

JOURNAL OF ASFMRA

NEWS

Photo Credit: Renee E. Hendrick – MAI, ARA, R/W-AC, California chapter



**American Society
of Farm Managers
& Rural Appraisers**

From the Editor's Desk



**MARIA A.
BOERNGEN,
PH.D.**

Chair, ASFMRA Editorial
Task Force and Editor,
Journal of ASFMRA

Dear ASFMRA members and professional colleagues,

On behalf of the American Society of Farm Managers and Rural Appraisers, I am pleased to present the 2026 issue of the *Journal of the ASFMRA*. These papers were selected following a rigorous peer-review process, and they cover a variety of relevant and timely topics, including farmland leases and valuation, crop insurance, appraisal education, and cattle markets, just to name a few. The authors represent both industry and academia, indicating that the journal is attracting a wide audience of stakeholders. The ASFMRA Editorial Task Force and I trust that you will enjoy reading these papers as much as we did.

Our inaugural photo contest was announced at the 2025 ASFMRA Annual Conference in Clearwater, Florida, and we were delighted to receive more than two dozen submissions, representing seven photographers across six states. The winning photo, taken by Renee Hendrick, is featured on the cover of this issue, but please don't miss the photo collage highlighting contest submissions and participants. We were extremely impressed by the high quality and professionalism represented by these images, and we are excited to bring these new features to this issue of the *Journal*.

Speaking of the Annual Conference, please be on the lookout for the *Journal* session at the 2026 ASFMRA Annual Conference, where a paper from this issue will be presented by its author. We will also feature a paper in the appraisers' Rapid Fire session, and we will recognize the 2026 Gold Quill Award winner for the most outstanding contribution to this year's *Journal*.

Thank you for your continued engagement with the *Journal of the ASFMRA*.

Maria A. Boerngen, Ph.D.

Chair, ASFMRA Editorial Task Force and Editor, *Journal of ASFMRA*

2026 PHOTO CONTEST ENTRANTS

Renaefrieden – CGA, Iowa chapter

Lori Leonard Reyman – IA

Ed Kiefer – AFM, ARA, retired, Illinois chapter

Cody White – Oklahoma chapter

Renee E. Hendrick – MAI, ARA, R/W-AC, California chapter

Casey Richards – Nebraska chapter

Shannon Champion – CAA, South Dakota chapter

Our inaugural cover photo contest opened at the 2025 ASFMR Annual Conference, and it closed on February 15 of this year. We were extremely impressed by the quality of the submissions, which are included in this photo collage. Thank you to our contest participants, whose work is truly outstanding!



Casey Richards, Nebraska chapter



Lori Leonard Reyman, IA



*Renee Hendrick —
MAI, ARA, R/W-AC,
California chapter*



*Shannon Champion — CAA,
South Dakota chapter*





Cody White, Oklahoma chapter



Ed Kiefer — AFM, ARA — retired, Illinois chapter



Renee Frieden — CGA, Iowa chapter

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By Christopher T. Bastian, Bree Thompson, Chian Jones Ritten, L. Steven Smutko, Vardges Hovhannisyan, and Amy M. Nagler

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By Savannah T. Jones and Kellie Curry Raper
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By Terry Wayne Griffin

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By Rabail Chandio, Mykel Taylor, Chrystal Thomas, and Wendong Zhang

The 2025 ASFMRA FutureEd Forum brought together university instructors, ASFMRA chapter leaders, and practitioners to examine how farm and rural property appraisal is taught across U.S. colleges. Using instructor surveys, forum discussions, and case studies from three land-grant universities, this article documents the objectives, structure, and challenges of university-based appraisal instruction. These courses emphasize foundational appraisal concepts, including scope of work, ethics, highest and best use, and the income, cost, and sales comparison approaches, reinforced through project-based learning and strong support from local ASFMRA chapters. We highlight effective teaching practices and opportunities to strengthen collaboration between academia and the profession.

Factors Influencing the Adoption of Flexible Lease Arrangements in Iowa



By Jingyi Tong, Michael Bootsma, Wendong Zhang, and Wei Zhang

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Abstract

The number of cash lease agreements in Iowa has steadily increased over the past few decades, with fixed cash leases being the dominant form. However, flexible leases, particularly those tied to both crop price and yield, saw increased adoption post-2002 and have maintained a steady market share since 2012. Using the Iowa Farmland Ownership and Tenure Survey (2002-2022), this study explores factors correlating with the adoption of flexible lease arrangement. Findings indicate that flexible leases

are more prevalent in long-term, trust-based arrangements. Key factors include landowner age, farm visit frequency, and soil productivity, with variations observed based on landowners' operating status, ownership structure, and geographic location.

INTRODUCTION

The rising values of farmland and cash leases in Iowa have attracted national attention in recent years. In 2022, farmland in Iowa sold for a record \$30,000 per acre, with additional sales reaching \$29,000 per acre in 2024 (Bausch, 2024). According to the USDA, Iowa's farmland reached an all-time high average value of \$9,420 per acre in 2024, driving up cash leases to their highest level at \$276 per acre. This surge benefits landowners, but it poses challenges for farm tenants facing increased leasing costs, declining commodity prices, and rising farm operating loan interest rates (Chandio, 2024; Iowa Farm Bureau, 2022).

Previous studies indicate a continuing shift toward fixed cash lease agreements as the preferred method for leasing U.S. farmland (Paulson and Schnitkey, 2013; Bigelow, Allison, and Todd, 2016; Burns et al., 2018). Excluding farmland under custom farming arrangements and government conservation programs, the share of cash leased farmland in Iowa has steadily risen from 40% in 2002 to 56% in 2022, while crop share leasing has declined from 18% to 8% (Tong and Zhang, 2023). This shift aligns closely with the broader national trend, indicating a sustained preference for cash lease agreements over time. In 2022, 72% of leased farmland acres were leased under fixed cash lease agreements, while flexible cash lease agreements accounted for approximately 13% of leased acres (Tong and Zhang, 2023). Although fixed cash lease remains the dominant choice, flexible cash lease agreements have established themselves as a persistent alternative due to their ability to share risks and rewards between landowners and tenants (Figure 1).

Using the state-representative data from the Iowa Farmland Ownership and Tenure Survey, this study

examines the increasing trend of flexible cash leases in Iowa from 2002 to 2022. We analyze flexible cash lease use by crop price, yield, or both, identifying trends and regional patterns while exploring farmland and owner attributes that may increase the likelihood of parties choosing the flexible cash lease arrangement.

BACKGROUND

Flexible cash lease agreements have become an established alternative to traditional fixed cash lease agreements. Unlike the fixed cash lease, which imposes a predetermined rental rate per acre, flexible cash lease agreements adjust based on specific factors such as commodity prices, yields, or production costs (Plastina, Edwards, & Johanns, 2024). This flexibility allows both parties to share risks and rewards, making it an appealing option in volatile agricultural markets. For instance, the lease payment may be calculated as a percentage (typically 25%-40%) of the gross revenue generated per acre, with prices determined using futures contracts or local elevator prices and yields based on actual production or regional averages. Similarly, yield-based agreements may rely on local averages or actual yields measured through weigh tickets or precision agriculture tools. Some agreements combine both price and yield factors, ensuring a comprehensive reflection of farming outcomes.

Flexible cash lease agreements allow for risk-sharing by aligning rent with actual farm performance, providing tenants with downside protection during low-yield years while offering landowners upside potential during high-price or high-yield periods. They also incentivize landowners to stay informed about agricultural market conditions and field productivity. For tenants, these agreements offer a financial cushion during unfavorable market conditions, potentially improving their long-term sustainability (Schnitkey, 2015). By mitigating financial distress for tenants during downturns, these agreements promote long-term tenant solvency and reduce the likelihood of costly lease turnover for landowners. However, flexible cash lease agreements come with drawbacks. They can be complex to draft and require careful consideration of the price determinant variables. Landowners accustomed to fixed payments may find flexible arrangements challenging to manage, especially in short-term leases. Additionally, Iowa Code Section 562.6 stipulates automatic lease renewal unless terminated in writing by September 1, which could result in unintended lease extensions under unfavorable terms. Nevertheless, for landowners willing to navigate these complexities, flexible leases offer a mutual exchange: they benefit landowners by

ensuring tenant solvency and minimizing costly lease turnover, while also offering the potential for higher rental income in profitable years and keeping owners informed about their land productivity.

