Accepted Manuscript
Version of record at: https://doi.org/10.1002/aepp.13215

Nudge to insure: Can informational nudges change enrollment decisions in pasture, rangeland, and forage rainfall index insurance?

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Funding information
Southern Extension Risk Management Education Center, Grant/Award Number: #14133; Northeast Extension Risk Management Education Center, Grant/Award Number: #14163

Editor: Daniel Petrolia

Abstract
Through a framed field experiment with livestock farmers in the Northeast and Southeast United States, this research explores whether an informational nudge changes producers' selection of two-month intervals and/or increases the likelihood of enrollment in pasture, rangeland, and forage (PRF) insurance. We find no evi-dence that a nudge influences interval choices; however, producers are more likely to enroll when PRF is framed as a risk management decision regarding forage loss. Risk aversion, familiarity with other United States Department of Agriculture livestock programs, and higher risk expo-sure increase the likelihood of enrollment. Past PRF and crop insurance participation decrease the amount insured during growing-season months.

Keywords
experimental economics, nudge, pasture, rangeland, and forage insurance, risk management

JEL Classification
Q18, D81, C93

Extreme weather events such as the 2012 drought experienced by U.S. farmers nationwide can severely impact livestock producers' inventories and balance sheets as producers reduce herd size or purchase supplemental forage or feed (Countryman et al., 2016; Leister et al., 2015; Selasco & Hungerford, 2018; Watkins, 2012). Livestock producers have historically had limited access to government-sponsored crop insurance programs, while disaster assistance programs such as the Livestock Indemnity Program, Livestock Forage Program, or Noninsured Crop Disaster Assistance Program (NAP) do not always compensate for losses incurred from drought management decisions (Countryman et al., 2016).

The United States Department of Agriculture (USDA) Risk Management Agency (RMA) introduced the pasture, rangeland, and forage (PRF) area-based rainfall index insurance program as a flexible product to protect livestock and forage producers against forage loss caused by a shortage of rainfall. Rather than measuring farm-level forage production and losses that can be costly to measure from an administrative standpoint (Wang et al., 1998), the product is based on a rainfall index calculated using the National Oceanic and Atmospheric Administration Climate Prediction Center grid system. Acreage is assigned to one or more grids measuring 0.25° in latitude and 0.25° in longitude. Indemnities are triggered when rainfall levels fall below the historical average for the grid in which a producer's acreage is located. Between 70% and 90% of average rainfall is guaranteed, depending on the coverage level selected by the participant. Therefore, PRF offers buy-up coverage that extends beyond the catastrophic coverage (50% forage loss) covered through NAP. Producers select index intervals, available in two-month increments from January to December.

Like other federal crop insurance policies, PRF premiums are set by the Federal Crop Insurance Corporation (FCIC). Through terms in Standard Reinsurance Agreements, the federal government and private crop insurance companies jointly underwrite policies in the Federal Crop Insurance Program (FCIP) (Smith et al., 2016). Producers must purchase their PRF policy through a certified crop insurance agent, and agents allocate that policy back to a private insurance company. For assuming the policy risk, private insurance companies receive payments proportional to the total premiums collected (producer premiums plus premium subsidies). Premiums are calculated separately for each index interval and grid to account for variability in rainfall during that time period. PRF premiums are subsidized by the U.S. government, with levels (51%, 55%, or 59%) varying based on the coverage level selected by the participant.

A recent review of PRF determined that the product is actuarially sound (Coble et al., 2020). However, among producers who do enroll in PRF insurance, there is a tendency to insure 2-month intervals that do not have a significant impact on forage growth in addition to, or instead of, those 2-month intervals that would impact forage growth (Goodrich et al., 2020). This strategy increases a participant's basis risk, that is, not receiving an indemnity when losses occur, in direct contrast with the program's goal of risk reduction. Participants enrolling in intervals that increase their basis risk might cause them to drop the insurance product once there is a disconnect between on-farm losses and an indemnity (Clarke, 2016; Elabed et al., 2013; Elabed & Carter, 2015). To deter producers from selecting risk-increasing intervals, one proposed change is to not allow producers to insure winter month intervals that USDA RMA would determine as not impacting forage growth (Coble et al., 2020; USDA RMA, 2020b). Westerhold et al. (2018) posit removing risk-increasing intervals would improve government allocation of resources. However, determining risk-increasing intervals for every grid would likely increase the cost of program implementation and would no doubt be met by political opposition (Babcock, 2011; Klein & Krohm, 2008). Not to mention, maintaining the flexibility for producers to choose the interval periods that best reduce risk on their own operation is important since forage production systems vary even within a county (Coble et al., 2020).

In addition to program challenges with sub-optimal interval decisions, PRF faces low enrollment. Currently, only 33% of eligible acreage in the United States is enrolled in PRF despite government subsidies, the existence of few other livestock insurance options, and the large number of livestock operations that depend on precipitation and forage for profitability. Typical approaches to increasing enrollment in crop insurance programs include increasing premium subsidies or substantially altering the program to make it more attractive to producers. Both of these alternatives are costly in terms of time and taxpayer dollars and may ultimately prove ineffective (Du et al., 2017; Goodwin, 1993). Our research explores whether framing the insurance decision using an informational nudge on the selection of two-month intervals will simplify the enrollment decision and increase program participation. We conduct a survey and framed field experiment to simulate PRF decisions among nearly 300 eligible livestock farmers in the Northeast and Southeast United States. The PRF program is especially under-enrolled in these areas, with only 2% of eligible acres enrolled in the Northeast and 22% of eligible acres enrolled in the Southeast (USDA NASS, 2017; USDA RMA, 2020a). Most of the states in these regions experience low to medium vulnerability to drought, compared to states in the Midwest and West where drought vulnerability ranks medium to high (Stevens, 2021). However, less than 1% of hay and pasture acreage is irrigated in each of the surveyed regions, making producers in these areas especially susceptible to risks from low rainfall (USDA NASS, 2017).

One potential explanation for under enrollment and risk-increasing behavior in PRF is the complexity of choice structures required to enroll in the program. Much different than traditional crop insurance programs, participants face a number of enrollment decisions such as two-month intervals to insure against low rainfall and percent of value to allocate to each interval, in addition to choosing coverage levels, productivity factors, and acreage to enroll. The complex structure of the program could potentially lead to confusion and psychological constraints among decision-makers. For example, the producer may face "choice overload" about the number of enrollment decisions to be made, leading to confusion and decision paralysis (Baicker et al., 2012). Previous studies have shown that behavioral mechanisms such as informational nudges (Clark et al., 2014; Manoli & Turner, 2016) or simplified enrollment instructions (Choi et al., 2010; Madrian & Shea, 2001) can improve program enrollment and selection decisions.

