



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

# Enrollment in Pasture, Rangeland, and Forage Rainfall Index Insurance: Awareness Matters

**Brittney K. Goodrich and Kelly A. Davidson**

Relatively little is known about producers' decisions to enroll in the Pasture, Rangeland and Forage Rainfall Index (PRF-RI) insurance program. By analyzing survey data from producers in the northeastern and southeastern United States, we show that assuming that producers are aware of crop insurance options leads to false inferences about enrollment decisions. Full-time producers who were more reliant on rented hay and pastureland and those who learned about PRF-RI from a crop insurance agent were more likely to enroll in PRF-RI. Livestock revenue insurance was found to be a complementary product to PRF-RI. Our study highlights the importance of targeted PRF-RI information campaigns.

*Key words:* cooperative extension, federal crop insurance program, hay production, livestock production, new insurance programs, risk exposure, risk management, risk preferences


## Introduction

Pasture, Rangeland and Forage Rainfall Index (PRF-RI) insurance is a relatively new US Federal Crop Insurance Corporation (FCIC) product that insures livestock and forage producers against low rainfall events. PRF-RI was introduced as a pilot program in 2007 and made available in all 48 contiguous states in 2016. The introduction of PRF-RI coincides with introductions of forage index insurance products in other countries (e.g., Canada and Spain) to mitigate the difficulties of measuring and, therefore, insuring grassland yields. Even though PRF-RI is highly subsidized and few other federal livestock insurance options are available, enrollment is much lower than for other traditional crop insurance programs. In 2021, only 45% of eligible acreage in the United States was enrolled in PRF-RI, compared with 80%–90% participation in traditional crop insurance programs (US Department of Agriculture, 2017a,b, 2022).

PRF-RI is an index insurance product; that is, indemnity payments are based on a calculated rainfall index rather than on a producer's measured forage yields. A producer purchasing PRF-RI is subject to basis risk, or the risk that index measurements are imperfectly correlated with the producer's forage yields.<sup>1</sup> Several recent studies have explored issues with PRF-RI policy design,

Brittney K. Goodrich (corresponding author, bkgoodrich@ucdavis.edu) is an assistant cooperative extension specialist in the Department of Agricultural and Resource Economics at the University of California, Davis. Kelly A. Davidson is an assistant professor in the Department of Applied Economics and Statistics at the University of Delaware.

This research was generously funded by the Northeast Extension Risk Management Education Center Exploratory Project #14163 and Southern Extension Risk Management Education Center Exploratory Project #14133. The contents are the responsibility of the authors and do not necessarily reflect the views of the United States government. The University of Delaware Center for Experimental and Applied Economics provided equipment and assistance with experiment testing. The authors wish to thank Max Runge, Ken Kelley, Melissa Langer, and Sarah Meyer for assistance with data collection. We also thank Stephen Devadoss, Deacue Fields, Robbin Shoemaker, other participants in the 2021 AAEA Mentoring Research Workshop, and seminar participants at Kansas State University for helpful comments on earlier drafts of this article. Finally, we thank Editor Christian Langpap and two anonymous reviewers for their service.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License. 

Review coordinated by Christian A. Langpap.

<sup>1</sup> See Benami et al. (2021) for full discussion of the economic implications of false negatives and false positives in index insurance.

such as quantifying the levels of basis risk in certain areas (Maples, Brorsen, and Biermacher, 2016; Yu et al., 2019; Keller and Saitone, 2022), how theoretical framing of the PRF-RI decision (e.g., profit maximization versus risk minimization) might affect specific PRF-RI policy decisions (Westerhold et al., 2018; Goodrich, Yu, and Vandever, 2020; Cho and Brorsen, 2021; Zapata and García, 2022), and how the availability of PRF-RI might impact decisions to invest in production and drought risk management (Shrum and Travis, 2022).

Coble et al. (2020) review PRF-RI and suggest policy changes such as restricting the time periods during which producers can insure, targeting viable forage-producing areas, and increasing livestock and forage producer education. However, to our knowledge, relatively little is known about what influences participation in PRF-RI. Identifying factors that impact producers' enrollment decisions would ensure that changes to PRF-RI more effectively align with program objectives. This article aims to determine how factors such as risk exposure, risk preferences, information and farm characteristics are related to a producer's decision to enroll in PRF-RI. We analyze survey data collected from roughly 250 livestock and forage producers in the northeastern and southeastern United States. Only 48% of our sample was familiar with PRF-RI prior to this study, suggesting that a primary limiting factor on the decision to enroll in PRF-RI is simply lack of awareness of the program. Thus, we utilize a sample selection model to first establish the factors related to whether a producer knows about PRF-RI; then, we establish the factors related to enrollment decisions given that he/she was aware of the program.

Common factors found to be associated with crop insurance enrollment decisions are the level of risk exposure, risk preferences, information dispersion through own and neighbors' prior experience with insurance, and other farm and operator characteristics (see, e.g., Sherrick et al., 2004; Jin, Wang, and Wang, 2016; Santeramo, 2019). For index insurance products like PRF-RI, increased basis risk has been shown to decrease enrollment (Elabed et al., 2013; Clarke, 2016). Roznik et al. (2019) explore factors affecting participation decisions in the Canadian forage index insurance program and determine that individuals with lower feed reserves, higher perceived drought and weather risks, and higher knowledge of crop insurance programs and younger farmers were more likely to purchase forage insurance. Specific to PRF-RI, we are aware of only one other study that offers some discussion of factors associated with the producer's decision to enroll. Davidson and Goodrich (2023) find modest evidence that a behavioral nudge framing PRF-RI as a risk management tool increases the likelihood that a producer enrolls in the program. The authors provide evidence that some measures of risk exposure and risk preferences are related to the enrollment decision; however, the study relied on hypothetical choice data. Our current study expands on this topic by evaluating factors related to actual enrollment decisions and leveraging information about producer awareness of the program using simultaneously estimated sample selection methods.

The prior literature on the US Federal Crop Insurance Program (FCIP) and Roznik et al. (2019) have assumed that producers are aware of the insurance products available to them. This assumption is likely accurate for traditional crops given the historical prevalence of crop insurance for traditional crops but less likely for forage insurance products, which were introduced more recently. Our findings show that it is important for relatively new insurance products to consider producer awareness of the program in addition to the commonly identified factors that influence participation. For example, when awareness of PRF-RI is not accounted for, we find that if a participant has had a catastrophic forage loss and collected a payment from the Livestock Forage Disaster Program (LFP) in the last 10 years, they are more likely to enroll in PRF-RI. However, when estimating the awareness and enrollment equations simultaneously, we find that collecting a payment from LFP increased the likelihood that the producer would be aware of PRF-RI but had no relationship with whether the producer enrolled in PRF-RI. Without information on awareness, we would associate catastrophic forage losses with an increased demand for PRF-RI. Thus, some of the findings of Roznik et al. may be driven by a lack of awareness of the relatively new forage insurance products in Canada (Vroege, Dalhaus, and Finger, 2019).

Our results show that farms with more hay and pasture acreage are more likely to be aware of PRF-RI but are less likely to enroll. This contradicts the findings of previous studies that larger operations are more likely to purchase insurance (Coble et al., 1996; Jose and Valluru, 1997; Sherrick et al., 2004). However, notably, each of those previous studies covered insurance demand for crop production rather than for livestock production. An increase in acreage as an input for livestock production may indicate more wealth and, as such, more wealth can indicate increased risk-bearing capacity (Sherrick et al., 2004). We do not discover any relationship between the PRF-RI enrollment decision and a proxy for spatial basis risk.<sup>2</sup>

Our findings also have important implications for PRF-RI outreach. We find that producers without prior access to a crop insurance agent are less likely to be aware of the program. Producers in the Southeast are more likely to be aware of PRF-RI than their Northeastern counterparts, despite the product having been available since 2011 in the Northeast and 2012 in the Southeast.<sup>3</sup> Targeting information campaigns in the Northeast region and toward livestock producers without prior interactions with crop insurance agents may increase awareness and enrollment in the program.

### PRF-RI Background

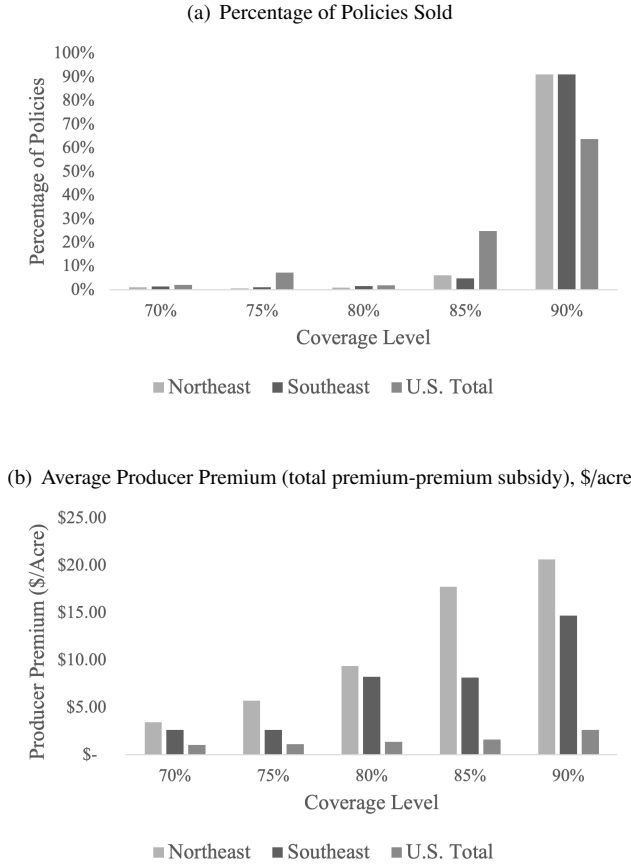
PRF-RI is an area-based rainfall index insurance product; rather than measuring farm-level forage production and losses, the product is based on a rainfall index calculated using the grid system developed by the National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC). Acreage is assigned to one or more NOAA grids, which measure 0.25 degrees in latitude and 0.25 degrees in longitude (17 x 17 miles at the equator). For each grid cell, a rainfall index is calculated for each of the 11 2-month increments from January to December so that the average historical rainfall equals 100 for each grid interval (i.e., a grid-interval index equal to 90 indicates rainfall 10% below the historical average). Producers select the period during the year to insure by placing a percentage of the value of the policy into nonoverlapping 2-month intervals. Indemnities are triggered when the calculated rainfall index for a 2-month interval and grid falls below the coverage level the producer selected; coverage level options range from 70% to 90% of average rainfall. The opportunity to buy up coverage is one factor that differentiates PRF-RI from the USDA Farm Service Agency's Noninsured Crop Disaster Assistance Program (NAP) and Livestock Forage Disaster Program (LFP), for which livestock producers also qualify. To receive an NAP or LFP indemnity, catastrophic levels of loss must occur to yield or inventory due to natural disasters. Rather than catastrophic coverage, PRF-RI covers losses that exceed 10% or more due to rainfall shortages, depending on the level of coverage selected.

