The Effectiveness of Pasture, Rangeland, and Forage Insurance

Jonathon Frost

Utah State University

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THE EFFECTIVENESS OF PASTURE, RANGELAND, AND FORAGE INSURANCE

by

Jonathon K. Frost

A thesis submitted in partial fulfillment

of the requirements for the degree

of

MASTER OF SCIENCE

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Agricultural Economics

Approved:

Tanner McCarty, Ph.D. Brandon Willis, LLM Law
Major Professor Committee Member

Dillon Feuz, Ph.D.
Committee Member

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The Effectiveness of Pasture, Rangeland, and Forage Insurance

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This thesis research tests the historical usefulness and desirability of pasture, rangeland, and forage insurance for ranchers in Utah. PRF insurance is specifically for ranchers who own livestock and rely on their livestock to graze in the fields for food consumption. If there is inadequate precipitation, there will be less grass growth for livestock which causes ranchers to purchase hay, leading to higher feed costs. It is similar to other insurance policies requiring premium and indemnity payments. By analyzing the historical payments, a decisive conclusion can be made that PRF suits both ranchers and USDA policymakers. Other studies that discussed precipitation levels and monthly intervals were included as comparisons. This thesis study comprises 2018 to 2022 and how feed costs differ with and without a PRF coverage level. Based on the historical payments, it is evident that PRF aids ranchers in reducing the risk of purchasing more feed costs.
DEDICATION

I dedicate my thesis research to my committee (Tanner McCarty, Brandon Willis, and Dillon Feuz). Thank you to Dr. Tanner McCarty for leading me and showing me how to write a successful thesis. I also want to dedicate my work to my parents for giving me hours of their time. I have gained a more excellent feeling of humility to my caring parents for always being there for me every step.
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I want to give a special thanks to all of the professors who guided and supported me. The professors I want to acknowledge are Tanner McCarty, Brandon Willis, and Dillon Feuz for their endless encouragement and patience. They assisted me with proper research and accurate data findings. My hard work is a representation of their moral support and teaching. I could only have accomplished this document with them.

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Jonathon K. Frost
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The Effectiveness of Pasture, Rangeland, and Forage Insurance

Introduction

Pasture and rangeland are key inputs to cattle production. Drought conditions can significantly hamper pasture and rangeland forage productivity, forcing ranchers to rely heavily on supplemental feed. Ensuring protection from shortfalls in forage production is paramount to the success of producers. Consequently, the government has implemented an agricultural insurance program specifically tailored to address the challenges faced by ranchers utilizing pasture and rangeland for grazing each season. This insurance, known as Pasture, Rangeland, and Forage (PRF), is designed to shield ranchers from the financial risks of inadequate precipitation. PRF insurance helps alleviate the financial burden when forage availability is low by providing payouts to producers when current precipitation falls below historical averages. The ultimate goal is to ensure a continuous feed supply even during challenging times.

To assess the effectiveness of PRF insurance in mitigating grazing risks, it is crucial to investigate its performance since its inception as a pilot program in 2007 (Graven, 2021). Has it genuinely managed the risks of forage loss for ranchers? Are there noticeable differences in feed costs, particularly during months with less precipitation? These essential questions need to be addressed. In this paper, we aim to compare the historical county-level forage availability from 1986 to 2022 with the forage availability from 2018 to 2022. By calculating the difference, we can determine whether additional hay needs to be purchased due to the lack of forage growth. Our analysis will focus on
specific premium and indemnity payments from each county in Utah, considering a 90% coverage level within the insurance contract. Furthermore, we will examine the historical data to identify extra feed costs resulting from fluctuations in forage availability.

This research intends to determine whether expenses are effectively reduced and additional feed costs are managed using the PRF program. The insights gained from this study will help ranchers make informed decisions regarding their insurance coverage levels and whether PRF insurance genuinely reduces the number of feed costs due to forage shortfalls. Selecting the appropriate coverage level should effectively reduce their risk exposure to forage loss, ultimately aiding in the sustainability and prosperity of their operations.