Our experiment explores the role of behavioral mechanisms to simplify PRF interval decisions and increase enrollment. We randomly assigned participants to receive one of two informational nudges prior to making hypothetical PRF enrollment decisions. One informational nudge (*forage loss*) reminds participants of potential forage losses in the growing-season months that are most important for their operation, that is, wide framing of the insurance decision as a risk management tool (Babcock, 2015). The other informational nudge (*probability of payment*) notifies the participant of the growing-season months when a producer in their area has the highest likelihood of receiving an indemnity payment from PRF enrollment, that is, narrow framing of the insurance decision as a one-time investment (Babcock, 2015). The control group is never exposed to an informational nudge. We hypothesized that compared to the control, (1) the *forage loss* nudge would increase the percentage of value placed in growing-season months, while the *probability of payment* nudge would decrease the percentage of value placed in growing-season months and (2) the nudges would increase enrollment through the reduction in choice overload. The first hypothesis relies on the assumption that there is little intersection between growing-season months and those with high probabilities of payment.

While we do not find an effect of the nudges on the value placed in growing-season months, our results show that a subtle reminder framing PRF as a risk management tool seems to increase enrollment more than when the decision is framed as an investment. This suggests providing enrollment recommendations may alleviate choice overload and increase the likelihood of enrollment in the program. This research highlights important policy implications and suggests a promising direction for future research at the intersection of behavioral economics, insurance demand, and the FCIP. As far as we are aware, we are the first study to apply behavioral economics through a framed field experiment exploring decisions in the FCIP. Our findings suggest education campaigns focusing on the risk mitigation benefits of crop insurance by Cooperative Extension or crop insurance agents may increase enrollment and better align participant decisions with the goals of crop insurance programs.

Our findings also suggest crop insurance companies and/or agent incentives may play a larger role in participant behavior than previously thought. Since premiums are set by the FCIC, crop insurance companies cannot compete through lowering premiums, but they can compete through offering compensation to agents for providing customers with higher underwriting gains. If the months with high probability of payment provide higher underwriting gains on average, it seems likely that insurance companies might provide compensation incentives to agents for enrolling participants in these months. Just et al. (1999) and Goodwin (1993) suggest risk aversion has little impact on crop insurance decisions in the United States, and Goodrich et al. (2020) document that observed PRF participation patterns in Nebraska and Kansas over time trended toward risk-increasing behavior. However, we show that producers with higher levels of risk aversion are more likely to enroll in PRF. In addition, we find participants who had enrolled in PRF in a prior year or in other FCIC insurance programs insured significantly less value into growing-season (basis risk-reducing) months. If producers' observed behaviors do not match their risk aversion preferences, this suggests a presence of some other influence on producer decisions. These findings highlight the need for further research on how crop insurance company and agent incentives may affect producer enrollment decisions across the entire FCIP.

EXPERIMENTAL DESIGN

In a framed field experiment using computer software programmed by SoPHIELabs, 262 livestock or hay producers engaged in a simulation of PRF enrollment decisions. To begin the experiment, each participant watched an informational video about PRF. The video was prepared by agricultural extension services and provided farmers with content that would usually be disseminated at an extension outreach event:[1] the basics of PRF, policy decisions that must be made, enrollment deadlines, and how to locate a crop insurance agent. Following the video, the participant answered survey questions about the nature of their operation and made hypothetical enrollment decisions about PRF insurance. The decisions exactly mimicked those decisions producers would make during the actual enrollment process (coverage level[2], acreage enrolled, interval of months insured, percent of value assigned to each interval). Participants provided the zip code for their largest hay or pasture acreage at the beginning of the survey, and the corresponding grid was accessed using the USDA RMA PRF Support Tool.[3] Policy data from the 2019 crop year (premiums, base value of acreage, and premium subsidies) were autopopulated from USDA RMA's Actuarial Information based on the participant's actual operation and grid. To mitigate potential hypothetical bias, participants read a cheap talk script (Lusk, 2003; Murphy et al., 2005) prior to the decision, and we invoke consequentiality (Broadbent, 2012; Carson & Groves, 2007; Vossler et al., 2012) by providing farmers with the

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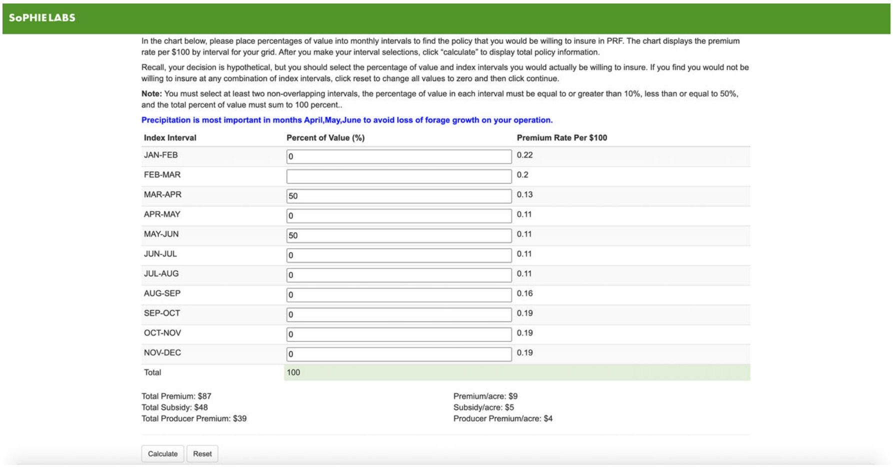

FIGURE 1 Screenshot of pasture, rangeland, and forage decision matrix in survey with forage loss treatment. The 50% in March–April and 50% in May–June were input by the authors to show the display when a participant had entered values. All entries were 0 when the participant entered the screen as in Figure 2. Participants assigned to the control saw the instructions with no additional informational nudge [Color figure can be viewed at wileyonlinelibrary.com]

option to receive a copy of their enrollment decisions to share with a crop insurance agent after the study.

