this time, recommend it for development. Given the comparatively easier road of WCRP, the Contractor recommends that if WCRP has a favorable experience during the pilot period, a lamb product like WCRP could be considered for development, but acknowledges this design is in its initial year of implementation as a pilot program and is being tested in an industry and segment for which superior independent and transparent pricing and production data are available. It remains to be seen if the program (the first ever approved to directly address livestock production risk) will be viable in the real world. The Contractor cannot recommend

development of a product modeled on WCRP concept for development into the much more challenging lamb data environment at this time.

While generally outside the scope of this report, the Contractor also notes the potential for development of a cost of feed product for some subsets of the lamb industry, particularly lamb feeders/feedlots. Many of the inputs used in a feedlot trade on futures markets and the general ratio of these inputs to a pound of gain in feeder lambs is well established in academic literature. Additionally, coverage for inputs such as fuel and interest and even hay prices might be developed that assist in managing the risk for a much broader sector of the lamb industry.

The Contractor notes that the industry, if it desires income support for periods of depressed prices which are at times caused by policy effects, could pursue a pseudo-insurance-styled farm program similar to Dairy Margin Coverage (DMC) or Price Loss Coverage (PLC). This sort of tool could provide much better price protection, particularly for instances when an insurance projected price may be well below producers the cost of production, due to the potential severity of price dynamics. Moreover, such a tool would not be bound by actuarial soundness or underwriting sustainability viability standards that currently make an insurance product infeasible. Furthermore, such programs are generally associated with little (DMC) or no (PLC) producer premiums due and very low standards for data reported by participants. Depending on the success of the WCRP program or until a transparent, reliable, and consistent market-based measure of forward prices becomes available, the Contractor believes the best route forward for the lamb industry would be a counter-cyclical risk management tool and not a Federal Crop Insurance product.

VIII. CONCLUSION

As required under the SOW, the Contractor conducted a detailed data gathering and analysis effort to assess the potential feasibility of a risk management product for lamb. These efforts included four dedicated on-site listening sessions, dozens of consultations with industry experts, and literally hundreds of comments from stakeholders. Based on the collective information received, it is clear there is a strong perceived need among producers for a tool (or tools) to assist in managing the risks faced by lamb producers.

The Contractor examined five specific potential conceptual insurance models for insuring risks faced by lamb producers. These could be characterized as being production-based (mortality, morbidity, daily gain, etc), Price-Based (index-oriented plans that use forward pricing tools to establish guarantees and current market measures to settle coverage), and hybrid models (that incorporate both production and price risks). While each of these models is detailed specifically, they are all subject to fundamental considerations; to warrant a recommendation for feasibility, coverage must meaningfully support a transfer of risk in an offer that has value for producers, sufficient data must exist to reliably support actuarially appropriate ratemaking for each offer, underwriting must protect the integrity of the program such that it will not be subject to fraud, waste, abuse, information asymmetry, adverse selection, or moral hazard. In this data gathering and feasibility research, no program concept was identified that could meet all these standards with a high degree of certainty and therefore no specific recommendation for a feasible model to further pursue is provided in this report.

Creation of a new insurance-based risk management tool for an industry or sector that is not currently insured is fraught with challenges. Today over 200 crop and livestock sectors benefit from programs administered under the Federal Crop Insurance program. This is an indication of the success of the program, that all of the readily served industries are already being offered programs; those that remain unserved are without programs because of specific difficulties in extending coverage to include them. Insuring risk in the livestock sector has proven especially difficult. Animal husbandry is fundamentally different than crop production; animals require food, water, shelter and management on a continuous basis and therefore are subject to a multitude of management decisions constantly. In the presence of an insurance program, incentives for producers to continuously maximize the health and productivity of their livestock (to employ good management practices) can be skewed. This is true of any insurance program, but livestock is special because management is applied continuously, even a brief lapse or misdeed can have substantial effects, and the ability to definitively identify the cause of the effect as insurable (that good management practices have been faithfully employed) is very difficult. The response of the insurance sector has been to avoid these issues entirely. Other than the newly implemented pilot program for weaned calves, no livestock insurance program has offered any coverage for loss of livestock production. Instead, all offers are index-based coverage oriented around futures markets to produce revenue projections and guarantees.[274] This is not because producers in those sectors (beef, dairy, swine, etc.) would not be interested in coverage for their production, but rather because no feasible way of extending coverage to them for those risks has been devised.

[274] The Dairy Revenue Program technically includes a 'yield risk' component in its coverage, but this is a state or regional index measure of change in productivity that is beyond the influence of any individual insured and historically has had a relatively small effect on the triggering or settlement of indemnities.

The lamb industry has been resilient and innovative in the face of challenges. Some of its most outstanding stakeholders worked together to create a LRP policy to offer price-based coverage for lamb despite the lack of a futures market for lambs (or any reliable statistical relationships between the prices of lambs and futures prices for substitute or alternative proteins or inputs). The fundamental problem in offering a program to insure future prices is the establishment of expected values for future time periods. In a sense, a futures market is a representation of the vested collective knowledge of an entire industry; a largely unbiased clearing house of bets regarding future value. Some of the smartest people in the livestock sector worked to develop, revise, and revise again a statistical model to produce reliable estimates of future prices, but these models all proved inferior to the collective knowledge of industry participants. Despite serious efforts to do so in this data gathering effort, no sufficiently transparent, independent, and consistently available source of market-vested forward pricing data was identified. The Contractor concluded that a pricing-based insurance product for lambs could not be feasible without this critical data item.

Finally, it is the Contractor's expectation that this report will be widely read among lamb industry stakeholders, and the inability to identify a feasible development pathway will be met with disappointment. Stakeholders have made it very clear they face risks that challenge the viability of their operations and the overall the lamb industry. These are producers who would benefit from the sort of protections that are offered to other industries through Federal Crop Insurance or other risk management tools. The unavoidable fact is that, without a reliable, transparent, and consistent forward pricing market, any new price protection effort is likely to fall victim to the same shortcomings of previous efforts. To attain access to price insurance tools, the industry needs to initiate an independent, transparently-reported, public forward-pricing market. Fortunately, for perils not explicitly price-related, this is less so a limiting factor. The Contractor found that innovative policies such as the WCRP do present future opportunities for the lamb industry, perhaps with lamb-specific adaptations modeled on ARH/PRH or WFRP to utilize a producers' own historical sales for expected valuation. This product, however, because it introduces a novel form of livestock insurance, should complete its pilot phase before a final determination can be made on feasibility.

While Federal Crop Insurance faces critical constraints regarding responsibility to taxpayers, sustainable actuarial soundness, and strong underwriting and loss adjustment standards, those constraints do not apply to price support or disaster-relief programs. Recent programs oriented around trade-disruption (Market Facilitation Program, for example) included provisions to compensate livestock producers for price and supply-chain-oriented disruptions with sparse producer data reporting requirements and without the requirement to pay premiums or elect to participate in coverage prior to the indemnifiable event. Based on the risks that are faced, the relatively small scale of the lamb sector overall, and the challenges to insurance feasibility, producers may be well served to pursue the creation and implementation of Federal risk management tools that fall outside the Federal Crop Insurance sector.

Appendix A

Data for Figure IV.3. Contract Sales Average Price and Head Count

Report Date	Head Count	Weighted Avg Price
1/19/2024	5,098	425.79
1/12/2024	1,412	480.05
1/5/2024	3,555	444.85
12/29/2023	3,801	443.07
12/22/2023	1,795	457.99
12/15/2023	4,064	451.87
12/8/2023	4,862	442.91
12/1/2023	2,906	445.02
11/24/2023	2,936	444.14
11/17/2023	2,584	447.58
11/10/2023	3,280	450.16
11/3/2023	4,056	447.84
10/27/2023	4,004	448.83
10/20/2023	3,925	451.09
10/13/2023	3,876	449.30
10/6/2023	3,866	444.62
9/29/2023	4,852	444.57
9/22/2023	3,908	423.73
9/15/2023	3,503	450.44
9/8/2023	2,836	450.40
9/1/2023	3,715	447.30
8/25/2023	3,247	435.69
8/18/2023	3,903	432.82
8/11/2023	2,362	427.05
8/4/2023	3,253	418.62
7/28/2023	3,128	411.50
7/21/2023	3,518	395.84
7/14/2023	2,494	388.86
7/7/2023	2,401	401.96
6/30/2023	3,245	394.25
6/23/2023	2,506	382.10
6/16/2023	3,009	386.73
6/9/2023	3,053	387.64
6/2/2023	3,410	369.00
5/26/2023	3,411	374.56
5/19/2023	4,935	365.81
5/12/2023	2,455	377.25
5/5/2023	3,425	360.56
4/28/2023	2,612	389.92
4/21/2023	3,151	363.49
4/14/2023	5,286	381.45
4/7/2023	4,398	381.97
3/31/2023	5,369	369.10
3/24/2023	3,923	377.38
3/17/2023	4,452	367.16
3/10/2023	6,159	360.57
3/3/2023	3,614	361.85
2/24/2023	3,926	356.68
2/17/2023	3,880	359.80
2/10/2023	4,438	346.25
2/3/2023	4,157	360.51
1/27/2023	3,936	365.46
1/20/2023	4,560	361.89
1/13/2023	4,457	361.84
1/6/2023	2,488	388.07
12/30/2022	3,061	377.59
12/23/2022	4,229	374.01
12/16/2022	4,207	375.90
12/9/2022	4,009	367.23
12/2/2022	4,647	356.93
11/25/2022	2,860	383.77
11/18/2022	4,593	360.28
11/11/2022	3,823	381.33
11/4/2022	2,606	402.17
10/28/2022	2,467	401.03
10/21/2022	2,416	406.29
10/14/2022	2,201	371.98
10/7/2022	2,971	377.79
9/30/2022	4,141	365.12
9/23/2022	3,059	385.41
9/16/2022	3,648	384.50
9/9/2022	3,083	374.12
9/2/2022	4,862	371.29
8/26/2022	3,548	397.44
8/19/2022	2,651	387.18
8/12/2022	3,266	383.02
8/5/2022	2,032	408.57
7/29/2022	3,070	417.26
7/22/2022	4,443	427.96
7/15/2022	2,758	440.34
7/8/2022	3,345	437.60
7/1/2022	2,512	448.01
6/24/2022	3,875	439.89
6/17/2022	1,799	478.71
6/10/2022	4,276	446.91
6/3/2022	3,568	450.44
5/27/2022	5,015	458.64
5/20/2022	3,106	450.91
5/13/2022	4,452	461.94
5/6/2022	2,295	484.17
4/29/2022	3,526	473.26
4/22/2022	3,720	476.33
4/15/2022	3,416	490.66
4/8/2022	3,761	485.15
4/1/2022	4,059	484.99
3/25/2022	2,833	493.08
3/18/2022	3,357	482.98
3/11/2022	2,988	485.81
3/4/2022	2,661	493.10
2/25/2022	4,304	488.63
2/18/2022	1,957	517.73
2/11/2022	4,460	498.12
2/4/2022	4,325	509.91
1/28/2022	4,459	519.00
1/21/2022	4,269	524.05
1/14/2022	3,029	518.35
1/7/2022	2,208	534.26
12/30/2021	1,073	547.93
12/23/2021	1,922	542.78
12/17/2021	4,022	521.87
12/10/2021	2,164	529.31
12/3/2021	3,614	523.78
11/26/2021	3,357	524.53
11/19/2021	4,018	524.32
11/12/2021	3,826	545.05
11/5/2021	4,085	527.31
10/29/2021	3,842	537.39
10/22/2021	2,549	539.35
10/15/2021	2,828	550.75
10/8/2021	4,712	546.96
10/1/2021	3,025	550.26
9/24/2021	3,353	
9/17/2021	2,028	
9/10/2021	3,660	
9/3/2021	2,979	
8/27/2021	3,504	
8/20/2021	2,809	
8/13/2021	2,544	
8/6/2021	1,469	
7/30/2021	3,485	
7/23/2021	2,586	
7/16/2021	3,054	
7/9/2021	3,151	
7/2/2021	4,196	
6/25/2021	3,794	
6/18/2021	2,880	
6/11/2021	3,636	
6/4/2021	2,693	
5/28/2021	4,236	
5/21/2021	3,439	
5/14/2021	5,493	
5/7/2021	5,494	
4/30/2021	6,315	
4/23/2021	7,164	
4/16/2021	4,827	
4/9/2021	6,806	
4/2/2021	4,957	
3/26/2021	7,494	
3/19/2021	7,246	
3/12/2021	4,460	
3/5/2021	6,317	
2/26/2021	5,466	
2/19/2021	7,689	
2/12/2021	3,279	
2/5/2021	5,451	
1/29/2021	5,579	
1/22/2021	4,061	
1/15/2021	5,089	
1/8/2021	2,899	
12/31/2020	4,704	
12/23/2020	2,492	
12/18/2020	3,868	
12/11/2020	4,156	
12/4/2020	4,144	
11/27/2020	4,182	
11/20/2020	4,517	
11/13/2020	2,694	
11/6/2020	2,412	
10/30/2020	2,454	
10/23/2020	2,606	
10/16/2020	2,385	
10/9/2020	2,704	
10/2/2020	2,850	
9/25/2020	2,887	
9/18/2020	3,039	
9/11/2020	2,931	
9/4/2020	2,663	
8/28/2020	3,354	
8/21/2020	3,161	
8/14/2020	2,921	