**Background**

Initially introduced as a pilot product in 2007, PRF was tested to assess its performance. Despite its potential benefits, participation has remained relatively low since its inception. In 2019, the national adoption of the insurance program was only 22% (Cho and Brorsen, 2021). Interestingly, the program finds more extensive use in drier states, particularly in regions like Utah, where the demand for such coverage is higher due to their arid climate. This preference is understandable as the eastern part of the United States receives comparatively more moisture, reducing the urgency for such insurance.

In the preliminary stages of PRF insurance, forage production losses were estimated using two separate pilot programs: a vegetative index and a rainfall index. Ranchers had the flexibility to identify months with reduced vegetation growth by
analyzing growth patterns from satellite imagery based on their knowledge of the crop. Subsequently, the PRF insurance program provided payments for the identified months with decreased vegetation greenness. On the other hand, the rainfall index solely focused on measuring historical precipitation levels and did not estimate crop growth (USDA, 2022). This index, known as the Rainfall Index-PRF (RI-PRF), utilized a grid system with a coverage area of 0.25 degrees in latitude and longitude, established by the Climate Prediction Center (CPC) from the National Oceanic and Atmospheric Administration. Unlike the vegetative index, the RI-PRF utilized 2-month intervals, offering 11 intervals in total (USDA, 2022).

PRF insurance is a vital risk management tool that assists ranchers in dealing with potential hay costs arising from insufficient precipitation for healthy forage growth. This insurance coverage extends to protect against production losses in forages, such as rangeland and pasture. The primary objective of the Rainfall Index-PRF (RI-PRF) is to provide ranchers with revenue in the form of indemnities when they experience hay losses significant enough to impact cattle feeding due to low precipitation levels (Vandeveer et al., 2017). In contrast to measuring rainfall over two-month intervals within a grid system, PRF traditionally employed indexes that measured forage production at the county level (Vandeveer et al., 2017). By utilizing the RI-PRF with its refined grid system and focusing on vegetation growth and historical precipitation levels, the PRF insurance program has continued to evolve, enhancing its ability to mitigate forage-related risks for ranchers.
The Rainfall Index-PRF (RI-PRF) offers a range of coverage levels and production types to cater to diverse forage usage for haying or grazing purposes. Ranchers can choose from various coverage levels, ranging from 70 percent to 90 percent, with increments of 5 percent. The primary loss PRF covers is the lack of rainfall, which is crucial for maintaining healthy forage growth. The National Oceanic and Atmospheric Administration (NOAA) collects information from weather stations closest to individual grids (Duane Jindra Crop Insurance Agency) to assess rainfall data. When the final grid index falls below the trigger grid index, the insurance company pays the rancher, known as the indemnity payment. This payment helps compensate for the financial losses incurred due to insufficient rainfall. It is important to note that regardless of whether a loss occurs, the rancher must pay a premium to the insurance company. This premium is a standard payment made by the rancher to maintain coverage and ensure protection against potential rainfall-related losses.

To assess the effectiveness of PRF insurance, numerous scientists have conducted studies examining the relationship between forage yields and weather-related variables, particularly rainfall (Yu et al., 2019). For instance, the USDA's Soil Conservation Service embarked on a comprehensive data collection effort, studying forage production and annual precipitation across 9,000 sites in the central part of the United States. Their analysis revealed that the combined impact of precipitation and soil water-holding capacity could explain 90% of the variations in forage production in this region. However, a study conducted in North Central Colorado took a different approach, utilizing a 52-year dataset to explore the correlation between shortgrass production and weather variables, including annual precipitation (Yu et al., 2019). Their model
specifically focused on the precipitation levels during the growing season, spanning from April to September, which accounted for approximately 45% of the forage production in the region. Surprisingly, the researchers found that total annual precipitation levels alone did not accurately represent the overall forage production.

