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RESEARCH ARTICLE

Factors Affecting Enrollment in General Conservation Reserve Program: A Duration Analysis of Producers in Southern United States

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Abstract
Since the Conservation Reserve Program (CRP) was created in 1985, producers in the United States (US) have voluntarily enrolled their environmentally sensitive agricultural lands for conservation in exchange for an annual rental payment. However, enrollment in General CRP has been decreasing over time. This study used a discrete-time duration analysis model to examine factors influencing the length of time producers in the southeastern US ($n = 5000$) take to enroll in the General CRP. Younger producers enrolled relatively faster than their older counterparts. Furthermore, increased total land area, awareness about CRP, and positive perspectives on the sign-up ranking process reduced overall time to enrollment.

Keywords: discrete-time duration analysis; federal conservation program; sustainable agriculture; Southern United States

1. Introduction

The Federal government in the United States has been investing in conservation programs for more than a century to improve the flow of ecosystem services for the overall well-being of the nation (Jones, 2021). For instance, the 2018 Farm Bill allocated $29.5 billion over five years of mandatory funding for conservation on 13 different conservation programs (USDA, 2023b), including the Conservation Reserve Program (CRP). CRP is a voluntary land retirement program authorized by the Food Security Act of 1985 and reauthorized by the Agricultural Improvement Act of 2018. It remains the country's largest private land retirement program (USDA, 2024c). CRP is administered by the United States Department of Agriculture (USDA) Farm Service Agency (FSA). It pays a yearly rental payment for a contract period of 10–15 years in exchange for agricultural producers (both landowners and operators) voluntarily removing their environmentally sensitive lands from agricultural production and planting perennial species that improve environmental quality (USDA, 2024c). USDA has continuously supported CRP program since its initiation in 1985. The FSA spent about $1.8 billion in 2023 (USDA, 2024c) and plans to spend about $2.4 billion per year between 2023 and 2032 (Coppess et al., 2022).

Although CRP was initially designed to reduce soil erosion, later, it has broadened its focus on a wide range of environmental issues such as wildlife habitat, water quality, and air quality (Stubbs, 2019), and carbon sequestration (USDA, 2021c). Previous studies have found that CRP increased wildlife populations and enhanced habitat restoration (Adkins et al., 2019; Geaumont et al., 2017; Harryman et al., 2019; Sullins et al., 2018), reduced soil erosion and improved soil quality (Dale et al., 2014; Jobe et al., 2018), and increased soil carbon (Abraha et al., 2018, 2019; Johnson et al., 2016; Li et al., 2017). However, maintaining these environmental benefits depends on continued producers' voluntary enrollment in CRP.

Agricultural producers can enroll their environmentally sensitive lands in CRP through three signups: General, Continuous, and Grassland (USDA, 2024c). As of 2024, Grassland CRP is the most prevalent, enrolling 9.7 million acres of environmentally sensitive land, followed by Continuous CRP (8.4 million acres) and General CRP (7.8 million acres). In 2024, approximately 199,214 acres of environmentally sensitive lands were enrolled through General signup. As a result, General CRP now accounts for 30% of the total land (25.9 million acres) enrolled under CRP nationwide (USDA, 2024d). This study only focuses on General CRP, where producers submit their offers to enroll their environmentally sensitive lands and get selected based on their land's potential environmental benefits and costs on a competitive basis (Hellerstein, 2017; USDA, 2023a).

The FSA pays an annual rental payment as part of the CRP contract, covers up to 50% of the cost for establishing conservation practices, and provides a conservation plan for these practices (USDA, 2023a). CRP includes practices such as native and non-native perennial grass, softwood and hardwood tree, and wildlife habitat plantings under General CRP and field windbreaks, grassed waterways, filter strips, and riparian buffers under Continuous CRP (USDA, 2024b). Furthermore, General and Continuous signups allow non-emergency and emergency haying and grazing, while Grassland CRP allows haying and grazing as core parts of the program. However, General CRP and Continuous CRP imposes a 25% annual rental payment reduction for non-emergency grazing and haying unless used as a mid-term management technique (USDA, 2020b, 2021b).

Despite CRP's benefits and widespread promotion, overall enrollment in General CRP has declined over the years due to relatively high crop prices and limited re-enrollment opportunities by lowering the cap from 32 million acres to 24 million acres between 2013 and 2016 (Atkinson et al., 2011; Bigelow et al., 2020; Morefield et al., 2016; USDA, 2020a). The area under General CRP has declined by more than half from 17.9 million acres in 2015 to 7.8 million acres in 2024, whilst the area under Continuous CRP increased from 6.2 million acres to 8.4 million acres during the same period (USDA, 2015, 2024a). However, the area under Grassland CRP increased from 89,052 acres to 9.7 million acres in the same period (USDA, 2017, 2024a). The appeal may be attributed to the program's allowance for largely unrestricted grazing and haying practices while receiving an annual payment.

Given the declining trend in General CRP enrollment, a deeper understanding of the underlying drivers of enrollment becomes increasingly critical for successful design, implementation, and continuation. This is particularly pertinent, as only a few studies have explored the factors affecting agricultural producers' decisions to enroll in CRP. Cramton et al. (2021) found that excessively tight price bid caps negatively affect CRP enrollment and reduce the program's efficiency and cost-effectiveness. Additionally, a qualitative study by Wachenheim (2019) reported that positive attitudes and perceptions about conservation, participation in different conservation programs, and CRP specifically contribute to increased enrollment. Morrison and Hardy (2014) applied an institutional analysis and development framework. They discovered that the biophysical environment (less productive and environmentally sensitive land), behavioral norms (positive attitudes towards conservation and sustainability), and institutional rules (flexible regulations for choosing conservation practices and interagency cooperation) significantly contribute to the enrollment and implementation of CRP. Lambert and Sullivan (2006) reported that the percentage of land enrolled in CRP was negatively related to the presence of high-value crops and positively related to farm ownership and participation in other conservation programs. Barnes et al.

(2023) observed that intrinsic motivations to improve the beauty of the field and to increase the value of wildlife promoted landowners' intention to enroll in CRP. Thapa et al. (2024) noted that positive attitudes, subjective norms, and perceived behavior increase the likelihood of intention to enroll in CRP. Lim and Wachenheim (2022) conducted a discrete choice experiment and analyzed data using a mixed-ordered logit model. They observed that older and male producers were more willing to enroll in CRP than their younger and female counterparts. They also reported that higher rental payments and cost share, a mid-contract adjusted payment, and more flexible land use increased interest in enrollment in CRP. Brimlow (2008) utilized a two-sided Tobit model and estimated that lower land productivity in a land parcel increased the likelihood of CRP enrollment.