Producers often learn about PRF-RI through a crop insurance agent or through USDA-funded risk management extension education programs. To enroll in PRF-RI, producers must make a series of decisions, including the type of forage production to insure (grazing or hay production), the number of acres to enroll, the coverage level, the irrigation practice, the productivity factor, the 2-month intervals to enroll, and the percentage of value to assign in each interval. Premiums are calculated separately for each 2-month interval to account for variability in rainfall during that period. Like other federal crop insurance policies, PRF-RI premiums are set by the FCIC. PRF-RI premiums are subsidized by the US government, with subsidy levels varying based on the selected coverage level selected.<sup>4</sup> Producers must purchase their PRF-RI insurance policy through a certified crop insurance agent.

<sup>2</sup> We use average distance from the county centroid to four closest National Oceanic and Atmospheric Administration (NOAA) weather stations as a proxy for spatial basis risk.

<sup>3</sup> Most (80%) of the Southeast sample came from Alabama, Georgia, and Florida. Alabama had access to PRF-RI in 2008, and Florida and Georgia received access to PRF-RI in 2012 (US Department of Agriculture, 2018). 84% of the Northeast sample came from New York and Pennsylvania, where select counties had access to PRF-RI beginning in 2007 (Pennsylvania) and 2010 (New York); all counties gained access in 2011 (US Department of Agriculture, 2018).

<sup>4</sup> 70% and 75% coverage levels receive a 59% premium subsidy, 80% and 85% levels receive a 55% premium subsidy, and the 90% level receives a 51% premium subsidy.



**Figure 1. PRF-RI Policy Information by Coverage Level and Region, 2020**

*Notes:* Southeast states are Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. Northeast states are Connecticut, Delaware, Maryland, Massachusetts, New York, Ohio, Pennsylvania, Rhode Island, and Vermont.

*Source:* US Department of Agriculture (2022).

Figure 1 shows the distribution of participants across coverage levels (panel a) and average premiums paid per acre (panel b) for the Northeast, Southeast and entire United States for the 2020 crop year. Most producers throughout the United States enroll in higher coverage levels of 85% and 90%, despite the higher premiums per acre. In the Northeast and Southeast, more than 90% of policies are sold at the highest coverage level of 90%. The Northeast and Southeast regions tend to pay higher premiums per acre than the rest of the United States due to regional differences in the value of forage acreage and/or variability in rainfall patterns.

**Empirical Methodology**

Following Smith and Baquet (1996), we assume that a producer’s insurance participation decision takes place in two steps: (i) deciding whether to enroll in insurance and (ii) making specific policy decisions (e.g., coverage level, 2-month intervals to insure). In this article, we explore the characteristics associated with enrollment decisions and leave analysis of factors associated with the more specific policy decisions for future work. We model the PRF-RI enrollment decision as a Heckman-style sample selection problem using the nonlinear methods outlined in Greene (2008). This model is most appropriate because of the omitted behavior that arises in our dataset (i.e., a person who is not aware of PRF-RI cannot decide whether to enroll in PRF-RI). Thus, equation (1)

represents whether the participant had prior knowledge of PRF-RI and equation (2) represents whether the participant enrolled in PRF-RI in a prior year given that they had knowledge of the program. The model takes the form

$$(1) \quad Y^* = \mathbf{X}\boldsymbol{\beta} + \epsilon;$$

$$(2) \quad Y = \begin{cases} 1 & \text{when } Y^* > 0; \\ 0 & \text{when } Y^* < 0; \end{cases}$$

$$(3) \quad E^* = \mathbf{X}_1\boldsymbol{\beta}_1 + \mu;$$

$$(4) \quad E = \begin{cases} 1 & \text{when } E^* > 0; \\ 0 & \text{when } E^* < 0; \end{cases}$$

where  $Y^*$  is a latent variable for awareness of PRF-RI and  $E^*$  represents the enrollment decision, which is only observed if the participant had prior knowledge of PRF-RI ( $Y = 1$ );  $\epsilon$  and  $\mu$  are error terms:  $\epsilon$  is assumed to be distributed normally with a mean of 0 and a standard deviation of 1 and  $E[\mu|\epsilon] = \gamma\epsilon$ . The independent variables,  $\mathbf{X}$ , in equation (1) include those likely correlated with producer awareness of PRF-RI. The independent variables,  $\mathbf{X}_1$ , in equation (3) include those likely related to the enrollment decision. We use the *stats* and *MASS* packages in R to estimate the probit models of awareness and the enrollment decision. We use the *sampleSelection* package in R to simultaneously estimate the selection and outcome equations using maximum likelihood estimation (Toomet and Henningsen, 2008).

We combine the results from Davidson and Goodrich (2023) and Roznik et al. (2019) with previous literature on demand for other crop insurance products to inform our hypotheses about the factors that may be related to actual PRF-RI enrollment decisions. The variables and expected coefficient signs are defined and outlined in Table 1 and discussed in the following paragraphs. The variables were collected through a survey instrument and are divided into the broad categories of factors related to crop insurance awareness and enrollment: the level of risk exposure, risk preferences, information dispersion through own and neighbors’ prior experience with insurance, and other farm and operator characteristics.

*Variables Related to Awareness of and Enrollment in PRF-RI*

To date, most literature investigating crop insurance demand has used expected utility theory to explain participation decisions. Following the theoretical model outlined by Roznik et al. (2019), factors that influence the level of risk exposure and farmer risk preferences are likely to impact the demand for PRF-RI insurance. Additionally, more recent literature has investigated the role of knowledge spillover from neighboring farmers in crop insurance decisions (Santeramo, 2019). Although cumulative prospect theory, as defined by Tversky and Kahneman (1992), has also been proposed as a model potentially fitting producer crop insurance decisions better than expected utility theory (Babcock, 2015; Cao, Weersink, and Ferner, 2020; Luckstead and Devadoss, 2019), our summary focuses on the expected utility theory literature covering the US FCIP, as these findings are most directly relevant to our analysis of PRF-RI.

To our knowledge, no prior literature has explored awareness of specific programs offered by the US FCIP when investigating insurance uptake, although this topic has been investigated in the context of crop insurance in developing countries (e.g., Mukherjee and Pal, 2019). We expect that many of the same factors related to crop insurance enrollment will impact a producer’s awareness of insurance through motivating efforts to seek information about insurance products. Many variables associated with the enrollment decision could also influence the choices of specific policy decisions.

**Table 1. PRF-RI Survey Data Variable Descriptions and Expected Relationship of Variables to Awareness of and Enrollment in PRF-RI**

Variable	Values	Expected Relationship with	
		Awareness ( $X$ in eq. 1)	Enrollment ( $X_1$ in eq. 3)
<i>Aware of PRF-RI</i>	Indicator variable equal to 1 if the participant had heard about PRF-RI prior to the survey and 0 otherwise		
<i>Enrolled in PRF-RI</i>	Indicator variable equal to 1 if the participant had enrolled in PRF-RI in previous years and 0 otherwise		
<b>Risk exposure</b>			
<i>Proportion Livestock</i>	Proportion calculated as the sum of the proportion of total farm income from livestock and the proportion of total farm income from hay	+	+
<i>Proportion Hay Sold</i>	Proportion calculated as the amount of hay sold divided by the sum of hay produced and hay purchased		-
<i>Livestock Margin Insurance</i>	Indicator variable equal to 1 if the participant had enrolled within the last 10 years in Livestock Gross Margin Insurance (LGM) or Margin Protection Program for Dairy (MPP-Dairy) and 0 otherwise		-
<i>Livestock Revenue Insurance</i>	Indicator variable equal to 1 if the participant had enrolled within the last 10 years in Livestock Risk Protection (LRP) or Dairy Revenue Protection (Dairy-RP) and 0 otherwise		+
<i>Rainfall Variability<sup>a</sup></i>	Variability measured as the maximum standard deviation in rainfall in the participant’s NOAA grid during the participant’s stated month intervals that are important for rainfall for forage growth	+	+
<i>County Base Value<sup>a</sup></i>	PRF-RI County base value in \$/acre for dryland hay production in a participant’s county		+/-
<i>LFP</i>	Indicator variable equal to 1 if the participant had utilized Livestock Forage Disaster Program (LFP) in the last 10 years and 0 otherwise	+	+/-
<i>Acres</i>	Continuous variable equal to the participant’s total number of acres dedicated to pasture land and hay production	+	+
<i>Rent Proportion</i>	Proportion of hay and pastureland rented over total hay and pastureland		+
<i>Fulltime</i>	Indicator variable equal to 1 if the participant identifies as a full-time farmer and 0 otherwise	+	+
<i>Avg Dist to 4 Closest WS</i>	Average distance in kilometers between the participant’s county centroid and the four closest NOAA CPC weather stations		-
<b>Risk preferences</b>			
<i>Risk Aversion</i>	Constant relative risk aversion (CRRA) measured through a risk elicitation exercise with real payouts following Akay et al. (2012), Eckel and Grossman (2008), and Holt and Laury (2002). CRRA values calculated by the certainty-equivalent mid-point value at which a participant decided to switch from the sure payoff to the lottery. Possible CRRA values: -0.4, -0.2, -0.1, -0.03, 0.03, 0.1, 0.17, 0.24, 0.3, and 0.4"	+	+
<i>Other Insurance</i>	Ordered categorical variable equal to -1 if the participant did not grow crops, 0 if the participant grew field or specialty crops but did not enroll in crop Yield or Revenue protection, and 1 if the participant grew crops and previously enrolled in crop Yield or Revenue protection.		+

Continued on next page...