Report Date	Head Count	Weighted Avg Price
8/7/2020	3,646	
7/31/2020	2,837	
7/24/2020	2,793	
7/17/2020	3,414	
7/10/2020	1,968	
7/2/2020	2,425	
6/26/2020	2,701	
6/19/2020	2,542	
6/12/2020	1,975	
6/5/2020	3,626	
5/29/2020	1,932	
5/22/2020	3,057	
5/15/2020	2,016	
5/8/2020	2,522	
5/1/2020	2,603	
4/24/2020	1,841	
4/17/2020	1,704	
4/10/2020	934	
4/3/2020	1,902	
3/27/2020	3,161	
3/20/2020	4,004	
3/13/2020	4,442	
3/6/2020	4,297	
2/28/2020	4,835	
2/21/2020	3,312	
2/14/2020	4,087	
2/7/2020	3,092	
1/31/2020	4,061	
1/24/2020	4,293	
1/17/2020	2,927	
1/10/2020	3,116	
1/3/2020	2,509	
12/27/2019	2,022	
12/20/2019	3,812	
12/13/2019	2,796	
12/6/2019	3,063	
11/29/2019	2,354	
11/22/2019	2,790	
11/15/2019	3,625	
11/8/2019	2,861	
11/1/2019	2,142	
10/25/2019	3,191	
10/18/2019	2,443	
10/11/2019	3,164	
10/4/2019	3,092	
9/27/2019	3,136	
9/20/2019	3,234	
9/13/2019	2,748	
9/6/2019	2,342	
8/30/2019	2,269	
8/23/2019	2,562	
8/16/2019	2,850	
8/9/2019	2,088	
8/2/2019	1,972	
7/26/2019	1,481	
7/19/2019	1,917	
7/12/2019	1,620	
7/5/2019	2,265	
6/28/2019	2,858	
6/21/2019	2,216	
6/14/2019	2,330	
6/7/2019	2,505	
5/31/2019	2,322	
5/24/2019	2,464	
5/17/2019	2,523	
5/10/2019	2,817	
5/3/2019	2,416	
4/26/2019	3,270	
4/19/2019	4,343	
4/12/2019	4,053	
4/5/2019	3,942	
3/29/2019	3,979	
3/22/2019	3,978	
3/15/2019	2,676	
3/8/2019	2,292	
3/1/2019	2,653	
2/22/2019	2,432	
2/15/2019	2,084	
2/8/2019	2,721	
2/1/2019	2,887	
1/25/2019	1,398	
1/18/2019	2,596	
1/11/2019	2,275	
1/4/2019	2,117	
12/28/2018	2,202	
12/21/2018	2,206	
12/14/2018	2,584	
12/7/2018	3,410	
11/30/2018	2,679	
11/23/2018	1,710	
11/16/2018	2,960	
11/9/2018	2,628	
11/2/2018	2,509	
10/26/2018	2,486	
10/19/2018	2,474	
10/12/2018	2,602	
10/5/2018	2,839	
9/28/2018	2,607	
9/21/2018	2,581	
9/14/2018	3,330	
9/7/2018	925	
8/31/2018	2,735	
8/24/2018	2,796	
8/17/2018	2,497	
8/10/2018	2,389	
8/3/2018	2,406	
7/27/2018	2,292	
7/20/2018	2,489	
7/13/2018	2,765	
7/6/2018	1,480	
6/29/2018	2,565	
6/22/2018	2,425	
6/15/2018	2,000	
6/8/2018	2,471	
6/1/2018	2,349	
5/25/2018	2,396	
5/18/2018	2,781	
5/11/2018	2,645	
5/4/2018	1,952	
4/27/2018	2,353	
4/20/2018	2,788	
4/13/2018	2,100	
4/6/2018	3,137	
3/30/2018	4,088	
3/23/2018	3,659	
3/16/2018	3,367	
3/9/2018	3,759	
3/2/2018	3,678	
2/23/2018	3,119	
2/16/2018	2,437	
2/9/2018	2,384	
2/2/2018	2,288	
1/26/2018	2,561	
1/19/2018	2,389	
1/12/2018	2,278	
1/5/2018	3,032	
12/29/2017	1,839	
12/22/2017	2,722	
12/15/2017	3,524	
12/8/2017	3,710	
12/1/2017	3,003	
11/24/2017	1,260	
11/17/2017	3,134	
11/10/2017	3,120	
11/3/2017	3,111	
10/27/2017	2,810	
10/20/2017	2,705	
10/13/2017	2,624	
10/6/2017	2,777	
9/29/2017	2,650	
9/22/2017	2,741	
9/15/2017	2,796	
9/8/2017	2,474	
9/1/2017	3,177	
8/25/2017	2,543	
8/18/2017	2,580	
8/11/2017	3,078	
8/4/2017	2,829	
7/28/2017	2,507	
7/21/2017	2,641	
7/14/2017	3,110	
7/7/2017	1,523	
6/30/2017	2,598	
6/23/2017	3,019	
6/16/2017	2,681	
6/9/2017	2,260	
6/2/2017	2,476	
5/26/2017	3,523	
5/19/2017	2,004	
5/12/2017	3,046	
5/5/2017	2,210	
4/28/2017	2,977	
4/21/2017	2,506	
4/14/2017	5,154	
4/7/2017	4,977	
3/31/2017	5,004	
3/24/2017	6,289	
3/17/2017	4,694	
3/10/2017	4,479	
3/3/2017	3,791	

Report Date	Head Count	Weighted Avg Price
2/24/2017	4,650	
2/17/2017	3,629	
2/10/2017	3,896	
2/3/2017	4,735	
1/27/2017	3,826	
1/20/2017	4,355	
1/13/2017	3,176	
1/6/2017	3,692	
12/30/2016	3,892	
12/23/2016	2,932	
12/16/2016	3,352	
12/9/2016	2,686	
12/2/2016	2,605	
11/25/2016	2,057	
11/18/2016	4,347	
11/11/2016	4,005	
11/4/2016	4,079	
10/28/2016	4,472	
10/21/2016	4,077	
10/14/2016	3,404	
10/7/2016	4,342	
9/30/2016	4,449	
9/23/2016	4,199	
9/16/2016	4,612	
9/9/2016	3,697	
9/2/2016	4,284	
8/26/2016	3,976	
8/19/2016	3,951	
8/12/2016	4,389	
8/5/2016	5,282	
7/29/2016	4,361	
7/22/2016	3,997	
7/15/2016	4,448	
7/8/2016	4,497	
7/1/2016	4,612	
6/24/2016	2,465	
6/17/2016	4,886	
6/10/2016	4,500	
6/3/2016	4,698	
5/27/2016	4,866	
5/20/2016	4,748	
5/13/2016	4,959	
5/6/2016	4,898	
4/29/2016	4,667	
4/22/2016	4,285	
4/15/2016	4,300	
4/8/2016	758	
4/1/2016	6,239	
3/25/2016	3,790	
3/18/2016	5,153	
3/11/2016	6,146	
3/4/2016	5,641	
2/26/2016	5,636	
2/19/2016	3,550	
2/12/2016	4,360	
2/5/2016	3,936	
1/29/2016	3,889	
1/22/2016	5,040	
1/15/2016	4,789	
1/8/2016	5,441	

Report Date	Head Count	Weighted Avg Price
1/1/2016	3,922	
12/25/2015	6,174	
12/18/2015	6,946	
12/11/2015	6,809	
12/4/2015	7,182	
11/27/2015	4,324	
11/20/2015	6,674	
11/13/2015	7,285	
11/6/2015	6,952	
10/30/2015	6,364	
10/23/2015	6,782	
10/16/2015	6,275	
10/9/2015	6,138	
10/2/2015	6,788	
9/25/2015	6,186	
9/18/2015	6,703	
9/11/2015	6,124	
9/4/2015	5,097	
8/28/2015	7,152	
8/21/2015	5,374	
8/14/2015	5,804	
8/7/2015	6,257	
7/31/2015	5,439	
7/24/2015	5,422	
7/17/2015	5,232	
7/10/2015	6,611	
7/2/2015	3,805	
6/26/2015	5,531	
6/19/2015	5,607	
6/12/2015	5,829	
6/5/2015	5,968	
5/29/2015	5,560	
5/22/2015	6,499	
5/15/2015	5,444	
5/8/2015	6,292	
5/1/2015	6,159	
4/24/2015	5,693	
4/17/2015	5,658	
4/10/2015	4,945	
4/3/2015	6,740	
3/27/2015	6,936	
3/20/2015	7,531	
3/13/2015	5,910	
3/6/2015	6,398	
2/27/2015	6,217	
2/20/2015	5,356	
2/13/2015	5,776	
2/6/2015	5,587	
1/30/2015	5,510	
1/23/2015	6,075	
1/16/2015	5,721	
1/9/2015	6,864	
1/2/2015	3,878	
12/26/2014	3,459	
12/19/2014	7,279	
12/12/2014	6,248	
12/5/2014	7,586	
11/28/2014	4,198	
11/21/2014	6,068	
11/14/2014	7,644	

Report Date	Head Count	Weighted Avg Price
11/7/2014	6,727	
10/31/2014	6,272	
10/24/2014	6,579	
10/17/2014	6,759	
10/10/2014	6,950	
10/3/2014	6,491	
9/26/2014	6,739	
9/19/2014	6,800	
9/12/2014	6,633	
9/5/2014	5,113	
8/29/2014	5,899	
8/22/2014	5,418	
8/15/2014	5,460	
8/8/2014	4,923	
8/1/2014	5,262	
7/25/2014	6,154	
7/18/2014	5,668	
7/11/2014	5,783	
7/3/2014	4,138	
6/27/2014	4,891	
6/20/2014	4,267	
6/13/2014	5,437	
6/6/2014	6,390	
5/30/2014	4,415	
5/23/2014	5,359	
5/16/2014	6,834	
5/9/2014	5,178	
5/2/2014	4,970	
4/25/2014	5,795	
4/18/2014	7,803	
4/11/2014	6,994	
4/4/2014	6,162	
3/28/2014	7,146	
3/21/2014	6,689	
3/14/2014	4,738	
3/7/2014	6,503	
2/28/2014	6,071	
2/21/2014	5,891	
2/14/2014	5,995	
2/7/2014	7,115	
1/31/2014	5,441	
1/24/2014	5,929	
1/17/2014	6,136	
1/10/2014	6,263	
1/3/2014	5,692	
12/27/2013	5,699	
12/20/2013	7,157	
12/13/2013	7,240	
12/6/2013	6,929	
11/29/2013	5,706	
11/22/2013	6,526	
11/15/2013	6,583	
11/8/2013	6,944	
11/1/2013	5,802	
10/25/2013	6,411	
9/27/2013	7,134	
9/20/2013	6,740	
9/13/2013	7,156	
9/6/2013	3,785	
8/30/2013	7,120	