Although several studies have investigated factors affecting General CRP at a single point in time (e.g., either enrolled or not enrolled at the time of the survey) using cross-sectional survey data (Konyar and Osborn, 1990; Lim and Wachenheim, 2022; Thapa et al., 2024; Wachenheim et al., 2018), they assume that those producers who are currently not enrolled may remain non-enrollees forever. However, no study has considered factors that might influence the length of time the producer waits from first hearing about the program or the year in which a producer began managing/operating a farm until they enroll in General CRP. Because General CRP enrollment is typically a complex, multi-stage process (Hellerstein, 2017), it is critical to consider enrollment patterns over time (Dimara and Skuras, 2003; Feder and Umali, 1993; Konyar and Osborn, 1990). Therefore, to bridge this gap, we employed a discrete-time duration analysis approach to examine the factors influencing the time that transpired before an agricultural producer enrolled in General CRP, starting at either the initiation of CRP (in 1985) or the year in which a producer began managing/operating a farm – whichever is the latest. This model assumes that producers who are not currently enrolled may enroll in the future if they have conducive conditions to enroll in CRP. Thus, investigating the determinants of the duration of General CRP enrollment decision could help to illuminate barriers to participation and inform evidence-based and context-specific policies for accelerating participation in General CRP. Furthermore, this model helps evaluate the impact of CRP processes, such as the Sign-up ranking process, enrollment process, rules, etc., on the length of time taken to enroll in General CRP.

2. Materials and methods

2.1. General CRP

Enrollment in General CRP involves several steps (Figure 1). First, the FSA announces a specific application submission date, which usually occurs annually. Once the application period opens, producers submit an offer/bid for a particular parcel of their environmentally sensitive agricultural lands with a proposed conservation practice. Annual payment rates are capped by a parcel's soil rental rate (SRR). The SRR is calculated using parcel-specific soil productivity measures, county-level average estimates of non-irrigated cropland rental rates, and professional expertise of field office staff (Hellerstein, 2017). After submission, FSA ranks the submitted offers based on the Environmental Benefits Index (EBI), which considers wildlife habitat potential (10–100 points), water quality benefits (0–100 points), erosion reduction (0–100 points), post-CRP environmental benefits (0–50 points), air quality benefits (3–45 points) and annual payments (USDA, 2021a). The FSA then sets a threshold for EBI after the distribution of offers is known, to accept only those offers that meet or exceed the threshold. In addition, to be eligible for General CRP, the land must have a crop history (the land must have been planted to an agricultural commodity in four of the six crop years before the year of the most recent Farm Bill) or be expiring CRP acres. Furthermore, the land must have considerable erosion potential or be in a national or state CRP conservation priority area (USDA, 2024a). The number of acres enrolled is subject to both a National Cap

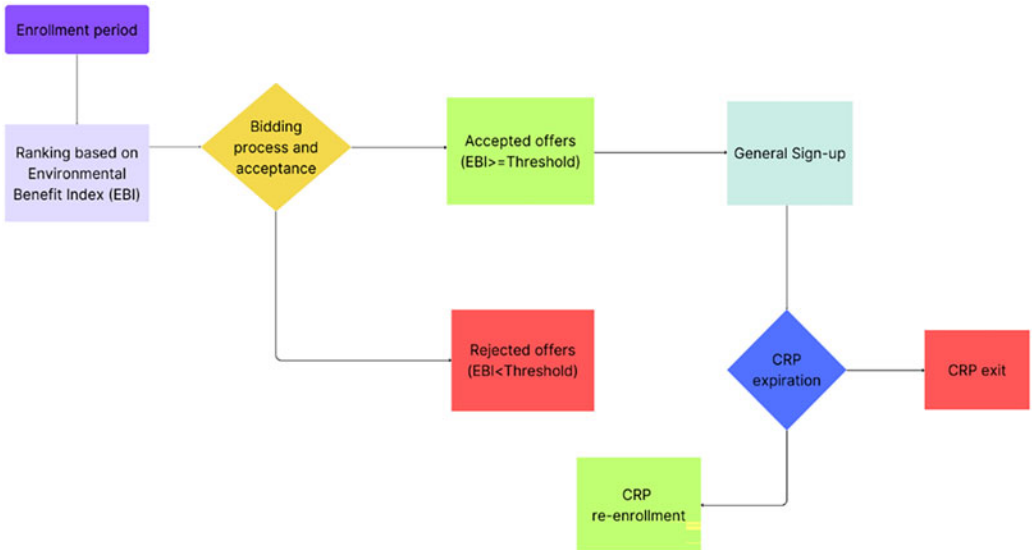

Figure 1. General Conservation Reserve Program enrollment procedure.

mandated by the most recent Farm Bill and a county limit of 25% cropland (Hellerstein, 2017). Finally, producers enroll their environmentally sensitive lands in General CRP for 10–15 years and, upon the contract expiration, either seek re-enrollment or exit the program.

2.2. Study area

Our survey population included agricultural producers in six southeastern states (Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina) either currently (as of 2023) or previously enrolled in the program (Figure 2). One reason for choosing this study area is the rapid pace of land-use change in the Southeast region as a result of economic and population growth and urban expansion (Napton et al., 2010; Zhao et al., 2013). Additionally, this region is significant from a conservation point of view. According the National Environment Education Foundation (2024), the Southeast includes one of the world's oldest and best-preserved freshwater systems. The United States Fish and Wildlife Service (2019) National Wetlands Inventory reported that stormwater runoff significantly contributes to water quality problems in North Carolina, and wetlands are the most essential filters of agricultural runoff in the coastal region. Moreover, the region is also a part of the North American Biodiversity Hotspot (Walls, 2014), and is, therefore, a critical target for conservation efforts. Finally, CRP enrollment fell roughly 50% between 2015 and 2023 to 752 thousand acres in the study area (2023c, USDA, 2015).