The reasons for the predominance of fixed cash lease contracts have been widely studied in the literature. First, sharecropping contracts offer weaker tenant incentives due to the inherent structure of risk and reward sharing (Marshall, 2013). Second, rising expected net returns per acre and decreasing relative variance of returns on cash leased land have further incentivized this contract choice (Allen and Lueck, 1999; Prendergast, 2002; Fukunaga and Huffman, 2009; Lee et al., 2023). Moreover, advancements in farm management practices, crop insurance systems, enforceable contracts, and USDA support programs have mitigated production and price risks, reducing the necessity for shared-risk arrangements such as crop share contracts (Styan, Boerngen, & Barrowclough, 2021).

Existing literature has extensively analyzed the risk-return trade-offs between flexible and fixed cash lease arrangements. Langemeier and Liu (2020) found that flexible cash leases are optimal for risk-neutral landowners seeking high returns, whereas risk-averse landowners tend to prefer fixed cash lease agreements. Edwards and Hart (2013) highlighted that fixed cash leases can become problematic for tenants during periods of market volatility, as the fixed obligation remains high even when revenue falls. Flexible leases help mitigate tenants' solvency risk by adjusting the rent based on actual outcomes. Their analysis showed that yield-based flexible leases transfer the least risk from tenant to landowners, whereas revenue-based leases shift the most. Hybrid leases, which incorporate both price and yield factors, then shift a moderate amount of risk.

Flexible leases offer a dual advantage, allowing landowners to benefit from higher rent revenue while safeguarding tenants during market downturns. However, empirical evidence quantifying the magnitude of these profitability differences remains limited. More recently, Lin (2024) revisited the topic, suggesting that crop-sharing leases minimize tenant risk, while flexible cash leases provide a balanced approach by mitigating risk and enhancing expected returns.

DATA AND MODEL

This study utilizes data from the Iowa Farmland Ownership and Tenure Survey, conducted every

five years via telephone as mandated by Iowa law. The survey uses a random areal sampling design, ensuring geographic representation across the state. Specifically, the 1988 baseline survey sampled 705 farmland parcels, employing proportional allocation within Iowa's seven crop-reporting regions. Each region was divided into sections, from which 40-acre units were randomly selected, creating a sample statistically representative of all farmland and owners in Iowa and allowing for robust generalizations about the land acres and population.

To address potential biases, particularly non-response bias, the survey incorporates sample weights. These weights adjust the estimates to match the totals reported in the Census of Agriculture, ensuring alignment with broader agricultural statistics. For instance, the acre weights in the 2022 survey were explicitly designed to adjust for non-response bias, ensuring that the weighted sum equaled the total land area in farms as reported in the 2022 Census¹. This adjustment enhances the accuracy and reliability of state- and district-level estimates derived from the survey.

For this study, we combine farmland ownership and tenure information from surveys conducted over 2002 to 2022. This results in a dataset of 3,691 observations, providing a longitudinal view of farmland ownership dynamics over 21 years. The data reflects significant changes in ownership patterns over time. A single farm may have one or multiple owners, and the composition of ownership often changes due to life events such as divorce, death, or intergenerational transfers. Over the years, some farms experienced a decrease in owners as a result of these events, while others saw ownership transferred to the next generation, usually younger family members.

To maintain consistency and avoid duplication in ownership records, we retained only the primary farmland owner in cases of multiple ownership. Table 1 presents the summary statistics for the variables of interest in this study. We focus on farms that have opted for flexible cash lease arrangements at least once over the past 21 years, which represents approximately 25% of the surveyed farms. These farms form the basis of our analysis.

To understand the likelihood of adopting flexible cash lease agreements, we include variables related to lease characteristics, landowner demographics, and farm-specific attributes. As an overview of the data and its characteristics, among all the leases, 38% of the arrangements are written contracts, while the remaining 62% are verbal agreements. When

examining the relationship between the tenant and landowner, 31% of landowners lease their farmland to relatives. The lease length for the farms who have leases ranges from 1 to 11 years, with an average duration of five years, providing insight into the stability and terms of these agreements².

Regarding landowner demographics, the ages of the surveyed landowners range from 25 to 97 years, with an average age of 67, reflecting the relatively senior age profile of farmland owners. Education levels vary, with 6% having less than a high school degree, 66% of landowners having a high school or post-high school degree, 28% holding a college or graduate degree.

To capture landowner engagement with their farmland, we define a variable, "rarely visiting site" that applies to landowners who visit their farms once or twice a year or not at all. This group constitutes 26% of the sample. Furthermore, 87% of the landowners are Iowa residents, indicating strong ties to the local agricultural community.

In addition to these variables, we include the corn suitability rating 2 (CSR2) to measure the productivity of the soil for each farm parcel. CSR2 is widely used in agricultural studies to assess soil quality and its potential impact on lease arrangements and land use decisions.

To investigate the factors influencing the adoption of a flexible cash lease, we employ a logistic regression model. This model estimates the likelihood of choosing the flexible cash lease as a function of the aforementioned attributes. We control the district fixed effect across Iowa's Crop Reporting Districts (CRDs) to make sure to make sure that regional differences, such as soil quality, climate conditions, and local market dynamics, do not confound the estimated relationships. The CRDs, established by the National Agricultural Statistics Service (NASS), are groupings of counties defined by geography, climate, and agricultural practices, including soil type, elevation, mean temperature, annual precipitation, and growing season length (NASS, 2018).

In logistic regression, the p-value represents the probability of observing the correlations while there was actually no real correlation in the population. A smaller p-value indicates stronger evidence against the null hypothesis, suggesting that the corresponding variable has a statistically significant relationship with the likelihood of adopting a flexible cash lease. We report significance at the 10%, 5%, and 1% levels, respectively. After removing missing values, 495

farmland owners were retained in the final sample for regression analysis.

RESULTS³

Figure 1 illustrates the shares of different cash lease types in Iowa over the years, focusing on the key categories relevant to this study: the fixed cash lease, and flexible cash leases based on crop price, crop yield, or both. Fixed cash lease experienced a decline from 2002 to 2012, after which its utilization remained stable. By 2022, it constituted 72% of all leased acres and 82% of the cash lease acres. Meanwhile, the share of flexible leases based on both crop price and yield increased from 2007 and plateaued after 2012, potentially reflecting landowners' preference for risk diversification by using multiple metrics to determine rent. In 2022, flexible lease agreements constituted approximately 13% of all leased acres and 18% of the cash lease acres.

Although the shares of flexible lease tied solely to crop yield or price remain relatively low (1% of cash lease acres were subject to formula based upon yield and 3% based upon price), notable trends emerge. Flexible leases based on crop price show a steady rise from 2007, peaking in 2017. This trend likely correlates with rising crop prices starting around 2005, driven by the implementation of the Renewable Fuel Standard (RFS), which increased demand for corn as a feedstock for ethanol production (Lark et al., 2022). The resulting surge in corn prices likely made crop price-based flexible leases more attractive.

The severe 2012 drought in the U.S. Midwest triggered a significant supply shock, leading to a sharp surge in crop prices that year. The peak in flexible price-based leases around 2017 may reflect a delayed response to these events, as landowners adjusted to evolving market conditions. Alternatively, it could indicate the stabilization of markets over time. The 2012 supply shock could have discouraged yield-based flexible leases due to heightened concerns over production variability during extreme weather events.

Figure 2 illustrates the average shares of fixed cash rent leases, flexible cash rent leases, and crop share leases across different categories of landowners. Building on the study by Bigelow, Allison, and Todd (2016), which examined lease type distribution based on landowners' operating status and ownership type at the national level using the 2014 Tenure, Ownership, and Transition of Agricultural Land (TOTAL) survey, we analyze similar patterns across Iowa over the 21 years.

First, we compare the leasing preferences of operating landowners (OLs), who actively farm at least part of their land, and non-operating landowners (NOLs), who lease out all their land without engaging in farming. OLs tend to favor cash leases—particularly a fixed cash rent lease—potentially due to its predictable income stream and lower administrative complexity. In contrast, NOLs are more inclined to adopt crop share agreements, which allow them to share in both the risks and rewards of agricultural production. This preference aligns with national patterns, where NOLs often choose crop share leases to mitigate market fluctuations while capitalizing on potential gains during high-yield or high-price years.

The divergence in rental preferences between OLs and NOLs reflects their differing levels of involvement and expertise in farming operations. OLs, being directly engaged in production, possess a deeper understanding of market conditions and production risks. This may allow them to manage their operations more efficiently without the need for shared-risk contracts. On the other hand, NOLs, who lack direct involvement in day-to-day operations, may view crop share leases to align their interests with those of their tenants, leveraging the tenant's expertise to maximize productivity while sharing financial outcomes.