After making PRF enrollment decisions, all participants engaged in an incentive-compatible risk elicitation exercise where one in six participants was randomly selected to earn real cash. The exercise followed Akay et al. (2012), Eckel and Grossman (2008), and Holt and Laury (2002).[4] All participants then completed general survey questions about PRF experience and farm characteristics. At the end of the survey, participants were asked if they were planning to enroll in PRF in the upcoming year.

All participants watched the same PRF video, answered survey questions, made enrollment choices, and engaged in the risk elicitation activity. Upon logging into the experiment software, each participant was randomly assigned to one of two informational nudge treatments or to the control. The assigned informational nudge was displayed at the top of the PRF decision-matrix screen where the treated participant made decisions about the percent of value and two-month intervals he or she would be willing to enroll in PRF (Figures 1 and 2). The nudge was displayed for the duration of the participant's decision-making process. Participants randomly assigned to the control group received no informational nudge.

Informational nudges

The informational nudges were informed by prior research on participation in the U.S. FCIP that shows farmer decisions are impacted by whether the decision is framed as a one-time investment (narrow frame) or a risk management tool (wide frame) (Babcock, 2015; Cao et al., 2019; Luckstead & Devadoss, 2019). Du et al. (2017) suggest that helping growers broaden their frames of reference with respect to crop insurance could help them "foster more reflective decision-making."

Treatment 1 (*forage loss*) displayed in Figure 1 framed PRF as a risk management tool (wide frame). The *forage loss* nudge informed the participant about the months when precipitation is

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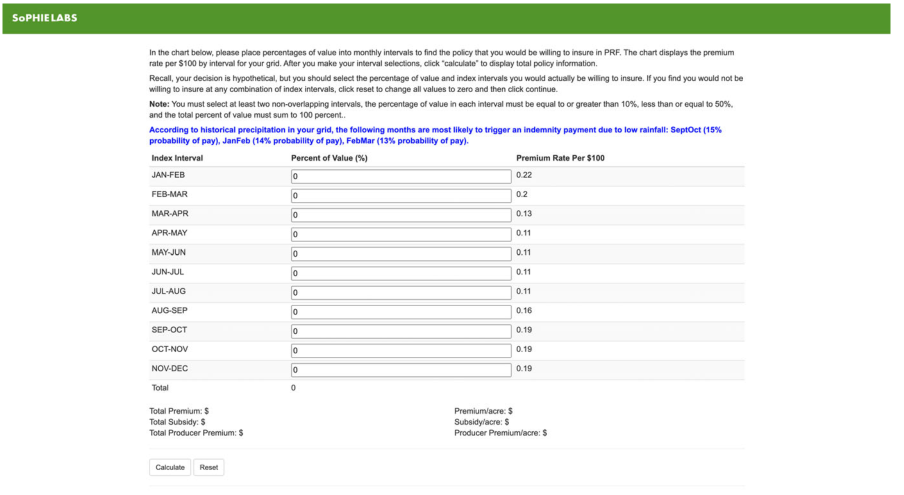

FIGURE 2 Screenshot of pasture, rangeland, and forage decision matrix in survey with probability of payout treatment. All entries were 0 when the participant entered the screen and participants entered values as demonstrated in Figure 1. Participants assigned to the control saw the instructions with no additional informational nudge [Color figure can be viewed at wileyonlinelibrary.com]

most important to avoid the loss of forage growth, leveraging producer knowledge of his or her own operation. The *forage loss* nudge populated with the participant's response to an earlier survey question about perceived months that are most important for rainfall to avoid loss of forage growth.[5] For brevity, we refer to these as growing-season months (intervals). We acknowledge the limitation of this self-reported nudge; however, national data are not available on the correlation between forage loss and rainfall throughout the year at a regional or grid level.

An individual assigned to treatment 2 (*probability of payment*) received a nudge informing him or her about the three intervals when the participant is most likely to receive an indemnity payment (Figure 2). The *probability of payment* nudge is meant to prompt the participant to think of PRF as a one-time investment (narrow frame). The probability of payment for a given grid and two-month interval is calculated as the proportion of years that the level of precipitation has fallen below the covered level of average historical precipitation, that is, the number of years in which an indemnity payment would have been paid. Average historical precipitation is calculated over 70 years of precipitation data. On average, winter months, when rainfall presumably would not have an impact on forage growth in many areas, have a much higher likelihood of triggering an indemnity (see Figures 3 and S4).

Framing the PRF decision using informational nudges simulates conversations that may take place between the producer and the crop insurance agent. Many crop insurance companies market PRF using the idea behind the *probability of payment* nudge.[6] They use software to find the month intervals with the highest rainfall volatility that provide the highest probability of receiving a crop insurance indemnity from the PRF policy. Crop insurance agents may also use the *forage loss* nudge in an attempt to narrow down the number of index intervals that a producer must choose from, although we have no evidence of this being a marketing strategy. Namely, we investigate the role of information about forage loss compared to potential indemnity payments to understand how producers' decisions change under different sets of information.

We hypothesize that the percentage of value placed in growing-season months will vary by treatment, with the *forage loss* nudge garnering positive impacts on growing-season month

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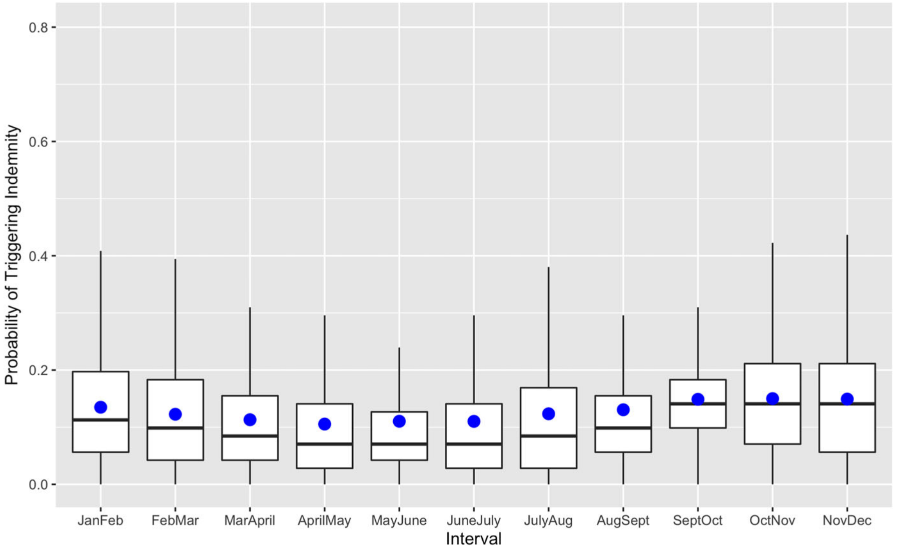