Report Date	Head Count	Weighted Avg Price
8/23/2013	5,508	
8/16/2013	5,635	
8/9/2013	5,601	
8/2/2013	6,626	
7/26/2013	7,129	
7/19/2013	6,799	
7/12/2013	6,429	
7/5/2013	3,941	
6/28/2013	6,611	
6/21/2013	5,815	
6/14/2013	6,746	
6/7/2013	5,803	
5/31/2013	5,141	
5/24/2013	6,538	
5/17/2013	5,857	
5/10/2013	5,518	
5/3/2013	8,084	
4/26/2013	4,911	
4/19/2013	5,459	
4/12/2013	6,404	
4/5/2013	5,587	
3/29/2013	6,034	
3/22/2013	7,729	
3/15/2013	6,642	
3/8/2013	6,609	
3/1/2013	4,541	
2/22/2013	5,849	
2/15/2013	6,652	
2/8/2013	5,932	
2/1/2013	5,572	
1/25/2013	5,563	
1/18/2013	5,938	
1/11/2013	7,366	
1/4/2013	5,517	
12/28/2012	3,704	
12/21/2012	6,775	
12/14/2012	6,723	
12/7/2012	6,114	
11/30/2012	7,176	
11/23/2012	5,241	
11/16/2012	6,927	
11/9/2012	6,687	
11/2/2012	6,906	
10/26/2012	7,246	
10/19/2012	6,275	
10/12/2012	6,515	
10/5/2012	6,489	
9/28/2012	6,559	
9/21/2012	6,218	
9/14/2012	5,986	
9/7/2012	4,826	
8/31/2012	5,743	
8/24/2012	5,166	
8/17/2012	6,350	
8/10/2012	6,606	
8/3/2012	4,679	
7/27/2012	4,926	
7/20/2012	5,437	
7/13/2012	5,406	
7/6/2012	3,323	
6/29/2012	5,351	
6/22/2012	4,948	
6/15/2012	6,755	
6/8/2012	6,102	
6/1/2012	5,836	
5/25/2012	4,466	
5/18/2012	5,105	
5/11/2012	5,613	
5/4/2012	5,848	
4/27/2012	5,775	
4/20/2012	6,661	
4/13/2012	6,763	
4/6/2012	7,332	
3/30/2012	9,007	
3/23/2012	9,095	
3/16/2012	8,500	
3/9/2012	8,148	
3/2/2012	6,310	
2/24/2012	8,090	
2/17/2012	7,857	
2/10/2012	6,409	
2/3/2012	7,714	
1/27/2012	7,390	
1/20/2012	6,938	
1/13/2012	7,147	
1/6/2012	5,115	
12/30/2011	6,718	
12/23/2011	9,398	
12/16/2011	9,021	
12/9/2011	8,038	
12/2/2011	7,947	
11/25/2011	7,973	
11/18/2011	8,269	
11/11/2011	8,569	
11/4/2011	8,053	
10/28/2011	8,833	
10/21/2011	7,642	
10/14/2011	7,738	
10/7/2011	9,383	
9/30/2011	9,413	
9/23/2011	9,529	
9/16/2011	7,976	
9/9/2011	7,470	
9/2/2011	8,647	
8/26/2011	7,528	
8/19/2011	8,583	
8/12/2011	7,709	
8/5/2011	7,520	
7/29/2011	7,783	
7/22/2011	8,818	
7/15/2011	7,600	
7/8/2011	5,158	
7/1/2011	7,739	
6/24/2011	9,006	
6/17/2011	8,037	
6/10/2011	9,531	
6/3/2011	5,737	
5/27/2011	9,916	
5/20/2011	11,228	
5/13/2011	9,919	
5/6/2011	9,079	
4/29/2011	6,831	
4/22/2011	13,091	
4/15/2011	10,498	
4/8/2011	10,749	
4/1/2011	9,952	
3/25/2011	11,232	
3/18/2011	8,973	
3/11/2011	8,109	
3/4/2011	8,611	
2/25/2011	7,627	
2/18/2011	9,589	
2/11/2011	7,919	
2/4/2011	8,440	
1/28/2011	8,398	
1/21/2011	7,666	
1/14/2011	7,969	
1/7/2011	7,782	
12/30/2010	8,859	
12/23/2010	6,925	
12/17/2010	12,213	
12/10/2010	11,869	
12/3/2010	9,531	
11/26/2010	11,089	
11/19/2010	12,808	
11/12/2010	11,349	
11/5/2010	11,070	
10/29/2010	10,228	
10/22/2010	10,346	
10/15/2010	9,830	
10/8/2010	11,016	
10/1/2010	9,058	
9/24/2010	9,721	
9/17/2010	10,790	
9/10/2010	7,244	
9/3/2010	9,792	
8/27/2010	8,652	
8/20/2010	11,368	
8/13/2010	12,523	
8/6/2010	10,131	
7/30/2010	10,424	
7/23/2010	-	
7/16/2010	-	
7/9/2010	-	
7/2/2010	-	
6/25/2010	9,048	
6/18/2010	11,533	
6/11/2010	9,459	
6/4/2010	9,582	
5/28/2010	11,143	
5/21/2010	11,003	
5/14/2010	-	
5/7/2010	10,988	
4/30/2010	-	
4/23/2010	10,398	
4/16/2010	10,583	
4/9/2010	10,942	
4/2/2010	17,882	
3/26/2010	14,024	
3/19/2010	14,799	

Report Date	Head Count	Weighted Avg Price
3/12/2010	12,976	
3/5/2010	12,918	
2/26/2010	13,940	
2/19/2010	9,671	
2/12/2010	16,645	
2/5/2010	15,405	
1/29/2010	13,718	
1/22/2010	12,107	
1/15/2010	13,516	
1/8/2010	8,437	
12/31/2009	10,105	
12/24/2009	12,160	
12/18/2009	10,848	
12/11/2009	13,817	
12/4/2009	13,620	
11/27/2009	9,949	
11/20/2009	12,269	
11/13/2009	11,788	
11/6/2009	14,991	
10/30/2009	9,904	
10/23/2009	11,361	
10/16/2009	11,290	
10/9/2009	11,043	
10/2/2009	12,293	
9/25/2009	15,035	
9/18/2009	12,269	
9/11/2009	-	
9/4/2009	10,109	
8/28/2009	12,461	
8/21/2009	-	
8/14/2009	12,901	
8/7/2009	11,769	
7/31/2009	10,760	
7/24/2009	13,205	
7/17/2009	-	
7/10/2009	9,412	
7/2/2009	8,262	
6/26/2009	10,936	
6/19/2009	10,956	
6/12/2009	11,243	
6/5/2009	10,438	
5/29/2009	-	
5/22/2009	7,401	
5/15/2009	10,660	
5/8/2009	10,166	
5/1/2009	10,171	
4/24/2009	10,964	
4/17/2009	11,550	
4/10/2009	12,022	
4/3/2009	13,189	
3/27/2009	12,056	
3/20/2009	12,568	
3/13/2009	11,260	
3/6/2009	10,089	
2/27/2009	12,110	
2/20/2009	8,632	
2/13/2009	-	
2/6/2009	9,373	
1/30/2009	-	
1/23/2009	-	

Report Date	Head Count	Weighted Avg Price
1/16/2009	-	
1/9/2009	-	
1/2/2009	10,052	
12/26/2008	-	
12/19/2008	11,458	
12/12/2008	11,880	
12/5/2008	9,968	
11/28/2008	-	
11/21/2008	11,704	
11/14/2008	12,758	
11/7/2008	12,492	
10/31/2008	11,791	
10/24/2008	12,001	
10/17/2008	12,594	
10/10/2008	12,015	
10/3/2008	13,077	
9/26/2008	12,326	
9/19/2008	13,754	
9/12/2008	10,774	
9/5/2008	11,875	
8/29/2008	8,725	
8/22/2008	9,521	
8/15/2008	-	
8/8/2008	-	
8/1/2008	-	
7/25/2008	-	
7/18/2008	-	
7/11/2008	-	
7/4/2008	-	
6/27/2008	-	
6/20/2008	-	
6/13/2008	-	
6/6/2008	-	
5/30/2008	-	
5/23/2008	-	
5/16/2008	-	
5/9/2008	-	
5/2/2008	-	
4/25/2008	-	
4/18/2008	-	
4/11/2008	-	
4/4/2008	-	
3/28/2008	-	
3/21/2008	-	
3/14/2008	-	
3/7/2008	-	
2/29/2008	-	
2/22/2008	-	
2/15/2008	-	
2/8/2008	-	
2/1/2008	-	
1/25/2008	-	
1/18/2008	-	
1/11/2008	-	
1/4/2008	-	
12/28/2007	-	
12/21/2007	-	
12/14/2007	-	
12/7/2007	-	
11/30/2007	-	

Report Date	Head Count	Weighted Avg Price
11/23/2007	-	
11/16/2007	-	
11/9/2007	-	
11/2/2007	-	
10/26/2007	-	
10/19/2007	-	
10/12/2007	-	
10/5/2007	-	
9/28/2007	-	
9/21/2007	-	
9/14/2007	-	
9/7/2007	-	
8/31/2007	11,742	
8/24/2007	14,913	
8/17/2007	13,158	
8/10/2007	-	
8/3/2007	-	
7/27/2007	-	
7/20/2007	-	
7/13/2007	-	
7/6/2007	-	
6/29/2007	10,279	
6/22/2007	7,930	
6/15/2007	8,774	
6/8/2007	8,211	
6/1/2007	8,869	
5/25/2007	9,417	
5/18/2007	10,240	
5/11/2007	7,544	
5/4/2007	8,607	
4/27/2007	9,934	
4/20/2007	9,874	
4/13/2007	8,924	
4/6/2007	16,041	
3/30/2007	11,911	
3/23/2007	14,654	
3/16/2007	13,392	
3/9/2007	12,493	
3/2/2007	11,612	
2/23/2007	11,280	
2/16/2007	12,530	
2/9/2007	11,186	
2/2/2007	11,327	
1/26/2007	10,710	
1/19/2007	10,544	
1/12/2007	8,533	
1/5/2007	9,694	
12/29/2006	14,827	
12/22/2006	13,523	
12/15/2006	12,636	
12/8/2006	13,519	
12/1/2006	13,588	
11/24/2006	9,458	
11/17/2006	12,477	
11/10/2006	10,870	
11/3/2006	14,297	
10/27/2006	13,457	
10/20/2006	16,270	
10/13/2006	9,135	
10/6/2006	14,792	

Report Date	Head Count	Weighted Avg Price
9/29/2006	12,545	
9/22/2006	15,752	
9/15/2006	13,124	
9/8/2006	14,323	
8/30/2006	10,987	
8/23/2006	8,586	
8/16/2006	9,256	
8/9/2006	10,502	
8/2/2006	14,975	
7/26/2006	13,578	
7/19/2006	10,365	
7/12/2006	9,553	
7/5/2006	10,646	
6/28/2006	10,122	
6/21/2006	10,801	
6/14/2006	9,349	
6/7/2006	9,783	
5/31/2006	10,515	
5/24/2006	6,934	
5/17/2006	8,789	
5/10/2006	9,936	
5/3/2006	6,701	
4/26/2006	8,040	
4/19/2006	10,856	
4/12/2006	11,733	
4/5/2006	9,252	
3/29/2006	10,910	
3/22/2006	11,434	
3/15/2006	8,042	
3/8/2006	8,568	
3/1/2006	8,838	
2/22/2006	9,148	
2/15/2006	12,085	
2/8/2006	6,424	
1/18/2006	12,734	
1/11/2006	18,253	
1/4/2006	11,000	
12/28/2005	13,520	
12/21/2005	13,716	
12/14/2005	17,375	
12/7/2005	15,146	
11/30/2005	13,826	
11/23/2005	18,789	
11/16/2005	15,075	
11/9/2005	17,113	
11/2/2005	12,582	
10/26/2005	12,966	
10/19/2005	13,552	
10/12/2005	16,930	
10/5/2005	9,030	
9/28/2005	17,879	
9/21/2005	16,330	
9/14/2005	15,730	
9/7/2005	15,653	
8/31/2005	20,040	
8/24/2005	18,116	
8/17/2005	16,414	
8/10/2005	16,598	
8/3/2005	20,312	
7/27/2005	17,388	
7/20/2005	16,539	
7/13/2005	17,681	
7/6/2005	13,111	
6/29/2005	16,412	
6/22/2005	18,150	
6/15/2005	14,471	
6/8/2005	15,306	
6/1/2005	18,838	
5/25/2005	11,604	
5/18/2005	19,804	
5/11/2005	14,613	
5/4/2005	14,522	
4/27/2005	18,040	
4/20/2005	18,786	
4/13/2005	15,909	
4/6/2005	16,553	
3/30/2005	24,238	
3/23/2005	24,560	
3/16/2005	24,129	
3/9/2005	20,598	
3/2/2005	19,726	
2/23/2005	15,654	
2/16/2005	17,896	
2/9/2005	14,694	
2/2/2005	19,628	
1/26/2005	21,163	
1/19/2005	14,987	
1/12/2005	18,913	
1/5/2005	20,014	
12/29/2004	13,816	
12/22/2004	13,955	
12/15/2004	16,201	
12/8/2004	13,733	
12/1/2004	14,208	
11/24/2004	12,526	
11/17/2004	12,447	
11/10/2004	13,540	
11/3/2004	13,932	
10/27/2004	16,462	
10/20/2004	15,972	
10/13/2004	14,610	
10/6/2004	19,192	
9/29/2004	19,699	
9/22/2004	15,910	
9/15/2004	15,409	
9/8/2004	15,549	
9/1/2004	17,669	
8/25/2004	17,630	
8/18/2004	16,789	
8/11/2004	15,974	
8/4/2004	15,914	
7/28/2004	14,059	
7/21/2004	17,395	
7/14/2004	13,339	
7/7/2004	10,830	
6/30/2004	13,353	
6/23/2004	15,214	
6/16/2004	13,105	
6/9/2004	10,456	
6/2/2004	9,776	
5/26/2004	10,481	
5/19/2004	10,227	
5/12/2004	14,059	
5/5/2004	15,111	
4/28/2004	12,870	
4/21/2004	13,203	
4/14/2004	12,996	
4/7/2004	11,939	
3/31/2004	19,735	
3/24/2004	21,345	
3/17/2004	16,836	
3/10/2004	17,511	
3/3/2004	12,969	
2/25/2004	14,771	
2/18/2004	11,330	
2/11/2004	15,336	
2/4/2004	22,724	
1/28/2004	14,885	
1/21/2004	15,946	
1/14/2004	15,667	
1/7/2004	15,479	
12/31/2003	12,886	
12/24/2003	19,804	
12/17/2003	19,362	
12/10/2003	15,344	
12/3/2003	18,234	
11/26/2003	14,933	
11/19/2003	18,175	
11/12/2003	19,090	
11/5/2003	17,107	
10/29/2003	17,245	
10/22/2003	13,793	
10/15/2003	16,542	
10/8/2003	18,083	
10/1/2003	17,673	
9/24/2003	18,868	
9/17/2003	16,428	
9/10/2003	18,176	
9/3/2003	12,773	
8/27/2003	18,147	
8/20/2003	16,069	
8/13/2003	15,727	
8/6/2003	16,678	
7/30/2003	15,796	
7/23/2003	14,574	
7/16/2003	17,366	
7/9/2003	13,799	
7/2/2003	11,773	
6/25/2003	17,444	
6/18/2003	19,661	
6/11/2003	17,547	
6/4/2003	13,362	
5/28/2003	10,939	
5/21/2003	15,335	
5/14/2003	15,762	
5/7/2003	15,317	
4/30/2003	15,343	
4/23/2003	17,955	
4/16/2003	22,103	
4/9/2003	22,295	