Previous research suggests that tenants with multiple landowners are less likely to choose crop share agreements because managing shared responsibilities can be complicated, and it is often easier to secure land through straightforward cash bids (Fukunaga and Huffman, 2009; Harwood et al., 1999). Flexible cash lease agreements offer similar risk-sharing benefits to crop share agreements but give tenants more control over management and marketing, much like fixed cash leases (Paulson, 2012). However, these agreements tend to have more complex contract terms, requiring landowners to have a better understanding of the price determinants. Our results show that corporations, which often have multiple stakeholders and prioritize financial stability, seem to favor fixed cash lease agreements over flexible cash leases. This aligns with that larger ownership groups may be less willing to engage in flexible lease terms.

Figure 3a presents a national map illustrating the share of flexible cash leases relative to total fixed cash rent acres, based on data from the 2014 TOTAL survey (Bigelow, Allison, and Todd, 2016). On average, the Midwest region had approximately 10% of leased acres under flexible cash lease arrangements in 2014. Our survey data covering the period from 2002 to 2022 indicates that Iowa exhibits a relatively higher

share of flexible cash leases, averaging 15% within the Midwest.

Figure 3b presents the average share of acres subject to a flexible cash lease (including both crop yield- and price-based flexible lease) among cash leased acres across CRDs. The data shows that northeast, northwest, and central-east Iowa generally have a higher share of acres rented under flexible cash leases, the total acres exceeding 20%. In contrast, southern Iowa exhibits relatively lower shares. This variation may be partly attributed to differences in soil quality across Iowa, as northern and central regions have more fertile soil conducive to crop planting (Chandio, 2024). The higher crop yields in these regions likely make flexible cash lease more attractive to landowners seeking to share in the benefits of strong yields.

Interestingly, central-west Iowa has the lowest share of flexible cash leases, a trend that is not readily explained by soil quality alone. Other factors may contribute to this anomaly and warrant further investigation. We also acknowledge that our small sample size may not fully capture the actual cash lease conditions in this region.

Using our sample of 495 landowners, we compare the attributes of farmland acres for the groups of fixed and flexible cash leases in Table 2. Surprisingly, the arguably more complicated flexible cash lease arrangements are more likely to be verbal as compared to a fixed cash lease agreement. One might surmise that the flexible lease agreement, which contains a formula, would be more likely to be written. However, the fact that more flexible leases are verbal might be a logical conclusion since the leases are more likely to be entered with a relative as opposed to a fixed cash lease agreement.

Interesting results arise when relationships between the landowner and tenant are studied. Relatives are more likely to lease farmland from an owner under a flexible cash lease agreement as opposed to a neighbor or someone else. This result may arise because the owner is more likely to engage in risk sharing with a relative as opposed to others. However, it is noteworthy that the flexible cash lease also shows a higher share with tenants categorized as “someone else” compared to fixed cash lease, which may require further explanation as one might expect landowner to be more likely to contract with “someone else” under a fixed cash lease agreement. Based on these expectations, lease arrangements with relatives are likely to have longer durations. It is notable that the

flexible cash lease agreement would have a longer duration than the fixed cash lease agreement if the flexible cash lease agreement is a tool used to combat volatility. The answer may lie in the fact that relatives constituted a large share of the flexible lease population.

Age and education can be used as a proxy for farming experience and knowledge, which can influence lease preferences. Education as a category saw a higher level of college-educated landowners who were also older in age on average. Greater experience and education levels may make landowners more likely to opt for flexible cash lease, as they may feel more confident in predicting crop prices and yields to maximize potential benefits. Greater experience and education may also lead landowners to be more sympathetic toward the plight of the tenant. However, experienced landowners might also prefer simpler arrangements, such as a fixed cash lease, to avoid the complexities and risks associated with flexible cash lease. As a result, the relationship between age and flexible lease adoption remains ambiguous, and there is no clear expectation for this variable. The data tends to align with the former hypothesis: more educated landowners are more likely to adopt flexible leases.

Flexible cash lease ties payments to farm performance, creating an incentive for landowners to monitor operations more closely. Hence, one may assume that local residency can facilitate better tenant relationships and oversight, especially for those who value active engagement and the land's productivity. Contrary to the assumption that performance-based leases require more physical oversight, our data indicates that flexible cash lease arrangements are actually associated with lower frequencies of farm visits. From Table 2, 33.6% of landowners with flexible leases visit their property “never” or only “once or twice a year,” compared to 23.3% of those with fixed leases. This suggests that flexible leases allow landowners to substitute informational monitoring for physical presence. This may result in fewer farm visits and appeal to absentee owners who view farmland as an investment rather than a personal legacy. These owners often rely on tenants or technology, making proximity less necessary. However, the results do not portray much difference in state residency.

We expect the flexible cash lease to correlate with higher CSR2, which can be related to Figure 3. It may also correlate with higher average lease prices per acre in these districts. The lion's share of flexible lease

agreements is based upon a mixture of yield and price, the higher CSR2 is expected to a higher yield and increased revenue.

Table 3 presents the average marginal effects of each factor on the likelihood of choosing flexible cash leases from the logistic model, with the first column showing the results for the full sample. The regression results of all the coefficients can be found in Table A1 from the Appendix. The statistically significant correlations of verbal arrangements, longer lease durations, and an insignificant, but positive correlation, with the share of leasing to relatives with the likelihood of choosing flexible lease suggests that the flexible cash lease is more commonly used in settings requiring trust as well as in more stable, long-term leasing relationships.

Education shows a positive but statistically insignificant correlation with the choice of a flexible cash lease. However, the significantly positive correlation between age and flexible cash leases may suggest that more senior and experienced landowners are better equipped to manage the risks and complexities associated with flexible leasing arrangements, potentially due to their confidence in understanding crop prices, yields, and tenant relationships.

Our data confirms that landowners visiting the farmland less frequently are more likely to use flexible cash leases. Landowners may feel less compelled to monitor day-to-day activities through physical visits, instead relying on remote assessment of outcomes or trusting tenants to manage the land effectively. However, local residency often reflects long-term ties to the community, family heritage, or social connections, which are unnecessarily related to lease type. Even if landowners visit less, they may choose to stay nearby for personal reasons rather than farm management needs. In addition, soil productivity plays a significant role in the adoption of a flexible cash lease, with higher corn suitability rates associated with a higher likelihood of choosing this arrangement.

We also tested the model in the subsamples of OLs vs. NOLs. We have 79% of the owners actively operating their farmland. Among the OLs, 25% use flexible cash leases, while for NOLs, 24% adopt this type of lease arrangement. For OLs, the results align closely with the full sample, except for the frequency of visiting farmland. This finding is intuitive, as OLs tend to visit their land more frequently to oversee operations and ensure proper management.

In the case of NOLs, we do not observe a significant relationship between verbal contracts and the likelihood of choosing flexible cash leases. However, there is a stronger relationship between infrequent farmland visits and the probability of adopting flexible cash leases. This trend is driven by the hands-off approach of NOLs, who may prefer to rely on trusted tenants to manage operations. Moreover, the need for remote management among NOLs is often accompanied by more formal contract structures, as opposed to verbal agreements. In addition, NOLs who lease land to relatives and have a college education or higher are more likely to opt for flexible cash leases.

Following Figure 2, we further examine the differences between landowners with various ownership types. Sole ownership, joint tenancy, tenancy in common, partnership, and estates are categorized as traditional ownership. In contrast, corporations and trusts—entities with more complex ownership structures that often involve multiple stakeholders in decision-making—are classified as institutional ownership. We segment the sample into institutional farms and traditional farms, with institutional farms accounting for 27% of the total owners. Among institutional farms, 31% of the owners use a flexible cash lease, compared to 22% in traditional farms.

Landowners with traditional ownership exhibit attributes that closely align with those observed among OLs in relation to the likelihood of adopting a flexible cash lease. Conversely, institutional ownership does not show significant relationships with these attributes, except for the lease length and the corn suitability rating. This suggests that institutional owners represent a highly complex demographic that cannot simply be considered equivalent to NOLs. Their decision-making processes and motivations may differ substantially, necessitating further research to fully understand their unique characteristics and management preferences.

To further investigate the regional patterns influencing the probability of using flexible cash leases, we divide the sample into two main regions: the crop-intensive region, which includes northern and central Iowa (the first six CRDs), and the non-crop-intensive region, comprising southern Iowa (the last three CRDs)⁴. In the crop-intensive region, 20% of landowners use flexible leases, whereas in the non-crop-intensive region, this proportion is higher at 26%.