**Table 1. – continued from previous page**

Variable	Values	Expected Relationship with	
		Awareness (X in eq. 1)	Enrollment (X <sub>1</sub> in eq. 3)
Information spillover effects			
<i>Crop Insurance Agent</i>	Indicator variable equal to 1 if the participant already has a crop insurance agent that they work with, 0 otherwise	+	
<i>Info Source</i>	Indicator variable equal to 1 if the participant learned about PRF-RI from that source and 0 otherwise. Possible sources are News/media, Friend/Family Member/Neighboring farmer, Extension agent, and Crop insurance agent		+
<i>Prop County Enrolled<sup>a</sup></i>	Hay and grazing acreage enrolled in PRF-RI for 2019 from USDA Summary of Business data divided by 2017 USDA Agricultural Census values for total hay and pasture acreage	+	+
Farm and operator characteristics			
<i>Age</i>	Participant’s age in years	?	
<i>Male</i>	Indicator variable equal to 1 if the participant identifies as male, and 0 otherwise	?	
<i>Dairy</i>	Indicator variable equal to 1 if the participant indicated they operate a dairy and 0 otherwise	?	?
<i>Beef</i>	Indicator variable equal to 1 if the participant indicated they have beef cows and 0 otherwise	?	?
<i>Region: SE</i>	Indicator variable equal to 1 if the participant is located in the Southeast, 0 otherwise. Southeast states: AL, FL, GA, KY, MS, NC, SC, and TN Northeast states: MA, CT, DE, MD, NY, OH, PA, RI, VT, and VA	?	?
<i>Farm income</i>	Integer ranging from 1 to 7 representing the participants’ agricultural gross sales in 2018: (i) <\$5,000 (ii) \$5,000–\$9,999 (iii) \$10,000–\$24,999 (iv) \$25,000–\$49,999 (v) \$50,000–\$99,999 (vi) \$100,000–\$249,999 (vii) >\$250,000	+	–

Notes: <sup>a</sup>Indicates variable is calculated from data sources outside of survey data.

For example, Westerhold et al. (2018), Goodrich, Yu, and Vandever (2020), Cho and Brorsen (2021) and Zapata and García (2022) show theoretically that risk preferences can impact the preferred choices of 2-month intervals to insure. In this article, we measure only the characteristics associated with enrollment decisions and leave analysis of the factors associated with more specific policy decisions to future work.

*Level of Risk Exposure*

We expect that producers with greater levels of risk exposure will be more likely to purchase crop insurance than those with lower levels of risk exposure. With traditional crop insurance, Sherrick et al. (2004) determine that farmers with higher debt-to-asset ratios, who perceive higher levels of yield variability, and who lease more land are more likely to purchase yield, revenue or hail insurance. Coble et al. (1996) find that producers with greater market return risk are more likely



to enroll in Multiple Peril Crop Insurance (MPCI). Smith and Baquet (1996) show that higher perceived yield variability, more debt, and receiving disaster relief payments in the past increase the likelihood that a farmer will purchase MPCI. Jose and Valluru (1997) determined that producers with a majority of farm income from crop production were more likely to purchase crop insurance than their counterparts with a majority of income from livestock production. Jose and Valluru also find that participation in other farm programs increased the likelihood of insurance purchase.

Roznik et al. (2019) conclude that higher perceived drought and weather risks and lower feed reserves increase the likelihood that a producer participates in Canadian forage index insurance. Similarly, Davidson and Goodrich (2023) find that a higher proportion of hay sold leads to a lower likelihood of a producer enrolling in PRF-RI because producers can reduce risk exposure by using hay inventory to feed livestock in the instance of drought. Davidson and Goodrich also showed that a higher proportion of total farm income coming from livestock or hay production and from collecting a disaster payment from USDA livestock disaster programs at least once in the last 10 years increases the likelihood of a producer enrolling in PRF-RI.

Following the previous literature, we include the following variables to measure the level of risk exposure of the participant, which could relate to the decision to enroll in PRF-RI: proportion of farm income from livestock production (*Proportion Livestock*), proportion of hay produced on-farm that is sold (*Proportion Hay Sold*), whether they have purchased livestock revenue or margin insurance products offered by USDA in the past (*Livestock Margin Insurance* and *Livestock Revenue Insurance*), a measure of rainfall variability during the growing season in their NOAA grid (*Rainfall Variability*), whether they collected a payment from LFP in the last 10 years (*LFP*), number of acres of hay and pasture (*Acres*), the proportion of hay and pasture acreage that is rented (*Rent Proportion*), the base value USDA RMA uses for dryland hay production to calculate the value of protection in a participant's county (*County Base Value*), and whether they are full-time farmers (*Fulltime*). *Proportion Livestock*, *Acres*, and *Fulltime* are expected to increase overall risk exposure, increasing the likelihood that a producer will enroll in PRF-RI. *Rainfall Variability* is calculated as the maximum standard deviation of rainfall across growing season month intervals, where important growing season months were indicated by the participant during the survey. Like the measures of risk exposure in Sherrick et al. (2004), Smith and Baquet (1996), and Roznik et al. (2019), we expect higher *Rainfall Variability* during the growing season to be associated with a higher demand for PRF-RI.<sup>5</sup> Having collected an LFP payment in the last 10 years could indicate more variability in rainfall in the area and/or an expectation that future catastrophic droughts will occur. Thus, *LFP* is expected to increase the likelihood of insurance uptake. Following Roznik et al. (2019) and Davidson and Goodrich (2023), we expect *Proportion of Hay Sold* to be negatively related to the insurance enrollment decision. *Livestock Margin Insurance* insures producers against unfavorable revenue and input cost movements and might be viewed as a substitute for PRF-RI, thus decreasing risk exposure and their need for PRF-RI. *Livestock Revenue Insurance* protects producers from downward movements in revenue; thus, PRF-RI may be viewed as a complementary insurance product.

The sign on the relationship between *County Base Value* and enrollment is ambiguous due to conflicting incentives between the level of risk exposure and the premiums producers must pay. *County Base Value* is calculated by USDA RMA based on hay yields collected by USDA NASS. A higher *County Base Value* indicates a more productive area in terms of forage production, which would increase the level of risk exposure due to low precipitation, presumably making enrollment in PRF-RI more attractive. However, a higher *County Base Value* increases premiums, which may lead to lower demand (Cabas, Leiva, and Weersink, 2008).

---

<sup>5</sup> Westerhold et al. (2018), Goodrich, Yu, and Vandevener (2020), and Cho and Brorsen (2021) show theoretically that if a producer is not risk averse, profit maximization results in a producer selecting 2-month intervals with the highest rainfall variability to maximize the PRF-RI subsidy. This could translate to the enrollment decision, in which producers who are not risk averse might be more likely to enroll in areas with high rainfall variability. Thus, we include an interaction between *Rainfall Variability* and *Risk Aversion*.

Basis risk, a major factor inhibiting the uptake of index insurance, can be divided into three main components: design, spatial risk, and temporal risks (Dalhaus and Finger, 2016). Spatial basis risk is particularly important in PRF-RI given that the precipitation indices are determined using a weighted average of precipitation data from at least the four closest reporting weather stations (National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC), 2021), which may not accurately depict precipitation at a specific farm (Ritter, Mußhoff, and Odening, 2014). Thus, we include a proxy for spatial basis risk (*Avg Dist to 4 Closest WS*), which is the average distance from the centroid of a producer's county to the four closest NOAA CPC Climate Assessment Database (CADBv2) weather stations (National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC), 2020).<sup>6</sup> The larger the average distance is, the less accurate the index will be at measuring the rainfall for locations within that county, increasing the spatial basis risk and making PRF-RI less attractive. Design risk, or how well precipitation alone predicts forage yields, is difficult to measure given the lack of information on forage yields. We assume that design risk will be similar across all producers in these regions; therefore, the region indicator variable (*Region: SE*) will control for any region-specific design risk. Temporal risk, or the risk that the index insurance does not insure the right time frame when precipitation impacts forage growth, can be alleviated when producers select which 2-month intervals to insure throughout the year. This flexibility means that temporal basis risk should not impact a producer's decision to enroll in PRF-RI.

With regard to awareness of PRF-RI, we expect that producers with higher risk exposure will be more likely to seek out information regarding insurance and other risk management options. Thus, we expect the *Proportion Livestock*, *Acres*, *Fulltime*, *LFP*, and *Rainfall Variability* variables to be positively related to PRF-RI awareness.

