Risk and Risk Management in the Agricultural Economy: Introduction

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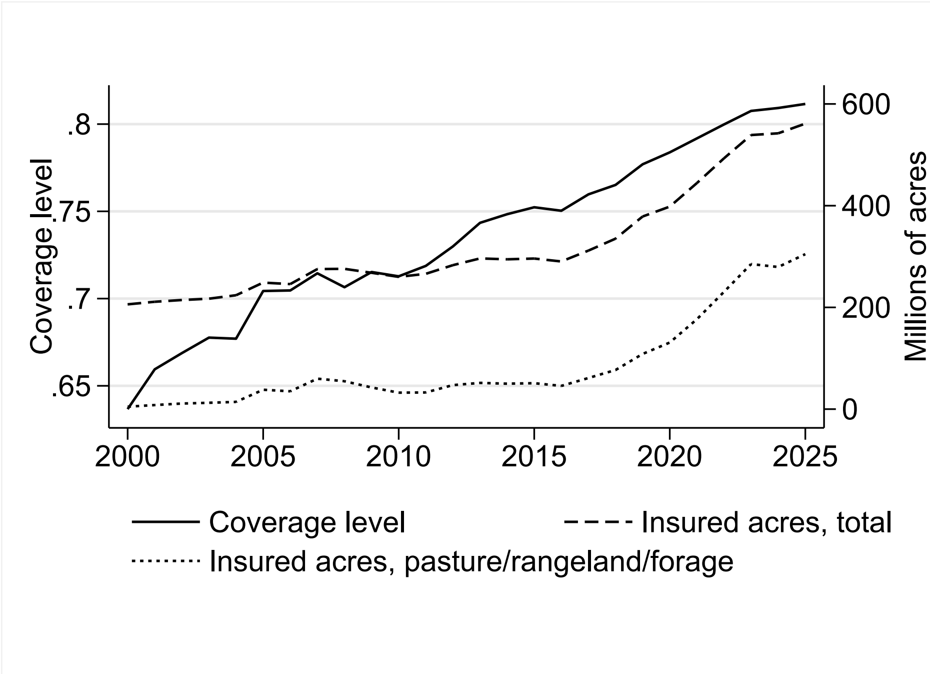
1 Background

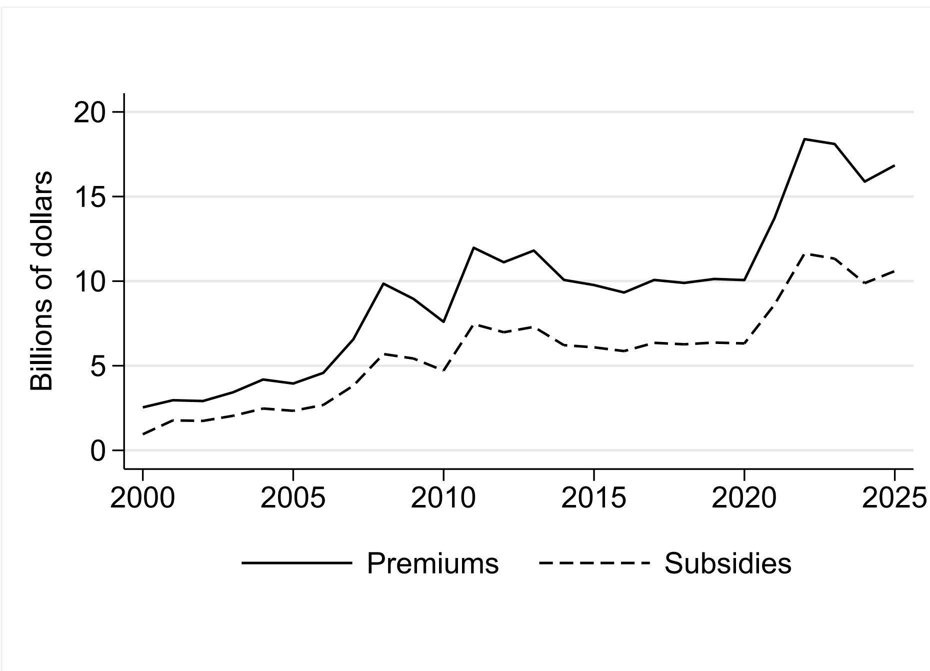
This volume contains six papers that were presented at the NBER Conference on Agricultural Risk on November 20-21, 2025. The papers examine agricultural risk through the lenses of insurance design, subsidy policy, and climate-driven changes in risk. A central theme is subsidized crop insurance. Two papers examine subsidy harvesting in livestock insurance. Two others analyze how crop insurance design can be improved through better modeling of yield risk and farmers' responses to embedded incentives. A fifth paper studies how climate change is reshaping agricultural risk and government outlays on crop insurance subsidies. The contributions of these and the sixth paper, which examines the design of policies to encourage adoption of conservation practices under uncertainty, are discussed in more detail below.