The implications of these findings are critical in the context of PRF insurance. While rainfall can significantly influence forage production, it also possesses limitations and can be an inadequate indicator. This raises concerns that relying solely on rainfall data may lead to misleading conclusions and potentially overlook the intricacies of healthy forage growth.

In a study conducted in Nebraska, two ranches, Gudmundsen Sandhills Laboratory (GSL), and Barta Brothers Ranch (BBR), were examined. GSL encompassed 11,800 acres of rangeland, while BBR covered an area of 5,800 acres. The study employed a conceptual model based on expected utility, distinguishing between variable one, representing the purchase of PRF insurance, and zero, indicating the absence of a policy. The primary objective was to compare multiple insurance intervals against having no insurance, focusing on analyzing the producer's net return and risk (Vandeveer et al., 2017). Both research sites had on-site weather stations providing daily precipitation data and annual forage production information (Vandeveer et al., 2017).

A 90% coverage level was utilized at both ranch sites, and various scenarios were explored based on annual precipitation levels. These scenarios were further broken down into monthly intervals, with some months classified as having low, medium, or high levels of rainfall. For instance, designations like "High early" and "High late" represented
months with the highest rainfall, while "early/late" indicated whether the interval was April/May or July/August. A table from the study presented a comparison of forage production net income risk with and without RI-PRF at GSL and BBR, examining their averages and variances (Vandeveer et al., 2017).

For GSL, the variance without PRF was 205.78. However, by purchasing a 90% coverage during the high early period, the variance reduced the net income risk to 122.92. Conversely, during low precipitation months, the variance was higher with PRF than without, with 368.83 and 208.83, respectively. The same pattern emerged at the BBR ranch site, where the variance without PRF insurance was 1,623.59. By opting for the high early coverage, the net income risk decreased to 1,417.04. However, the net income risk increased during low precipitation months as the variance for the low precipitation column reached 1,812.65 (Vandeveer et al., 2017). By evaluating these variances and comparing the net return and risk associated with different insurance scenarios, the study sheds light on the effectiveness of PRF insurance in mitigating risk for ranchers operating in areas with varying precipitation patterns.

A strategic risk management plan tailored for ranchers in Oklahoma was the focus of a study conducted at Oklahoma State University. The research delved into two critical aspects of PRF insurance, aiming to optimize its implementation for ranchers. The first issue examined the relationship between the rainfall index and actual rainfall and their corresponding accuracy. The study analyzed bi-monthly intervals and their correlations between the years 1994 to 2017. Encouragingly, the results indicated a high correlation between actual rainfall and the rainfall index, with the lowest value recorded as 0.9040
from August to September. On average, the correlation reached 0.95, suggesting that the rainfall index values could reliably predict rainfall, making PRF insurance a dependable tool for protecting against rainfall-related risks (Cho and Brorsen, 2021).

The second aspect of the study focused on selecting optimal coverage plans to provide ranchers with adequate protection. Two strategies were explored: Profit maximization and risk minimization. Ranchers were empowered to customize their coverage level percentage and interval selection, offering flexibility in tailoring their insurance plans. The study found that for-profit maximization ranchers could achieve higher expected income by opting for a 90% coverage level and selecting January-February and November-December as their intervals. During these months, Oklahoma receives the lowest rainfall, leading to substantial indemnity payouts that cover the ranchers' losses, contributing to increased overall profitability (Cho and Brorsen, 2021). Conversely, for risk minimization, the study identified that a 90% coverage level with intervals encompassing the spring and summer months, from March to August, was the optimal choice. From a risk management perspective, these months proved more favorable, enabling ranchers to enhance their expected return by $0.82 per acre (Brorsen, 2021). By thoughtfully considering the coverage level and intervals, ranchers can make well-informed decisions to maximize their profits or minimize risks, making the RI-PRF insurance program a valuable tool in their strategic risk management approach.