### *Risk Preferences*

The literature on the role of risk aversion in crop insurance decisions is mixed. Petrolia, Landry, and Coble (2013), Condliffe and Fiorentino (2014), Jin, Wang, and Wang (2016), and Menapace, Colson, and Raffaelli (2016) determine that insurance enrollment is more likely as risk aversion increases, while Just, Calvin, and Quiggin (1999) and Goodwin (1993) suggest that risk aversion has little impact on crop insurance decisions in the United States. However, Sherrick et al. (2004) find that participants with high stated preferences for the importance of risk management are more likely to be crop insurance users. Greene et al. (2022) find that ranchers in the western United States purchase PRF-RI as part of their drought risk management strategy, indicating that risk preferences may have an impact on the decision to enroll. Results from both Davidson and Goodrich (2023) and Shrum and Travis (2022) suggest a positive relationship between the level of risk aversion and the hypothetical decision to enroll in PRF-RI. While Roznik et al. (2019) do not explicitly investigate risk aversion, they determine that producers with a better attitude toward forage index insurance are more likely to enroll, perhaps implicitly relating attitudes toward risk preferences.

All survey participants engaged in an incentive-compatible exercise to elicit their risk preferences (*Risk Aversion*). A screenshot of the risk elicitation exercise is available in the appendix (Figure A1). In this risk elicitation exercise, one in six participants was randomly selected to earn real cash. The exercise followed Holt and Laury (2002), Eckel and Grossman (2008), and Akay et al. (2012). As *Risk Aversion* increases, we expect the likelihood of enrollment in PRF-RI to increase, in

<sup>6</sup> The NOAA CPC CADBv2 weather stations list contains 2,933 weather stations for the contiguous United States (National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC), 2020), whereas the daily CPC Gauge Analysis procedure that underlies the rainfall index used by PRF-RI uses data from 8,000–9,000 weather stations on average (National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC), 2021). This number varies as not all stations report daily. As far as we are aware, NOAA CPC does not release the locations of all weather stations used in the CPC Gauge Analysis, so we use the CADBv2 locations as a proxy for the CPC Gauge Analysis weather stations. This assumes that counties with fewer nearby CADBv2 weather stations (i.e., a larger average distance to the four closest weather stations) will also have a larger average distance to the four closest CPC Gauge Analysis stations.

accordance with expected utility theory. We also include an ordered categorical variable to represent whether the participant has purchased yield or revenue protection for traditional or specialty crops when they have access to those insurance products (*Other Insurance*). This variable could indicate a preference for insurance, so we expect that having *Other Insurance* will increase the likelihood of enrollment in PRF-RI.

Regarding the relationship between risk preferences and awareness of PRF-RI, we expect producers who are more averse to risk to be more likely to seek out information about insurance and other risk management options. We also expect an interaction between *Rainfall Variability* and *Risk Aversion* (e.g., a highly risk averse producer in a highly variable precipitation area may be more likely to seek out information than a highly risk averse producer in a less variable area).

### *Information Spillover Effects*

Santeramo (2019) explores the effects of information and experience on crop insurance decisions in Italy. Santeramo shows that the more farmers in a region that have crop insurance, the more likely a participant is to enroll in crop insurance, suggesting that information spillovers from other farmers have an impact on individual decisions. Additionally, Santeramo finds that prior experience with crop insurance increases the likelihood that a farmer will enroll. Similarly, Roznik et al. (2019) determine that a higher stated knowledge of agricultural insurance was associated with higher forage insurance uptake.

Following Santeramo (2019), we expect that higher proportions of hay and pasture acreage in a participant's county that enrolled in PRF-RI in 2019 (*Prop County Enrolled*) will increase the likelihood of that participant being aware of and enrolling in PRF-RI due to information spillover effects. Relatedly, if the participant has already worked with a crop insurance agent (*Crop Insurance Agent*) for other USDA livestock or crop insurance programs, we expect them to be more likely to be aware of PRF-RI. We asked participants where they had learned about PRF-RI. We expect that learning about PRF-RI from a friend, family member, neighbor, Cooperative Extension Agent, or crop insurance agent will increase the likelihood that individuals enroll compared to hearing about it from other sources (e.g., news, farm journal, internet), although we do not have expectations for how these sources will relate to one another.

### *Farm Characteristics*

Multiple studies have shown a positive association between total farm acreage and crop insurance uptake (Coble et al., 1996; Jose and Valluru, 1997; Sherrick et al., 2004). Using another measure of farm size, Coble et al. determine that farm net worth was negatively associated with crop insurance uptake. They also find regional differences in enrollment, potentially due to climatic differences or information transfer as farmers in the area learn more about participation. Davidson and Goodrich (2023) show that hay and other livestock producers are more likely than beef producers to enroll in PRF-RI in a hypothetical setting, although the finding that other livestock producers are likely to enroll may suffer from hypothetical bias.

Assuming that gross farm sales are correlated with farm wealth, as in Coble et al. (1996), we expect that as gross farm sales increase (*Farm Income*), participants will be more likely to be aware of PRF-RI but less likely to enroll in PRF-RI. We include indicator variables for whether the participant's operation had dairy (*Dairy*) or beef (*Beef*) cows, and whether the participant's operation is in the Southeast (*Region: SE*). We do not have expectations on how livestock operation or regional differences will relate to awareness and the enrollment decision.

### *Operator Characteristics*

It is not immediately clear how farm operator characteristics influence crop insurance decisions; however, they will certainly impact the perceptions and preferences regarding risk and impact awareness through social networks and education. Sherrick et al. (2004) determine age to be positively associated with enrollment decisions, while Jose and Valluru (1997) show no effect of age on enrollment. Roznik et al. (2019) find that younger producers were more likely to participate in forage index insurance. Jose and Valluru, Sherrick et al., Roznik et al., and Smith and Baquet (1996) show no effect of education level on farmers' decision to enroll in crop insurance.

Because the prior research provides mixed results for the effect of age on other crop insurance demand (Sherrick et al., 2004; Jose and Valluru, 1997), there does not seem to be a significant relationship between age and insurance demand in either direction. Thus, we do not include *Age* as a control variable for PRF-RI enrollment, but we do include it as a control variable for awareness of PRF-RI. We also include an indicator for the participant's gender (*Male*) as a control variable in the awareness equation. Age and gender control for different levels of awareness because of differences in social networks or ways of accessing information, but we do not have expectations regarding the sign on either coefficient.

### **Survey Data**

We conducted a survey of livestock and hay producers by convenience sampling at regional farm shows in the southeastern and northeastern United States in October 2019 and February 2020, respectively.<sup>7,8</sup> Participants were at least 18 years of age and self-reported as the primary decision makers on their operation. The survey completion time was approximately 30 minutes, and participants were compensated \$20 with the potential to earn up to an additional \$40 during the risk elicitation exercise.

Table 2 reports summary statistics for the survey data. The sample includes 133 farmers from the Southeast and 121 from the Northeast. On average, participants have 260 acres of hay and pasture, of which an average of 31% is rented. Livestock and hay production accounts for 73% of farm income on average, and 24% of hay produced is sold. The average participant coefficient of constant relative risk aversion (CRRA) is 0.04, indicating that participants are close to risk neutral, on average. Of those who were aware of PRF-RI, 17% had enrolled in PRF-RI in a previous year, 34% learned about it from Cooperative Extension, and 33% learned about it from a crop insurance agent. Less than 20% of those aware of PRF-RI learned about it from news/media or friends/family/neighboring farmers. 30% of the sample had already worked with a crop insurance agent in the past, 12% had purchased livestock revenue insurance, and 7% had purchased livestock margin insurance; 15% of participants had collected a payment from LFP at least once in the last 10 years. Of the 197 producers that produced row and/or specialty crops, 18% had purchased yield or revenue crop insurance. Over one-third of participants (35%) considered themselves full-time farmers.

Table 3 compares our sample with the corresponding populations in the Northeast and Southeast regions from the 2017 USDA Agricultural Census.<sup>9</sup> Values for the total United States are also included. The average age of producers in our sample is younger than the average age of the

<sup>7</sup> These regions were selected based on their relatively low PRF-RI enrollment numbers. As seen in Table 3, Northeast and Southeast enrollments were 2.6% and 13%, respectively, compared to 31% enrollment nationwide.

<sup>8</sup> These data come from a survey that accompanied an economic experiment (Davidson and Goodrich, 2023). Recruiting agricultural producers for economic experiments is difficult, time-intensive, and costly, and response rates are often low (Weigel et al., 2021). Convenience samples reduce the cost and time associated with data collection and have been shown to represent the general class of farms as well as randomly selected samples (Luschei et al., 2009). Limitations of convenience sampling are that bias may arise and results may not be generalizable (Stratton, 2021). However, given the comparison with the population shown in Table 3 and corresponding discussion, it does not seem that our sample suffers from significant bias.

<sup>9</sup> Figures S1 and S2 in the online supplementary materials (see [www.jareonline.org](http://www.jareonline.org)) show the comparison of gross farm sales categories for our sample and the population in the Northeast and Southeast, respectively.