Report Date	Head Count	Weighted Avg Price
4/2/2003	17,897	
3/26/2003	19,004	
3/19/2003	18,293	
3/12/2003	17,460	
3/5/2003	15,460	
2/26/2003	16,200	
2/19/2003	17,635	
2/12/2003	19,985	
2/5/2003	15,640	
1/29/2003	18,234	
1/22/2003	16,588	
1/15/2003	17,202	
1/8/2003	20,483	
1/2/2003	16,144	
12/26/2002	15,802	
12/18/2002	20,909	
12/11/2002	16,934	
12/4/2002	14,628	
11/27/2002	18,288	
11/20/2002	21,086	
11/13/2002	16,043	
11/6/2002	18,168	
10/30/2002	19,297	
10/23/2002	18,705	
10/16/2002	19,251	
10/9/2002	17,436	
10/2/2002	18,052	
9/25/2002	20,150	
9/18/2002	15,825	
9/11/2002	18,105	
9/4/2002	16,833	
8/28/2002	17,266	
8/21/2002	16,932	
8/14/2002	19,121	
8/7/2002	20,613	
7/31/2002	16,171	
7/24/2002	16,772	
7/17/2002	16,779	
7/10/2002	11,174	
7/3/2002	16,004	
6/26/2002	15,847	
6/19/2002	17,128	
6/12/2002	17,204	
6/5/2002	19,277	
5/29/2002	17,229	
5/22/2002	11,722	
5/15/2002	17,072	
5/8/2002	16,602	
5/1/2002	12,364	
4/24/2002	11,299	
4/17/2002	11,708	
4/10/2002	18,313	
4/3/2002	16,177	
3/27/2002	25,879	
3/20/2002	16,017	
3/13/2002	16,534	
3/6/2002	20,257	
2/27/2002	18,287	
2/20/2002	16,161	
2/13/2002	13,494	
2/6/2002	16,408	
1/30/2002	17,410	
1/23/2002	18,534	
1/16/2002	18,877	
1/9/2002	17,729	
1/2/2002	13,360	
12/26/2001	15,903	
12/19/2001	24,364	
12/12/2001	20,987	
12/5/2001	18,348	
11/28/2001	13,989	
11/21/2001	17,882	
11/14/2001	20,524	
11/7/2001	20,673	
10/31/2001	17,490	
10/24/2001	18,691	
10/17/2001	15,409	
10/10/2001	19,522	
10/3/2001	15,960	
9/26/2001	17,051	
9/19/2001	16,532	
9/12/2001	20,769	
9/5/2001	17,139	
8/29/2001	17,292	
8/22/2001	16,032	

Source: After USDA AMS (LM_XL555), accessed January 2024.

Appendix B

Data for Figure IV.4. Lamb and Mutton in Cold Storage, Frozen

Date	Value
4/1/2023	24,519,000
8/1/2023	26,174,000
2/1/2023	29,658,000
1/1/2023	25,312,000
7/1/2023	27,398,000
6/1/2023	24,834,000
3/1/2023	25,772,000
5/1/2023	25,111,000
11/1/2023	22,431,000
10/1/2023	26,127,000
9/1/2023	26,155,000
4/1/2022	24,414,000
8/1/2022	29,198,000
12/1/2022	26,505,000
2/1/2022	22,224,000
1/1/2022	21,856,000
7/1/2022	25,626,000
6/1/2022	22,807,000
3/1/2022	24,006,000
5/1/2022	22,185,000
11/1/2022	29,674,000
10/1/2022	28,651,000
9/1/2022	30,823,000
4/1/2021	24,753,000
8/1/2021	22,051,000
12/1/2021	22,124,000
2/1/2021	26,833,000
1/1/2021	24,470,000
7/1/2021	21,010,000
6/1/2021	21,489,000
3/1/2021	25,342,000
5/1/2021	21,896,000
11/1/2021	23,487,000
10/1/2021	27,155,000
9/1/2021	25,607,000
4/1/2020	40,790,000
8/1/2020	39,466,000
12/1/2020	24,911,000
2/1/2020	37,379,000
1/1/2020	36,856,000
7/1/2020	44,712,000
6/1/2020	46,524,000
3/1/2020	37,575,000
5/1/2020	48,023,000
11/1/2020	25,917,000
10/1/2020	25,731,000
9/1/2020	30,668,000
4/1/2019	40,949,000
8/1/2019	46,642,000
12/1/2019	34,752,000
2/1/2019	35,503,000
1/1/2019	38,376,000
7/1/2019	43,052,000
6/1/2019	40,025,000
3/1/2019	31,026,000
5/1/2019	38,484,000
11/1/2019	34,022,000
10/1/2019	37,805,000
9/1/2019	41,648,000
4/1/2018	33,992,000
8/1/2018	39,386,000
12/1/2018	36,454,000
2/1/2018	28,280,000
1/1/2018	26,790,000
7/1/2018	42,129,000
6/1/2018	38,678,000
3/1/2018	28,615,000
5/1/2018	35,591,000
11/1/2018	37,859,000
10/1/2018	39,321,000
9/1/2018	40,466,000
4/1/2017	28,603,000
8/1/2017	32,383,000
12/1/2017	26,714,000
2/1/2017	25,694,000
1/1/2017	20,361,000
7/1/2017	26,770,000
6/1/2017	26,177,000
3/1/2017	25,792,000
5/1/2017	29,859,000
11/1/2017	28,977,000
10/1/2017	31,594,000
9/1/2017	31,415,000
4/1/2016	39,787,000
8/1/2016	36,563,000
12/1/2016	26,140,000
2/1/2016	40,051,000
1/1/2016	47,111,000
7/1/2016	40,979,000
6/1/2016	39,518,000
3/1/2016	40,648,000
5/1/2016	44,816,000
11/1/2016	21,876,000
10/1/2016	29,439,000
9/1/2016	32,736,000
4/1/2015	37,004,000
8/1/2015	41,883,000
12/1/2015	41,452,000
2/1/2015	36,771,000
1/1/2015	35,206,000
7/1/2015	39,064,000
6/1/2015	35,470,000
3/1/2015	34,250,000
5/1/2015	38,360,000
11/1/2015	44,693,000
10/1/2015	40,742,000
9/1/2015	41,921,000
4/1/2014	26,536,000
8/1/2014	40,157,000
12/1/2014	33,942,000
2/1/2014	26,191,000
1/1/2014	25,658,000
7/1/2014	33,968,000
6/1/2014	31,119,000
3/1/2014	28,076,000
5/1/2014	25,208,000
11/1/2014	31,366,000
10/1/2014	38,686,000
9/1/2014	39,693,000
4/1/2013	21,463,000
8/1/2013	21,988,000
12/1/2013	24,508,000
2/1/2013	19,833,000
1/1/2013	18,768,000
7/1/2013	23,324,000
6/1/2013	19,307,000
3/1/2013	17,624,000
5/1/2013	19,793,000
11/1/2013	21,697,000
10/1/2013	23,967,000
9/1/2013	23,444,000
4/1/2012	19,711,000
8/1/2012	24,233,000
12/1/2012	21,379,000
2/1/2012	20,851,000
1/1/2012	19,275,000
7/1/2012	24,291,000
6/1/2012	22,460,000
3/1/2012	21,846,000
5/1/2012	19,680,000
11/1/2012	18,978,000
10/1/2012	23,210,000
9/1/2012	23,453,000
4/1/2011	13,279,000
8/1/2011	21,209,000
12/1/2011	16,857,000
2/1/2011	12,582,000
1/1/2011	13,278,000
7/1/2011	21,034,000
6/1/2011	18,097,000
3/1/2011	12,874,000
5/1/2011	15,062,000
11/1/2011	19,014,000
10/1/2011	20,021,000
9/1/2011	22,218,000
4/1/2010	16,453,000
8/1/2010	19,859,000
12/1/2010	15,206,000
2/1/2010	12,922,000
1/1/2010	11,759,000
7/1/2010	22,059,000
6/1/2010	22,972,000
3/1/2010	16,313,000
5/1/2010	20,448,000
11/1/2010	16,500,000

Date	Value
10/1/2010	16,189,000
9/1/2010	18,046,000
4/1/2009	19,801,000
8/1/2009	19,045,000
12/1/2009	14,519,000
2/1/2009	18,279,000
1/1/2009	19,469,000
7/1/2009	20,062,000
6/1/2009	21,568,000
3/1/2009	19,274,000
5/1/2009	19,694,000
11/1/2009	15,052,000
10/1/2009	15,301,000
9/1/2009	17,426,000
4/1/2008	17,783,000
8/1/2008	21,147,000
12/1/2008	21,001,000
2/1/2008	18,157,000
1/1/2008	15,177,000
7/1/2008	19,723,000
6/1/2008	19,598,000
3/1/2008	17,118,000
5/1/2008	18,411,000
11/1/2008	21,659,000
10/1/2008	21,331,000
9/1/2008	20,796,000
4/1/2007	18,206,000
8/1/2007	15,692,000
12/1/2007	12,918,000
2/1/2007	15,570,000
1/1/2007	15,640,000
7/1/2007	13,811,000
6/1/2007	15,410,000
3/1/2007	15,996,000
5/1/2007	16,644,000
11/1/2007	13,096,000
10/1/2007	13,944,000
9/1/2007	14,734,000
4/1/2006	15,247,000
8/1/2006	15,353,000
12/1/2006	15,769,000
2/1/2006	15,777,000
1/1/2006	15,730,000
7/1/2006	15,254,000
6/1/2006	15,126,000
3/1/2006	15,454,000
5/1/2006	15,215,000
11/1/2006	15,862,000
10/1/2006	15,452,000
9/1/2006	15,228,000
4/1/2005	8,739,000
8/1/2005	11,790,000
12/1/2005	9,967,000
2/1/2005	7,585,000
1/1/2005	7,549,000
7/1/2005	11,756,000
6/1/2005	9,362,000
3/1/2005	7,650,000
5/1/2005	9,719,000
11/1/2005	9,332,000
10/1/2005	10,137,000
9/1/2005	10,942,000
4/1/2004	3,251,000
8/1/2004	3,878,000
12/1/2004	3,497,000
2/1/2004	3,355,000
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7/1/2004	3,376,000
6/1/2004	3,872,000
3/1/2004	3,164,000
5/1/2004	3,504,000
11/1/2004	3,715,000
10/1/2004	4,166,000
9/1/2004	4,179,000
4/1/2003	5,016,000
8/1/2003	5,855,000
12/1/2003	3,795,000
2/1/2003	4,063,000
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7/1/2003	5,929,000
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3/1/2003	3,900,000
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11/1/2003	4,883,000
10/1/2003	4,485,000
9/1/2003	6,210,000
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7/1/2002	14,215,000
6/1/2002	13,553,000
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9/1/2002	11,961,000
4/1/2001	13,551,000
8/1/2001	15,266,000
12/1/2001	11,905,000
2/1/2001	13,141,000
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7/1/2001	15,744,000
6/1/2001	15,443,000
3/1/2001	13,729,000
5/1/2001	14,586,000
11/1/2001	11,336,000
10/1/2001	13,238,000
9/1/2001	13,979,000
4/1/2000	13,345,000
8/1/2000	14,042,000
12/1/2000	13,455,000
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7/1/2000	13,557,000
6/1/2000	13,984,000
3/1/2000	11,437,000
5/1/2000	13,137,000
11/1/2000	12,486,000
10/1/2000	12,195,000
9/1/2000	12,867,000
4/1/1999	13,146,000
8/1/1999	12,240,000
12/1/1999	8,740,000
2/1/1999	12,134,000
1/1/1999	10,452,000
7/1/1999	11,975,000
6/1/1999	12,459,000
3/1/1999	12,374,000
5/1/1999	12,313,000
11/1/1999	9,446,000
10/1/1999	9,210,000
9/1/1999	9,815,000
4/1/1998	16,306,000
8/1/1998	14,530,000
12/1/1998	11,721,000
2/1/1998	15,284,000
1/1/1998	13,920,000
7/1/1998	16,188,000
6/1/1998	16,040,000
3/1/1998	16,226,000
5/1/1998	16,666,000
11/1/1998	11,870,000
10/1/1998	12,558,000
9/1/1998	12,253,000
4/1/1997	13,027,000
8/1/1997	19,383,000
12/1/1997	13,741,000
2/1/1997	9,862,000
1/1/1997	9,473,000
7/1/1997	18,535,000
6/1/1997	16,594,000
3/1/1997	11,163,000
5/1/1997	15,220,000
11/1/1997	16,534,000
10/1/1997	16,894,000
9/1/1997	16,119,000
4/1/1996	13,649,000
8/1/1996	14,645,000
12/1/1996	8,899,000
2/1/1996	13,017,000
1/1/1996	9,794,000
7/1/1996	13,164,000
6/1/1996	13,726,000