2.3. Sampling method and data collection

We used the USDA FSA administrative data as a sampling frame to select farmers enrolled in CRP (General and Continuous CRP). We followed a stratified random sampling strategy to select CRP participants from six southern states who were previously or currently enrolled in the CRP as of 2023. The survey was sent to a total of 5,000 randomly selected CRP participants; the percentage randomly selected from each state was chosen to be proportional to the percentage of CRP participants in each state from a total of six states (USDA, 2023c, 2023d). The Institutional Review Board (#00007239) approved the mail survey at the University of Georgia, and the mail packet

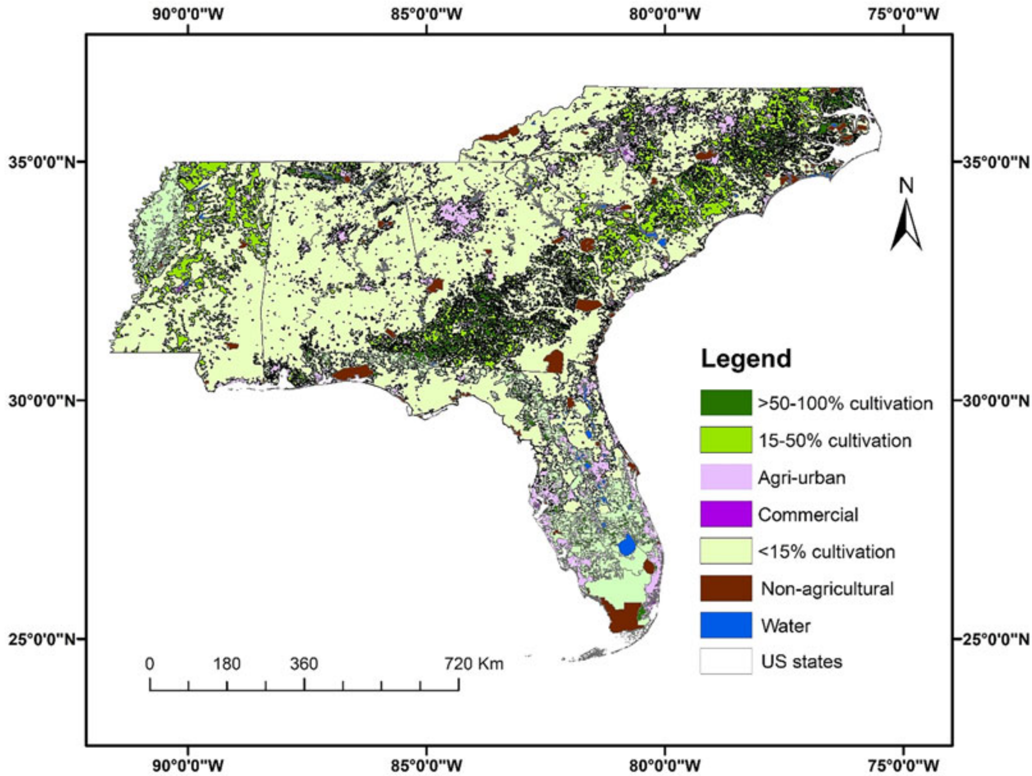

Figure 2. Land use map of the six southeastern states selected for the study (USDA, 2021d).

included a survey questionnaire and a pre-addressed stamped return envelope to return the completed questionnaire. The survey included questions related to socio-demographics (gender, age, educational status, annual income, employment status, etc.), farm characteristics (farm tenure, total owned and operated land, and distance of home from land), information regarding producers' awareness of, sentiments about, and participation in CRP.

2.4. Conceptual framework

Producers with eligible agricultural lands can choose to enroll in General CRP. According to the random utility theory, they anticipate the costs and direct and indirect benefits when deciding whether to enroll or not (Ochieng et al., 2022; Pham et al., 2022). A rational producer compares the expected utility received during the contract period (between 10 and 15 years after enrollment) with the expected utility received during the same period of non-enrollment. In complex and uncertain situations involving risk, attitudes and social norms can guide decision-making more effectively than relying solely on calculated expected utility. Regarding the benefits of non-enrollment in CRP, producers presumably continue to earn income from crop production or other land uses. Accordingly, under the random utility framework, the expected utility for the i^{th} producer in any enrollment year (t) from the enrollment in CRP can be represented as (π_{eit}), which is compared to the expected utility with non-enrollment (π_{neit}). The i^{th} producer will choose to participate in CRP in any given year (t) if the expected utility (benefit) from enrolling in CRP is greater than the utility (benefit) of not enrolling in CRP (Plantinga et al., 2001). The expected net utility (U_i^*) by the producer in any given enrollment year (r_t) can be represented as:

$$U_i^* = [\pi_{eit} - \pi_{neit}] > 0 \tag{1}$$

Enrollment in General CRP is a stepwise (i.e., multi-stage) and dynamic process (i.e., the enrollment process can change based on eligibility criteria, changes in program rules, changes in environmental priorities, etc.) affected by policy changes in which producers, based on their knowledge and experiences, form an attitude towards the program (i.e., expected net benefits, suitability with existing agricultural conditions, and CRP attributes) over time and then decide to enroll or not enroll at a particular time. However, the decision to enroll in General CRP also varies with individual producers, which might be related to their household socio-demographics, farm characteristics, perspectives on CRP enrollment process, and perceptions and attitudes. Furthermore, external factors such as agriculture and energy policies could also influence CRP enrollment. We used a discrete-time duration analysis model to examine the key determinants influencing how soon enrollment in General CRP occurs. This model assumes that producers who have higher expected returns from enrolling in General CRP enroll sooner. The early enrollees are less likely to be influenced by time-varying factors, as they have already committed to the program and are receiving its benefits.