**Table 2. Summary Statistics**

Variable	N	Mean	St. Dev.	Min.	Pctl(25)	Pctl(75)	Max.
<i>Aware of PRF-RI</i>	254	0.48	0.50	0	0	1	1
<i>Risk Aversion</i>	254	0.04	0.23	-0.40	-0.10	0.24	0.40
<i>Acres (thousands)</i>	254	0.26	0.38	0.002	0.06	0.30	3.56
<i>Rent Proportion</i>	254	0.31	0.34	0.00	0.00	0.59	1.00
<i>Farm Income</i>	254	3.70	1.92	1	2	5	7
<i>Age</i>	254	46.62	16.23	19	32	60	86
<i>Male</i>	254	0.85	0.36	0	1	1	1
<i>Proportion Livestock</i>	254	0.73	0.35	0	0.46	1	1
<i>Proportion Hay Sold</i>	254	0.24	0.33	0	0	0.40	1
<i>Rainfall Variability</i>	254	82.97	18.19	46.53	66.51	95.02	143.69
<i>Crop Insurance Agent</i>	254	0.30	0.46	0	0	1	1
<i>Livestock Revenue Insur.</i>	254	0.12	0.32	0	0	0	1
<i>Livestock Margin Insurance</i>	254	0.07	0.26	0	0	0	1
<i>LFP</i>	254	0.15	0.36	0	0	0	1
<i>Fulltime</i>	254	0.35	0.48	0	0	1	1
<i>Other Insurance</i>	254	-0.08	0.60	-1	0	0	1
<i>Prop County Enrolled</i>	254	0.04	0.11	0	0	0.1	1
<i>County Base Value</i>	254	312.30	85.65	159	257	380	500
<i>Beef</i>	254	0.76	0.43	0	1	1	1
<i>Dairy</i>	254	0.13	0.33	0	0	0	1
<i>Region: SE</i>	254	0.52	0.50	0	0	1	1
<i>Avg Dist to 4 Closest WS</i>	254	38.77	10.79	15.69	32.35	44.98	71.82
<i>Enrolled in PRF-RI</i>	121	0.17	0.38	0	0	0	1
<i>Info Source: News</i>	121	0.19	0.39	0	0	0	1
<i>Info Source: Friends</i>	121	0.15	0.36	0	0	0	1
<i>Info Source: Extension</i>	121	0.34	0.48	0	0	1	1
<i>Info Source: Agent</i>	121	0.33	0.47	0	0	1	1

population.<sup>10</sup> The sample represents less than 1% of operations with cattle in each of the regions; however, the distributions of cattle operations with respect to the types of cattle and the proportion of hay and pasture acreage are similar to those of the population in each region.

Table 3 shows the percentage of hay and pastureland enrolled in PRF-RI in 2019 and the measure of spatial basis risk in each region and for the total United States, compared with those of the sampled counties. The counties sampled in the Northeast were identical to the population in terms of PRF-RI enrollment in 2019, while roughly 8% of the sampled area in the Southeast was enrolled in PRF-RI, compared to 13% of the population area. The population average in the Southeast is raised substantially by Florida, where almost one-third of total acreage was enrolled in PRF-RI in 2019. Only 16% of the sample in the Southeast came from Florida, so the sample average is much more in line with the other states' enrolled proportions, ranging from 5% to 8%. Both the Northeast and Southeast regions lag behind the US average of 31% of hay and pasture acreage enrolled in PRF-RI. In terms of spatial basis risk, the sampled counties in the Northeast were farther on average from the four closest weather stations than the population; in the Southeast, the population and sample basis risk measures were similar. The population measures in each region were lower than the US average, suggesting that the Northeast and Southeast have lower spatial basis risk on average than the United States as a whole. Combined, acreage enrolled in PRF-RI in the Northeast and Southeast made up about 1% of the total acreage enrolled in PRF-RI in 2019.

<sup>10</sup> Our sample includes only cattle and hay producers, whereas the US Census data only provide producer age in aggregate.

**Table 3. Representativeness of Sample Compared to Producers Enrolled in PRF-RI in the Northeast and Southeast**

Variable	Northeast		Southeast		US
	Population	Sample	Population	Sample	Population
Operator age	56	47	58	46	58
Operations with cattle	51,545	97	87,367	115	768,542
Percentage of cattle operations (%)					
with beef cows	78.7	81.4	98.8	97.4	94.9
with dairy cows	26.2	26.8	2.9	4.3	7.1
Total hay and pasture acreage:	7,064,803	25,548	13,031,943	33,211	50,466,457
Percentage hay acreage (%)	50.9	68.0	25.4	27.9	11
Percentage pasture acreage (%)	49.1	31.9	74.6	72.1	89
Percentage hay and pasture acreage enrolled in PRF-RI in 2019 (%)	2.6	2.6	13	7.6	31
Distance (km) from county centroid to 4 closest NOAA weather stations (%)	34.72	39.73	38.63	38.47	42.86

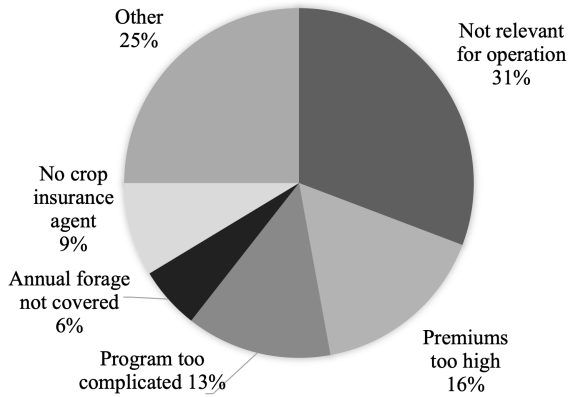
*Notes:* Census statistics for operations with cow inventories in 2017. Only those states that represented at least 2% of the participants in our sample were included in population and sample calculations. Northeast states included Delaware, New York, Pennsylvania, Vermont and Virginia, and Southeast states included Alabama, Florida, Georgia, and Tennessee. *Sources:* US Department of Agriculture (2017a, 2022), National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC) (2020).

**Table 4. Average Awareness of PRF-RI and Source of Information by Region**

Variable	Northeast (%)	Southeast (%)	Unequal Variance <i>t</i> -Test <i>p</i> -Value (Null: Population means differ)
<i>Aware of PRF-RI</i>	36	58	0.00
<i>Info Source: News</i>	30	13	0.04
<i>Info Source: Friends</i>	5	21	0.00
<i>Info Source: Extension</i>	30	36	0.44
<i>Info Source: Crop Insurance Agent</i>	27	36	0.30

Table 4 reports values for producer awareness of PRF-RI and information sources by region: 57% of participants in the Southeast had been aware of PRF-RI prior to our study, compared with only 36% of those in the Northeast. Sources of information about PRF-RI also seem to differ by region. In the Northeast, 30% of those aware of PRF-RI had heard about it through a news source, compared to 13% of those in the Southeast. Consistent with the relatively higher rates of enrollment in the Southeast, 21% of those aware of PRF-RI in the Southeast had heard about it from a friend, family member, or neighbor, compared with only 5% of those in the Northeast. In the Southeast, a slightly higher percentage had heard about PRF-RI from Cooperative Extension and crop insurance agents, although these differences were not determined to be statistically significant.

To gather additional information, we asked participants who had been aware of PRF-RI prior to the study but had not enrolled to indicate their reason for not enrolling. Figure 2 shows the results. The most common response was that PRF-RI was not relevant for the farmer’s operation (31%); however, only farmers qualifying for PRF-RI were allowed to participate in our study. This likely indicates that even though these participants were aware of PRF-RI, they did not fully understand its purpose due to either lack of adequate information or the complexity of the program. Similarly, 13% of producers stated that the complexity of PRF-RI prevented them from enrolling. Both findings indicate that additional education is necessary to increase enrollment.



**Figure 2. Percentage of Participants Who Were Aware of PRF-RI by Stated Reason for Not Enrolling ( $N = 104$ )**

## Results

Table A1 in the appendix shows the probit regressions for the dependent variables: awareness of and enrollment in PRF-RI.<sup>11</sup> As expected, the results change once we control for sample selection. Table 5 displays the results of the simultaneously estimated sample selection regressions (equations 1–4) for the dependent variables: awareness of and enrollment in PRF-RI. The estimated correlation between error terms ( $\rho$ ) is significant at the 1% level, suggesting that the sample selection estimates should be used.

The only statistically significant variables associated with awareness of PRF-RI were *Acres*, *Crop Insurance Agent*, *LFP*, and *Region: SE*. Larger farms, in terms of acreage, were more likely to be aware of PRF-RI. Farmers who already had a crop insurance agent with whom they worked regularly and those who had collected an LFP payment in the last 10 years were more likely to be aware of PRF-RI. The regional variable shows that farmers in the Southeast were more likely to be aware of PRF-RI.

The following variables all had the expected positive relationship with enrollment: *Fulltime*, *Info Source: Agent*, *Livestock Revenue Insurance*, and *Rent Proportion*. One notable finding when comparing the probit regressions in appendix Table A1 and the sample selection regression in Table 5 is that the relationship between LFP and enrollment is positive and significant in the probit regressions but statistically insignificant when awareness of PRF-RI is accounted for.

Full-time farmers were not more likely to be aware of PRF-RI, but were more likely to be enrolled, revealing the role higher that risk exposure can play in enrollment decisions. Table 5 shows that larger farms in terms of hay and pasture acreage are more likely to be aware of PRF-RI but—contrary to the results of prior literature on crop insurance—less likely to be enrolled. Mishra and El-Osta (2009) show that dairy and livestock operations are associated with greater wealth accumulation than are operations involving other types of production, likely due to the capital-intensive nature of such operations. Acres of hay and pasture are an input to livestock and dairy production, so more acres likely indicate a larger livestock operation and more wealth accumulation. As discussed in Sherrick et al. (2004), if larger farms have more wealth, they may have higher risk-bearing capacity, which could help explain the negative association between these variables and PRF-RI enrollment. Like Sherrick et al. (2004), Table 5 shows that a higher proportion of rented hay and pasture acreage is associated with a higher likelihood of enrollment. Those with higher levels of land ownership

<sup>11</sup> Table S1 in the online supplementary materials displays Pearson correlation coefficients between the explanatory variables and the two dependent variables.