Date	Value
3/1/1996	12,247,000
5/1/1996	12,187,000
11/1/1996	9,788,000
10/1/1996	10,494,000
9/1/1996	11,249,000
4/1/1995	14,934,000
8/1/1995	10,240,000
12/1/1995	7,606,000
2/1/1995	10,825,000
1/1/1995	11,621,000
7/1/1995	10,679,000
6/1/1995	12,306,000
3/1/1995	12,679,000
5/1/1995	13,992,000
11/1/1995	7,846,000
10/1/1995	7,503,000
9/1/1995	7,412,000
4/1/1994	11,505,000
8/1/1994	11,016,000
12/1/1994	10,913,000
2/1/1994	9,507,000
1/1/1994	9,198,000
7/1/1994	12,026,000
6/1/1994	12,124,000
3/1/1994	11,194,000
5/1/1994	11,368,000
11/1/1994	8,796,000
10/1/1994	8,946,000
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7/1/1993	13,495,000
6/1/1993	13,152,000
3/1/1993	6,661,000
5/1/1993	11,181,000
11/1/1993	10,161,000
10/1/1993	11,843,000
9/1/1993	12,615,000
4/1/1992	8,580,000
8/1/1992	9,314,000
12/1/1992	7,864,000
2/1/1992	6,670,000
1/1/1992	7,255,000
7/1/1992	11,711,000
6/1/1992	10,968,000
3/1/1992	8,455,000
5/1/1992	9,870,000
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9/1/1992	8,751,000
4/1/1991	7,277,000
8/1/1991	6,130,000
12/1/1991	6,296,000
2/1/1991	9,829,000
1/1/1991	9,438,000
7/1/1991	6,917,000
6/1/1991	8,002,000
3/1/1991	8,070,000
5/1/1991	8,436,000
11/1/1991	6,659,000
10/1/1991	5,739,000
9/1/1991	5,287,000
4/1/1990	8,390,000
8/1/1990	9,144,000
12/1/1990	8,414,000
2/1/1990	8,468,000
1/1/1990	7,844,000
7/1/1990	10,107,000
6/1/1990	9,685,000
3/1/1990	7,905,000
5/1/1990	8,052,000
11/1/1990	8,099,000
10/1/1990	8,458,000
9/1/1990	8,929,000
4/1/1989	6,558,000
8/1/1989	7,731,000
12/1/1989	7,625,000
2/1/1989	6,487,000
1/1/1989	7,267,000
7/1/1989	7,841,000
6/1/1989	8,003,000
3/1/1989	6,619,000
5/1/1989	6,827,000
11/1/1989	7,990,000
10/1/1989	7,707,000
9/1/1989	7,057,000
4/1/1988	7,639,000
8/1/1988	7,253,000
12/1/1988	6,115,000
2/1/1988	6,190,000
1/1/1988	8,069,000
7/1/1988	8,537,000
6/1/1988	8,738,000
3/1/1988	7,056,000
5/1/1988	8,018,000
11/1/1988	6,001,000
10/1/1988	6,396,000
9/1/1988	6,827,000
4/1/1987	13,248,000
8/1/1987	8,468,000
12/1/1987	7,949,000
2/1/1987	13,565,000
1/1/1987	11,550,000
7/1/1987	9,311,000
6/1/1987	12,007,000
3/1/1987	13,595,000
5/1/1987	13,997,000
11/1/1987	8,637,000
10/1/1987	7,036,000
9/1/1987	6,978,000
4/1/1986	12,754,000
8/1/1986	15,459,000
12/1/1986	12,603,000
2/1/1986	13,813,000
1/1/1986	11,615,000
7/1/1986	14,318,000
6/1/1986	14,068,000
3/1/1986	11,811,000
5/1/1986	12,742,000
11/1/1986	13,843,000
10/1/1986	14,641,000
9/1/1986	14,450,000
4/1/1985	7,644,000
8/1/1985	9,541,000
12/1/1985	12,766,000
2/1/1985	6,840,000
1/1/1985	7,339,000
7/1/1985	9,193,000
6/1/1985	8,931,000
3/1/1985	6,547,000
5/1/1985	8,068,000
11/1/1985	12,525,000
10/1/1985	10,033,000
9/1/1985	9,237,000
4/1/1984	9,123,000
8/1/1984	7,267,000
12/1/1984	7,066,000
2/1/1984	7,542,000
1/1/1984	8,365,000
7/1/1984	8,026,000
6/1/1984	8,404,000
3/1/1984	8,057,000
5/1/1984	8,839,000
11/1/1984	7,890,000
10/1/1984	8,403,000
9/1/1984	8,889,000
4/1/1983	8,331,000
8/1/1983	8,815,000
12/1/1983	10,701,000
2/1/1983	7,673,000
1/1/1983	7,682,000
7/1/1983	7,717,000
6/1/1983	8,691,000
3/1/1983	8,218,000
5/1/1983	8,839,000
11/1/1983	10,270,000
10/1/1983	9,092,000
9/1/1983	8,622,000
12/1/1982	8,653,000
2/1/1982	8,449,000
1/1/1982	9,569,000
6/1/1982	8,266,000

Date	Value
3/1/1982	8,783,000
9/1/1982	8,571,000
4/1/1981	10,196,000
8/1/1981	13,694,000
12/1/1981	10,540,000
2/1/1981	7,843,000
1/1/1981	8,997,000
7/1/1981	12,564,000
6/1/1981	12,297,000
3/1/1981	7,823,000
5/1/1981	10,403,000
11/1/1981	11,362,000
10/1/1981	12,676,000
9/1/1981	13,311,000
4/1/1980	8,475,000
8/1/1980	8,880,000
12/1/1980	9,142,000
2/1/1980	9,464,000
1/1/1980	10,302,000
7/1/1980	10,263,000
6/1/1980	10,229,000
3/1/1980	7,945,000
5/1/1980	8,995,000
11/1/1980	9,779,000
10/1/1980	8,165,000
9/1/1980	8,336,000
4/1/1979	12,072,000
8/1/1979	11,763,000
12/1/1979	10,751,000
2/1/1979	10,827,000
1/1/1979	10,965,000
7/1/1979	11,943,000
6/1/1979	11,483,000
3/1/1979	12,022,000
5/1/1979	12,897,000
11/1/1979	11,071,000
10/1/1979	11,697,000
9/1/1979	10,951,000
4/1/1978	9,176,000
8/1/1978	11,259,000
12/1/1978	11,716,000
2/1/1978	8,628,000
1/1/1978	9,261,000
7/1/1978	11,891,000
6/1/1978	10,011,000
3/1/1978	7,947,000
5/1/1978	10,149,000
11/1/1978	11,804,000
10/1/1978	12,200,000
9/1/1978	11,323,000
4/1/1977	12,771,000
8/1/1977	13,567,000
12/1/1977	10,096,000
2/1/1977	13,884,000
1/1/1977	14,131,000
7/1/1977	13,848,000
6/1/1977	14,381,000
3/1/1977	11,813,000
5/1/1977	14,583,000
11/1/1977	9,356,000
10/1/1977	10,097,000
9/1/1977	11,630,000
4/1/1976	9,626,000
8/1/1976	15,152,000
12/1/1976	14,535,000
2/1/1976	11,123,000
1/1/1976	10,808,000
7/1/1976	14,461,000
6/1/1976	12,261,000
3/1/1976	9,244,000
5/1/1976	10,935,000
11/1/1976	16,552,000
10/1/1976	15,678,000
9/1/1976	16,958,000
4/1/1975	9,963,000
8/1/1975	10,107,000
12/1/1975	11,785,000
2/1/1975	11,221,000
1/1/1975	12,154,000
7/1/1975	9,089,000
6/1/1975	7,388,000
3/1/1975	9,254,000
5/1/1975	8,819,000
11/1/1975	11,543,000
10/1/1975	10,765,000
9/1/1975	10,749,000
4/1/1974	14,149,000
8/1/1974	15,333,000
12/1/1974	13,690,000
2/1/1974	13,018,000
1/1/1974	12,465,000
7/1/1974	15,977,000
6/1/1974	15,909,000
3/1/1974	13,749,000
5/1/1974	16,820,000
11/1/1974	14,169,000
10/1/1974	14,894,000
9/1/1974	14,198,000
12/1/1972	13,210,000
12/1/1972	12,739,000
12/1/1972	15,034,000
12/1/1972	11,847,000
12/1/1972	14,258,000
12/1/1972	14,451,000
12/1/1972	16,004,000
12/1/1972	10,920,000
12/1/1972	15,644,000
12/1/1972	14,691,000
12/1/1972	15,517,000
12/1/1972	13,083,000
12/1/1971	15,205,000
12/1/1971	21,220,000
12/1/1971	15,704,000
12/1/1971	12,836,000
12/1/1971	16,355,000
12/1/1971	21,272,000
12/1/1971	19,277,000
12/1/1971	12,238,000
12/1/1971	19,916,000
12/1/1971	17,200,000
12/1/1971	18,226,000
12/1/1971	19,171,000
12/1/1970	20,221,000
12/1/1970	19,391,000
12/1/1970	19,260,000
12/1/1970	19,653,000
12/1/1970	20,526,000
12/1/1970	21,292,000
12/1/1970	22,848,000
12/1/1970	20,403,000
12/1/1970	22,506,000
12/1/1970	18,626,000
12/1/1970	20,059,000
12/1/1970	20,719,000
12/1/1969	20,919,000
12/1/1969	22,834,000
12/1/1969	19,336,000
12/1/1969	18,064,000
12/1/1969	17,074,000
12/1/1969	23,093,000
12/1/1969	20,032,000
12/1/1969	21,794,000
12/1/1969	18,808,000
12/1/1969	19,653,000
12/1/1969	21,028,000
12/1/1969	20,738,000
12/1/1968	16,906,000
12/1/1968	15,215,000
12/1/1968	16,134,000
12/1/1968	9,479,000
12/1/1968	10,417,000
12/1/1968	12,456,000
12/1/1968	12,946,000
12/1/1968	12,201,000
12/1/1968	15,758,000
12/1/1968	17,343,000
12/1/1968	17,037,000
12/1/1968	16,022,000
12/1/1967	12,459,000
12/1/1967	10,534,000
12/1/1967	14,139,000
12/1/1967	12,883,000
12/1/1967	14,940,000
12/1/1967	12,191,000
12/1/1967	12,426,000

Date	Value
12/1/1967	12,843,000
12/1/1967	11,738,000
12/1/1967	14,756,000
12/1/1967	12,919,000
12/1/1967	11,855,000
12/1/1966	15,556,000
12/1/1966	10,905,000
12/1/1966	15,308,000
12/1/1966	15,317,000
12/1/1966	15,333,000
12/1/1966	12,841,000
12/1/1966	14,620,000
12/1/1966	15,475,000
12/1/1966	16,717,000
12/1/1966	14,526,000
12/1/1966	13,067,000
12/1/1966	11,444,000
12/1/1965	17,658,000
12/1/1965	22,016,000
12/1/1965	17,210,000
12/1/1965	11,216,000
12/1/1965	10,382,000
12/1/1965	25,513,000
12/1/1965	22,426,000
12/1/1965	12,986,000
12/1/1965	20,117,000
12/1/1965	18,111,000
12/1/1965	19,714,000
12/1/1965	20,982,000
12/1/1964	10,962,000
12/1/1964	9,835,000
12/1/1964	11,781,000
12/1/1964	10,578,000
12/1/1964	12,349,000
12/1/1964	10,311,000
12/1/1964	9,915,000
12/1/1964	11,197,000
12/1/1964	11,428,000
12/1/1964	11,898,000
12/1/1964	12,265,000
12/1/1964	10,132,000
12/1/1963	16,314,000
12/1/1963	16,148,000
12/1/1963	13,147,000
12/1/1963	18,364,000
12/1/1963	18,257,000
12/1/1963	17,268,000
12/1/1963	18,231,000
12/1/1963	18,280,000
12/1/1963	16,438,000
12/1/1963	12,954,000
12/1/1963	13,711,000
12/1/1963	15,271,000
12/1/1962	23,687,000
12/1/1962	19,839,000

Date	Value
12/1/1962	18,588,000
12/1/1962	21,000,000
12/1/1962	13,432,000
12/1/1962	19,946,000
12/1/1962	19,761,000
12/1/1962	22,801,000
12/1/1962	21,436,000
12/1/1962	17,201,000
12/1/1962	17,813,000
12/1/1962	17,974,000
12/1/1961	18,548,000
12/1/1961	11,818,000
12/1/1961	15,284,000
12/1/1961	16,128,000
12/1/1961	16,347,000
12/1/1961	11,814,000
12/1/1961	14,693,000
12/1/1961	18,287,000
12/1/1961	17,920,000
12/1/1961	11,038,000
12/1/1961	9,615,000
12/1/1961	10,241,000
12/1/1960	22,033,000
12/1/1960	23,006,000
12/1/1960	17,603,000
12/1/1960	11,767,000
12/1/1960	12,352,000
12/1/1960	24,809,000
12/1/1960	26,014,000
12/1/1960	17,618,000
12/1/1960	24,312,000
12/1/1960	18,379,000
12/1/1960	19,749,000
12/1/1960	21,019,000
12/1/1959	10,921,000
12/1/1959	13,434,000
12/1/1959	12,442,000
12/1/1959	12,203,000
12/1/1959	14,046,000
12/1/1959	13,178,000
12/1/1959	11,654,000
12/1/1959	11,188,000
12/1/1959	9,943,000
12/1/1959	12,424,000
12/1/1959	12,286,000
12/1/1959	12,644,000
12/1/1958	13,478,000
12/1/1958	14,605,000
12/1/1958	14,794,000
12/1/1958	11,053,000
12/1/1958	10,118,000
12/1/1958	17,374,000
12/1/1958	16,614,000
12/1/1958	10,991,000
12/1/1958	15,730,000