2.5. Econometric model specification

Duration analysis deals with the simultaneous adoption and diffusion of practice or technology within a dynamic process that helps in identifying barriers to adoption and strategies to promote faster and more widespread diffusion (Alcon et al., 2011; Genius et al., 2013). More recently, duration analysis has been widely used in the adoption of happy seeder technology (Kaur et al., 2023), laser land leveler technology (Sheikh et al., 2022), conservation tillage (D'Emden et al., 2006; Gao et al., 2023), sustainable agricultural practices (Dadi et al., 2004; Yigezu et al., 2018), conservation agriculture (Khataza et al., 2018), and organic farming (Burton et al., 2003; Kallas et al., 2010). Our study used duration analysis to examine the factors influencing the length of a spell, i.e., the length of time taken to enroll in General CRP. The spell starts when CRP enrollment is initiated for the first time (in 1985) or the year in which the producer began managing/operating the farm, if that is later; the spell ends when a producer enrolls the farm in the General CRP. Producers who enrolled before the end of the survey are called uncensored producers. We only included uncensored producers because, due to our sample frame, our sample does not include those who have never participated in the program. In cross-sectional surveys, the researchers are dependent on recall data on the first enrollment date of General CRP or the year in which a producer began managing/operating the farm, if that is later; these dates are usually reported on grouped or interval-censored scales, such as months or years (An and Butler, 2012; Burton et al., 2003; Khataza et al., 2018). It is reasonable to apply a discrete-time duration analysis model over the continuous-time duration analysis approach for interval-censored (discrete time) data (Jenkins, 1995; Khataza et al., 2018; Tiller et al., 2010). Thus, we applied the discrete-time duration model, and the model specification for it is as follows (Jenkins, 1995; Khataza et al., 2018):

Let $'T'$ be a random variable, which represents the discrete-time ($T \geq 0$) before enrollment in General CRP (in years); $f(t)$ represents a continuous probability density function of a random variable (T), where $'t'$ is the time duration from initiation of General CRP or the year in which a producer began managing/operating the farm, if that is later, until enrollment in General CRP; $F(t)$ refers to the corresponding cumulative density function of a random variable (T) (describing the probability that a producer will have enrolled in General CRP before the time $'t'$), which is given by:

$$F(t) = \int_0^t f(s)\,\mathrm{d}s = \Pr\,(T \le t), \quad t \ge 0 \tag{2}$$

The survival function ($S(t)$) refers to the probability of surviving (i.e., not enrolling in General CRP) until time $'t'$, which can be expressed as:

$$S(t) = 1 - F(t) = \Pr\,(T > t) \tag{3}$$

The hazard function ($h(t)$) estimates the probability of enrolling in General CRP at the time $'t'$, given that the producer has not enrolled before the time $'t'$, which can be specified as follows.

$$h(t) = \lim_{\mathrm{d}t \to 0}\left[\frac{\Pr(t \le T < t + \mathrm{d}t | T \ge t)}{\mathrm{d}t}\right] = \lim_{\mathrm{d}t \to 0}\left[\frac{\mathrm{F(t + d}t) - \mathrm{F(t)}}{\mathrm{d}t(1 - F(t))}\right] = \frac{f(t)}{S(t)} \tag{4}$$

The hazard function depends on the elapsed time length and explanatory variables/covariates (e.g., household socio-demographics, farm characteristics, CRP attributes, institutional factors) on the time duration until enrollment. A proportional hazard specification examines the effects of both the baseline hazard and explanatory variables on a hazard function (Jenkins, 1995; Khataza et al., 2018). The baseline hazard function is only a function of time but not any covariates, and it is common for all producers, i.e., enrollment is associated with time only. In contrast, the relative hazard is contingent on explanatory variables or covariates, which vary with each producer (Yigezu et al., 2018). For the estimation of the proportional hazard model, parametric duration models (Weibull, exponential, logistic, log-normal, log-logistic, and Gompertz) were used for continuous-time duration data (Kiefer, 1988), while logistic and complementary log–log specifications were used for discrete-time duration data (Khataza et al., 2018). The generalized representation of the proportional hazard model is specified as follows:

$$h(t, X) = h_0(t)\exp(\beta' X) \tag{5}$$

where $h(t, X)$ is the hazard rate at the time $'t'$; $h_0(t)$ is the baseline hazard function, which depends on $'t'$ (but not on any covariates $'X'$); $\exp\,(\beta' X)$ is a producer-specific non-negative function of covariates $'X'$, which scales the baseline hazard function.

We used a complementary log–log specification for the proportional hazard model because it is the discrete-time equivalent of the continuous-time proportional hazard model (Bontemps et al., 2013; Jenkins, 1995; Khataza et al., 2018), which can be represented as follows:

$$\ln(-\ln[1 - h(t, X)]) = h_0(t)\exp[X(t)\beta + e_i] = \alpha\gamma_t + \beta' X + e_i \tag{6}$$

where $h(t, X)$ is the hazard rate for the t^{th} time interval; $h_0(t)$ is the baseline hazard function; γ_t is a time variable capturing the pattern of duration dependence (baseline hazard); α and β are the unknown parameters to be estimated; X is a vector of covariates; e_i is an error term representing producer-specific characteristics, unobserved variables (e.g., market conditions, policy changes, motivation, risk tolerance, life-events, etc.). All coefficients for the discrete-time duration analysis model are reported in terms of hazard ratios (HRs), which are reported in the exponential form ($e^{\beta'}$). The coefficient of HR (the null hypothesis of HR is not different from one) is interpreted as a proportional shift in the hazard function to a per unit change in the covariates (Beyene and Kassie, 2015). For instance, an HR of two for a particular covariate implies a doubling of the hazard rate with a one-unit increase in the covariate (Khataza et al., 2018). This model also assumes a higher hazard rate for early enrollees than for late enrollees in General CRP. In this complementary log–log model, explanatory variables or covariates can enter the model in two ways: time-invariant covariates (e.g., gender) enter as fixed predictors across all time intervals, while time-varying covariates (e.g., policy changes) are allowed to change at each discrete time point. These covariates influence the hazard or probability of the event (i.e., enrolling in General CRP) occurring at each time point, conditional on survival up to that point.

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2.6. Data and variable description

The dependent variable in our model is the time duration between the year 1985, when CRP was first initiated or the year a producer begins to manage/operate the farm, if that is later, until the moment the producer enrolls in General CRP. The explanatory variables in the model include socio-demographic factors (gender, age, employment status, annual income, educational status, and race), farm characteristics (farm tenure type and total area of owned and operated land), and awareness about CRP incentives and perspective with CRP attributes (sign-up ranking process, enrollment process (office and site visit), rules and regulations, grass establishment, and tree establishment). A description of all model variables appears in Table 1.