**Table 5. Sample Selection Regressions of Awareness of PRF-RI and Prior Enrollment in PRF-RI on Regressors (N = 254)**

Variables	Dependent Variable	
	Aware of PRF-RI 1	Enrolled in PRF-RI 2
<i>Acres (thousands)</i>	0.65* (0.34)	-0.0135
<i>Beef</i>	0.42 (0.29)	-0.10 (0.15)
<i>Dairy</i>	-0.05 (0.39)	-0.18 (0.21)
<i>Risk Aversion</i>	0.67 (1.66)	0.38 (0.74)
<i>Rainfall Variability</i>	-0.003 (0.01)	-0.001 (0.003)
<i>Farm Income</i>	0.08 (0.06)	-0.03 (0.02)
<i>Fulltime</i>	-0.22 (0.22)	0.21** (0.09)
<i>Info Source: Extension</i>		0.06 (0.07)
<i>Info Source: Friends</i>		-0.07 (0.09)
<i>Info Source: Agent</i>		0.19** (0.08)
<i>Other Insurance</i>		0.02 (0.06)
<i>Proportion Livestock</i>	0.10 (0.25)	0.11 (0.11)
<i>Age</i>	0.004 (0.005)	
<i>Male</i>	0.08 (0.22)	
<i>Crop Insurance Agent</i>	0.44** (0.22)	
<i>Proportion Hay Sold</i>		-0.05 (0.12)
<i>Livestock Revenue Insurance</i>		0.25** (0.11)
<i>Livestock Margin Insurance</i>		-0.004 (0.18)
<i>LFP</i>	0.65** (0.27)	0.06 (0.10)
<i>Proportion County Enrolled</i>	-0.89 (0.83)	0.45 (0.45)
<i>Rent Proportion</i>		0.19** (0.09)
<i>County Base Value</i>		-0.0000005
<i>Avg Dist to 4 Closest WS</i>		0.0003 (0.003)
<i>Region: SE</i>	0.49** (0.25)	-0.13 (0.13)
<i>Risk Aversion × Rainfall Variability</i>	-0.01 (0.02)	-0.004 (0.01)
Constant	-1.29** (0.61)	0.70** (0.34)
Log-likelihood		-188.10
$\rho$		-0.74*** (0.17)

Notes: Values in parentheses are standard errors. Single, double, and triple asterisks (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% level, respectively.

are likely to have more wealth and therefore more risk-bearing capacity. The coefficient on *County Base Value* is negative and statistically significant, suggesting that the large premiums associated with more valuable land outweigh the impact of productive land on risk exposure, leading to lower levels of enrollment for more productive land. Enrollment in livestock revenue insurance programs is related to an increase in the likelihood of a producer being enrolled in PRF-RI, suggesting that—as hypothesized—these programs insure different parts of the producer’s profitability consideration and are complementary. There was no significant relationship between the other measures of risk exposure and the enrollment decision, including the proxy for spatial basis risk.



Similar to previous studies of FCIC insurance demand, the level of risk aversion did not have a statistically significant association with the demand for PRF-RI. The coefficients on rainfall variability and the interaction term between the risk aversion and rainfall variability variables were not statistically significant.<sup>12</sup> Potentially, the small sample size does not provide enough power to estimate these effects, especially with regard to risk aversion, given that risk preferences were elicited into only 10 levels. Additionally, there may be conflicting effects with rainfall variability. Because PRF-RI premiums are actuarially fair, higher variability means higher premiums for enrolling in those months. Thus, the large premiums from high rainfall variability during the growing season may lead to lower demand (Cabas, Leiva, and Weersink, 2008), counteracting the increased demand from higher risk exposure.

Surprisingly, the proportion of a producer's county acreage enrolled in PRF-RI had no statistically significant relationship with awareness of PRF-RI or the decision to enroll in PRF-RI. Given that the median was 0, there may not be enough awareness and current enrollment in PRF-RI for information spillover effects to take place. Learning about PRF-RI from a crop insurance agent is associated with an increase in the likelihood that a farmer enrolled in PRF-RI in the past. This makes sense given that crop insurance agents have both the ability and incentives to sell PRF-RI policies.

### Conclusion

The Pasture, Rangeland and Forage Rainfall Index insurance program has been available in the contiguous United States since 2016, however, it has experienced relatively low enrollment rates to date. This article explores characteristics related to awareness of and enrollment in PRF-RI to inform policy makers and researchers assessing potential changes to the program and to assist USDA RMA and extension educators tasked with growing awareness of this risk management tool.

We find that, of those who were aware of PRF-RI but did not enroll, 13% said the program was too complicated and 31% perceived PRF-RI as not relevant for their operation, even though any nonqualifying farmers had been screened out of the survey. Thus, additional education is necessary. Producers without prior access to a crop insurance agent and producers in the Northeast were less likely to be aware of PRF-RI, which suggests a need for targeted information campaigns to increase awareness and enrollment. In recent years, the USDA RMA has offered funding for education in "targeted states," where crop insurance participation has traditionally been low. Many of these states are in the Northeast, so our results provide support for this initiative.

We find that full-time producers with less hay and pasture acreage and a lower proportion of owned forage land were more likely to enroll in PRF-RI when they were aware of the program. Thus, relatively small producers with more risk from land tenure agreements participated in PRF-RI. Producers who enrolled in other livestock revenue insurance products were more likely to enroll in PRF-RI, suggesting that revenue protection products are complementary to input cost protection products like PRF-RI.

Producers who had received a payment from catastrophic losses through the Livestock Forage Disaster Program (LFP) in the last 10 years were more likely to be aware of PRF-RI but not more likely to enroll when these equations were estimated simultaneously. Relatedly, producers who had learned about PRF-RI from a crop insurance agent were more likely to enroll in PRF-RI. This demonstrates that participation in other USDA crop insurance and disaster programs can be a catalyst for educating producers about the various program options available, although these approaches may need to be more intentional to translate into increased enrollment.

One limitation of this analysis is that we cannot make causal inferences. As with all surveys, one must balance the length of the survey with the respondent burden, so we could not control for all

---

<sup>12</sup> Additional models were run without the interaction variable, and a rainfall variability measure that was an average of the standard deviations in rainfall over growing season months. Results were similar.

confounding factors that might have a direct impact on insurance decisions (e.g., debt-asset-ratios, drought risk perceptions of producers). We also acknowledge the limited statistical power of our analysis. Our small sample size is directly related to the low awareness and enrollment rates in PRF-RI in the Northeast and Southeast regions. Less than half of survey participants were aware of PRF-RI, and only 17% of those aware enrolled in PRF-RI. As PRF-RI awareness and enrollment increase, future survey analyses may have additional statistical power.

Despite these limitations, we contribute to the relatively sparse literature covering PRF-RI, identifying significant relationships between awareness and enrollment in this relatively new insurance product, with important implications for policy design and extension education. Most importantly, our study shows that it is useful to account for producers' awareness of new insurance products when making inferences about insurance uptake. Such analyses can serve dual purposes by providing information for targeted education efforts in addition to indicating segments of the population that are aware of but not utilizing the insurance, potentially narrowing in on ways to improve the policy for wider enrollment.

[First submitted April 2023; accepted for publication November 2023.]

## References

- Akay, A., P. Martinsson, H. Medhin, and S. T. Trautmann. 2012. "Attitudes toward Uncertainty among the Poor: An Experiment in Rural Ethiopia." *Theory and Decision* 73(3):453–464.
- Babcock, B. A. 2015. "Using Cumulative Prospect Theory to Explain Anomalous Crop Insurance Coverage Choice." *American Journal of Agricultural Economics* 97(5):1371–1384. doi: 10.1093/ajae/aav032.
- Benami, E., Z. Jin, M. R. Carter, A. Ghosh, R. J. Hijmans, A. Hobbs, B. Kenduyiwo, and D. B. Lobell. 2021. "Uniting Remote Sensing, Crop Modelling and Economics for Agricultural Risk Management." *Nature Reviews Earth & Environment* 2(2):140–159. doi: 10.1038/s43017-020-00122-y.
- Cabas, J. H., A. J. Leiva, and A. Weersink. 2008. "Modeling Exit and Entry of Farmers in a Crop Insurance Program." *Agricultural and Resource Economics Review* 37(1):92–105. doi: 10.1017/S1068280500002173.
- Cao, Y., A. Weersink, and E. Ferner. 2020. "A Risk Management Tool or an Investment Strategy? Understanding the Unstable Farm Insurance Demand via a Gain-Loss Framework." *Agricultural and Resource Economics Review* 49(3):410–436. doi: 10.1017/age.2019.15.
- Cho, W., and B. W. Brorsen. 2021. "Design of the Rainfall Index Crop Insurance Program for Pasture, Rangeland, and Forage." *Journal of Agricultural and Resource Economics* 46(1): 85–100. doi: 10.22004/ag.econ.303607.
- Clarke, D. J. 2016. "A Theory of Rational Demand for Index Insurance." *American Economic Journal: Microeconomics* 8(1):283–306. doi: 10.1257/mic.20140103.
- Coble, K. H., B. K. Goodwin, M. F. Miller, R. M. Rejesus, A. Harri, and D. Linton. 2020. *Review of the Pasture, Rangeland, Forage Rainfall Index Crop Insurance Program Indexing and Rating Methodology*. Final Report. Washington, DC: USDA Risk Management Agency.
- Coble, K. H., R. O. Knight, R. D. Pope, and J. R. Williams. 1996. "Modeling Farm-Level Crop Insurance Demand with Panel Data." *American Journal of Agricultural Economics* 78(2): 439–447. doi: 10.2307/1243715.
- Condliffe, S., and G. T. Fiorentino. 2014. "The Impact of Risk Preference on Health Insurance and Health Expenditures in the United States." *Applied Economics Letters* 21(9):613–616. doi: 10.1080/13504851.2013.879275.
- Dalhaus, T., and R. Finger. 2016. "Can Gridded Precipitation Data and Phenological Observations Reduce Basis Risk of Weather Index—Based Insurance?" *Weather, Climate, and Society* 8(4): 409–419. doi: 10.1175/WCAS-D-16-0020.1.