We begin by documenting crop insurance trends over the past 25 years in Figures 1a and 1b. In 2000–2025, both insurance scale (as measured by insured acres) and scope (as measured by average coverage levels) increased substantially. Insured acreage increased from roughly 206 million acres in 2000 to more than 560 million acres by 2025, with the pace of growth accelerating noticeably beginning in 2017. This sharp increase likely reflects rapid expansion in participation in pasture, rangeland, and forage insurance, which substantially increased total insured acreage. Average coverage levels rose from 64 percent to 81 percent over the same period.

Figure 1: Trends in U.S. crop insurance, 2000–2025



(a) Trends in acres insured and coverage levels



(b) Trends in crop insurance premiums and subsidies

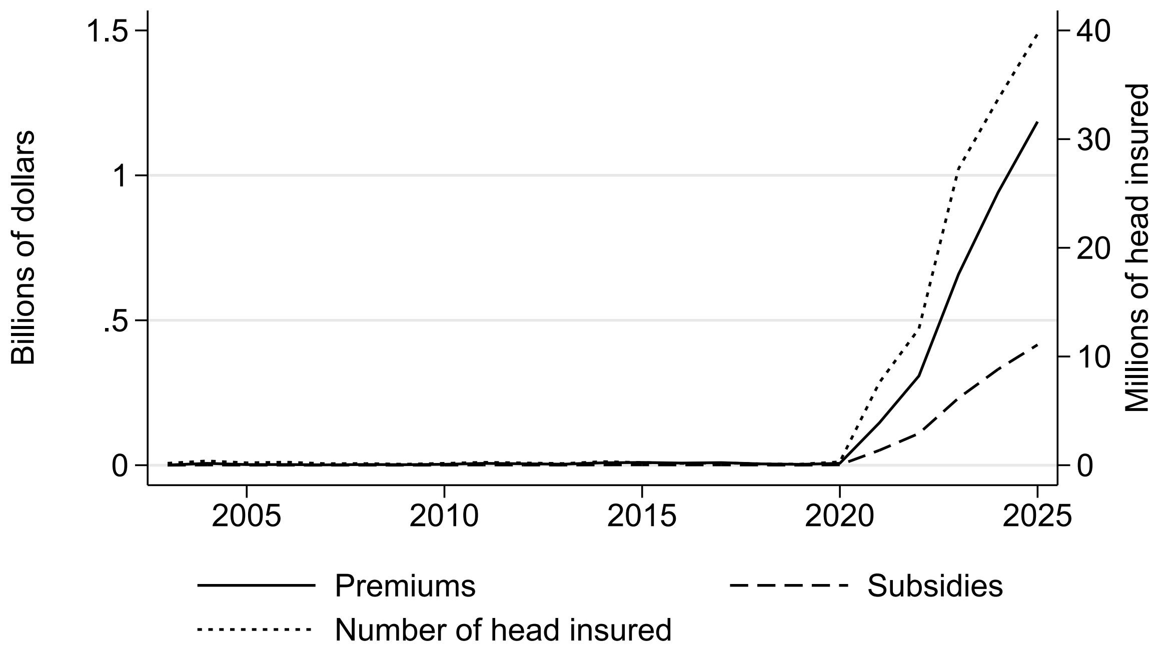
Notes: Panel (a) shows trends in average coverage level and total acres insured, both overall and for pasture, rangeland, and forage. Panel (b) shows trends in total crop insurance premiums and premium subsidies. Source: USDA Risk Management Agency Summary of Business data.

Figure 1b shows trends in total crop insurance premiums and premium subsidies. Consistent with patterns in Figure 1a, both premiums and subsidies have grown substantially: in nominal terms, premiums grew from about \$2.5 billion in 2000 to almost \$17 billion in 2025. Subsidies grew from \$0.65 billion to \$10.6 billion. With the exception of 2000, when the subsidy share was under 40 percent of premiums, the ratio of subsidies to total premiums has been fairly constant over this time period, ranging from 58 to 63 percent.