The difference between this research paper and the Oklahoma State study is the data sources. While the Oklahoma State study relied on historical rainfall data, this paper takes a distinct approach by utilizing observed historical indemnity and premium
payments from the Risk Management Agency. By examining the payment history between the ranchers and the insurance program, this paper seeks to determine the effectiveness of the policy program across all Utah counties. Unlike historical rainfall data, which can fluctuate significantly from season to season, actual payment history offers a more precise and concrete overview of the effectiveness of the pasture, rangeland, and forage insurance program.

PRF serves as a risk management tool, aiding ranchers in reducing feed costs for their operations by covering additional expenses caused by insufficient precipitation. The program's primary objective is to manage production losses in forage availability by providing ranchers with payments to offset losses and feed expenses. Several theories support the effectiveness of purchasing PRF coverage. Firstly, Utah's susceptibility to recurring droughts means ranchers can benefit from PRF payments due to limited rainfall. The program's reliance on precipitation data to predict coverage needs during specific intervals proves accurate and beneficial for ranchers. While rainfall data is essential, this analysis focuses on the actual historical payments of premiums and indemnities to assess PRF's reliability in delivering financial support to ranchers.

**Data & Methodology**

Using Excel, I model and compare feed input costs' probability density functions with and without PRF insurance in @Risk. These distributions are derived from observations across various counties and years, providing valuable insights into PRF's effectiveness in assisting ranchers with financial losses from reduced rainfall levels. @Risk, as a risk management software, enhances decision-making for ranchers by
simulating potential feed cost variability during specific months through advanced iterations and sensitivity analysis. This enables ranchers to understand better the likelihood of different outcomes with and without PRF insurance (Alfasoft, 2023). PRF insurance provides indemnity payments to ranchers when financial losses occur due to insufficient rainfall affecting healthy forage growth. This quantitative analysis examines historical premium and indemnity payments and their impact on feed costs. By comparing net payments from each Utah county between 2018 and 2022 with feed costs, we determine whether ranchers needed to purchase hay (negative outcome) or had sufficient means for their livestock (positive outcome). We subtract the year's forage availability from the historical average (1986 to 2022) specific to each county to calculate feed costs. The lost pounds of forage are then multiplied by the dry-matter ratio between forage and hay and the sales price of hay sourced from the National Agricultural Statistics Service (NASS, 2023). Additionally, satellite imagery from the rangeland analysis platform (RAP, 2019) provides data on historical forage availability and cattle consumption in various Utah counties.

PRF insurance is a reasonably new program; understanding its effectiveness will help identify ranchers’ involvement. Historical payments, such as the premiums and indemnities, will be reviewed for each county in Utah. The payment data comes from a report generator the Risk Management Agency created. This payment history will aid in comparing the different coverage levels the insurance provides and the feed costs. These numbers will help with the calculation in describing the net worth of insurance. This equation begins with feed cost, then adds the premium per acre and subtracts the indemnity per acre. This equation is shown below.
Feed Cost/acre + Premium/acre – Indemnity/acre = Extra Cost w/ Insurance

(1)

The generator report provides the yearly payments and total acreage for a specific coverage level to determine premium and indemnity payments per acre. We obtain the payments per acre by dividing the total premium and indemnity payments for the year by the number of acres. To calculate the premium payment from the rancher's perspective, we subtract the subsidy from the total premium and divide the result by the total acreage. Considering the varying moisture content in different feed types (pasture hay or alfalfa), dry matter composition must be factored into feed cost calculations. For this, we use dry matter conversion, where alfalfa's moisture content (90.2%) is divided by pasture hay's moisture content (17.5%). These percentages are derived from reputable sources like a research study in Kentucky (Kentucky Equine Research Staff, 2012) and a livestock feed-type table in California by the California Certified Organic Farmers (CCOF, 2015). The equation below illustrates the dry matter composition conversions, which are crucial in understanding feed costs since dry matter contains more nutrients. Ranchers rely on drier feed to ensure healthy and marketable growth rates for their livestock.