For the estimation of a discrete-time duration analysis model, the original data structure was reorganized from one producer with one observation format to one producer with multiple observation formats (Jenkins, 1995). In other words, a unique producer can have as many data rows of observations as the total number of time intervals (i.e., years) with a risk of the event (i.e., enrolling in CRP) occurring. A unique producer consists of data rows of zeros (since the inception of General CRP Sign-up in 1985 or the year in which the producer began managing/ operating the farm, if that is later) and is replaced with a value of 1 when the producer had enrolled in General CRP in time $t \leq T$. Reorganizing our data in this way also helps to incorporate time-varying variables in the model and easy estimation of log-likelihood for the model (Jenkins, 1995).

3. Results and discussion

3.1. Descriptive statistics

A total of 761 surveys were returned with a 15.2% response rate. Out of 761 producers, we used only the 416 observations reporting about the time duration (dependent variable) between the year 1985, when CRP was first initiated or the year a producer begins to manage/operate the farm, if that is later, and the moment the producer enrolls in General CRP. Therefore, we used these 416 observations of our dependent variable as the final dataset for our regression analysis because regression analysis only considers an equal number of observations of the dependent and independent variable samples. Descriptive statistics show that most producers (83.0%) were currently enrolled in General CRP, and the average duration from initiation until enrollment in the General CRP for all producers in our sample was seven years (Table 2). The average total land area owned by the sampled producers was about 475 acres, ranging from 4 to 9600 acres (Table 2).

In our sample, we noticed a cyclic rise and fall in General CRP enrollment due to the availability of signups, the acreage cap in each farm bill, the availability of funds, market prices of agricultural crops, and other related reasons (Figure 3).

Around 75.1% of producers were male, and 24.1% were female; among those producers, more than three-fourths (77.4%) were 65 years of age and above (Table 3). In our sample, nearly two-thirds (64.9%) of the producers retired, and roughly one-quarter (23.4%) of producers worked full-time (off-farm). More than 13.7% of the producers had an annual income between $25,000–$49,999, 20.1% had an annual income between $100,000–$199,999, and 21.3% of producers did not disclose their annual income. Around 33.7% of producers had bachelor's degrees, whilst 26.9% had graduate degrees. Around 71.7% of producers owned and operated agricultural land, while the rest only owned land. More than 90.0% of producers were white, while 2.5% were Black (as compared to 1.4% of the Black farmers in the region). Nearly two-thirds (63.5%) of producers had either a positive or very positive perspective on CRP signup ranking process (Table 4). Furthermore, more than three-fourths (77.2%) of producers had either positive or very positive perspectives on the General CRP enrollment process in terms of office and site visits for

Table 1. Description of dependent and explanatory variables used in the discrete-time duration analysis model

Variables	Description
Dependent variable	
Duration	The time length between CRP initiation year or the year the producers begin to manage/operate their farm – whichever is the latest – until the moment the producers enroll in the General CRP.
Explanatory variables	
Log (time)	The logarithm of time from the first initiation of General CRP to the end of the survey
Gender	Value 1, if a producer is female, 2 for male, and 0 for, prefers not to say
Age	Value 1 if the age of the producer is less than 45 years, 2 for 45–54 years, 3 for 55–64 years, 4 for 65–74 years, 5 for greater than 75 years, and 0 for prefers not to say
Employment status	Value 1 if the employment status of a producer is other, 2 for part-time, 3 for full-time, 4 for retired, and 0 for prefers not to say
Annual income	Value 1 if producer earns less than $25,000, 2 for $25,000–$49,000, 3 for $50,000–$99,000, 4 for $100,000–$199,999, 5 for more than $200,000, and 0 for prefers not to say
Educational status	Value 1, if the educational status of a producer is other, 2 for some school, 3 for high school, 4 for associate, 5 for trade school, 6 for bachelor, 7 for graduate, and 0 for, prefers not to say
Race	Value 1 if the race of the producer is other, 2 for Asian, 3 for Black, 4 for Native American, 5 for White, and 0 for prefers not to say
Farm tenure	Value 1 (Yes) if producers have both owned and operated agricultural land, 0 (No) for producers who have only owned agricultural land
Total land area*	Total area of owned lands in acres/100
CRP awareness**	Value 1 is a major challenge, 2 for a challenge, 3 for a moderate challenge, 4 for a slight challenge, and 5 for not a challenge
Sign-up ranking process	Value 1–very negative, 2–negative, 3–neutral, 4–positive, 5–very positive, and 0–not applicable
Enrollment process	Value 1–very negative, 2–negative, 3–neutral, 4–positive, 5–very positive, and 0–not applicable
Perception of rules and regulations	Value 1–very negative, 2–negative, 3–neutral, 4–positive, 5–very positive, and 0–not applicable
Perspective of grass establishment	Value 1–very negative, 2–negative, 3–neutral, 4–positive, 5–very positive, and 0–not applicable
Perspective of tree establishment	Value 1–very negative, 2–negative, 3–neutral, 4–positive, 5–very positive, and 0–not applicable

Note: *Total land area: We rescaled the total land area by dividing by 100. As the original variable's value decreases by 100, its original regression coefficient (0.00016) increases by 100 to balance this change in the original variable's value. However, we reported the hazard ratio in our study; it changes the original hazard ratio (1.00016) to a new hazard ratio (1.016) after rescaling.
**CRP awareness: CRP awareness means knowledge about CRP objectives, eligibility criteria for enrollment, knowledge of the application process for enrollment, knowledge of enrollment types, knowledge about program benefits.

enrollment. Forty percent of producers had a positive perception about CRP rules and regulations on conservation practices and maintenance, while nearly one-third (32.4%) reported a neutral perception. Around 40.0% of producers had a neutral perspective on grass establishment (i.e., the importance of grass establishment in land management and conservation without emphasizing its benefits or shortcomings), followed by 21.0% of producers who had a positive perspective (i.e., more awareness about the environmental and economic benefits from grass establishment). In comparison, more than two-thirds (70.9%) of producers had a positive or very positive

Table 2. Summary of producers currently and previously enrolled in CRP, time length until enrollment, and owned agricultural land

Variables	Observations	Mean	Std. dev.	Min	Max
CRP enrollment (yes = 1)	706	0.83	0.37	0	1
Duration (years)	416*	7.26	8.96	0	36
Total land area (acres)	716	4.75	8.23	0.04	96

Note: 1 ha = 2.47 acres; Total number of observations varies with each question answered by the producers. * In our sample, the number of observations for the duration is much smaller than the total number of observations because many producers did not indicate how long they owned the farm or when they first enrolled in CRP. As it is a recall method, they might be unable to recall the exact year when they first enrolled in CRP or began operating the farm. These observations represent the final dataset used for the discrete-time duration analysis model.