Key variables correlating with lease choices vary by region. In crop-intensive areas, lease length plays a

crucial role, likely reflecting a preference for long-term stability. In non-crop-intensive regions, verbal agreements and owners living in Iowa are more influential, potentially suggesting the importance of informal relationships and local presence.

CRD fixed effects further reveal regional patterns. Aligning with Figure 3, landowners in east central Iowa are less likely to use flexible cash leases compared to other districts. While OLs follow overall regional trends, NOLs in east central, south central, and southeast Iowa also exhibit a lower probability of using flexible cash leases. Landowners with traditional farms in northeast Iowa have a higher probability of using flexible cash leases, whereas those with institutional farms have a lower probability in west central, central, east central, and southeast Iowa. These results highlight the varying likelihood of flexible cash lease use across regions, suggesting that lease preferences can vary systematically across operating status, ownership type, and local conditions.

CONCLUSION

This study provides valuable insights into the evolving landscape of cash lease agreements in Iowa, with a particular focus on the adoption of flexible cash lease arrangements. Over the past two decades, the fixed cash lease has remained the dominant leasing type, though flexible cash lease—especially those incorporating both crop price and yield metrics—has gained traction in 2000s and preserved a steady portion after 2012. The findings suggest that flexible lease agreements appeal to landowners seeking to balance risk and reward, with their adoption associated with factors such as market volatility, production risks, and evolving landowner-tenant relationships.

The analysis highlights key differences in leasing preferences among different types of landowners. OLs, who are actively engaged in farming, predominantly utilize the fixed cash lease. This pattern is consistent with a preference for its predictable income and lower administrative complexity. NOLs, on the other hand, show a higher propensity for crop share leases and, to a lesser extent, flexible cash leases, aligning with their interest in shared financial outcomes without direct management involvement. Institutional ownership structures, such as corporations and trusts, demonstrate a greater inclination toward fixed cash lease agreements, likely due to their preference for financial stability and streamlined operations.

Various factors are associated with the likelihood of using flexible cash leases across different landowner

and farm groups. In general, senior landowners and those who prefer longer lease terms are more likely to use flexible cash leases. Verbal leases, compared to written agreements, are associated with a significantly higher probability of flexible cash lease use, except among NOLs and institutional farm owners. NOLs who lease to relatives, have a college degree or higher, and visit their farmland less frequently are more likely to use flexible cash leases. While professional farm management services could theoretically explain this reduced oversight, such services cover less than 5% of leased acres in Iowa (Tong and Zhang, 2023) and were not present in our sample⁵. Thus, this pattern is more likely to reflect a specific reliance on tenant integrity to manage production risks. Residency in Iowa is correlated with a higher adoption likelihood of the flexible cash lease in the non-crop-intensive region. Additionally, higher soil productivity, as measured by corn suitability ratings, is associated with a higher probability of using flexible cash leases, suggesting that landowners are more willing to share the benefits of higher yields.

Despite the increasing prevalence of flexible cash leases, its complexity compared to fixed cash lease arrangements poses challenges. While older and more experienced landowners may feel confident in managing the risks associated with flexible cash leases, the lack of formal agreements and longer leasing contacts in many cases may suggest that landowners rely on trust and longstanding relationships with tenants. The study's findings underscore the importance of considering landowner demographics, lease structures, and regional factors when assessing lease preferences and market dynamics.

While our results identify significant associations between landowner characteristics and lease choices, establishing direct causality requires further longitudinal data and econometric techniques. Therefore, while this study offers valuable insights, it remains unclear whether factors such as market volatility, rising production costs, increasing leases, and higher land values are the key drivers of the shift toward flexible cash lease agreements. Future research should examine how these external economic pressures interact with landowner preferences to drive the shift toward flexible arrangements.

Our findings offer actionable insights for multiple stakeholders. For landowners, this study helps them better understand the pros and cons of different types of contracts and offers a peer benchmark, showing the demographic profile of the landowners who opt for flexible cash lease. Encouraging flexible

leasing options could help landowners enhance risk management and financial resilience in an increasingly volatile agricultural sector. For policymakers and extension professionals, these results underscore the need for targeted decision-support tools that help landowners navigate the complexity of flexible leases. To facilitate this, we have compiled a summary of resources and decision tools in Table A2 (Appendix), offering practical guidance for lease structuring and net return analysis between alternative leases.

FOOTNOTES

- 1 Tong and Zhang (2023) include the details about the sampling design of the 2022 survey questionnaire. Surveys of other years follow the same weight construction.
- 2 This information is not reported in Table 1, since the descriptive statistics reported in the table includes the farms that did not lease land out.
- 3 The shares in Figure 1-3 are weighted by survey acre weights in each year, representing the statistics at the state level. The info in Table 1-3 are the results from the sample of 495 landowners and do not represent the state-level facts.
- 4 The division is according to the 2020 Iowa Agricultural Statistics from USDA 2020-Iowa-Annual-Bulletin.pdf. For the medium level of crop production in East Central Iowa, the results look similar if we categorize it to the non-crop-intensive region.
- 5 According to Tong and Zhang (2023), the proportion of landowners using farm managers is also very small. Among OLs, about 2% employed farm managers; among NOLs, about 6% employed farm managers.

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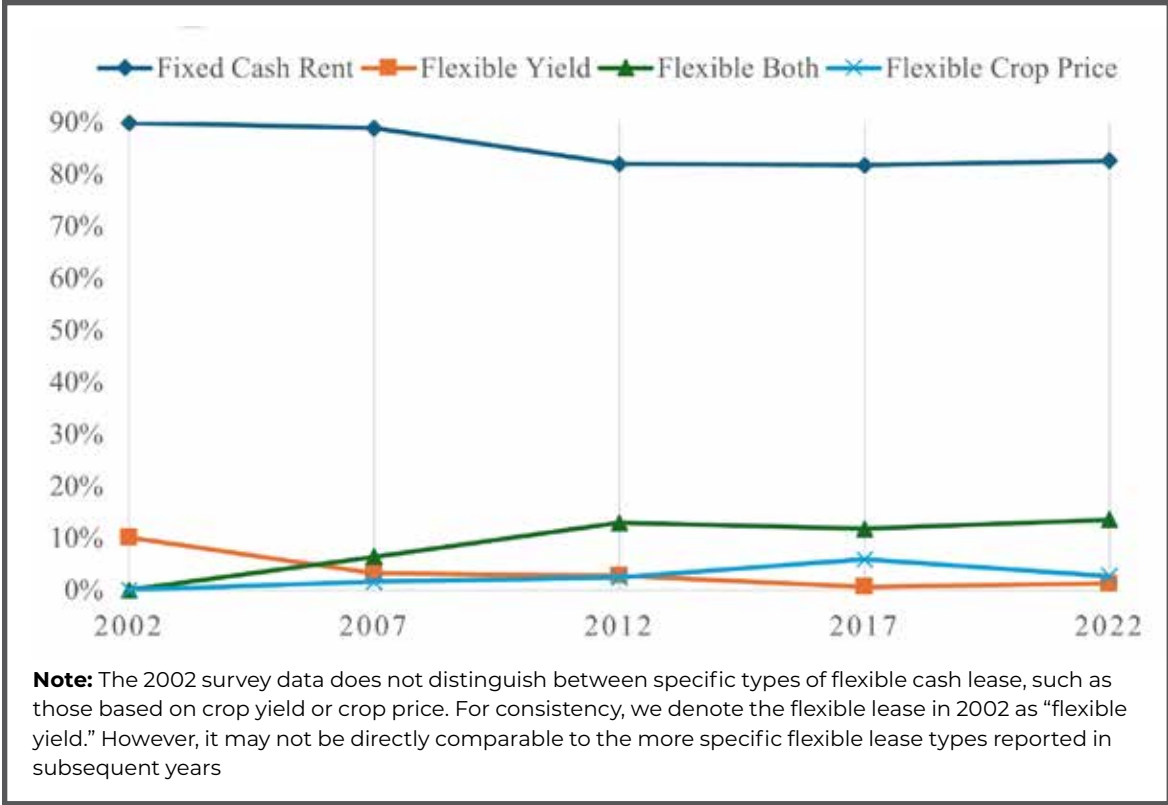