\[ H/P \text{ ratio} = \frac{\text{Pasture dry matter} \%}{\text{Alfalfa dry matter} \%} \]

(2)

The H/P ratio in equation 2 represents the pounds of hay required to offset 1 pound of lost forage. This is because of more nutrients in hay due to a higher dry matter composition. This accurately represents feed cost because ranchers want to buy more dry weight for their cattle, not wet pasture. The data will be used in diverse ways to depict if PRF insurance makes a difference in offsetting feed costs that ranchers face due to the
lack of rainfall. The feed costs with and without PRF insurance coverage will be compared amongst each county in Utah, along with different years and coverage levels. This data will be implemented into @Risk software to explore the potential risks and compare PRF insurance outcomes using batch fit and a probability density function (PDF).

To gain a comprehensive understanding of feed costs and payment history, it is essential to leverage historical state forage availability and precipitation data, which can significantly contribute to assessing the effectiveness of PRF insurance. Figure 1 presents a graphical representation of the average forage availability in Utah for each year from 2018 to 2022, allowing for a direct comparison with the long-term average spanning 1986 to 2022. Analyzing this data will provide valuable insights into the fluctuations in forage availability over time, thus facilitating a more informed evaluation of the PRF insurance program's impact.
Figure 1 Avg. Forage Availability

This bar chart illustrates Utah's historical average forage availability (lbs./acre) and supports the need for PRF insurance. In 2022, which experienced a severe drought, the chart displays the lowest average forage availability compared to the other four years and the historical average of the past thirty-six years. Despite 2019 receiving more rain than the other four years, its forage production still fell short of the historical average. This chart demonstrates the necessity of PRF insurance for ranchers, as the past five years have consistently shown lower forage availability compared to the historical average. The declining forage availability below the historical average highlights the relevance and importance of PRF in mitigating risks during such challenging periods. In the following figure, I show historical rainfall at the state level and then compare that to availability.

Figure 2 Yearly & Average Precipitation (inches)
The bar chart reveals a correlation between forage availability and precipitation levels. Over the past five years, three of them fell below the historical precipitation average. Notably, 2020 was the lowest year in terms of precipitation but the second-highest in forage availability. This anomaly suggests that the previous year's precipitation levels might have influenced the following year's forage production. Therefore, precipitation alone does not always accurately represent good forage production. For instance, in 2019, rainfall significantly exceeded the historical average, resulting in the highest forage production among the five years analyzed. This graph highlights why PRF participation becomes more prevalent during low precipitation years.

PRF is anticipated to mitigate forage loss risks effectively, as the past five years' forage availability has consistently fallen below the historical average. As an insurance product, PRF offers the potential to decrease feed cost expenses. Without PRF insurance, there is a likelihood that feed costs per acre will escalate, resulting in increased risk exposure for ranchers.

Results

Analyzing historical premium and indemnity payments provides the foundation for assessing PRF insurance effectiveness for ranchers. While PRF is typically purchased in 2-month intervals, this study uses annual payment averages. This approach includes months with minimal participation, like winter months, potentially affecting payment accuracy. However, it also yields more data points, enhancing the precision of premium and indemnity payments. Premium payments represent rancher expenses. The analysis includes three graphs comparing feed costs with and without PRF insurance, using the
90% coverage level due to its supported effectiveness. Figure 3 depicts the dry year 2022, with PRF implications on feed costs. Figure 4 illustrates feed cost distributions for 2019, a wet year in Utah, showing the impact of PRF insurance. In 2019, Utah experienced a damp spring with 14.21 inches of rainfall from January to May (Carroll, 2019). Approximately 99.39% of Utah was experiencing drought in 2022, indicating widespread drought conditions (Utah Division of Water Resources, 2022).