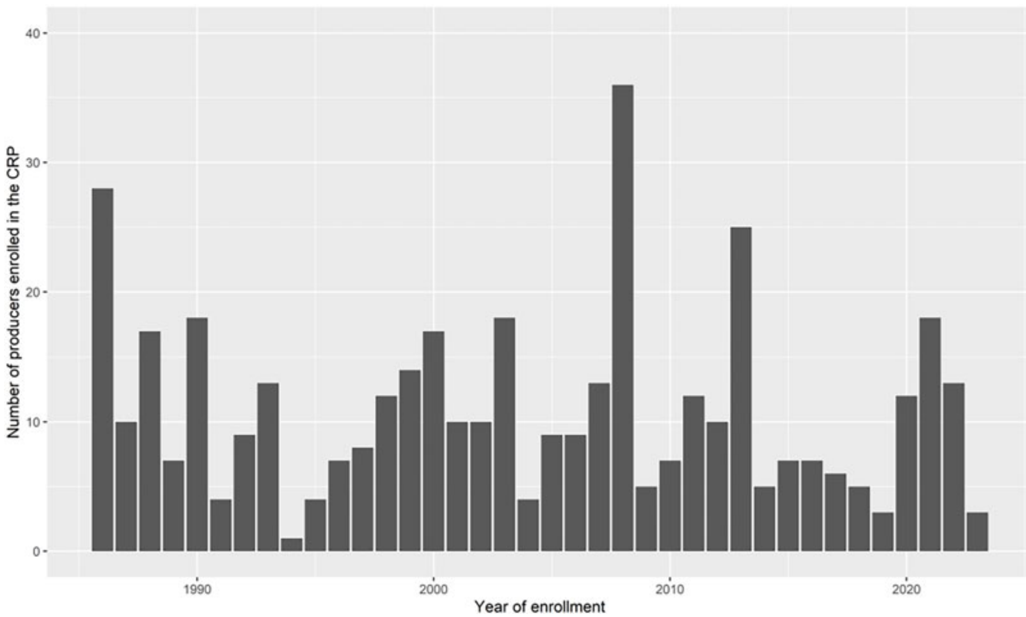

Figure 3. Number of agricultural producers enrolled in the Conservation Reserve Program General signup by year.

perspective on tree establishment (i.e., more awareness about the environmental and economic benefits of tree establishment) (Table 4). Around 7.0% of producers reported that CRP awareness is a major challenge, while 55.0% considered it not a challenge for enrollment in General CRP.

3.2. Regression results of discrete-time duration analysis

We have reorganized our data from one producer with one observation format to one producer with multiple observation formats. Specifically, each of the 416 producers can have up to 38 yearly observations from 1986 to 2023, totalling 15,808 observations. For example, if a producer enrolled in 1995, they receive a value of 0 for each year from 1986 to 1994, and a value of 1 in 1995. All subsequent years (1996–2023) are removed, resulting in 28 dropped observations. Similarly, a producer who enrolled in 2000 is assigned 0 from 1986 to 1999, and 1 in 2000. Observations from 2001 onward are removed, eliminating 23 observations for that producer. Following this approach across all the producers, we removed post-enrollment years, ultimately retaining 1,230 observations relevant for the analysis. Our complementary log–log model was estimated using

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Table 3. Descriptive statistics of southeastern US agricultural producers' socio-demographic attributes in CRP General Sign-up

Descriptive characteristics	Observations (*n*)	Percent (%)
Gender		
Female	173	24.1
Male	539	75.1
Prefer not to say	6	0.8
Total	718	100.0
Age		
< 45 years	16	2.2
45–54 years	25	3.5
55–64 years	109	15.2
65–74 years	250	34.9
75+ years	305	42.5
Prefer not to say	12	1.7
Total	717	100.0
Employment status		
Full-time	168	23.4
Part-time	60	8.4
Retired	465	64.8
Prefer not to say	9	1.3
Other	15	2.1
Total	717	100.0
Annual income		
<$25,000	23	3.3
$25,000–$49,999	97	13.7
$50,000–$99,999	193	27.3
$100,000–$199,999	142	20.1
$200,000+	101	14.3
Prefer not to say	150	21.3
Total	706	100.0
Educational status		
Some school	3	0.4
High School	135	18.9
Associate	52	7.3
Trade school	35	4.9
Bachelors	241	33.7
Graduate	192	26.8
Prefer not to say	22	3.1

(*Continued*)

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Table 3. (*Continued*)

Descriptive characteristics	Observations (*n*)	Percent (%)
Other	35	4.9
Total	715	100.0
Race		
Asian	1	0.2
Black	18	2.5
Native American	11	1.5
White	657	91.4
Other	7	0.9
Prefer not to say	25	3.5
Total	719	100.0
Farm tenure		
Yes	516	71.7
No	204	28.3
Total	605	100.0

Note: The total number of observations varies with each question answered by the producers.

Table 4. Descriptive summary of southeastern US agricultural producers' perspective on various aspects of CRP

CRP aspects	Not applicable	Very negative	Negative	Neutral	Positive	Very positive	Total
Sign-up ranking process	17 (2.9)	12 (2.0)	28 (4.7)	160 (26.9)	230 (38.7)	147 (24.8)	594 (100.0)
Enrollment process	14 (2.4)	8 (1.3)	18 (3.0)	96 (16.1)	256 (42.9)	205 (34.3)	597 (100.0)
Rules and regulations	4 (0.7)	14 (2.3)	34 (5.8)	191 (32.4)	237 (40.2)	110 (18.6)	590 (100.0)
Perspective of grass establishment	140 (24.9)	9 (1.6)	22 (3.9)	221 (39.3)	118 (21.0)	52 (9.3)	562 (100.0)
Perspective of tree establishment	32 (5.4)	10 (1.7)	15 (2.6)	115 (19.4)	257 (43.4)	163 (27.5)	592 (100.0)

Note: Numbers in parentheses represent the percentage; the total number of observations varies with each question answered by the producers.

maximum likelihood estimation using STATA 18. The discrete-time duration analysis showed that the baseline hazard (HR = 1.72) function rises with elapsed survival time. In other words, the likelihood that producers enroll their environmentally sensitive agricultural lands in CRP General signup increases over time, irrespective of their characteristics. This baseline hazard ratio is also influenced by the time producers owned or started operating a farm. Sheikh et al. (2022) have also observed that the baseline hazard function rises with elapsed survival time; that is, the adoption of the innovation (in their case, a laser land leveler) increased as time went by (i.e., years) at risk from the first introduction of the innovation. Figure 4 shows a cumulative enrollment over time. We found that more than half of the producers enrolled in General CRP Sign-up by 2005, and there was a sharp increase in General CRP enrollment in 2008 and 2013 (Figures 3 and 4).