FIGURE 3 Box plots of probabilities of triggering pasture, rangeland, and forage (PRF) indemnities by index interval, All U.S. grids 90% coverage level. Box plots represent the distribution of probabilities of triggering a PRF indemnity at the 90% level for each index interval across all grids in the United States. The lower and upper sides of each rectangle are the 25th and 75th percentiles of each intervals' probability distribution. The horizontal line in each rectangle represents the median, and the blue circle represents the average [Color figure can be viewed at wileyonlinelibrary.com]

enrollment and the *probability of payment* nudge decreasing the percentage of value placed in growing-season intervals. Figures 3 and S4 support a key assumption on our hypothesis that there is little intersection between growing-season months and those with high probabilities of payment. Our secondary hypothesis predicts that exposure to an informational nudge (*forage loss* or *probability of payment*) will increase PRF enrollment compared to the control.

Study sites

Data for this experiment were collected at regional farm shows in the Southeast United States in October 2019 and the Northeast United States in February 2020. Participants were selected via convenience sampling. Eligible individuals included those who were over 17 years of age and who self-reported as the primary decision-maker of a livestock or hay operation. Our sample[7] includes 147 farmers from the southeast region and 116 from the northeast region. Participants were compensated $20 in cash for their time spent taking the survey (approximately 30 min).[8] During the risk elicitation exercise, the participant could earn up to an additional $40.

EMPIRICAL METHODOLOGY

Following Smith and Baquet (1996), we model the insurance decision as a two-step sample selection problem: The participant first decides whether or not to enroll in PRF and next decides how to allocate percentages of value across 2-month intervals. The model takes the following form:

$$Y^* = X\beta + \epsilon. \tag{1}$$

$$Y = \begin{cases} 1 \text{ when } Y^* > 0 \\ 0 \text{ when } Y^* < 0 \end{cases}. \tag{2}$$

$$P = X_1\beta_1 + \mu. \tag{3}$$

Y^* is a latent variable, defined below, for the PRF enrollment decision, and P represents the percentage allocated into growing-season intervals, which is only observed if the participant enrolls ($Y = 1$). ϵ and μ are error terms; ϵ is assumed to be distributed normally with mean zero and SD one and $E[\mu|\epsilon] = \gamma\epsilon$. The independent variables, X, in Equation (1) include indicator variables for the two treatments, as well as the covariates described in Table 1. The independent variables, X_1, in Equation (3) include a subset of those in Equation (1).

We provide three different specifications of the dependent variable, Y^*, for the selection Equation (1) as robustness checks because we are cognizant that hypothetical bias may arise in our design. The different specifications of the PRF enrollment decision impact whether or not the outcome variable in Equation (3) (percentage allocation in growing-season intervals) is observed. In a real situation, if a producer chooses not to enroll in PRF, their percentage allocation decision would not be observed. The first specification of Y^*, denoted as *Purchase*, equals 1 when the participant indicates they would purchase the insurance policy they explored, and 0 if they would not purchase the insurance policy.[9] The second specification of Y^*, *Purchase* × *Summary*, invokes consequentiality on the hypothetical *Purchase* decision. *Summary* equals 1 when the participant indicated they wished to receive a copy of their decisions to share with a crop insurance agent after the study, and 0 if they did not want a summary. Hence, *Purchase* × *Summary* will equal 1 when the participant is serious about talking to their crop insurance agent about a specific policy (i.e., the decision has consequence), and 0 otherwise. The third specification of Y^*, *EnrollNext*, equals 2 when the participant indicated they would enroll in PRF in the upcoming year, 1 when the participant indicated they were unsure about enrollment, and 0 when the participant indicated they would not enroll in PRF in the upcoming year.[10] The *EnrollNext* variable is based on a question asked near the end of the survey, which did not refer to the specific policy the participant had explored. We model the third specification using an ordered probit regression to illustrate the enrollment decision, but this specification is not used in the sample selection model.[11]

The dependent variable, P, in the outcome Equation (3) is calculated as the sum of percentages placed into index intervals that overlapped with the grower's stated important growing-season months. For example, if the grower stated May, June, and July were months when precipitation is most important to avoid loss of forage growth, the growing-season percentage would be the sum of values placed in April–May, May–June, June–July, and July–August index intervals. For all specifications, equations are estimated first without covariates and then with observable covariates to test model sensitivity.

RESULTS

Table 2 displays summary statistics for the data. The average participant coefficient of constant relative risk aversion (CRRA) is 0.04, indicating that participants are close to risk neutral, on average. Average farm size is 270 acres of hay and pasture, and livestock and hay production

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TABLE 1 Description and values of covariates

Covariate	Description	Values
Risk aversion	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). Participants choose between a certain bet with a small payoff and a risky bet with a large payoff	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
Production type	Binary variable indicating whether the observation pertains to the participant's hay or grazing operation	Indicator variable equal to 1 for hay and 0 for grazing
Acres	Continuous variable equal to the participants' total number of acres dedicated to pasture land and hay production	Number of acres
Rent	Proportion of hay and pasture acreage that the producer rents from a landowner versus owning his or herself	Proportion calculated as the number of hay and pasture acres rented divided by the total number of hay and pasture acres
Farm income	Integer ranging from 1 to 7 representing the participants' agricultural gross sales in 2018	Gross sales categories: (1) <$5000 (2) $5000–$9999 (3) $10,000–$24,999 (4) $25,000–$49,999 (5) $50,000–$99,999 (6) $100,000–$249,999 (7) >$250,000
ProportionLivestock	Proportion of total farm income coming from livestock and hay production	Proportion calculated as the sum of the proportion of total farm income from livestock and the proportion of total farm income from hay
LivestockType[b]	Categorical variable representing the type of livestock raised	Categories: 1. beef cattle[a] 2. dairy cattle 3. hay production only 4. other types of livestock, for example, sheep, goats, horses
Proportion Hay Sold	Proportion of hay sold off-farm vs. used on farm	Proportion calculated as the amount of hay sold divided by the sum of hay produced and hay purchased
Experience	Continuous variable equal to the number of years the participant has been farming	Number of years
PRFprior	Binary variable indicating whether the participant had enrolled in PRF in a previous year	Indicator variable equal to 1 if the participant had enrolled in PRF in previous years and 0 otherwise