Figure 1. Share of Iowa farmland cash lease types from 2002 to 2022

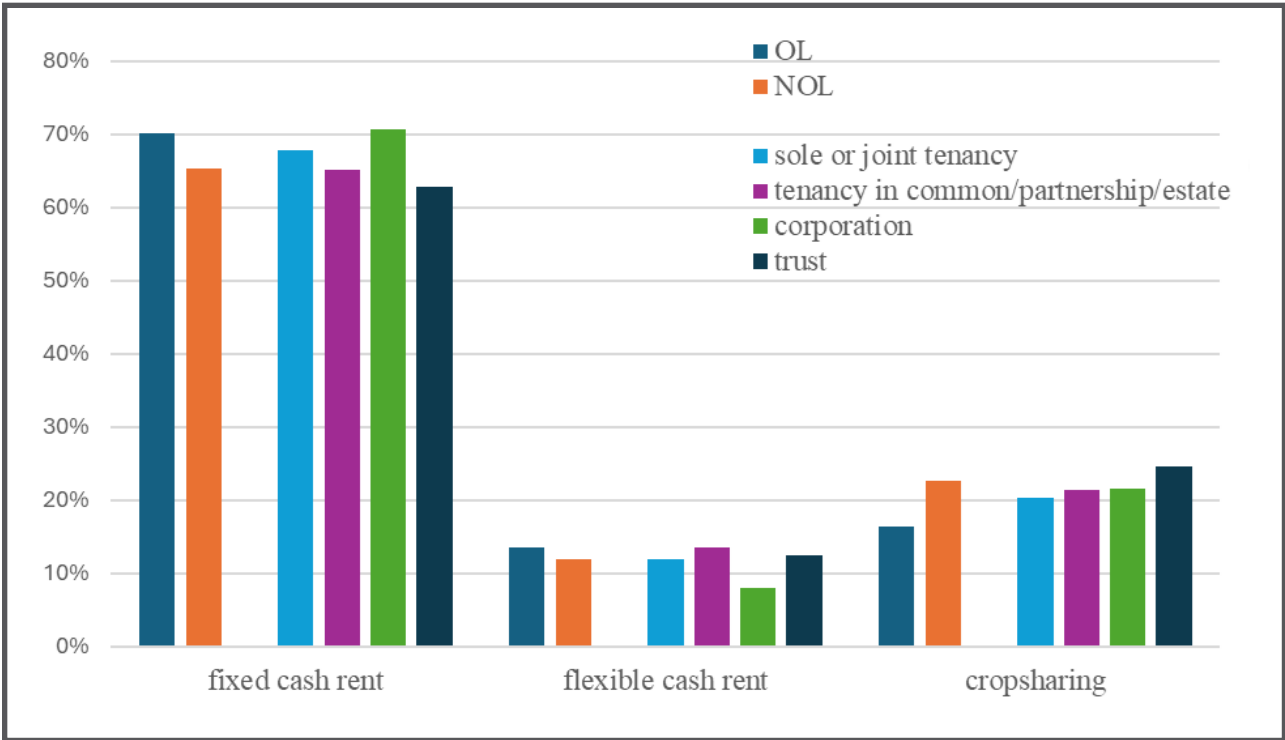


Figure 2. Average share of leasing types by operating status and by farmland ownership arrangements (2002-2022)

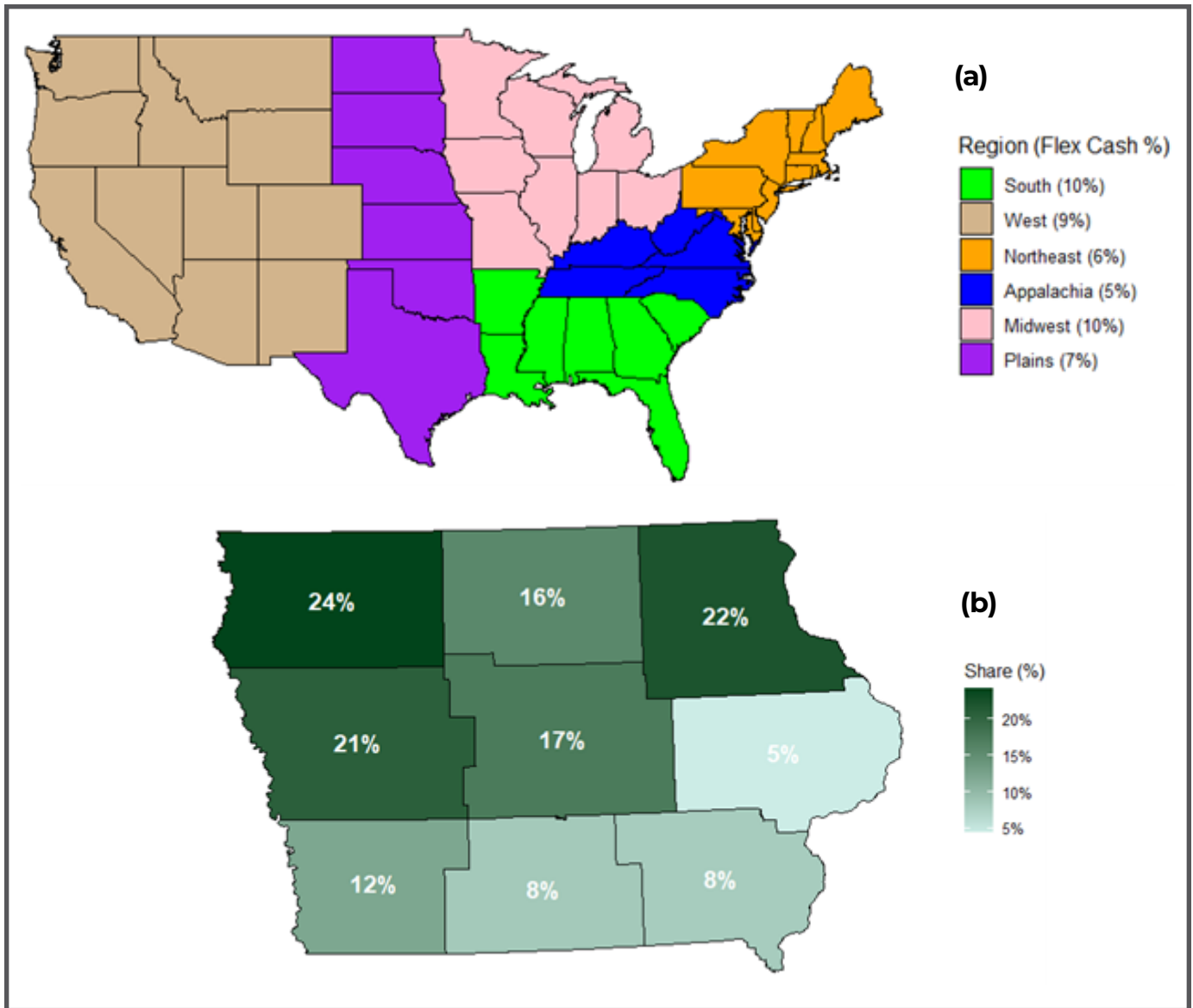


Figure 3. Average shares of flexible cash lease: (a) from 2014 TOTAL survey; (b) in each crop-reporting district of Iowa from 2002 to 2022

Table 1. Descriptive Statistics of Survey Sample (N = 495)

Variable	Description	Mean	Std Dev	Min	Max
Flexible Cash Lease	The share lease as flexible cash lease (flexible = 1, or else = 0)	0.25	0.43	0	1
Lease Characteristics					
Written Lease	The lease agreement is written (written = 1, verbal = 0)	0.38	0.49	0	1
Lease Length	The duration of the lease agreement	1.23	2.92	0	11
Lease to Relatives	The farmland is leased to relatives of landowners (relatives = 1, others = 0)	0.31	0.46	0	1
Landowner Characteristics					
Age	Years of age	67	14	25	97
Education	Educational level: college or above = 2	0.28	/	/	/
	Educational level: high school = 1	0.66	/	/	/
	Educational level: below high school = 0	0.06	/	/	/
Rarely Visiting Site	Frequency of landowners visiting the farmland: never or once or twice = 1, higher frequency = 0	0.26	0.44	0	1
Iowa Resident	Residency of landowners: live in Iowa = 1, other states = 0.	0.87	0.34	0	1
Land Quality					
Corn Suitability Rating	Corn suitability rating for each parcel site	67.96	19.30	11.60	98.00

Table 2. Shares of Farmland with Each Characteristic within Fixed vs. Flexible Cash Lease