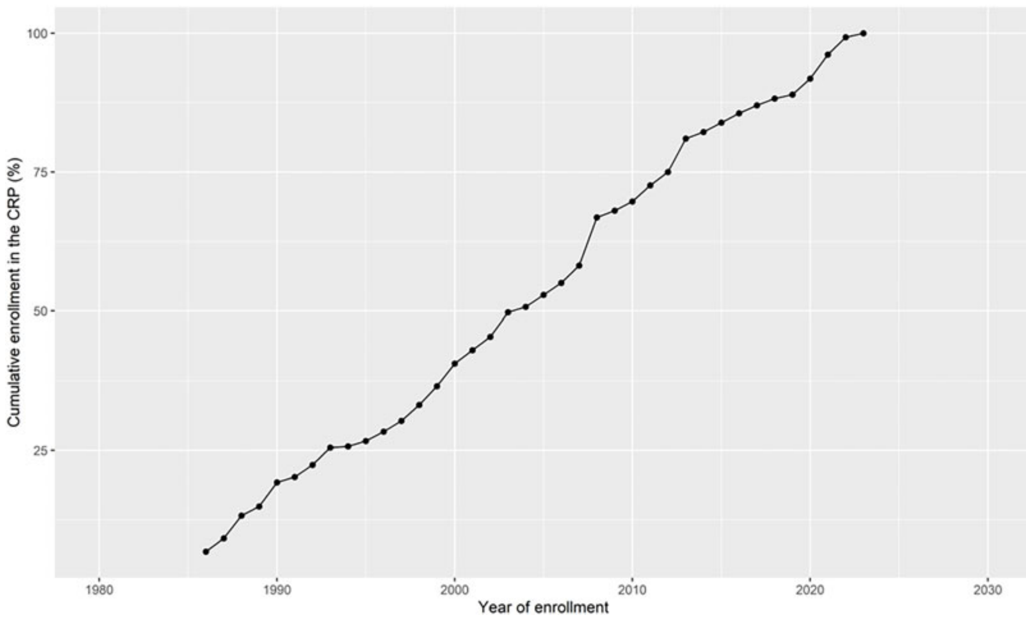

Figure 4. Cumulative enrollment in General CRP.

Younger producers enrolled their environmentally sensitive lands faster in General CRP than their older counterparts (Table 5). This may be because younger producers, particularly those recently attracted to the Sunbelt (Glaeser and Tobio, 2008), are more likely to adopt conservation programs as they see them as an opportunity for long-term benefits than older producers. Additionally, younger producers might be more financially constrained and risk-averse than older producers, and enrolling in CRP could provide a stable income for them, hence allowing them to enroll faster than older producers. Our finding corroborates those of Konyar and Osborn (1990), who reported that the older the producer, the lower the probability of participation in CRP. In contrast, Parks and Kramer (1995) and Wachenheim et al. (2018) noted that the likelihood of enrollment in CRP increased with age in the Prairie Pothole region of the country and across the nation. Similarly, Adhikari et al. (2022) and McLean-Meyinsse et al. (1994) also noted that older landowners are more willing to participate in CRP than their younger counterparts in Louisiana and across the United States.

The total land area owned by the producer (HR = 1.02) significantly reduced the length of time until enrollment in General CRP (Table 5). This may be because producers with more land can enroll some portion of the total land while still retaining enough in production to withstand yield risk. Similarly, Lambert et al. (2007) reported that operators of larger farms are more likely to enroll in CRP. In addition, Adhikari et al. (2022) indicated that landowners with relatively large cropland parcels were more satisfied with CRP than those who owned relatively smaller parcels across the United States and had a greater chance of enrolling in CRP. In contrast, Konyar and Osborn (1990) observed that the rate of participation in CRP by large farms was lower than that among smaller farms in the United States, while the effect is constrained by an annual adjusted gross income eligibility limitation (must be less than $900,000), the trend toward consolidation is increasing the average size of farms (Graddy, 2024).

Our findings reported that producers who were more familiar with CRP and faced fewer challenges (knowledge about the application process, enrollment types, and program benefits) enrolled faster (HR = 1.18) than producers who were unaware of CRP and had faced major challenges (Table 5). This finding aligns with Wachenheim (2019), who also indicated that awareness about CRP increases enrollment. Similarly, Esseks and Kraft (1988) found that

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Table 5. Complementary log–log model results predicting the length of time until enrollment in General CRP

Variables	Hazard ratio	Robust standard error
55–64 years	0.35***	0.13
65–74 years	0.27***	0.09
75+ years	0.33***	0.12
Farm tenure	1.12	0.26
Total land area	1.02*	0.01
CRP awareness	1.18**	0.09
CRP sign-up ranking	1.38**	0.18
CRP enrollment process	0.78	0.16
CRP rules and regulations	0.93	0.21
Perspective of grass establishment	1.01	0.13
Perspective of tree establishment	1.55**	0.20
Constant	0.01***	0.01
Observations	1,230	
Log pseudolikelihood	−445.43	

Note: The default categories for the independent variables in the model have been taken from the explanatory variables in Table 1. The default categories are the lowest values for the corresponding explanatory variables.
***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The null hypothesis is that the parameter = 1.

producers did not participate in the first four CRP signup periods due to being unaware of their eligibility, CRP payments, or the program's basic incentive structure. Collectively, these results suggest that raising awareness about CRP could lead to faster enrollment in General CRP. Furthermore, Adhikari et al. (2022) observed that an increase in the frequency of contact with federal agencies (i.e., more awareness) was associated with higher satisfaction with CRP across the United States and enrollment rates.