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TABLE 1 (Continued)

Covariate	Description	Values
Familiar	Binary variable indicating whether the participant had heard of PRF prior to this experiment	Indicator variable equal to 1 if the participant had heard about PRF prior to the experiment and 0 otherwise
OtherInsurance[c]	Categorical variable indicating other crop insurance programs in which the participant is enrolled.	Categories: 1. NAP[a] 2. yield or revenue protection for field or specialty crops 3. Not enrolled in any other insurance programs
OtherLivestockInsurance	Binary variable indicating if the participant has previously enrolled in other insurance programs offered for livestock producers by USDA RMA. The programs include: Livestock Risk Protection (LRP), Livestock Gross Margin Insurance (LGM), Margin Protection Program for Dairy (MPP-Dairy), or Dairy Revenue Protection (Dairy-RP)	Indicator variable equal to 1 if the participant had enrolled within the last 10 years in any of the insurance programs and 0 otherwise
OtherLivestockPrograms	Binary variable indicating if the participant has previously participated in any USDA livestock disaster programs. These programs include: Livestock Indemnity Program (LIP), Livestock Forage Disaster Program (LFP), Emergency Assistance for Livestock, Honey Bees, and Farm Raised Fish (ELAP)	Indicator variable equal to 1 if the participant had enrolled within the last 10 years in any of the disaster programs and 0 otherwise
Fulltime	Binary variable indicating whether the participant identifies as a full-time or part-time farmer	Indicator variable equal to 1 if the participant identifies as a full-time farmer and 0 otherwise

[a]Denotes reference category in regression.
[b]Some producers had both beef and dairy cattle; these producers were put in the dairy category for *LivestockType*.
[c]Some producers enrolled in NAP and yield or revenue protection for field or specialty crops; these producers were put into the yield or revenue protection category for *OtherInsurance*.

accounts for 73% of farm income. The majority of our sample raises beef cattle, with dairy being our next largest category of producers. 84% of participants were not enrolled in other livestock insurance programs, and 79% of participants were not enrolled in any other crop insurance programs, including the NAP. Only 47% of our sample was familiar with PRF prior to this study, and 8% had enrolled in PRF in a prior year. We asked participants who were aware of PRF prior to the study but had not enrolled to state their reason for not enrolling: 16% indicated premiums were too high, 13% said the program was too complicated, 31% perceived PRF as not relevant for their operation, 6% stated it was because annual forage is not covered in PRF, 9% indicated it was due to not having a crop insurance agent, and 25% indicated some "Other" reason.

TABLE 2 Summary statistics

Statistic	*N*	Mean	SD	Min	Pctl(25)	Pctl(75)	Max
Purchase yes	261	0.58	0.49	0.00	0.00	1.00	1.00
Send summary	262	0.53	0.50	0	0	1	1
Enroll next year[a]	257	0.84	0.72	0.00	0.00	1.00	2.00
Treatment	262	0.99	0.81	0	0	2	2
Risk aversion	258	0.04	0.23	−0.40	−0.10	0.24	0.40
Production type: hay vs. graze	262	0.50	0.50	0	0	1	1
Acres (in 1000s)	258	0.27	0.38	0.002	0.06	0.30	3.56
Rent	258	0.31	0.35	0.00	0.00	0.59	1.00
Farm income category	255	3.68	1.92	1.00	2.00	5.00	7.00
Proportion livestock income	255	0.73	0.36	0.00	0.40	1.00	1.00
Proportion hay sold	258	0.23	0.33	0.00	0.00	0.41	1.00
PRF Prior	262	0.08	0.28	0	0	0	1
Familiar	262	0.47	0.50	0	0	1	1
Other livestock insurance	262	0.16	0.36	0	0	0	1
Other livestock programs	262	0.17	0.37	0	0	0	1
Fulltime	262	0.34	0.47	0	0	1	1
Experience	258	23.74	16.03	1.00	10.00	35.00	66.00
Primary livestock: beef	262	0.76	0.43	0	1	1	1
Primary livestock: dairy	262	0.12	0.33	0	0	0	1
Primary livestock: hay only	262	0.08	0.27	0	0	0	1
Primary livestock: other	262	0.05	0.21	0	0	0	1
Other insurance: nap	257	0.05	0.23	0.00	0.00	0.00	1.00
Other insurance: not enrolled	257	0.79	0.41	0.00	1.00	1.00	1.00
Other insurance: yield or revenue	257	0.15	0.36	0.00	0.00	0.00	1.00

[a]Enroll next year values: 0 = No, 1 = Unsure, 2 = Yes.

Common "Other" themes included not taking the time to learn about the program, being a relatively new producer, or having participated before, but not received a payout. Only farmers qualifying for PRF were allowed to participate in our study; thus, it seems the 32% that said the program is not relevant likely did not have a good understanding of the program, perhaps due to its complexity.

Table 3 displays a comparison of our sample statistics with those in each region from the 2017 USDA Agricultural Census.[12] Overall, our sample looks similar to the general population of cattle and forage producers in the target regions.

We find statistical balance of covariates across randomized treatment and control groups for all determinants except risk aversion and production type.[13] For this reason, we present only results of regressions with covariates to control for the imbalance.[14]

Table 4 displays the results of the probit and ordered probit selection regressions (Equation 1) where the dependent variables are variations of the enrollment decision variables defined earlier. Table 5 displays average marginal effects for each treatment across the

TABLE 3 Sample representativeness compared to producers enrolled in PRF in the Northeast and Southeast

	Northeast		Southeast	
	Population	**Sample**	**Population**	**Sample**
Operations with cattle	51,545	100	87,367	122
Percentage of cattle operations: with beef cows	78.7%	82.0%	98.8%	97.5%
with dairy cows	26.2%	31.7%	2.9%	4.1%
Total hay and pasture acreage	7,064,803	27,630	13,031,943	38,086
Percentage hay acreage	50.9%	69.1%	25.4%	27.8%
Percentage pasture acreage	49.1%	30.9%	74.6%	72.2%
Average PRF Premium $/Acre:				
Grazing acreage	$8.25	$19.16	$12.95	$23.44
Hay acreage	$44.61	$37.60	$76.01	$51.92

Note: 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 taken from 2017 USDA Agricultural Census, 2019 USDA RMA Summary of Business Data.

regressions. Models (1)–(3) in Table 4 show only the *forage loss* treatment had a positive impact on enrollment, and its coefficient and corresponding average marginal effect in Table 5 are statistically significant at the 5% level in the hypothetical *Purchase* decision (model 1). When consequentiality is invoked (model 2), treatment effects are not statistically significant, which suggests the presence of hypothetical bias. Furthermore, we find no statistical evidence that either nudge impacts the likelihood that a participant states he/she will enroll in PRF in the upcoming year (Table 5, model 3).