	Fixed Cash Lease	Flexible Cash Lease
Lease Type		
Written Lease	62.5%	59.0%
Verbal Lease	37.5%	41.0%
Lease Length		
Average Years of Lease	1	1.8
Tenant Type		
Relatives	28.4%	37.7%
Friends or Neighbor	56.0%	37.7%
Someone Else	15.5%	24.6%
Age		
Average Age of Landowners	66.2	70.0
Education		
College or Above	27.3%	32.0%
High School	66.5%	63.1%
Below High School	6.2%	4.9%
Visiting Frequency		
Never	6.4%	8.2%
Once or Twice	16.9%	25.4%
Once a Month	25.7%	15.6%
Once a Week	18.2%	16.4%
Daily	32.7%	34.4%
Residency		
Live in Iowa	87.1%	86.9%
Other States	12.9%	13.1%
Soil Productivity		
Corn Suitability Rating	66.3	73.1

Table 3. Average Marginal Effects on the Probability of Adopting Flexible Cash Lease from the Logit Model

	Likelihood of Opting for Flexible Cash Lease						
	(1) Full sample	(2) OL	(3) NOL	(4) Traditional	(5) Institutional	(6) Crop-intensive	(7) Non-crop-intensive
Written Lease	-0.103** (0.044)	-0.111** (0.048)	0.121 (0.082)	-0.126*** (0.048)	0.023 (0.095)	-0.071 (0.052)	-0.178** (0.074)
Lease Length	0.018*** (0.006)	0.018** (0.007)	0.026*** (0.009)	0.020*** (0.007)	0.023* (0.014)	0.019*** (0.006)	0.003 (0.018)
Lease to Relatives	0.048 (0.042)	0.035 (0.047)	0.171* (0.094)	0.033 (0.046)	0.152 (0.095)	0.049 (0.049)	0.077 (0.078)
Age	0.004** (0.001)	0.003** (0.002)	0.005* (0.003)	0.004** (0.002)	0.002 (0.003)	0.003* (0.002)	0.004* (0.003)
College or Above Education	0.063 (0.043)	0.052 (0.052)	0.153** (0.077)	0.054 (0.053)	0.028 (0.081)	0.074 (0.051)	0.027 (0.079)
Rarely Visiting Site	0.102* (0.053)	0.035 (0.061)	0.287*** (0.088)	0.078 (0.065)	0.137 (0.089)	0.082 (0.063)	0.131 (0.093)
Iowa Resident	0.046 (0.059)	0.046 (0.077)	0.064 (0.076)	0.084 (0.067)	0.098 (0.099)	0.006 (0.075)	0.182*** (0.063)
Corn Suitability Rating 2	0.003*** (0.001)	0.003*** (0.001)	0.008** (0.003)	0.003** (0.001)	0.006** (0.002)	0.004*** (0.001)	0.004* (0.002)
District Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	495	389	106	360	135	372	123

Note: *: p-value < 0.10; **: p-value < 0.05; ***: p-value < 0.01

APPENDIX

Table A1. Regression Coefficients on the Probability of Adopting Flexible Cash Lease from the Logit Model

	Binary variable of opting for flexible cash lease						
	(1) Full Sample	(2) OL	(3) NOL	(4) Traditional	(5) Institutional	(6) Crop-intensive	(7) Non-crop-intensive
Written Lease	-0.607** (0.256)	-0.647** (0.285)	1.358 (1.107)	-0.808*** (0.309)	0.144 (0.590)	-0.405 (0.294)	-1.329** (0.610)
Lease Length	0.109*** (0.036)	0.104** (0.044)	0.253** (0.102)	0.131*** (0.044)	0.142 (0.089)	0.112*** (0.038)	0.024 (0.130)
Lease to Relatives	0.282 (0.243)	0.203 (0.268)	1.568* (0.890)	0.208 (0.291)	0.912 (0.580)	0.280 (0.278)	0.525 (0.517)
Age	0.022** (0.009)	0.020** (0.010)	0.051* (0.030)	0.026** (0.011)	0.010 (0.016)	0.019* (0.010)	0.032 (0.019)
College or Above Education	0.383 (0.263)	0.306 (0.304)	1.503* (0.805)	0.352 (0.348)	0.169 (0.499)	0.429 (0.302)	0.192 (0.572)
Rarely Visiting Site	0.584** (0.288)	0.198 (0.341)	2.379*** (0.777)	0.478 (0.380)	0.825 (0.544)	0.457 (0.338)	0.867 (0.583)
Iowa Resident	0.289 (0.396)	0.284 (0.498)	0.673 (0.873)	0.621 (0.567)	0.640 (0.697)	0.033 (0.444)	2.001* (1.212)
Corn Suitability Rating 2	0.021*** (0.007)	0.020*** (0.008)	0.077** (0.034)	0.017** (0.008)	0.035** (0.016)	0.021** (0.008)	0.028* (0.016)
Intercept	-4.908*** (0.918)	-4.574*** (1.041)	-13.748*** (4.205)	-5.712*** (1.176)	-4.626** (1.856)	-4.488*** (1.012)	-7.807*** (2.310)
District Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	495	389	106	360	135	372	123

Note: *: p-value < 0.10; **: p-value < 0.05; ***: p-value < 0.01

Table A2. Resources for Flexible Leases for Potential Stakeholders

Subject	Region	Source/Link
Comparison Between Different Types of Rental Arrangements		
Introduction to Fixed and Flexible Cash Rent Lease Agreements	Midwest	North Central Regional (NCR) Cooperative Extension Services
Introduction to Crop Share Rental Agreements	Midwest	North Central Regional (NCR) Cooperative Extension Services
Introduction and Comparison between Different Types of leases	California	University of California
Purdue Farmland Value and Cash Rent Survey	Indiana	Center for Commercial Agriculture from Purdue University
Introduction to Flexible Farm Lease Agreements and Rent Calculation Methods	Iowa	Ag Decision Maker from Iowa State University
Comparing Net Returns for Alternative Leasing Arrangements	Indiana	Farmdoc Daily from University of Illinois Urbana-Champaign
Some Useful Tools		
Interactive Decision Tool Spreadsheet to Analyze Flexible Farm Lease Agreements	Iowa	Ag Decision Maker from Iowa State University
Computations on Cash Rents and Net Returns for Comparison	Indiana	Center for Commercial Agriculture from Purdue University
Flex Cash Lease Calculator	Nebraska	Center for Agricultural Profitability from University of Nebraska–Lincoln
Cash Rent with Bonus Worksheet	Illinois	Farmdoc from University of Illinois Urbana-Champaign
Flexible Cash Lease Calculator	Ohio	OSU Extension from Ohio State University
Flexible Cash Lease Decision-Aid	Kentucky	University of Kentucky
Land Rent Calculator	Michigan	Michigan State University

Farm Program Selection Using a Risk Programming Approach



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Abstract

U.S. crop producers have historically managed risk by participating in federal price and income support programs. While early farm programs focused on reducing agricultural output, programs in the last two decades have become structured more like insurance. Calculating payments from current programs has become more involved and deciding which programs will best fit a producer's needs is, unfortunately, not always straightforward. The choice of which Title I farm program to enroll in is modeled as a quadratic integer programming problem. This framework is used to determine optimum program selection for representative upland cotton production in Hale County, Texas.

INTRODUCTION

Agricultural production is inherently risky. It requires the investment of capital and labor months before the output is produced and before the value of the product is known. Although the value of agricultural products may, on average, cover the cost of inputs, there are years when they do not. In the case of upland cotton, unprofitable outcomes are unfortunately common (Liu, 2024). For agricultural firms to continue, they must be able to invest in production, year after year, until long-term averages make the enterprise successful.

Historically, U.S. crop producers have managed risk in the near term by participating in federal price and income programs (Mercier and Halbrook, 2020). While early farm programs focused on reducing agricultural output, programs in the last two decades have become structured more like insurance. Calculating payments from the various programs has become more involved, and the decision of which programs will best fit a producer's needs is, unfortunately, not always straightforward. This paper provides some guidance on risk management in general and farm program selection in particular. It examines the choice faced by cotton producers in Hale County, Texas, a county that was chosen for several reasons: Texas is the nation's largest cotton producer (USDA, 2025), and in 2018, the Texas High Plains produced 66% of Texas cotton and 30% of U.S. cotton. In that year, Hale County produced more cotton than any other county in the U.S. (Plains Cotton Growers, 2025).

The Title I farm programs available to U.S. cotton producers are the result of a series of events involving the U.S., Brazil, and the World Trade Organization (WTO), which are detailed by Schnepf (2018). Under threat of WTO-sanctioned retaliation by Brazil, the U.S. made upland cotton ineligible to participate in the Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC) programs of the 2014 Farm Bill. Retaliation was avoided when both countries signed a memorandum of understanding that prevented the U.S. from subsidizing upland cotton except through 2014 farm bill programs such as the Stacked Income Protection Plan (STAX) and Marketing Assistance Loans.