Date	Value
12/1/1958	12,624,000
12/1/1958	12,300,000
12/1/1958	13,736,000
12/1/1957	6,674,000
12/1/1957	10,969,000
12/1/1957	9,189,000
12/1/1957	4,381,000
12/1/1957	4,756,000
12/1/1957	10,411,000
12/1/1957	11,995,000
12/1/1957	4,861,000
12/1/1957	10,431,000
12/1/1957	9,280,000
12/1/1957	9,913,000
12/1/1957	9,927,000
12/1/1956	7,330,000
12/1/1956	5,194,000
12/1/1956	5,206,000
12/1/1956	8,987,000
12/1/1956	9,715,000
12/1/1956	6,399,000
12/1/1956	6,870,000
12/1/1956	8,100,000
12/1/1956	6,837,000
12/1/1956	5,309,000
12/1/1956	5,616,000
12/1/1956	5,745,000
12/1/1955	8,976,000
12/1/1955	9,002,000
12/1/1955	11,590,000
12/1/1955	10,060,000
12/1/1955	10,566,000
12/1/1955	7,975,000
12/1/1955	8,620,000
12/1/1955	9,875,000
12/1/1955	8,481,000
12/1/1955	11,016,000
12/1/1955	11,203,000
12/1/1955	9,703,000
12/1/1954	9,677,000
12/1/1954	8,737,000
12/1/1954	10,630,000
12/1/1954	8,743,000
12/1/1954	8,767,000
12/1/1954	8,597,000
12/1/1954	8,851,000
12/1/1954	9,089,000
12/1/1954	9,957,000
12/1/1954	9,884,000
12/1/1954	9,569,000
12/1/1954	8,683,000
12/1/1953	8,897,000
12/1/1953	7,867,000
12/1/1953	9,714,000
12/1/1953	10,808,000

Date	Value
12/1/1953	11,460,000
12/1/1953	7,780,000
12/1/1953	8,709,000
12/1/1953	9,445,000
12/1/1953	8,135,000
12/1/1953	8,518,000
12/1/1953	7,741,000
12/1/1953	7,359,000
12/1/1952	17,493,000
12/1/1952	9,460,000
12/1/1952	12,232,000
12/1/1952	22,206,000
12/1/1952	20,816,000
12/1/1952	10,410,000
12/1/1952	13,461,000
12/1/1952	19,945,000
12/1/1952	14,720,000
12/1/1952	11,151,000
12/1/1952	10,762,000
12/1/1952	10,113,000
12/1/1951	13,067,000
12/1/1951	11,318,000
12/1/1951	21,912,000
12/1/1951	13,532,000
12/1/1951	13,840,000
12/1/1951	11,814,000
12/1/1951	14,902,000
12/1/1951	14,896,000
12/1/1951	16,141,000
12/1/1951	17,580,000
12/1/1951	16,002,000
12/1/1951	12,553,000
12/1/1950	5,435,000
12/1/1950	6,407,000
12/1/1950	13,720,000
12/1/1950	9,474,000
12/1/1950	10,072,000
12/1/1950	6,211,000
12/1/1950	5,235,000
12/1/1950	7,727,000
12/1/1950	5,862,000
12/1/1950	12,536,000
12/1/1950	9,767,000
12/1/1950	7,227,000
12/1/1949	8,440,000
12/1/1949	5,998,000
12/1/1949	10,479,000
12/1/1949	13,062,000
12/1/1949	14,332,000
12/1/1949	6,079,000
12/1/1949	6,681,000
12/1/1949	10,689,000
12/1/1949	7,099,000
12/1/1949	9,416,000
12/1/1949	7,994,000

Date	Value
12/1/1949	6,486,000
12/1/1948	9,864,000
12/1/1948	6,869,000
12/1/1948	13,811,000
12/1/1948	19,571,000
12/1/1948	22,466,000
12/1/1948	6,651,000
12/1/1948	6,761,000
12/1/1948	14,268,000
12/1/1948	7,007,000
12/1/1948	10,534,000
12/1/1948	8,222,000
12/1/1948	7,268,000
12/1/1947	9,106,000
12/1/1947	9,847,000
12/1/1947	26,209,000
12/1/1947	16,971,000
12/1/1947	19,294,000
12/1/1947	8,557,000
12/1/1947	7,999,000
12/1/1947	14,890,000
12/1/1947	7,665,000
12/1/1947	23,305,000
12/1/1947	16,296,000
12/1/1947	10,478,000
12/1/1946	10,808,000
12/1/1946	7,837,000
12/1/1946	20,317,000
12/1/1946	16,554,000
12/1/1946	17,114,000
12/1/1946	8,085,000
12/1/1946	9,348,000
12/1/1946	14,110,000
12/1/1946	9,563,000
12/1/1946	17,280,000
12/1/1946	11,893,000
12/1/1946	6,645,000
12/1/1945	12,171,000
12/1/1945	13,135,000
12/1/1945	16,893,000
12/1/1945	16,533,000
12/1/1945	19,189,000
12/1/1945	9,108,000
12/1/1945	10,378,000
12/1/1945	15,513,000
12/1/1945	10,863,000
12/1/1945	15,696,000
12/1/1945	10,602,000
12/1/1945	8,844,000
12/1/1944	11,541,000
12/1/1944	9,918,000
12/1/1944	17,406,000
12/1/1944	17,195,000
12/1/1944	18,258,000
12/1/1944	14,842,000

Date	Value
12/1/1944	18,121,000
12/1/1944	15,264,000
12/1/1944	13,870,000
12/1/1944	15,394,000
12/1/1944	13,066,000
12/1/1944	9,177,000
12/1/1943	16,723,000
12/1/1943	15,027,000
12/1/1943	20,183,000
12/1/1943	32,251,000
12/1/1943	34,599,000
12/1/1943	12,721,000
12/1/1943	14,616,000
12/1/1943	21,659,000
12/1/1943	14,479,000
12/1/1943	18,874,000
12/1/1943	17,882,000
12/1/1943	16,069,000
12/1/1942	11,649,000
12/1/1942	13,777,000
12/1/1942	33,172,000
12/1/1942	19,748,000
12/1/1942	24,885,000
12/1/1942	9,660,000
12/1/1942	7,808,000
12/1/1942	12,571,000
12/1/1942	10,284,000
12/1/1942	31,267,000
12/1/1942	23,207,000
12/1/1942	17,704,000
12/1/1941	7,108,000
12/1/1941	7,602,000
12/1/1941	34,819,000
12/1/1941	8,122,000
12/1/1941	8,228,000
12/1/1941	5,487,000
12/1/1941	5,313,000
12/1/1941	8,180,000
12/1/1941	5,711,000
12/1/1941	26,462,000
12/1/1941	17,896,000
12/1/1941	11,260,000
12/1/1940	4,718,000
12/1/1940	3,306,000
12/1/1940	7,936,000
12/1/1940	4,448,000
12/1/1940	4,699,000
12/1/1940	3,211,000
12/1/1940	3,638,000
12/1/1940	4,378,000
12/1/1940	4,130,000
12/1/1940	6,432,000
12/1/1940	4,783,000
12/1/1940	4,093,000
12/1/1939	3,580,000

Date	Value
12/1/1939	3,192,000
12/1/1939	5,119,000
12/1/1939	4,448,000
12/1/1939	4,412,000
12/1/1939	3,342,000
12/1/1939	3,245,000
12/1/1939	4,257,000
12/1/1939	3,463,000
12/1/1939	4,427,000
12/1/1939	3,817,000
12/1/1939	3,411,000
12/1/1938	1,956,000
12/1/1938	2,459,000
12/1/1938	4,803,000
12/1/1938	2,773,000
12/1/1938	2,925,000
12/1/1938	1,893,000
12/1/1938	1,837,000
12/1/1938	2,412,000
12/1/1938	1,791,000
12/1/1938	4,187,000
12/1/1938	3,499,000
12/1/1938	2,965,000
12/1/1937	2,121,000
12/1/1937	1,861,000
12/1/1937	3,541,000
12/1/1937	3,523,000
12/1/1937	3,294,000
12/1/1937	1,972,000
12/1/1937	2,148,000
12/1/1937	2,901,000
12/1/1937	2,125,000
12/1/1937	3,171,000
12/1/1937	2,606,000
12/1/1937	2,318,000
12/1/1936	4,574,000
12/1/1936	1,928,000
12/1/1936	2,895,000
12/1/1936	9,807,000
12/1/1936	10,491,000
12/1/1936	1,840,000
12/1/1936	2,171,000
12/1/1936	7,174,000
12/1/1936	2,950,000
12/1/1936	2,286,000
12/1/1936	2,376,000
12/1/1936	1,887,000
12/1/1935	1,785,000
12/1/1935	2,634,000
12/1/1935	10,228,000
12/1/1935	2,563,000
12/1/1935	2,824,000
12/1/1935	1,478,000
12/1/1935	1,122,000
12/1/1935	2,334,000
12/1/1935	1,282,000
12/1/1935	8,450,000
12/1/1935	5,930,000
12/1/1935	3,374,000
12/1/1934	3,031,000
12/1/1934	1,730,000
12/1/1934	3,025,000
12/1/1934	3,506,000
12/1/1934	3,819,000
12/1/1934	2,109,000
12/1/1934	2,376,000
12/1/1934	3,218,000
12/1/1934	2,818,000
12/1/1934	2,661,000
12/1/1934	1,968,000
12/1/1934	1,376,000
12/1/1933	1,281,000
12/1/1933	1,608,000
12/1/1933	4,560,000
12/1/1933	3,052,000
12/1/1933	4,183,000
12/1/1933	1,518,000
12/1/1933	1,450,000
12/1/1933	2,024,000
12/1/1933	1,363,000
12/1/1933	4,687,000
12/1/1933	3,074,000
12/1/1933	2,400,000
12/1/1932	1,773,000
12/1/1932	1,487,000
12/1/1932	4,012,000
12/1/1932	1,683,000
12/1/1932	2,029,000
12/1/1932	1,594,000
12/1/1932	1,807,000
12/1/1932	1,818,000
12/1/1932	1,843,000
12/1/1932	2,888,000
12/1/1932	2,511,000
12/1/1932	1,886,000
12/1/1931	1,061,000
12/1/1931	1,305,000
12/1/1931	2,767,000
12/1/1931	1,784,000
12/1/1931	1,947,000
12/1/1931	1,012,000
12/1/1931	1,010,000
12/1/1931	1,222,000
12/1/1931	1,018,000
12/1/1931	2,904,000
12/1/1931	2,974,000
12/1/1931	1,983,000
12/1/1930	2,529,000
12/1/1930	1,975,000
12/1/1930	2,318,000
12/1/1930	3,573,000
12/1/1930	4,081,000
12/1/1930	1,892,000
12/1/1930	2,685,000
12/1/1930	3,063,000
12/1/1930	2,371,000
12/1/1930	1,985,000
12/1/1930	1,975,000
12/1/1930	1,908,000
12/1/1929	5,190,000
12/1/1929	3,977,000
12/1/1929	4,677,000
12/1/1929	5,408,000
12/1/1929	4,667,000
12/1/1929	4,476,000
12/1/1929	4,820,000
12/1/1929	5,174,000
12/1/1929	4,639,000
12/1/1929	4,628,000
12/1/1929	4,326,000
12/1/1929	4,320,000
12/1/1928	2,533,000
12/1/1928	3,159,000
12/1/1928	5,317,000
12/1/1928	3,252,000
12/1/1928	4,009,000
12/1/1928	2,639,000
12/1/1928	3,061,000
12/1/1928	3,109,000
12/1/1928	2,461,000
12/1/1928	5,194,000
12/1/1928	4,992,000
12/1/1928	4,113,000
12/1/1927	1,828,000
12/1/1927	1,691,000
12/1/1927	5,623,000
12/1/1927	4,020,000
12/1/1927	4,404,000
12/1/1927	1,822,000
12/1/1927	1,947,000
12/1/1927	3,252,000
12/1/1927	1,276,000
12/1/1927	5,472,000
12/1/1927	4,321,000
12/1/1927	2,113,000
12/1/1926	1,862,000
12/1/1926	1,302,000
12/1/1926	4,408,000
12/1/1926	4,074,000
12/1/1926	4,447,000
12/1/1926	1,161,000
12/1/1926	1,360,000
12/1/1926	2,940,000
12/1/1926	1,210,000
12/1/1926	3,790,000

Date	Value
12/1/1926	2,958,000
12/1/1926	1,991,000
12/1/1925	2,393,000
12/1/1925	1,929,000
12/1/1925	4,556,000
12/1/1925	3,346,000
12/1/1925	2,354,000
12/1/1925	1,813,000
12/1/1925	1,871,000
12/1/1925	3,289,000
12/1/1925	1,697,000
12/1/1925	3,166,000
12/1/1925	2,814,000
12/1/1925	2,234,000
12/1/1924	1,998,000
12/1/1924	1,339,000
12/1/1924	1,820,000
12/1/1924	2,294,000
12/1/1924	2,336,000
12/1/1924	1,349,000
12/1/1924	1,535,000
12/1/1924	2,090,000
12/1/1924	1,913,000
12/1/1924	1,549,000
12/1/1924	1,435,000
12/1/1924	1,112,000
12/1/1923	2,093,000
12/1/1923	2,230,000
12/1/1923	2,949,000
12/1/1923	2,173,000
12/1/1923	2,306,000
12/1/1923	2,257,000
12/1/1923	2,917,000
12/1/1923	1,719,000
12/1/1923	2,273,000
12/1/1923	3,326,000
12/1/1923	3,166,000
12/1/1923	2,525,000
12/1/1922	5,774,000
12/1/1922	1,785,000
12/1/1922	2,493,000
12/1/1922	5,758,000
12/1/1922	5,980,000
12/1/1922	2,752,000
12/1/1922	3,556,000
12/1/1922	6,635,000
12/1/1922	4,445,000
12/1/1922	2,014,000
12/1/1922	1,997,000
12/1/1922	1,719,000
12/1/1921	2,071,000
12/1/1921	3,376,000
12/1/1921	4,523,000
12/1/1921	2,863,000
12/1/1921	3,914,000