Our hypothesis that a *probability of payment* nudge would result in farmers allocating a lower percentage of value to growing-season months depended on the assumption that little to no overlap exists between growing-season months and probability of payment. Upon comparing respondents' stated important growing-season intervals with the high probability of payment intervals for their grid, we found that for 70% of our respondents, the *probability of payment* nudge would have suggested at least one growing-season interval, which violates our assumption. The *probability of payment* nudge might actually increase the percentage of value placed into growing-season months compared to our control, which may explain the lack of impact found on the *probability of payment* nudge.

Table 6 displays the results of the simultaneously estimated sample selection regressions (Equations 1–3) using the *Purchase* and $Purchase \times Summary$ specifications.[15] For both the hypothetical and consequential model, we find no statistical evidence that either nudge treatment impacts the percentage of value placed in growing-season intervals.

The effects of the covariates included in this analysis provide useful information regarding characteristics that impact PRF enrollment decisions. Table 5 displays the average marginal effects from covariates for regressions on enrollment decisions presented in Table 4. As one would expect, an increase in a participant's level of risk aversion increases the likelihood of enrollment across all models, although it is only statistically significant at the 10% level in the decision to enroll next year (model 3). These results are consistent with other studies of insurance demand that have found a positive relationship between risk aversion and insurance

TABLE 4 Probit regressions of enrollment decisions on treatments and covariates

	Purchase yes *probit* (1)	Purchase Yes x send Summary *probit* (2)	Enroll next year *ordered probit* (3)
T1: Forage loss	0.44** (0.22)	0.09 (0.22)	0.23 (0.19)
T2: Prob of payment	0.22 (0.23)	0.15 (0.23)	0.03 (0.20)
Risk aversion	0.40 (0.42)	0.30 (0.42)	0.69* (0.36)
PRF Prior	0.41 (0.41)	0.27 (0.37)	1.74*** (0.38)
Familiar	0.05 (0.20)	0.16 (0.20)	0.09 (0.17)
Farm income category	0.11 (0.07)	0.10 (0.07)	0.09 (0.06)
Fulltime	0.23 (0.24)	0.01 (0.24)	0.31 (0.21)
Other crop insurance: not enrolled	−1.12** (0.52)	−0.26 (0.48)	−0.21 (0.41)
Other crop insurance: yield or revenue	−1.22** (0.54)	−0.27 (0.50)	−0.08 (0.43)
Other livestock insurance	−0.51 (0.33)	−0.15 (0.32)	−0.27 (0.28)
Other livestock programs	0.69** (0.30)	0.65** (0.28)	0.20 (0.25)
Primary livestock: dairy	0.02 (0.35)	0.02 (0.37)	−0.35 (0.30)
Primary livestock: hay	0.27 (0.42)	0.67 (0.41)	0.68* (0.36)
Primary livestock: other	1.23** (0.55)	0.54 (0.47)	−0.60 (0.43)
Production type: hay vs. graze	−0.59** (0.23)	−0.34 (0.23)	−0.43** (0.20)
Proportion livestock income	0.46* (0.27)	0.68** (0.27)	0.82*** (0.24)
Proportion hay sold	−0.74** (0.33)	−0.60* (0.34)	−0.97*** (0.29)
Rent	0.03 (0.27)	0.38 (0.27)	−0.14 (0.24)
Acres (in 1000s)	−0.07 (0.27)	−0.36 (0.27)	−0.14 (0.22)
Experience	−0.01 (0.01)	0.004 (0.01)	−0.004 (0.01)
0–1			−0.34 (0.60)
1–2			1.28** (0.60)
Constant	1.08 (0.72)	−0.30 (0.69)	
State fixed effects	Yes	Yes	Yes
Observations	253	253	253
Log likelihood	−139.41	−139.26	−212.86
Akaike Inf. Crit.	348.82	348.53	497.72

Note: Enroll next year values: 0 = No, 1 = Unsure, 2 = Yes.
*$p < 0.10$.
**$p < 0.0$.
***$p < 0.01$.

enrollment (Jin et al., 2016; Menapace et al., 2016; Petrolia et al., 2013). The average marginal effect of being enrolled in PRF in a prior year is positive, though only statistically significant at the 1% level in the decision to enroll next year (model 3). Since re-enrollment in PRF is automatic until the producer elects to terminate (USDA RMA, 2019), it is not surprising that we find

TABLE 5 Average marginal effects of treatments on enrollment decisions

Variable	Purchase Yes (1)	Purchase yes × Send summary (2)	Enroll next year (3) $P(Y=0)$	$P(Y=1)$	$P(Y=2)$
T1: Forage loss	0.14**	0.029	−0.067	0.022	0.045
T2: Prob of payment	0.068	0.046	−0.0099	0.0035	0.0064
Risk aversion	0.12	0.093	−0.21*	0.074*	0.13*
PRF Prior	0.13	0.083	−0.33***	−0.18**	0.52***
Familiar	0.016	0.049	−0.026	0.0093	0.017
Farm income category	0.033	0.03	−0.028	0.01	0.018
Fulltime	0.073	0.0023	−0.093	0.03	0.063
Other crop insurance: not enrolled	−0.29***	−0.082	0.063	−0.02	−0.044
Other Crop Insurance: yield or revenue	−0.32***	−0.086	0.024	−0.009	−0.015
Other livestock insurance	−0.16	−0.048	0.082	−0.034	−0.048
Other livestock programs	0.22**	0.2**	−0.058	0.018	0.04
Primary livestock: dairy	0.006	0.0053	0.11	−0.048	−0.061
Primary livestock: hay	0.085	0.21*	−0.18**	0.021	0.16*
Primary livestock: other	0.32***	0.17	0.19	−0.097	−0.092*
Production type: hay vs graze	−0.18***	−0.11	0.13**	−0.047**	−0.083**
Proportion livestock income	0.14*	0.14***	−0.25***	0.088***	0.16***
Proportion hay sold	−0.23**	−0.19*	0.29***	−0.1***	−0.19***
Rent	0.0088	0.12	0.041	−0.015	−0.026
Acres (in 1000s)	−0.022	−0.11	0.042	−0.015	−0.027
Experience	−0.0016	0.0011	0.0012	−0.00042	−0.00074

*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

a "loyalty effect" where participants are likely to continue once enrolled (Enjolras & Sentis, 2011; Uzea et al., 2014a, 2014b).