In the years following the 2014 Farm Bill, the National Cotton Council lobbied for restored/increased federal support for U.S. cotton, owing to unfavorable market conditions. In addition to the hardships faced by the industry, brought about by unfavorable market conditions, the new system incentivized producers to grow commodities that still enjoyed government support. This industry lobbying contributed to an emergency supplemental bill H.R. 4667, which was passed in December 2017 and provided emergency assistance to producers of “seed cotton,” a heretofore nonexistent commodity comprising both lint and seed products. This legislation paved the way for the re-inclusion of cotton subsidies in the farm bill, and in 2018, seed cotton was included as a titled commodity and made eligible for enrollment in ARC and PLC.

As a result, there are a number of different support programs now available to cotton producers that can be partitioned into two main groups. The first group uses farm-level data to calculate payments while the second group does not. The first group also includes programs that rely both directly and indirectly on farm-level data to calculate payments. An example of a program that relies directly is ARC – Individual (ARC-I). An example of one that relies indirectly is the Supplemental Coverage Option (SCO). Payments for this option are calculated using county-wide data, but SCO must be accompanied by an insurance policy that calculates premiums and indemnities based on farm-level data.

The second group includes a set of programs that rely strictly on county-level data and is limited to PLC, the county level of ARC (ARC-CO), and STAX. This study will limit the choice set to programs in the second main group that do not rely on farm-level data. The limitation in scope is justified for several reasons, including that while inclusion of all available options would be more complete, it would transform this work into a case study, reducing its generality. From a practical policy perspective, the three options compared in this paper account for most of the cotton acres enrolled in Title I farm programs.

The programs under consideration were designed as risk management tools. In theoretical terms, they can be viewed as lotteries with non-negative returns, that is, farm program choices have risky, albeit mostly non-negative financial outcomes. From this perspective, the problem of program selection becomes similar to the stock portfolio selection problem, which is a more familiar research scenario.

As in choosing a stock portfolio, there is a tradeoff between risk and expected return when enrolling in

different farm programs. For instance, in this study, average PLC payments are significantly higher than average ARC payments. Unfortunately, the higher expected return of PLC is accompanied with a higher level of variance, making returns less certain. This study presents a framework for analyzing this tradeoff and shows how it relates to producer risk aversion.

LITERATURE REVIEW

The question of which stocks to include in an investment portfolio was addressed in a seminal paper by Markowitz (1952). His key insight was that investors do not choose a portfolio that maximizes the future value of discounted returns; instead, people are willing to forego some return in exchange for a reduction in risk. His model was able to account for the preference for diversification observed in actual portfolios.

Four years after Markowitz, Freund (1956) independently developed a multi-objective, quadratic programming model that incorporated the same insights as Markowitz. Freund’s model is expressed as:

$$(1) \quad \text{Max } \bar{C}'X - \theta X' S X$$

$$(2) \quad \text{s.t. } A'X \leq b$$

$$(3) \quad X \geq 0$$

where X is a vector of choice variables corresponding to the levels of stocks purchased, \bar{C} is a vector of expected returns on the stocks under consideration, A is a vector of stock prices, S is a variance-covariance matrix of the returns, B is the amount someone wants to invest in their portfolio, and θ is a parameter that captures risk aversion. We use this approach to model the subsidy selection problem and determine the optimal choice for a producer displaying the average level of risk aversion for cotton producers in Hale County, Texas.

There is a small amount of scholarly literature focusing on cotton policy selection, e.g., Graff et al. (2023) compared STAX and SCO to PLC and ARC-CO under different scenarios to demonstrate how different combinations of subsidy programs can be used to manage risk. Educational bulletins such as by the USDA Farm Services Agency (2018) are more typical of available publications.

There are various examples of stand-alone or online decision aids as well, and the simplest of these involve Microsoft Excel spreadsheets with formulas that allow

producers to enter production data and calculate static payments. Other tools, such as the one developed by the University of Illinois (2024), give the probability of payment and the expected payment amounts for different programs. Texas A&M University developed a tool that uses Monte Carlo simulation to derive the efficient frontier for the tradeoff between risk and expected payment for alternative farm management decisions (AFPC, 2024). None of these approaches involve optimization using linear or quadratic programming, though.

The purpose of this paper is to describe the implementation of an optimization framework that uses expected returns and the variance of those returns for making these types of decisions.

METHODS

The creation of the new farm program commodity—seed cotton—immediately raised the question of how to calculate its price. For the purposes of this study, it is important to also be able to calculate historic prices.

The market year average (MYA) price of seed cotton is a weighted average of the price of upland cotton lint and the price of cottonseed. More specifically, it is a weighted average of the revenue generated by upland cotton lint production and the revenue produced by cottonseed. If we define the gross value of lint production as:

$$(4) \text{ lint value} = U.S. \text{ upland cotton lint production} * U.S. \text{ upland cotton lint MYA price}$$

and

$$(5) \text{ cottonseed value} = U.S. \text{ cottonseed production} * U.S. \text{ cottonseed MYA price}$$

then the MYA price seed cotton can be calculated as:

$$(6) \text{ seed cotton MYA price} = \frac{(\text{lint value} + \text{cottonseed value})}{(U.S. \text{ upland lint production} + U.S. \text{ cottonseed production})}$$

With a price in hand, it is now possible to calculate subsidy payments. The analysis begins with PLC. Payments for this program depend critically on two parameters, the reference price and the price floor—for seed cotton, the reference price is set at \$0.367 per pound, and the price floor is set at \$0.25 per pound.

Calculating PLC payments requires three steps. First, one must derive the seed cotton payment yield, which is calculated as:

$$(7) \text{ seed cotton payment yield} = 2.4 * \text{lint yield}$$

Next, one calculates the PLC payment rate in dollars per pound:

$$(8) \text{ PLC payment rate} = \text{reference price} - \text{MAX}(\text{MYA price}, \text{price floor})$$

Finally, the PLC payment in dollars per base acre enrolled can be calculated as:

$$(9) \text{ PLC payment} = \text{PLC payment rate} * \text{payment yield} * 0.85$$

To calculate ARC-CO payments, it is first necessary to calculate the benchmark seed cotton price. It is an Olympic average of the previous five years' seed cotton price, meaning it is an average of the second, third, and fourth highest values from that period. Similarly, the benchmark seed cotton yield is the Olympic average of the seed cotton yield for the previous five years.

The benchmark revenue is:

$$(10) \text{ benchmark revenue} = \text{benchmark seed cotton MYA price} * \text{benchmark seed cotton yield}$$

The ARC-CO guarantee is set at:

$$(11) \text{ ARC - CO guarantee} = \text{benchmark revenue} * 86\%$$

The actual revenue is:

$$(12) \text{ actual revenue} = U.S. \text{ Seed Cotton MYA price} * \text{seed cotton yield}$$

The maximum possible ARC-CO payment is limited to:

$$(13) \text{ maximum ARC - CO payment} = 10\% * \text{benchmark revenue}$$

The revenue shortfall is defined as:

$$(14) \text{ revenue shortfall} = \text{ARC - CO guarantee} - \text{actual revenue}$$

Once all of these components have been calculated, they can be used to calculate the ARC-CO payments for each enrolled base acre using the following formula:

$$(15) \text{ ARC - CO payment} = \text{MIN}(\text{maximum ARC - CO payment}, \text{revenue shortfall}) * 85\%$$

The STAX program was first made available to cotton producers in the 2014 Farm Bill, and it remains available today. Unlike the ARC and PLC programs,

STAX payments are based on cotton lint, rather than the newer commodity seed cotton.

Enrollment in STAX precludes producers from enrolling in ARC or PLC. It can be purchased in conjunction with other insurance or as a standalone policy. STAX covers up to 20% of the adjusted area revenue, but a producer enrolling in STAX must choose values for two parameters. The first is the protection factor (PF), which has a range between 80% and 120% in 1% increments; the second value is an area loss trigger (ALT), which has a range from 75% to 90% in 5% increments.

Once a producer chooses an ALT, their choice determines the coverage range (CR), which is equal to the ALT minus the higher of the coverage level of any companion policy in effect and 70%. For example, with an ALT of 90% and a companion policy with a coverage level of 65%, the STAX CR would be 20%. With a companion policy that covered 80% of revenue, the CR would be 10%.

Before calculating the STAX indemnity, one must first calculate the expected area revenue and the actual area revenue. The expected area yield area yield is a 30-year average for the county in which the farm is located. The expected price, also referred to as the projected price, is the average of the daily settlement prices during the price discovery period for the Intercontinental Exchange (ICE) December cotton futures contracts. The expected area revenue is the product of the expected area yield and the expected price. The harvest price is the average settlement price for the ICE December cotton futures contracts in the harvest period, and the actual area revenue is the product of the actual area yield and the harvest price.