Date	Value
12/1/1921	3,308,000
12/1/1921	3,720,000
12/1/1921	2,878,000
12/1/1921	2,310,000
12/1/1921	3,633,000
12/1/1921	3,458,000
12/1/1921	3,473,000
12/1/1920	25,129,000
12/1/1920	5,903,000
12/1/1920	6,444,000
12/1/1920	59,304,000
12/1/1920	78,082,000
12/1/1920	6,751,000
12/1/1920	8,714,000
12/1/1920	38,520,000
12/1/1920	15,877,000
12/1/1920	7,520,000
12/1/1920	6,840,000
12/1/1920	5,993,000
12/1/1919	2,579,000
12/1/1919	11,021,000
12/1/1919	68,032,000
12/1/1919	5,781,000
12/1/1919	7,787,000
12/1/1919	2,299,000
12/1/1919	4,311,000
12/1/1919	3,517,000
12/1/1919	5,735,000
12/1/1919	56,702,000
12/1/1919	48,997,000
12/1/1919	25,325,000
12/1/1918	7,623,000
12/1/1918	7,817,000
12/1/1918	10,290,000
12/1/1918	8,013,000
12/1/1918	11,360,000
12/1/1918	7,263,000
12/1/1918	7,279,000
12/1/1918	6,505,000
12/1/1918	7,718,000
12/1/1918	9,409,000
12/1/1918	7,894,000
12/1/1918	8,318,000
4/1/1918	3,348,000
8/1/1918	4,046,000
12/1/1918	12,760,000
2/1/1918	7,855,000
1/1/1918	6,315,000
7/1/1918	3,150,000
6/1/1918	2,429,000
3/1/1918	5,599,000
5/1/1918	3,860,000
11/1/1918	9,035,000
10/1/1918	8,645,000
9/1/1918	5,275,000

Date	Value
4/1/1917	4,369,000
8/1/1917	2,716,000
12/1/1917	7,403,000
2/1/1917	4,949,000
1/1/1917	5,895,000
7/1/1917	3,912,000
6/1/1917	4,380,000
3/1/1917	4,872,000
5/1/1917	3,508,000
11/1/1917	5,406,000
10/1/1917	4,194,000
9/1/1917	2,768,000

Source: After USDA NASS Survey, accessed January 2024.

Appendix C

Data for Figure IV.5. Average Price Paid at Fort Collins, CO Auction for Choice and Prime Shorn Slaughter Lambs

Report Date	Avg Price
1/8/2000	70.63
1/15/2000	66.25
1/22/2000	64.21
1/29/2000	66.25
2/5/2000	66.25
2/12/2000	66.71
2/19/2000	75.13
2/26/2000	77.88
3/4/2000	80.58
3/11/2000	79.75
3/18/2000	77.50
3/25/2000	81.25
4/1/2000	80.59
4/8/2000	78.63
4/15/2000	80.13
4/22/2000	78.83
5/6/2000	92.00
5/13/2000	100.50
5/20/2000	101.00
5/27/2000	97.88
6/3/2000	97.06
6/10/2000	95.13
6/17/2000	92.60
6/24/2000	91.25
7/1/2000	80.00
7/22/2000	85.50
8/5/2000	87.83
8/12/2000	89.50
8/19/2000	84.75
8/26/2000	81.38
9/2/2000	81.25
9/9/2000	83.50
9/16/2000	80.19
9/23/2000	78.33
9/30/2000	75.00
10/7/2000	76.13
10/14/2000	74.50
10/21/2000	72.75
10/28/2000	71.56
11/4/2000	67.50
11/11/2000	67.88
11/18/2000	67.75
11/25/2000	67.38
12/2/2000	68.00
12/9/2000	68.25
12/16/2000	69.31
12/23/2000	70.19
12/30/2000	69.63
1/6/2001	70.13
1/13/2001	70.75
1/20/2001	73.00
1/27/2001	73.67
2/3/2001	72.29
2/10/2001	80.63
2/17/2001	81.38
2/24/2001	84.94
3/3/2001	84.88
3/10/2001	84.38
3/17/2001	83.50
3/24/2001	83.00
3/31/2001	83.66
8/4/2001	48.50
8/11/2001	52.75
8/18/2001	50.50
8/25/2001	47.00
9/1/2001	53.00
9/8/2001	50.00
9/15/2001	53.00
10/13/2001	44.50
11/10/2001	51.63
11/24/2001	54.00
12/1/2001	55.00
12/22/2001	55.00
2/16/2002	60.75
3/9/2002	64.50
3/23/2002	55.00
3/30/2002	49.00
5/11/2002	53.00
8/17/2002	74.50
8/24/2002	72.50
8/31/2002	71.50
9/7/2002	71.75
10/12/2002	76.50
11/9/2002	85.00
12/21/2002	87.50
2/1/2003	80.50
2/8/2003	84.00
3/1/2003	87.50
3/8/2003	93.00
3/15/2003	91.50
7/19/2003	89.00
8/16/2003	75.25
8/23/2003	78.50
9/6/2003	82.50
9/13/2003	79.00
9/20/2003	82.50
9/27/2003	89.50
10/18/2003	89.00
12/20/2003	88.38
3/20/2004	95.50
8/14/2004	83.50
8/28/2004	83.00
9/4/2004	87.50
9/25/2004	82.25
10/2/2004	91.50
10/9/2004	88.50
10/16/2004	86.50
10/23/2004	84.00
11/6/2004	86.00
1/29/2005	97.50
2/19/2005	108.50
6/18/2005	110.00
8/13/2005	95.00
8/27/2005	79.17
9/3/2005	93.00
9/10/2005	90.50
9/17/2005	89.50
9/24/2005	93.63
10/1/2005	91.50
10/8/2005	95.50
10/15/2005	94.00
10/22/2005	94.75
11/12/2005	91.50
12/17/2005	75.50
4/1/2006	74.00
6/24/2006	82.00
7/1/2006	92.50
7/22/2006	88.50
7/29/2006	87.50
8/12/2006	88.00
8/19/2006	90.25
8/26/2006	84.50
9/23/2006	89.25
10/7/2006	92.50
10/14/2006	93.25
11/4/2006	91.50
5/5/2007	101.50
5/19/2007	102.50
6/9/2007	95.25
6/16/2007	94.25
6/30/2007	101.50
8/4/2007	94.50
8/11/2007	96.25
9/1/2007	99.50
9/8/2007	95.83
3/15/2008	98.50
6/7/2008	101.00
8/2/2008	104.00
8/9/2008	96.00
8/16/2008	101.88
8/23/2008	92.75
8/30/2008	93.00
9/6/2008	105.75
9/13/2008	103.25
9/27/2008	93.00
10/4/2008	91.75
10/18/2008	97.50
10/25/2008	94.00
11/22/2008	101.00
12/13/2008	108.00
4/11/2009	105.50
5/16/2009	115.50

Report Date	Avg Price
6/27/2009	107.00
8/15/2009	96.25
8/22/2009	88.50
9/12/2009	91.00
11/21/2009	118.50
9/4/2010	128.50
10/2/2010	130.50
10/9/2010	126.56
10/23/2010	134.50
1/8/2011	165.00
4/16/2011	185.00
7/30/2011	178.25
8/13/2011	181.88
8/20/2011	178.00
8/27/2011	179.50
9/3/2011	175.00
9/24/2011	174.50
10/1/2011	178.00
10/15/2011	155.00
4/14/2012	164.38
8/4/2012	88.00
8/11/2012	97.75
8/18/2012	85.50
8/25/2012	92.25
9/8/2012	95.00
11/10/2012	104.00
8/10/2013	109.50
11/2/2013	148.00
1/25/2014	182.50
8/23/2014	163.00
8/1/2015	170.25
9/12/2015	206.25
3/12/2016	200.00
8/20/2016	166.50
8/27/2016	176.50
9/17/2016	156.00
3/10/2018	185.63
7/28/2018	152.50
11/3/2018	153.75
11/10/2018	155.00
4/24/2019	192.00
5/1/2019	212.81
5/8/2019	185.25
5/15/2019	178.15
5/22/2019	175.90
5/29/2019	207.96
6/5/2019	157.57
6/12/2019	166.66
6/19/2019	166.88
6/26/2019	152.19
7/17/2019	152.68
7/24/2019	165.55
8/7/2019	151.20
8/14/2019	159.40
8/21/2019	156.08
8/28/2019	145.55
9/4/2019	156.93
9/11/2019	158.43
9/18/2019	146.47
9/25/2019	149.55
10/9/2019	152.63
10/16/2019	149.49
10/23/2019	150.52
11/6/2019	153.39
11/13/2019	159.95
11/20/2019	163.10
11/27/2019	176.85
12/4/2019	170.90
12/11/2019	170.54
12/18/2019	171.93
1/8/2020	179.94
1/15/2020	184.84
1/22/2020	186.10
1/29/2020	185.58
2/5/2020	194.08
2/12/2020	205.54
2/19/2020	185.13
2/26/2020	193.58
3/4/2020	209.93
3/11/2020	203.31
3/18/2020	178.90
3/25/2020	169.25
4/1/2020	156.40
4/8/2020	196.00
4/15/2020	225.70
4/22/2020	191.56
4/29/2020	179.79
5/6/2020	182.75
5/13/2020	154.33
5/20/2020	156.98
5/27/2020	173.50
6/3/2020	160.09
6/10/2020	177.07
6/17/2020	179.17
6/24/2020	187.33
7/15/2020	165.97
7/22/2020	187.50
7/29/2020	141.64
8/5/2020	154.97
8/12/2020	127.78
8/19/2020	140.45
8/26/2020	141.57
9/2/2020	160.62
9/9/2020	177.40
9/16/2020	163.73
9/23/2020	148.70
9/30/2020	147.41
10/7/2020	155.54
10/14/2020	166.00
10/21/2020	161.04
10/28/2020	168.61
11/4/2020	172.63
11/11/2020	170.39
11/18/2020	190.04
11/25/2020	182.51
12/2/2020	194.12
12/9/2020	206.81
12/16/2020	186.81
1/6/2021	219.33
1/13/2021	237.26
1/20/2021	221.79
1/27/2021	235.00
2/3/2021	190.18
2/10/2021	178.96
2/17/2021	250.31
2/24/2021	200.32
3/3/2021	244.76
3/10/2021	231.63
3/17/2021	250.42
3/24/2021	216.41
3/31/2021	241.26
4/7/2021	259.89
4/14/2021	276.15
6/9/2021	287.32
6/16/2021	279.07
6/30/2021	306.23
7/21/2021	273.64
8/11/2021	255.91
8/25/2021	202.54
9/15/2021	266.29
1/12/2022	231.80
2/23/2022	270.00
3/16/2022	305.00
3/30/2022	274.10
4/13/2022	170.26
4/27/2022	330.42
5/4/2022	285.00
5/11/2022	235.28
5/18/2022	277.97
6/15/2022	203.19
6/22/2022	219.88
8/3/2022	86.00
8/10/2022	90.95
8/17/2022	86.18
8/24/2022	81.07
8/31/2022	78.31
9/7/2022	122.07
9/14/2022	125.98
9/21/2022	73.53
9/28/2022	88.86
10/5/2022	77.03
10/12/2022	157.26

Report Date	Avg Price
10/19/2022	134.57
10/26/2022	172.49
11/2/2022	184.95
11/9/2022	184.69
11/16/2022	192.56
11/23/2022	181.86
11/30/2022	184.36
12/7/2022	150.21
12/14/2022	160.30
12/21/2022	170.01
1/4/2023	185.55
1/11/2023	144.27
1/18/2023	181.81
1/25/2023	153.61
2/1/2023	221.79
2/8/2023	150.62
2/15/2023	212.04
2/22/2023	224.83
3/1/2023	199.12
3/8/2023	158.41
3/15/2023	206.20
3/29/2023	205.14
4/5/2023	232.76
4/12/2023	234.80
4/19/2023	209.69
4/26/2023	221.18
5/3/2023	217.50
5/10/2023	190.83
5/17/2023	207.76
5/24/2023	184.83
5/31/2023	196.16
6/7/2023	196.04
6/14/2023	195.91
6/21/2023	208.26
6/28/2023	196.13
7/19/2023	183.57
7/26/2023	211.55
8/2/2023	212.89
8/9/2023	195.42
8/16/2023	190.59
8/23/2023	192.99
8/30/2023	190.51
9/6/2023	195.38
9/13/2023	209.51
9/20/2023	198.14
9/27/2023	186.65
10/4/2023	189.41
10/11/2023	181.67
10/18/2023	197.30
10/25/2023	193.10
11/1/2023	191.52
11/8/2023	213.41
11/15/2023	211.09
11/22/2023	203.48
11/29/2023	202.21
12/6/2023	215.16
12/13/2023	199.29
12/20/2023	206.11
1/3/2024	270.83
1/10/2024	239.06
1/17/2024	222.23
1/24/2024	219.42

Source: After USDA AMS Market News, accessed January 2024.