Figure 3 Distribution of per acre cost of supplemental feed in 2022 dry year with and without PRF insurance across counties

In 2022, this distribution depicts feed costs per acre for all Utah counties. The blue line represents costs without PRF insurance, while the red line represents costs with PRF. Notably, the red distribution has data points in the negatives, indicating potential overcompensation by PRF for forage losses, but further verification is required. Indemnity payments exceeded premium payments, signifying significant financial
assistance provided by PRF. The mean for the insured distribution is lower at 0.0132 compared to 2.42 without PRF insurance, indicating a $2.40 per acre saving for ranchers. This reduction in feed costs demonstrates the benefits of purchasing a PRF coverage program. The standard deviation with PRF insurance is higher due to more data points in negative feed costs. This higher volatility implies increased risk, potentially caused by measurement errors at the county level. The percentage above zero represents the probability of needing to spend their own money on supplemental feed. With PRF, this percentage is about 38% lower than without PRF, highlighting its effectiveness in reducing the likelihood of farmers paying for supplemental feed out of pocket.

Figure 4 Distribution of per acre cost of supplemental feed in the 2019 wet year with and without PRF insurance across counties

This distribution represents all Utah counties in 2019. The standard deviation is higher with PRF, indicating greater volatility, likely due to the imperfect fit distribution.
The red distribution represents feed costs with PRF insurance. The mean without PRF insurance is $0.73, while with insurance, it is lower at $0.40. This demonstrates that PRF assistance reduces ranchers’ spending on feed costs. The probability above zero percentage is 10 percent lower with PRF coverage, implying a 10 percent reduced chance of purchasing supplemental feed. PRF proves to be beneficial even during a wet year in 2019.

Figure 5 Distribution of per acre cost of supplemental feed between 2018 – 2022 with and without PRF insurance across counties

Over the past five years, this distribution has encompassed feed costs per acre for every county, with and without PRF insurance. The blue distribution, representing costs without PRF, has a mean of $1.32, while the red distribution, indicating costs with PRF, has a mean of -$0.43. These values imply that PRF insurance effectively eliminates the
need for purchasing extra feed, reducing the cost of hay per acre and mitigating the risk of inadequate forage production for ranchers. The probability above zero percentage with PRF is 40 percent lower, indicating a reduced likelihood of ranchers paying out of pocket for supplemental feed. The higher volatility in the distribution with PRF is evident from the higher standard deviation value, attributed to the inclusion of more negative outcomes. This suggests that PRF potentially compensates or manages the risk of higher hay costs. As mentioned earlier in the paper, the negative values may suggest that PRF is potentially overcompensating for forage availability losses.

**Conclusion**

The PDF distributions effectively compared feed costs at the 90% coverage level and without insurance, highlighting PRF's importance for ranchers. Analyzing historical premium and indemnity payments in each Utah county concludes that PRF is effective in the 90% coverage level range, reducing net feed costs even with abundant rainfall. Ranchers benefit from enrolling in PRF programs and receiving appropriate indemnities. However, some assumptions require attention for a comprehensive analysis. PRF's grid index system for payment calculation may lead to inaccuracies due to varying rainfall within proximity. Using annual averages instead of 2-month intervals could impact results, especially for summer months. Data retrieval from the RAP tool for forage availability also has limitations due to imperfectly aligned regions and potential satellite-related inaccuracies.

The results positively impact both ranchers and USDA policymakers. Ranchers find PRF insurance worthwhile in mitigating forage loss risks by reducing feed costs.
PRF proves reliable as ranchers can use historical monthly rainfall to decide coverage intervals. Policymakers view PRF as reducing potential forage risks. Based on the distributions, PRF insurance has successfully managed forage risks with reduced mean values and favorable feed costs. In Utah's dry climate, relying solely on rainfall is riskier, making PRF a valuable tool for mitigating feed cost risks. Participating in PRF insurance is economically advantageous for ranchers, especially given Utah's drier conditions.
References


“Pasture, Rangeland, Forage (PRF) – Duane Jindra Crop Insurance Agency, L.l.c.”


“Rangeland Analysis Platform.” Usda.gov,