Figure 2 shows trends in the livestock risk protection (LRP) program participation and program scale from 2003 to 2025, measured by total premiums, premium subsidies, and the net number of head insured. The LRP program provides subsidized coverage of price risks for livestock commodities (cattle and swine). The insurance places a floor on the prices that producers receive for their cattle or swine. Premiums paid by producers for the coverage are heavily subsidized. The coverage essentially operates as a put option. If prices fall beneath a level of protection chosen by the producer, an indemnity payment is made.

For much of the period prior to 2021, participation was low and relatively stable. Total premiums remained below \$10 million annually, subsidies were correspondingly small, and the number of insured livestock head fluctuated at low levels, generally below 0.3 million head. Subsidy rates were also stable over this period, averaging about 13 percent of total premiums.

Figure 2: Trends in Livestock Risk Protection (LRP) participation and program scale, 2003–2025



Notes: The figure reports total premiums, premium subsidies, and the net number of head insured. Net number of head insured is defined as the number of livestock covered under LRP policies, adjusted for the producer's share in each endorsement. Source: USDA Risk Management Agency, Summary of Business data.

Beginning in 2021, the program experienced a sharp expansion along all dimensions. Total premiums increased by more than an order of magnitude between 2020 and 2021 and continued to grow rapidly thereafter, exceeding $1.1 billion by 2025. Premium subsidies rose in parallel, reaching over $400 million by 2025. At the same time, participation expanded dramatically: the number of insured livestock head increased from roughly 0.3 million in 2020 to over 7.6 million in 2021, and further to nearly 40 million by 2025.

This discrete shift coincides with a substantial increase in subsidy rates, which rose from roughly 13 percent prior to 2020 to approximately 35 percent thereafter. The combination of higher subsidy rates and increased participation drove a rapid expansion in program liabilities and fiscal exposure.

We next discuss how the papers in this volume contribute to our understanding of these important risk protection programs as well as of other dimensions of risk in agriculture.

2 Livestock Risk Protection (LRP) Program

Adjemian and Ramsey consider subsidy harvesting in the LRP program. Concerns have recently been raised that producers who choose to insure in the LRP program have an opportunity to arbitrage the coverage by taking offsetting positions in the options market. This activity has been termed "subsidy harvest" since producers may realize financial gains through the offsetting positions. As the authors note, since LRP works like a long put option, a producer can lock in a payoff equal to the value of the livestock under the LRP policy plus the subsidy, less transaction costs, and the opportunity cost of margin funds, by taking a LRP contract and writing an analogous put option. Alternatively, a producer can instead combine an LRP policy with a short call option to lock in the covered price today plus the subsidy, after transaction and margin costs. In both cases, producers essentially 'harvest' the subsidy associated with the subsidized insurance contract.

The authors note that subsidy harvesting can present several problems for the viability and operation of the program. Producers may assume additional risk, as subsidy harvest eliminates the downside protection intended by LRP. Subsidy harvesting may also limit upside gains to the current livestock price plus the subsidy, thereby reducing potential producer returns. Finally, they argue that subsidy harvesting may be an inefficient way to achieve risk protection due to the administrative and operating costs of the program. It is important to note that the LRP insurance provisions explicitly prohibit subsidy harvesting activities, although such a provision may be difficult to enforce.

The authors develop a theoretical model of livestock risk management under uncertainty in the presence of subsidized insurance for prices. Not surprisingly, their model predicts that subsidized insurance dominates unhedged behavior and market put options alone. Based on risk tolerance and wealth objectives, producers may select between LRP alone and two types of subsidy harvests: one that insulates producers from risk and another that removes the protection offered by the insurance policy. They compare the theoretical performance of these strategies under a variety of assumptions and offer important considerations for the design of subsidized insurance on prices from derivatives markets.

Zhang et al. also consider subsidy harvesting in the livestock (LRP) insurance program. They use county-level LRP endorsement data matched to CME options trading data from 2020 to 2025 to examine whether insurance contracts appear to be clustered around options expiration dates. They find evidence of such clustering and suggest that the pattern of trades is consistent with subsidy harvesting, though the mere timing of trades does not present unambiguous evidence of such behavior. They consider whether this pattern suggests profitable subsidy capture opportunities by simulating returns to LRP and options positions under realized market conditions and realistic transactions costs. They find that the premium wedge between LRP and options markets to be observable ex ante. However, net gains from such arbitrage are commodity- and volatility-regime- specific in that the premium wedge is only observed in low-volatility conditions. They also find that such arbitrage activities have considerable down-side risk.