- Davidson, K. A., and B. K. Goodrich. 2023. "Nudge to Insure: Can Informational Nudges Change Enrollment Decisions in Pasture, Rangeland, and Forage Rainfall Index Insurance?" *Applied Economic Perspectives and Policy* 45(1):534–554. doi: 10.1002/aep.13215.
- Eckel, C. C., and P. J. Grossman. 2008. "Forecasting Risk Attitudes: An Experimental Study Using Actual and Forecast Gamble Choices." *Journal of Economic Behavior & Organization* 68(1): 1–17. doi: 10.1016/j.jebo.2008.04.006.
- Elabed, G., M. F. Bellemare, M. R. Carter, and C. Guirkingner. 2013. "Managing Basis Risk with Multiscale Index Insurance." *Agricultural Economics* 44(4-5):419–431. doi: 10.1111/agec.12025.
- Goodrich, B., J. Yu, and M. Vandever. 2020. "Participation Patterns of the Rainfall Index Insurance for Pasture, Rangeland and Forage Programme." *Geneva Papers on Risk and Insurance - Issues and Practice* 45(1):29–51. doi: 10.1057/s41288-019-00149-3.
- Goodwin, B. K. 1993. "An Empirical Analysis of the Demand for Multiple Peril Crop Insurance." *American Journal of Agricultural Economics* 75(2):425–434. doi: 10.2307/1242927.
- Greene, C., H. Wilmer, D. B. Ferguson, M. A. Crimmins, and M. P. McClaran. 2022. "Using Scale and Human Agency to Frame Ranchers' Discussions about Socio-Ecological Change and Resilience." *Journal of Rural Studies* 96:217–226. doi: 10.1016/j.jrurstud.2022.11.001.
- Greene, W. H. 2008. *Econometric Analysis*, 6th ed. Upper Saddle River, NJ: Pearson Education.
- Holt, C. A., and S. K. Laury. 2002. "Risk Aversion and Incentive Effects." *American Economic Review* 92(5):1644–1655. doi: 10.1257/000282802762024700.
- Jin, J., W. Wang, and X. Wang. 2016. "Farmers' Risk Preferences and Agricultural Weather Index Insurance Uptake in Rural China." *International Journal of Disaster Risk Science* 7(4):366–373. doi: 10.1007/s13753-016-0108-3.
- Jose, H. D., and R. S. K. Valluru. 1997. "Insights from the Crop Insurance Reform Act of 1994." *Agribusiness* 13(6):587–598. doi: 10.1002/(SICI)1520-6297(199711/12)13:6<587::AID-AGR4>3.0.CO;2-#.
- Just, R. E., L. Calvin, and J. Quiggin. 1999. "Adverse Selection in Crop Insurance: Actuarial and Asymmetric Information Incentives." *American Journal of Agricultural Economics* 81(4): 834–849. doi: 10.2307/1244328.
- Keller, J. B., and T. L. Saitone. 2022. "Basis Risk in the Pasture, Rangeland, and Forage Insurance Program: Evidence from California." *American Journal of Agricultural Economics* 104(4): 1203–1223. doi: 10.1111/ajae.12282.
- Luckstead, J., and S. Devadoss. 2019. "Implications of Commodity Programs and Crop Insurance Policies for Wheat Producers." *Journal of Agricultural and Applied Economics* 51(02):267–285. doi: 10.1017/aae.2018.32.
- Luschei, E. C., C. M. Hammond, C. M. Boerboom, and P. J. Nowak. 2009. "Convenience Sample of On-Farm Research Cooperators Representative of Wisconsin Farmers." *Weed Technology* 23(2):300–307. doi: 10.1614/WT-08-083.1.
- Maples, J. G., B. W. Brorsen, and J. T. Biermacher. 2016. "The Rainfall Index Annual Forage Pilot Program as a Risk Management Tool for Cool-Season Forage." *Journal of Agricultural and Applied Economics* 48(1):29–51. doi: 10.1017/aae.2016.3.
- Menapace, L., G. Colson, and R. Raffaelli. 2016. "A Comparison of Hypothetical Risk Attitude Elicitation Instruments for Explaining Farmer Crop Insurance Purchases." *European Review of Agricultural Economics* 43(1):113–135. doi: 10.1093/erae/jbv013.
- Mishra, A., and H. S. El-Osta. 2009. "Estimating Wealth of Self-Employed Farm Households." *Agricultural Finance Review* 69(2):248–262. doi: 10.1108/00021460910978715.
- Mukherjee, S., and P. Pal. 2019. "On Improving Awareness about Crop Insurance in India." *Review of Agrarian Studies* 9(1):46–68.
- National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC). 2020. "CADBv2 Library CPC Station List Master." Available online at [https://ftp.cpc.ncep.noaa.gov/cadb\\_v2/library/](https://ftp.cpc.ncep.noaa.gov/cadb_v2/library/) [Accessed October 11, 2022].

- . 2021. “A Conceptual Description of the CPC Gauge Analysis Procedure.” Available online at [https://ftp.cpc.ncep.noaa.gov/cadb\\_v2/library/](https://ftp.cpc.ncep.noaa.gov/cadb_v2/library/) [Accessed October 11, 2022].
- Petroliia, D. R., C. E. Landry, and K. H. Coble. 2013. “Risk Preferences, Risk Perceptions, and Flood Insurance.” *Land Economics* 89(2):227–245. doi: 10.3368/le.89.2.227.
- Ritter, M., O. Mußhoff, and M. Odening. 2014. “Minimizing Geographical Basis Risk of Weather Derivatives Using a Multi-Site Rainfall Model.” *Computational Economics* 44(1):67–86. doi: 10.1007/s10614-013-9410-y.
- Roznik, M., M. Boyd, L. Porth, and C. B. Porth. 2019. “Factors Affecting the Use of Forage Index Insurance: Empirical Evidence from Alberta and Saskatchewan, Canada.” *Agricultural Finance Review* 79(5):565–581. doi: 10.1108/AFR-02-2019-0022.
- Santeramo, F. G. 2019. “I Learn, You Learn, We Gain Experience in Crop Insurance Markets.” *Applied Economic Perspectives and Policy* 41(2):284–304. doi: 10.1093/aep/ppy012.
- Sherrick, B. J., P. J. Barry, P. N. Ellinger, and G. D. Schnitkey. 2004. “Factors Influencing Farmers’ Crop Insurance Decisions.” *American Journal of Agricultural Economics* 86(1):103–114. doi: 10.1111/j.0092-5853.2004.00565.x.
- Shrum, T. R., and W. R. Travis. 2022. “Experiments in Ranching: Rain-Index Insurance and Investment in Production and Drought Risk Management.” *Applied Economic Perspectives and Policy* 44(3):1513–1533. doi: 10.1002/aep.13304.
- Smith, V. H., and A. E. Baquet. 1996. “The Demand for Multiple Peril Crop Insurance: Evidence from Montana Wheat Farms.” *American Journal of Agricultural Economics* 78(1):189–201.
- Stratton, S. J. 2021. “Population Research: Convenience Sampling Strategies.” *Prehospital and Disaster Medicine* 36(4):373–374. doi: 10.1017/S1049023X21000649.
- Toomet, O., and A. Henningsen. 2008. “Sample Selection Models in R: Package SampleSelection.” *Journal of Statistical Software* 27:1–23. doi: 10.18637/jss.v027.i07.
- Tversky, A., and D. Kahneman. 1992. “Advances in Prospect Theory: Cumulative Representation of Uncertainty.” *Journal of Risk and Uncertainty* 5(4):297–323. doi: 10.1007/BF00122574.
- US Department of Agriculture. 2017a. “2017 Ag Census, Pastureland (Excl Cropland and Woodland) State Data.”
- . 2017b. *The Risk Management Safety Net: Market Penetration and Market Potential: Analysis of the Federal Crop Insurance Portfolio*. Washington, DC: USDA Risk Management Agency. Available online at <https://www.rma.usda.gov/-/media/RMA/Publications/Market-Penetration-and-Market-Potential-2017.ashx?la=en> [Accessed July 1, 2021].
- . 2018. “PRF Archives.” Available online at <https://legacy.rma.usda.gov/policies/pasture-range/forage/archives.html> [Accessed October 5, 2022].
- . 2022. “Summary of Business Reports and Data.” Available online at <https://www.rma.usda.gov/SummaryOfBusiness> [Accessed October 5, 2022].
- Vroege, W., T. Dalhaus, and R. Finger. 2019. “Index Insurances for Grasslands — A Review for Europe and North-America.” *Agricultural Systems* 168:101–111. doi: 10.1016/j.agry.2018.10.009.
- Weigel, C., L. A. Paul, P. J. Ferraro, and K. D. Messer. 2021. “Challenges in Recruiting U.S. Farmers for Policy-Relevant Economic Field Experiments.” *Applied Economic Perspectives and Policy* 43(2):556–572. doi: 10.1002/aep.13066.
- Westerhold, A., C. Walters, K. Brooks, M. Vandever, J. Volesky, and W. Schacht. 2018. “Risk Implications from the Selection of Rainfall Index Insurance Intervals.” *Agricultural Finance Review* 78(5):514–531. doi: 10.1108/AFR-10-2017-0097.
- Yu, J., M. Vandever, J. D. Volesky, and K. Harmony. 2019. “Estimating the Basis Risk of Rainfall Index Insurance for Pasture, Rangeland, and Forage.” *Journal of Agricultural and Resource Economics* 44(1):179–193. doi: 10.22004/ag.econ.281319.
- Zapata, S. D., and J. M. García. 2022. “Risk-Efficient Coverage Selection Strategies for the Pasture, Rangeland, Forage (PRF) Insurance Program.” *Journal of Agricultural and Applied Economics* 54(2):286–305. doi: 10.1017/aae.2022.7.