Positive perspectives regarding various aspects of CRP enrollment process, especially how offers are ranked and selected (HR = 1.38), accelerated enrollment in General CRP (Table 5). General CRP is a competitive program, and offers are ranked based on EBI scores. Positive perspectives may indicate a willingness to adjust scores to increase the likelihood of offer acceptance. Thus, providing more information on the ranking process and how producers can affect their EBI scores may accelerate enrollment. Vukina et al. (2008) also emphasized that combination of low bids and environmental scores of individual plots could increase EBI score and ultimately increased the chance of being selected in the submitted bidding for enrollment in CRP.

Our results showed that producers with a positive perception of rules and regulations in the CRP process (HR = 0.934) took slightly more time to enroll in General CRP compared to producers with a negative perception of rules and regulations (Table 5), although the estimate is not statistically significant. This finding may be because even with a positive perception of rules and regulations, producers might be more cautious due to uncertainties and risks concerning market conditions and policy changes and delay enrollment in General CRP.

Positive perspectives on tree establishment (HR = 1.55) increase the speed of enrollment in General CRP (Table 5). This result may be due to more familiarity with afforestation and the economic significance of tree production in this region than grass establishment. Tree establishment practices might also motivate producers to enroll in General CRP because

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conservation-oriented producers are more likely to be concerned about the various ecosystem services, such as fresh air and carbon sequestration from trees. However, various farmer groups have varying perspectives on ecosystem services (Teixeira et al., 2018). In addition, producers may plant trees because trees could symbolize their status and public recognition in societies (Barona et al., 2022). Producers could receive additional benefits from the tree harvest upon exiting General CRP or Continuous CRP at the end of the contract period. Moreover, Dale et al. (2014), Jobe et al. (2018), and Onianwa et al. (1999) indicated that tree establishment under CRP reduced soil erosion in Iowa and Missouri, the High Plains, and Alabama, which increased favorability and accelerated enrollment. Hence, these results suggest that positive perspectives of tree establishment could accelerate enrollment in General CRP. Increased support for pruning, thinning, and disease management could similarly speed up enrollment in General CRP. In contrast, the factors associated with CRP enrollment process and perspectives on grass establishment had minimal effects on the time until enrollment in General CRP.

We found farm tenure to have little effect on time until enrollment in General signup. Konyar and Osborn (1990) observed that non-operating owners are more likely to enroll their eligible acres in CRP than owner-operators because owner-operators are more concerned about short-term profit and production. Similarly, gender, education, income, employment status, and race of the producers were not statistically significant predictors of time to enrollment in General CRP. Hence, we did not include these variables in the final model. Lute et al. (2018) did not find significant demographic differences among the landowners on CRP enrollment. Our results showed that male and female producers displayed no significant difference in the length of time until enrollment in General CRP. However, Hitchner et al. (2024) and Lim and Wachenheim (2022) indicated that female producers enrolled less land overall than male producers across the southeastern United States and in the Prairie Pothole Region, respectively. For income, Plantinga et al. (2001) found that an increase in median household income decreased participation in CRP in nine states. Moreover, the effect of Black producers on the length of time until enrollment in General CRP was insignificant, possibly due to the limited number of Black producers in our sample.

4. Conclusion

CRP enables agricultural producers to voluntarily remove their environmentally sensitive land temporarily from production for a contract period of 10–15 years in exchange for a yearly rental payment and cost-share for conservation-focused management practices. Previous studies have demonstrated that financial incentives, such as an annual payment rental rate, are not the only motivator for enrollment decisions in CRP (Barnes et al., 2023; Lambert and Sullivan, 2006; Lim and Wachenheim, 2022). Instead, they emphasized that non-financial, producer-level factors, such as socio-demographic characteristics, farm attributes, awareness about CRP, attitudes, and perceptions of producers, are crucial to increasing enrollment in General CRP (Brimlow, 2008; Morrison and Hardy, 2014; Thapa et al., 2024). In our econometric investigation of the context-specific factors influencing the time length to enrollment in General CRP among producers in the Southern United States, we found that younger producers and producers with larger land area, awareness about CRP, positive perspective of the CRP signup ranking process, and positive perspectives on tree establishment accelerated the speed of enrollment. On the other hand, producers with positive perceptions of CRP rules and regulations were slower to enroll than those with negative perceptions of rules and regulations.

Considering these patterns, additional outreach and education could favorably impact enrollment in several ways. First, they could enhance conservation benefits by increasing producers' awareness of CRP and encouraging smaller landholding producers to enroll faster in General CRP. This might be done by providing more information about ways to increase EBI scores during the ranking process. To reduce the length of time until CRP enrollment, outreach and education efforts could also focus on easy and timely access to information on tree

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establishments, which were positively viewed by most producers. In addition, FSA could provide detailed instructions and guidelines to ensure producers can prepare their applications efficiently to enroll faster in General CRP. Overall, our findings suggest that helping producers better navigate the CRP enrollment process (signup ranking process and perception of tree establishment) can accelerate enrollment in General CRP, expediting private land conservation efforts to deliver significant environmental benefits.

Although our model offers new insights regarding barriers to CRP General enrollment, results require cautious interpretation due to several limitations. First, the response rate to this survey was relatively low, so the possibility of non-response bias cannot be entirely ruled out. Perhaps producers who did not respond to the survey have different feelings about CRP and the enrollment process. Second, we did not have enough responses from some demographic groups (e.g., Black producers) to draw significant conclusions about them. Third, we assumed that producers in our sample had access to information about General CRP when they started managing or operating the farm, but this may not be the case. Fourth, we have only considered the factors influencing the time taken from first initiation to enroll in General CRP, but not in Continuous CRP. Fifth, our sample data is based on a recall method and there is a presence of potential recall bias for the enrollment year in General CRP when no official General signups were available for certain years. Finally, our study only accounted for current and past participants in General CRP and did not include the perspectives of producers who had never enrolled in CRP (i.e., most producers in the Southern United States). Producers who did not enroll (and were therefore not included in our sample) may experience different perceived barriers and constraints than those who enrolled. If we include never-enrolled individuals in this model, then we could have different HRs and different empirical outcomes compared to what we have reported in this study. Understanding the factors that obstruct enrollment, not just those that delay it, would be a worthwhile direction for future research. Future studies on General CRP enrollment must include both censored (never enrolled) and uncensored (enrolled) producers to avoid sample selection bias.

Data availability. Data was made available upon request.

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