Their results suggest that producers can, in principle, pair LRP contracts with options to construct related positions. The authors conclude that the subsidy wedge is real and observable ex ante, but that it is not harvestable ex post once realized market conditions and transactions costs are recognized. Across commodities and coverage levels, positive gains appear only in favorable low-volatility cases and are small and coupled with worse lower-tail outcomes relative to holding LRP alone. Thus, their results support subsidy harvest in a theoretical sense, but once actual trading frictions are realized, suggest that such subsidy harvest opportunities may not be profitable.

3 Crop Insurance Program

Sears et al. consider nonparametric copula models that relate weather (extreme heat and precipitation shortfalls) to corn and soybean yields. Their copula models allow them to consider the entire distribution of crop yields and the relationship of the distribution to climate extremes. They focus on a region within the US that typically consists of nonirrigated production of corn and soybeans. They utilize county-level yields collected from the National Agricultural Statistics Service (NASS) for the 1950–2016 period. Their analysis offers an innovative approach to modeling crop yields in that the entire joint distribution is modeled simultaneously.

The use of yields dated from the 1950s may raise questions regarding the extent to which such historical yields reflect technological improvements that have characterized crops in recent years. The corn rootworm trait, for example, was introduced in 2003 and now characterizes most of the corn planted in areas with corn rootworm pressures. In a wider sense, genetically modified corn and soybeans now account for the vast majority of plantings. Genetic traits such as the rootworm trait have had an important impact on the resilience of crops to weather extremes. Root balls are much larger and are better able to take up moisture during periods of heat and drought stress. Yields from the 1950s may not provide a good representation of the risks likely to face crops in the future when climate change risks become especially pertinent. It also appears that yields may be considered in a logarthmic form, which may impose inappropriate skewness of the distribution of yields.

In short, the paper of Sears et al. represents an innovative and forward-looking approach to modeling the distribution of yields and climate variables. It has important implications for future models of climate change and offers a holistic distributional approach to modeling crop yields. Their analysis may also have important implications for the design of crop insurance contracts by providing a better understanding of how crop yields respond to weather extremes.

In "Unpriced Diversification in US Crop Insurance," Sylvia Klosin and Adam Solomon identify an incentive problem embedded in the FCIP's rating structure that takes on added importance as climate change intensifies spatially correlated losses. A core design choice in the FCIP is "unit structure": farmers can insure each field separately or aggregate all fields of a given crop into a single policy. The program applies a discount to aggregate policies, reflecting the mechanical fact that aggregation reduces expected payouts when field yields are imperfectly correlated. But the actuarial rationale for this discount depends on the degree of correlation among fields, and that correlation may be endogenous to farmers' own production decisions. Farmers holding aggregate policies have weaker incentives to diversify across field types, since gains on one field offset losses on another within the aggregate contract, raising within-farm yield correlation and eroding the actuarial basis for the discount. The current rating formula ignores this endogeneity.

Klosin and Solomon demonstrate how diversification could be priced directly in the context of wheat. Wheat comes in winter and spring varieties that serve as natural hedges against each other: harsh winters that damage winter wheat leave spring wheat unaffected. The authors propose two observable rating factors: the mixture of winter versus spring wheat planted, and the number of fields. Using county-level claims data from the USDA Risk Management Agency, they construct a proxy for within-farm yield correlation and estimate its relationship to winter-wheat-share concentration. The estimates confirm that counties with more concentrated plantings exhibit significantly higher within-farm yield correlation than counties with balanced winter-spring mixtures, with correlation rising by 3.5 to 11.8 percentage points as the planting mix moves from maximal (50–50) to minimal (100–0 or 0–100) diversity. Feeding these estimates into simulations calibrated to FCIP contracts, the authors find large gaps between the discount implied by their estimates and the discount used in the FCIP. For a four-field farm, moving from a maximally diversified winter-spring mixture to full concentration in one variety increases expected aggregate payouts from 65% to 81% of separate payouts—a 16 percentage-point swing that the current formula entirely ignores. Similarly, holding the winter-spring mixture fixed, a two-field farm has aggregate payouts that are 27 percentage points higher relative to separate than a ten-field farm.

The implication of the paper is clear: incorporating the crop mixture and the number of fields as rating factors into the RMA's premium-setting methodology would allow farmers to internalize the costs of their diversification decisions, reducing moral hazard and improving the program's fiscal performance.