### Appendix

**Description of lottery basket:** For this task, a ball will be drawn from a basket that contains 5 white balls and 5 orange balls. This means there is a 50% chance of drawing a white ball and a 50% chance of drawing an orange ball.

**Your decision:** Decide when you want to begin choosing Option B (the sure amount). You may decide to first choose Option B in choice 1 or in any other choice in the list.

Choice	Option A		Your Decision	Option B
	Play the lottery			Sure amount
	The likelihood/chance of a white ball being drawn is: <b>50%</b>	The likelihood/chance of an orange ball being drawn is: <b>50%</b>		Payoff of the sure amount (U.S. Dollar)
	Payoff if white (U.S. Dollar)	Payoff if orange (U.S. Dollar)		
1	0	40	A <input checked="" type="radio"/> B <input type="radio"/>	10.59
2	0	40	A <input checked="" type="radio"/> B <input type="radio"/>	13.73
3	0	40	A <input checked="" type="radio"/> B <input type="radio"/>	15.46
4	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	16.71
5	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	17.94
6	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	19.05
7	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	19.99
8	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	20.85
9	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	21.88
10	0	40	A <input type="radio"/> B <input checked="" type="radio"/>	23.44

**Figure A1. Screenshot of Risk Elicitation Exercise in Survey**

**Table A1. Probit Regressions of Awareness of PRF-RI and Prior Enrollment in PRF-RI on Regressors**

Variables	Dependent Variable	
	Aware of PRF-RI 1	Enrolled in PRF-RI 2
<i>Acres (thousands)</i>	0.60* (0.34)	-0.80 (0.65)
<i>Beef</i>	0.43 (0.29)	4.19 (292.71)
<i>Dairy</i>	-0.02 (0.39)	2.57 (292.71)
<i>Risk Aversion</i>	0.24 (1.66)	-0.78 (5.17)
<i>Rainfall Variability</i>	-0.002 (0.01)	-0.003 (0.02)
<i>Farm Income</i>	0.10 (0.06)	-0.22 (0.16)
<i>Fulltime</i>	-0.18 (0.22)	1.34** (0.56)
<i>Info Source: Extension</i>		0.30 (0.42)
<i>Info Source: Friends</i>		-0.94 (0.85)
<i>Info Source: Agent</i>		1.31*** (0.47)
<i>Other Insurance</i>		0.14 (0.32)
<i>Proportion Livestock</i>	0.09 (0.25)	1.09 (0.79)
<i>Age</i>	0.002 (0.01)	
<i>Male</i>	-0.003 (0.24)	
<i>Crop Insurance Agent</i>	0.12 (0.20)	
<i>Proportion Hay Sold</i>		0.17 (0.63)
<i>Livestock Revenue Insurance</i>		1.48** (0.69)
<i>Livestock Margin Insurance</i>		1.16 (1.59)
<i>LFP</i>	0.63** (0.27)	0.86* (0.47)
<i>Proportion County Enrolled</i>	-0.71 (0.82)	2.87 (2.70)
<i>Rent Proportion</i>		1.51** (0.66)
<i>County Base Value</i>		-0.00003
<i>Avg Dist to 4 Closest WS</i>		0.01 (0.02)
<i>Region: SE</i>	0.48* (0.25)	-0.42 (0.82)
<i>Risk Aversion × Rainfall Variability</i>	-0.01 (0.02)	0.003 (0.06)
Constant	-0.713	-5.21 (292.72)
No. of obs.	254	121
Log Likelihood	-155.61	-35.4
$\rho$	343.23	116.79

Notes: Values in parentheses are standard errors. Single, double, and triple asterisks (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% level, respectively.

## Online Supplement: Enrollment in Pasture, Rangeland, and Forage Rainfall Index Insurance: Awareness Matters

Brittney K. Goodrich and Kelly A. Davidson

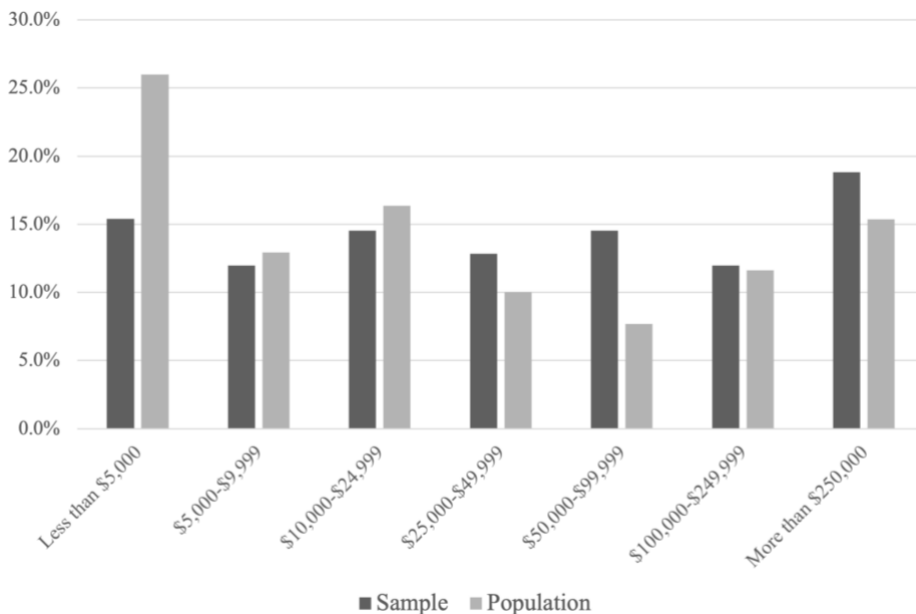
**Table S1. Pearson Correlation Coefficients of Explanatory Variables with Awareness of PRF-RI and Enrollment in PRF-RI**

	Aware of PRF-RI	Enrolled in PRF-RI
Farm Income	0.13**	0.11
Acres (thousands)	0.19***	0.02
Risk Aversion	-0.03	0.08
Rainfall Variability	0.15**	-0.06
Age	0.04	0.09
Male	0.06	-0.01
Dairy	-0.10	0.01
Beef	0.20***	0.07
Crop Insurance Agent	0.10	0.46***
Prop Livestock Income	0.05	0.07
Prop Hay Sold	0.01	-0.04
Livestock Revenue Insurance	0.02	0.22**
Livestock Margin Insurance	-0.06	-0.02
LFP	0.24***	0.25***
Fulltime	-0.01	0.17*
Other Insurance	0.17***	0.12
Prop County Enrolled	0.02	0.05
Rent Proportion	0.07	0.16*
County Base Value: Hay, Not irrigated	-0.19***	-0.08
Avg Distance 4 close WS	-0.01	-0.01
Info Source: News	N/A	-0.11
Info Source: Extension	N/A	0.04
Info Source: Friends	N/A	-0.13
Info Source: Agent	N/A	0.33***
Region: SE	0.22***	0.03
Observations	254	121

Notes: Single, double, and triple asterisks (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% level.

The material contained herein is supplementary to the article named in the title and published in the *Journal of Agricultural and Resource Economics (JARE)*.

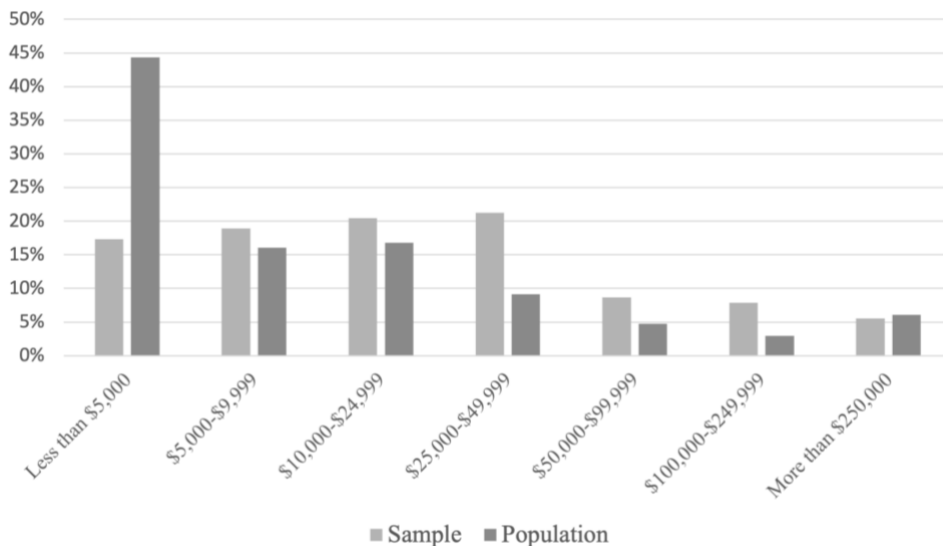
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.



**Figure S1. Northeast Percentage of Operations in Gross Farm Sales Category, Population and Sample**

*Notes:* Only those states that represented at least 2% of the participants in our sample were included in population and sample calculations. Northeast states included Delaware, New York, Pennsylvania, Vermont and Virginia, and Southeast states included Alabama, Florida, Georgia, and Tennessee.

*Source:* 2017 USDA Agricultural Census.



**Figure S2 Southeast Percentage of Operations in Gross Farm Sales Category, Population and Sample**

*Notes:* Only those states that represented at least 2% of the participants in our sample were included in population and sample calculations. Northeast states included Delaware, New York, Pennsylvania, Vermont and Virginia, and Southeast states included Alabama, Florida, Georgia, and Tennessee.

*Source:* 2017 USDA Agricultural Census.