Results also show that familiarity with other livestock programs and higher exposure to risk of low rainfall (a higher proportion of farm income is sourced from hay or livestock production) increase the likelihood that a producer enrolls in PRF. Producers are less likely to enroll in PRF if hay production is in surplus and hence the operation has a lower need to insure forage as an input to livestock production. Producers are less likely to enroll hay acreage in PRF compared to pastureland, which may reflect a resistance to higher premiums on hay acreage. Other covariates associated with farm characteristics, that is, farm income category, whether the operation is full or part-time, the proportion of pasture and hay acreage that is rented, the total

TABLE 6 Sample selection regressions on percent allocated to growing-season months

Selection equation (Table 4 Probit Regressions of enrollment decisions on treatments and covariates)	Percentage in growing-season months: Purchase yes (1)	Percentage in growing-season months: Purchase yes × send summary (2)
T1: Forage loss	−5.018 (5.668)	−11.101 (7.203)
T2: Prob of payment	1.305 (5.537)	−7.760 (7.560)
Risk aversion	−13.942 (9.428)	−6.286 (14.210)
Production type: hay vs. graze	8.021 (5.667)	5.100 (5.760)
PRF Prior	−15.559** (7.791)	−19.827* (10.397)
Familiar	−0.266 (4.593)	6.270 (5.534)
Other crop insurance: not enrolled	−7.668 (10.481)	−16.918 (11.762)
Other crop insurance: yield or revenue	−16.028 (10.423)	−27.228** (12.771)
Other livestock insurance	−15.485** (6.852)	−10.600 (7.508)
Other livestock programs	6.085 (6.076)	0.271 (8.513)
Constant	76.267*** (10.525)	95.083*** (25.565)
Observations	253	253
Log likelihood	−818.032	−805.683
ρ	0.144 (0.444)	−0.327 (0.943)

*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

number of pasture/hay acreage, and the number of years of experience did not have any statistically significant impacts on the participant's decision to enroll.

In terms of the factors influencing the percentage allocation into growing-season intervals, the only statistically significant coefficients in Table 6 were those associated with prior PRF enrollment and being enrolled in other crop or livestock insurance products. Being enrolled in PRF in a prior year actually decreased the percentage allocated to the growing-season months, while similarly, being enrolled in other crop and livestock insurance decreased the percentage allocated to the growing-season months.

CONCLUSIONS AND POLICY IMPLICATIONS

PRF is one of few government-sponsored risk management options available to livestock and forage producers. Despite federal subsidization of premiums and widespread eligibility of pasture and hay land, enrollment in PRF remains low. Potential barriers to enrollment include a lack of awareness about the program or a feeling of "choice overload" due to the complexity of the program. Amidst the complexity of choices, producers tend to insure 2-month intervals that increase basis risk. This study investigates whether nudging producers toward a wide or narrow frame of reference offsets these barriers to enrollment and directs producers toward better risk management choices. We also offer insight on the determinants of PRF enrollment.

Our findings show informational nudges about potential forage loss had a weakly positive effect on the PRF enrollment decision, but no discernable effect on the percentage allocated into growing-season months. Framing PRF as a one-time investment has little to no effect on enrollment. The positive effect of the *forage loss* nudge on enrollment has many interesting implications for policymakers, extension educators, and crop insurance agents. First, if the goals are to increase enrollment in this program and provide better risk management for livestock producers, USDA RMA and Cooperative Extension educators should engage in campaigns to explain PRF while also engaging producers to recall when forage losses from rainfall are important on their operations. In fact, this is a suggestion provided in the recent review of PRF (Coble et al., 2020). In past years, USDA RMA has offered funds to support crop insurance education through the Risk Management Education Partnership Program and Crop Insurance Education in Targeted States Program. Our research suggests these information campaigns may increase enrollment in under-enrolled regions or programs, especially if educators encourage producers to think about the risk management benefits of crop insurance on their farm.

Anecdotal evidence suggests that crop insurance agents often present PRF in the narrow frame, highlighting potential payoffs. By contrast, our results show a wider frame may be more effective at incentivizing enrollment. So, why would agents market PRF using the *probability of payment* strategy when focusing on risk management would result in higher enrollment? The underlying incentives of PRF enrollment for crop insurance agents might encourage this strategy because crop insurance agencies can only compete through offering compensation to agents for enlisting policies with higher underwriting gains or offering commissions on total premiums collected. Enrolling producers interested in collecting an indemnity payment may be more profitable for the crop insurance agent and private insurance company than enrolling producers interested in the risk management aspects of the policy.

Our findings regarding the impacts of risk aversion, prior enrollment in PRF, and enrollment in other crop or livestock insurance products support a further investigation on the influence of crop insurance agents and their incentives. Of particular note is the finding that producers' likelihood of enrolling in PRF increases as risk aversion increases, which contradicts findings by Goodrich et al. (2020) who observed risk-increasing behavior in PRF participation patterns. Similarly, we find that prior enrollment decreases the percentage of value placed in growing-season intervals and suggests the influence of the crop insurance agents' *probability of payment* strategy. Enrollment in other FCIC programs also decreased the percentage of value placed in growing-season months, suggesting these producers are targeted or influenced by agents to consider these decisions from a narrow frame. More research should explore the influence of the crop insurance agent on PRF enrollment and policy decisions. Both crop insurance agent education and a change in agent incentives may be necessary to improve the effectiveness of PRF as a risk management tool.