In "The Rising Cost of U.S. Crop Insurance under Climate Change," Marguerite Obolensky asks how the FCIP's premium-subsidy outlays will change as climate change increases the frequency and severity of crop losses. This question is of direct fiscal relevance: in 2024, almost 90% of major field-crop acreage was enrolled in FCIP and fiscal outlays on premium subsidies totaled over $10 billion. To answer it, Obolensky deploys a dynamic structural model of crop allocation and insurance choice developed in a related paper. The model captures how climate change shifts the distribution of growing-season heat and precipitation, which both raises actuarially fair premiums and widens the yield-loss distribution. Importantly, the model also endogenizes two forms of producer responses to changes in the yield distribution and crop insurance premiums: farmers (1) adjust their insurance participation and contract choice and (2) reallocate land across crops or into fallow. These margins, in turn, alter the base of insured exposure on which subsidies are paid as well as equilibrium crop prices, both of which Obolensky also captures in her empirical analysis.

Obolensky applies the model to counties west of the 100th meridian growing corn, soybeans, and wheat and compares a stationary-climate baseline with a climate-change scenario based on moderate emissions (RCP4.5) projections. She finds that climate change raises federal spending on crop-insurance premium subsidies by about 10% on average over 2030–2050—roughly $365 million per year—with the increase reaching nearly 15 percent by the late 2040s. The effects are uneven across locations: county-level changes range from roughly −30% to +60%, with the largest increases concentrated in the Corn Belt where downside yield and revenue risk grows most sharply. To examine the underlying mechanisms, Obolensky uses a Shapley-value decomposition that attributes the total change in subsidy outlays to four factors: rising yield-loss risk, changes in insurance participation and contract selection, adjustments in land use, and premium growth driven by price feedbacks resulting from aggregate acreage changes. The results indicate that higher loss risk is the primary driver of increased spending, raising subsidy spending by almost 14%, holding other factors constant. Land-use adaptation meaningfully reduces fiscal exposure—farmers leave more land fallow or shift toward less risky crops—but it also reduces overall crop supply. The resulting increase in equilibrium prices raises insurance liability and premiums, offsetting some of the fiscal savings. As a result, adaptation has opposing effects on government costs: it reduces the amount of insured acreage while increasing the value of the coverage on the remaining exposure, thereby increasing subsidy outlays.

The contribution of this paper is to quantify how climate change affects government costs once producer responses and market adjustments are taken into account. By incorporating endogenous insurance and land-use decisions, the analysis shows that fiscal impacts depend not only on rising risk but also on how producers adapt and highlights the importance of accounting for behavioral and equilibrium responses when projecting future subsidy costs.

4 Risk in Agricultural Conservation

Finally, Khyati Malik's chapter, "Farmer Adoption and Payment Design Under Risk: Variability in Soil Carbon Sequestration Across Conservation Practices," examines how policies can incentivize adoption of conservation practices such as no-till and reduced tillage that increase soil organic carbon (SOC). Agricultural soils represent a major potential source of carbon mitigation, yet participation in carbon payment programs remains limited. Malik argues that one explanation lies in how uncertainty in SOC accumulation interacts with farmers' dynamic decision-making. Using an infinite-horizon dynamic optimization model formulated as a Markov decision process, the chapter estimates the carbon payments required to induce adoption when sequestration outcomes are uncertain.

The model incorporates key features of soil carbon dynamics, including nonlinear accumulation, saturation, and asymmetric release under conventional tillage. It is calibrated using simulations from the Environmental Policy Integrated Climate (EPIC) model, a widely used biophysical simulation model of crop growth, soil processes, and carbon dynamics, applied across multiple Midwestern watersheds and soil types. The results reveal substantial heterogeneity in both yields and sequestration. Required payments vary widely, from about \$8 to \$32 per ton of carbon, reflecting differences in soil characteristics and associated yield trade-offs.

The analysis highlights the role of variability in shaping practice choice. When SOC outcomes under no-till are sufficiently uncertain, farmers may switch to reduced tillage at intermediate carbon levels, trading off lower expected gains for more stable outcomes. The model also shows that intertemporal preferences matter: because conservation practices shift income into the future, farmers who place greater weight on consumption smoothing require higher payments to adopt them.

Taken together, these results suggest that heterogeneity, uncertainty, and dynamic incentives are central to understanding participation decisions and required payment levels in carbon programs.

5 Summary

The papers in this volume highlight how agricultural risk management is shaped by the interaction of policy design, producer behavior, and underlying sources of uncertainty. Across settings, a common theme is that outcomes depend not only on risk itself but also on how producers respond to incentives embedded in insurance programs and environmental policies. The research demonstrates that these behavioral responses, together with broader market adjustments, play a central role in determining program performance, participation, and fiscal exposure. By combining empirical evidence with structural and modeling approaches, the contributions in this volume provide a more complete understanding of how risk management tools operate in practice and the factors that influence their effectiveness.