Appendix D

Listening Session Flyers

Background/Purpose

The Federal Crop Insurance Program is recognized today as a fundamental component of the U.S food safety net. The program has been increasingly utilized by livestock producers to offer stability during times of uncertainty. The USDA Risk Management Agency (RMA) has historically provided lamb producers with risk management options, but the Livestock Risk Protection (LRP) program for Lamb that was previously offered was discontinued due to changes in the marketplace. Nevertheless, recognizing that lamb producers are in need of more risk mitigation tools, a research effort was commissioned by the RMA to explore the feasibility of a viable insurance program for lamb producers.

The approved plan of development includes interactive listening sessions which will provide researchers with the opportunity to listen to the needs and concerns of a diverse group of stakeholders within the lamb production industry. This includes industry leaders and representatives, producers and grower groups, insurance personnel, university researchers, buyers, and any other interested parties within the lamb production sector who may be interested in contributing.

2 Listening Sessions

Date and Location (listed times shown below are in reference to each events time zone)

Date	Site Location
December 7th 7:00 PM MST	**The Branding Iron** 19079 US HWY 85 Belle Fourche SD, 57717
December 9th 10:30 AM CST	**Tom Green 4-H Center** 3168 US-67 San Angelo, TX 76905
January 12th 8:00 AM MST	*2024 American Sheep Industry Association Annual Convention:* **Sheraton Denver Downtown Hotel** 1550 Court Place Denver, CO 80202

Virtual Sessions and Meetings

National Virtual Listening Session: December 14th at 5:00 PM MST

Registration Information

Please use the links below to register for the listening sessions you'd like to attend:

https://form.jotform.com/233135438093051

Internal Use

3 **Listening Sessions**

For More Information

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Internal Use

WATTS AND ASSOCIATES

Lamb

Federal Insurance Program Development for Lamb Producers: A Feasibility Study

2023

Background

The Federal Crop Insurance Program (FCIP) is today recognized as a fundamental component of the U.S. food safety net. The program has been increasingly utilized by livestock producers to offer stability during times of uncertainty. The USDA Risk Management Agency (RMA) has historically provided lamb producers with risk management options, but due to changes in the marketplace the Livestock Risk Protection (LRP) for Lamb that was previously offered was discontinued. Nevertheless, recognizing that lamb producers are in need of more risk mitigation tools, a research effort was commissioned to explore all viable insurance options.

Where are we now?

WATTS AND ASSOCIATES

Tasked with providing stability to the agricultural sector, the Federal Crop Insurance Corporation (FCIC) oversees the federal insurance program by approving federal support for new innovations in agricultural insurance. Over the last three decades, the FCIP has grown tremendously. In 2022, the program reached an estimated $18.4B in premium, shattering all-time records and reflecting the value producers place in the coverages offered.

The RMA manages FCIC to bring these new innovative programs to producers in cooperation with Approved Insurance Providers through a public-private partnership.

To explore possible new forms of insurance plan development, RMA contracted Watts and Associates (W&A), a Billings MT-based economic consulting firm, to gather data, perform analysis, and develop a marketable and viable pilot insurance policy.

Data and Information Gathering

The approved plan of development includes listening sessions with industry leaders, producers, insurance personnel, university researchers, and other stakeholders in the lamb production domain. W&A will collect and compile data sources that could support a lamb insurance offering from all interested and supporting parties. These data sources will be documented from meetings, meeting participants, and follow-up conversations and referenced in a research report detailing possible forms of a new insurance program.

www.wattsandassociates.com 406-252-7776 mboyd@wattsandassociates.com

Listening Session Schedule:

WATTS AND ASSOCIATES

Boise, Idaho
November 4th at 2:00 PM
Belle Fourche, South Dakota
December 7th at 7:00 PM
San Angelo, Texas
December 9th at 10:30 AM
Denver, Colorado
January 12th at 8:00 AM
Nationwide Virtual Session
December 14th at 5:00 PM

These sessions will allow our researchers at W&A to listen to the needs of a variety of stakeholders, and gather the info needed for the program to be developed

What are some of the research questions the report hopes to answer?

- What are the types of risks faced by lamb producers? "What keeps these producers up at night?". Which, if any, of these risks may be appropriate for insurance coverage?
- Are there potential futures market and forward contracting opportunities for the lamb industry? Are there any other data sources that could be used to establish a market-based price projection?
- What are the good management practices that would be required to offer production-based insurance coverage? Are these practices widely adopted?
- What are the relevant units of exposure, types, practices, insurance dates, initial insurability requirements, pilot counties, insured causes of loss, uninsured causes of loss, loss triggers, and adjustment procedures.

We ask that you register for the sessions that you'd like to attend! Please see registration information below.

WATTS AND ASSOCIATES

Lamb Listening Session Registration Information

Please register for the session you'd like to attend using the link or QR code below.

Click here to register

https://form.jotform.com/233135438093051

Registration is completely free, we only ask for basic contact info so we can share updates and ensure that you are notified of any changes if they occur. You will receive an email after registering, that will contain all information related to the session you chose, and additional contact info for the Watts and Associates team.

If you'd like to register over the phone, or have any additional questions please call : 406-831-6932

For more information, to provide research support, or to schedule a meeting, please contact the project coordinators below.

Mark Boyd
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406-252-7776 / 406-599-2577 (cell)
mboyd@wattsandassociates.com

Kyle Jore
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Allyssa Avilez
Watts and Associates
406-252-7776 / 406-831-6932 (cell)
aavilez@wattsandassociates.com

These sessions will allow researchers at Watts and Associates to listen to the needs of a variety of stakeholders, producers, and industry participants to gather the information needed to determine the feasibility of a program. The topics to be addressed and discussed at these listening sessions are things such as (but not limited to):

- Types of risks faced by lamb producers
- Management and production practices
- Types of coverage that may benefit lamb and sheep producers
- Relevant units of exposure, types, practices, insurance dates, initial insurability requirements, pilot counties, insurable causes of loss, uninsured causes of loss, loss triggers, price mechanisms, adjustment procedures, and anything else that you think would be relevant to the discussion.

JOIN US TO CONTRIBUTE TO A POTENTIAL LAMB INSURANCE PROGRAM FOR THE AMERICAN SHEEP INDUSTRY!

Please register for the session using the link or QR code below.

Click here to register

Registration is completely free, we only ask for registrations so we can share updates in the event that any of the session details change. You will receive an email after registering, that will contain all information related to the session, and additional contact info for the Watts and Associates team.

THE BRANDING IRON : 19079 US HWY 85, BELLE FOURCHE, SD 57717

DECEMBER 7TH, 2023
BUFFET DINNER AT 6:00 PM MST
SESSION STARTS AT 7:00 PM MST

FOR INFO CONTACT YOUR STATE ASSOCIATION:
SD: LISA@SDSHEEPGROWERS.ORG
MT:STEFANIE@MTSHEEP.ORG
WY: ALISON@WYOWOOL.COM

Appendix E

Online Registration Form

WATTS AND ASSOCIATES

Lamb Listening Session Registration

Federal Insurance Program Development for Lamb Producers A Feasibility Study

Which of these Listening Sessions would you like to attend?

- [ ] Belle Fourche, SD (December 7th, 2023) (In person only)
- [ ] Denver, CO (January 12th, 2024 at 8:00 AM MST) at the American Sheep Industry Association Annual Convention (In person only)
- [ ] San Angelo, TX (December 9th at 10:30 AM CST) at the Tom Green 4H Center (In person only)
- [ ] National Virtual Listening Session (December 14th at 5:00 PM MST) This is an entirely virtual meeting, hosted online. Links to attend this meeting will be sent out via email to those who register here.

We prioritize the security of your information. To ensure you receive updates and detailed information about the upcoming listening sessions, we require your contact details. Information such as dates, locations, or links to virtual events will be provided via email upon submission of this form unless specified otherwise. Please be assured that we take your privacy seriously, and any information

collected will remain confidential. All data and input that is gathered during these sessions will be aggregated, with personal identifiers removed to guarantee the utmost security.

Name

First Name

Last Name

Email

example@example.com

Phone Number

(000) 000-0000

Please enter a valid phone number.

Please tell us what your occupation or role is in the lamb industry?

Example: rancher, buyer, extension agent, RMA / USDA / or other government organization, small flock, grower association, etc.

(Optional) Please use the space below to let us know about any additional comments, questions or concerns you may have regarding the listening sessions:

Submit

Appendix F

Automated Response Email Templates

(TEST) You are registered for the {whichOf} Listening Session! See Details below.

Jotform <noreply@jotform.com>
Tue 2/13/2024 12:54 AM
To:Allyssa Avilez <AAvilez@wattsandassociates.com>

Hello {name}, we are looking forward to having you join us for the Belle Fourche, SD Lamb Listening Session! See below for additional details.

The Belle Fourche Listening Session will be held on **Thursday, December 7th 2023.**

Address:
The Branding Iron
19079 US Hwy 85
Belle Fourche, SD
57717

Buffet Dinner begins at 6:00 PM (MST)
Official Listening Session begins at 7:00 PM (MST)

For this session, we are partnering with the Montana, Wyoming, and South Dakota Wool Growers Associations. The contact information for each state representative is listed below for your convenience. If you have any additional questions, please feel free to reply directly to this email, or reach Watts and Associates at the contact information given below.

Mark Boyd
Watts and Associates
Office: (406) 252-3337
Cell: (406) 596-5646
mboyd@wattsandassociates.com

Kyle Jore
Watts and Associates
Office: (406)-252-7776
Cell: (218)-686-8712
kjore@wattsandassociates.com

Allyssa Avilez
Watts and Associates
Office: (406)-252-7776
Cell: (406)-831-6932
aavilez@wattsandassociates.com

To reach your state's Wool Growers Association Representative, please use the emails listed below:
South Dakota Wool Growers Association: lisa@sdsheepgrowers.org
Montana Wool Growers Association: stefanie@mtsheep.org
Wyoming Wool Growers Association: alison@wyowool.com

(TEST) You are registered for the {whichOf} Listening Session! See Details below.

Jotform <noreply@jotform.com>
Tue 2/13/2024 12:57 AM
To:Allyssa Avilez <AAvilez@wattsandassociates.com>

Hello {name}, we are looking forward to having you join us for the Denver Listening Session! See below for additional details.

The Lamb Listening Session will be held in Denver, Colorado at the American Sheep Industry Association Annual Convention on January 10th - 13th, 2024.

Convention Address:
Sheraton Denver Downtown Hotel
1550 Court Pl.
Denver, CO
80202

Official Listening Session Date and Time:
January 12th, 2024 at 8:00 AM (MST)
Conference Room is TBD - additional emails will be sent as details get finalized.

Our listening sessions are free, and anybody is welcome to attend. While we are presenting at the American Sheep Industry Association Annual Conference, it is not necessary that you register for the conference to attend our session, however if you'd like to register for the conference, please visit the link below as their registration is completely separate. Please direct any booking or logistics questions for the conference to the American Sheep Industry Association.

https://web.cvent.com/event/23fcd273-7b63-415d-a057-0bd31c1a084d/summary?previewToken=e73fe11f78f961ad97b19c00006b68b7

If you have any additional questions, please feel free to reply directly to this email, or reach Watts and Associates at the contact information given below.

Mark Boyd
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mboyd@wattsandassociates.com

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kjore@wattsandassociates.com

Allyssa Avilez
Watts and Associates
Office: (406) 252-7776
Cell: (406) 831-6932
aavilez@wattsandassociates.com

(TEST) You are registered for the {whichOf} Listening Session! See Details below.

Jotform <noreply@jotform.com>
Tue 2/13/2024 1:00 AM
To:Allyssa Avilez <AAvilez@wattsandassociates.com>

Hello {name}, we are looking forward to having you join us for the San Angelo Listening Session! See below for additional details:

The **San Angelo, TX Lamb Listening Session** will be held on **December 9th, 2023**

Address:
Tom Green Co. 4-H Building
3168 US 67 N
San Angelo, TX

Official Listening Session begins at 10:30 AM (CST)

If you have any additional questions, please feel free to reply directly to this email, or reach Watts and Associates at the contact information given below.

Mark Boyd
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mboyd@wattsandassociates.com

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kjore@wattsandassociates.com

Allyssa Avilez
Watts and Associates
Office: (406)-252-7776
Cell: (406)-831-6932
aavilez@wattsandassociates.com

(TEST) You are registered for the National Virtual Lamb Listening Session! See Details below.

Jotform <noreply@jotform.com>
Tue 2/13/2024 1:00 AM
To:Allyssa Avilez <AAvilez@wattsandassociates.com>

Hello (name), we are looking forward to having you join us for the **National Virtual Listening Session!** See below for additional details.

The National Virtual Listening Session is free and open to anybody who may be interested in attending. **Please look for the link to attend the virtual session as we will be sending this out soon via email.**

National Virtual Lamb Listening Session:
December 14th at 5:00 PM (MST)
or 6:00 PM (CST)
or 7:00 PM (EST)

If you have any additional questions, please feel free to reply directly to this email, or reach Watts and Associates at the contact information given below.

Mark Boyd
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