As with any study, we acknowledge some experimental limitations. The participant faced multiple complex decisions while the nudge was displayed; thus, the weak impact may suggest that the nudge was simply insufficient to overcome choice overload. A better approach in future research may be to display an informational nudge on a standalone page, or to auto-populate suggested default allocations across the growing-season index intervals. Given our limited funding, a stated preference approach allowed us to conduct a preliminary investigation on nudges and PRF enrollment using real program data and an interface that simulates the actual decision-making process. However, a critical area for future research on behavioral nudges and risk management decisions would involve incentive-compatible experiments to mitigate hypothetical bias. Finally, the comparison between the *forage loss* and *probability of payment* nudges should be made with caution, since the former relies on self-reported data, whereas the latter is calculated using external data.

Despite its limitations, this study provides useful information to USDA RMA, Cooperative Extension educators, and crop insurance agents. A straightforward, but important, finding was that less than half of our participants were aware of PRF before participating in our experiment, highlighting the need for education programs to increase participation. Our experiment also provides evidence that educators could further increase enrollment in PRF by encouraging producers to reflect on the months when rainfall is important to avoid forage loss on their operations. Although we find weak effects of the nudges on enrollment, we recommend that future research explore the role of behavioral economics in crop insurance decisions.

Our findings and recommendations for future research reach further than PRF to the U.S. FCIP in general. We find that broadening producers' frame of reference through a reminder that crop insurance is a risk management tool as opposed to a one-time investment could increase enrollment. Our results show this is possible for PRF, but future research could apply this to other crops and perhaps test implications of the nudge or other behavioral mechanisms, such as default enrollment, alongside decreased premium subsidies. Rather than further subsidizing insurance, or redesigning insurance policies with narrow framing in mind as proposed by Dalhaus et al. (2020), our findings suggest policymakers may be able to leverage behavioral mechanisms or information campaigns to align participant decisions with program incentives at a much lower cost to taxpayers.

ACKNOWLEDGEMENTS

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 U.S. 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 Tom Sproul for feedback on the experiment and Jisang Yu for helpful critiques on an earlier draft of this article. We also thank participants in seminars at the University of California, Davis and the Center for Behavioral and Experimental Agri-Environmental Research (CBEAR) for useful suggestions. Finally, we thank the editor and two anonymous reviewers for their service.

ENDNOTES

[1] The video can be viewed at https://www.youtube.com/watch?reload=9&v=z_BLexYDAUY.

[2] To streamline the experimental design, participants were only offered the choice between 85% and 90% coverage levels. Actual PRF coverage levels range from 70% to 90% in 5% increments. In 2020, 85% and 90% coverage levels represented 89% and 83% of PRF policies and acreage, respectively (USDA RMA, 2020). We asked participants who chose not to enroll if they would have enrolled if lower coverage levels had been offered; 6.4% said they would have enrolled at a lower coverage level, 52.7% said maybe they would have enrolled at a lower coverage level, and 40.9% said they would not enroll at a lower coverage level.

[3] https://prodwebnlb.rma.usda.gov/apps/prf.

[4] A screenshot of the risk elicitation exercise can be found in the Figure S1.

[5] Ideally, the *forage loss* nudge would be externally calculated by analyzing historical rainfall and forage yields. However, forage yields are not readily available for all grids. In some cases, data are available in specific areas, for example, see Yu et al. (2019). County-level hay yields can be utilized from USDA NASS as done by Diersen

et al. (2015), although they are not available for all U.S. counties and, more importantly, might not precisely capture the rainfall-yield relationship within a specific grid.

[6] Two examples of insurance companies marketing PRF using this strategy are Redd Summit Advisors (https://www.youtube.com/watch?v=7zx0UrY2mTc) and Silveus Insurance Group (https://www.silveuscropins.com/pasture-rangeland-and-forage/). We have heard many additional anecdotal accounts of this type of marketing from PRF participants, crop insurance agents, and extension agents.

[7] An ex ante power analysis showed that a sample of 300 participants would detect an effect size of 0.1 on the percent-of-interval enrolled in the growing season at a desired statistical power of 0.80 with 95% confidence. Details can be found in the pre-analysis plan: https://doi.org/10.17605/OSF.IO/QY56K. The target sample was stratified by region, with a target of 150 farmers per farm show. Our sample in the northeast was hindered by unfavorable weather conditions resulting in a low turnout at the farm show. COVID-19 restrictions prevented us from pursuing follow-up recruitment in 2020.

[8] Base compensation was increased on the second day of data collection (from $10 to $20) to improve recruitment. We have no reason to believe that differences in base compensation affected participant decisions since enrollment was not incentive-compatible and risk elicitation payouts remained the same.

[9] Many participants likely had multiple parcels of pasture and hay acreage, sometimes even across grid and county lines. Thus, participants were first instructed to explore a policy related to their largest hay or pasture acreage. After each participant was done exploring the initial policy and asked to make a decision, they were asked if they would like to explore PRF options for another pasture or hay acreage. Seven individuals opted to explore and make a decision on more than one policy. In the analysis that follows, the data include only the first policy these seven participants explored.

[10] A summary of responses to each of the three enrollment decisions can be found in the Table S1.

[11] The production type (hay vs graze) is a choice in the PRF policy, and in our experiment, a producer chooses to explore insurance options for his/her hay and/or grazing land. Similarly, a participant's level of risk aversion (CRRA) could impact other policy decisions such as coverage level, which ultimately impacts premiums that the producer is offered. Because the production type and coverage level are chosen in addition to the decision to enroll, these variables potentially introduce endogeneity into regressions with $Purchase_i$ as a dependent variable. Regressions with $EnrollNext_i$ as the dependent variable should be free from this bias since the dependent variable does not pertain to a specific policy option. We ran models without the *Production Type* and *CRRA* variables and all coefficients were similar so the potential endogeneity does not seem to bias coefficient estimates.

[12] Figures S2 and S3 show how our sample compared in terms of gross farm sales with the census data.

[13] A summary of covariate balance, obtained from the *iebaltab* test in STATA, can be found in Table S2.

[14] Regression results and marginal treatment effects for models without covariates are presented in the Tables S3 and S4.

[15] ρ in Table 6 is the estimated correlation coefficient between the error terms of the outcome and selection equations; the lack of statistical significance of ρ suggests that ordinary least squares (OLS) estimates do not suffer from significant bias; however, this may be a result of small sample size. OLS regressions of the treatment effects on percentage of value placed in the growing season intervals are presented in Table S5.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.