STAX only pays if the actual area revenue is less than the area loss trigger percentage, chosen by the producer, of the expected area revenue. When a STAX indemnity is paid, it can be calculated in the following manner:

STAX indemnity = (expected area revenue * loss trigger * coverage range) *

$$(16) \quad \left(\text{MIN} \left(\frac{\text{MAX} \left(\frac{\text{loss trigger} - \frac{\text{actual revenue}}{\text{expected revenue}}}{\text{coverage range}}, 0 \right)}{\text{coverage range}}, 1 \right) \right)$$

For example, suppose the producer chooses a protection factor of 120%, an area loss trigger of 90%, and a companion policy with a coverage range of 70%. Also, suppose the expected area yield is 800 pounds per acre, the actual area yield is 750 pounds per acre, the expected price is 90 cents, and the harvest price

is 85 cents. In that case, the expected revenue is $800 \cdot 0.90 = \$720.00$, and the actual revenue is $750 \cdot 0.85 = \$637.50$. The indemnity is:

$$(17) \quad \text{STAX indemnity} = (720 \cdot 1.2 \cdot 0.2) \cdot \left(\text{MIN} \left(\frac{\text{MAX} \left(\frac{0.9 - \frac{637.50}{720}}{0.2}, 0 \right)}{0.2}, 1 \right) \right) = \$12.60$$

Optimal program selection was determined by solving a multi-objective, non-linear mathematical program using the following notation:

- X1: percent of available base acres enrolled in PLC
- X2: percent of available base acres enrolled in ARC-CO
- X3: percent of available base acres enrolled in STAX
- C1: average net return on PLC in dollars per acre
- C2: average net return on ARC-CO in dollars per acre
- C3: average gross return on STAX in dollars per acre
- \emptyset : risk aversion parameter
- V_{ij} : the covariance between the returns on i and j . When $i = j$, V_{ij} represents the variance of the returns on i .

The problem of program selection becomes:

$$(18) \quad \text{Max } C_1 X_1 + C_2 X_2 + C_3 X_3 - \emptyset \begin{bmatrix} X_1 X_1 V_{1,1} & + X_1 X_2 V_{1,2} & + X_1 X_3 V_{1,3} \\ + X_2 X_1 V_{2,1} & + X_2 X_2 V_{2,2} & + X_2 X_3 V_{2,3} \\ + X_3 X_1 V_{3,1} & + X_3 X_2 V_{3,2} & + X_3 X_3 V_{3,3} \end{bmatrix}$$

$$(19) \quad \text{S.T. } X_1 + X_2 + X_3 \leq 1$$

$$(20) \quad X_1, X_2, X_3 \in \{0,1\}$$

Before solving the model, the parameters must first be estimated. Hale County, Texas, was chosen as the geographic area, and a time series of each of the three programs was constructed, including every year from 1987 to 2021. Although these programs have only been available since 2014, the underlying data used to calculate the payment amounts is available for this entire period. To account for inflation, market year average prices from 1987 to 2014 were adjusted to 2014 values using the Consumer Price Index.

\emptyset is estimated using a method similar to (Brink and McCarl, 1979). This method calibrates the model by choosing a reference year and choosing a value of \emptyset that minimizes the difference between the model solution and the values chosen by producers in that year. The method described in this paper varies slightly by using the average from several years to determine

the reference values. The average participation rates for PLC by cotton producers in Hale County from 2014 to 2022 was 90%. The participation rate for ARC-CO was 10% and participation in STAX was negligible.

The following model was used to estimate \emptyset :

$$(21) \text{ Max } C_1 X_1 + C_2 X_2 + C_3 X_3 - \emptyset \begin{bmatrix} X_1 X_1 V_{1,1} & +X_1 X_2 V_{1,2} & +X_1 X_3 V_{1,3} \\ +X_2 X_1 V_{2,1} & +X_2 X_2 V_{2,2} & +X_2 X_3 V_{2,3} \\ +X_3 X_1 V_{3,1} & +X_3 X_2 V_{3,2} & +X_3 X_3 V_{3,3} \end{bmatrix}$$

$$(22) \text{ S.T. } X_1 + X_2 + X_3 \leq 1$$

$$(23) X_1, X_2, X_3 \geq 0$$

Unlike in the first model presented, the choice variables are continuous, so in other words, constraint (20) is different than (23). This model was solved for different values of \emptyset , using an iterative algorithm until the levels chosen by the model matched observed proportions. The original model was then solved by using the estimated value of \emptyset to determine the optimal subsidy selection for cotton producers in Hale County with an average aversion to risk. In addition, the integer model was solved using an iterative algorithm and different values of \emptyset to determine the level of risk aversion necessary for a producer to switch from one subsidy to another.

DATA DEVELOPMENT

PLC and ARC have only been available to cotton producers since 2018. The underlying data needed to calculate what the payments would have been, however, is available going back much further. The limiting factor in this study was the need to take a 30-year average when calculating the STAX indemnities. Data was available from 1956 to the present, which allowed calculation of hypothetical STAX payments from 1987 to 2021. Data was available to calculate PLC and ARC-CO payments during this time as well, so this study spans a 34-year period.

The yearly prices and U.S. production levels of both lint and cottonseed were secured from USDA National Agricultural Statistics Service (2024). This data was then used to calculate the nominal MYA price. Significant price inflation has occurred during this period, so using nominal values would have resulted in unrealistically high payments in years early in this series—to address this issue, real prices were used for years prior to 2014. This was accomplished by using the consumer price index to adjust prices to 2014 levels.

The PLC payments were calculated in the manner previously described (Figure 1). Things to note are the

high expected payment of \$44.12 per acre, as well as the high degree of variation.

The ARC-CO payments were also calculated for the period in question (Figure 2), with the expected payment being \$31.67 per acre; ARC-CO always pays something, and the lowest payment is \$16.36 per acre. STAX projected and harvest prices were calculated using historical ICE December cotton price settlements compiled at Texas A&M University (Gleaton, 2023).

Enrollment in the STAX program requires choosing both a price loss trigger and revenue protection level, and there are many different combinations of these two factors that a producer could choose. For this paper, the combination that resulted in the highest average STAX payments was chosen, and extensive trial and error showed a loss trigger of 90% and a protection level of 70% resulted in the highest revenue. It was also assumed that any companion policy held by the producer had a coverage level of not more than 70%. Although calculating net indemnities, i.e., indemnities minus premiums, would have been more realistic, the formulas used to calculate premium levels could not be obtained. Fortunately, this was not necessary. Even if a producer received STAX free of charge, it would still underperform PLC and ARC-CO for this specific group of producers in this time interval. Figure 3 shows STAX indemnities.

Comparative statistics for all three programs are given in Table 1. PLC has the highest average payment at \$44.12 per acre, and it also has the highest payment in a single year at \$162.00. Despite these advantages, there are many years in which PLC pays nothing, but it is also the most volatile option, with a variance far larger than ARC-CO or STAX.

ARC-CO has the second highest expected value at \$31.67 but the smallest variance of the group. In addition, it pays more than zero every single year, with the lowest payment being \$16.36.

Even though given every possible advantage and offered with a premium of \$0.00, STAX still has a much lower expected value than ARC-CO. In addition, it has over twice the variance of ARC-CO. It is clearly an inferior choice, and participation in this program should be within a rounding error of zero (details below).

PROGRAMMING ANALYSIS

The variance-covariance matrix for the three options is given in Table 2. Given the variances, covariances, and

expected values, \emptyset is estimated by repeatedly solving the following:

$$(24) \quad \text{Max } 44.12X_1 + 31.67X_2 + 10.01X_3 - \emptyset \begin{bmatrix} 2885.01X_1X_1 & +157.59X_1X_2 & +409.41X_1X_3 \\ +157.59X_2X_1 & +367.98X_2X_2 & +303.58X_2X_3 \\ +409.41X_3X_1 & +303.58X_3X_2 & +800.59X_3X_3 \end{bmatrix}$$

$$(25) \quad \text{S.T. } X_1 + X_2 + X_3 \leq 1$$

$$(26) \quad X_1, X_2, X_3 \geq 0$$

$$(27) \quad \text{This procedure yields } \emptyset = 0.002558$$

The risk parameter, \emptyset , is of interest in itself as it represents the willingness of producers to give up expected returns in exchange for less risk. In this case, the model is solving for the average risk aversion for a group of agricultural producers. Producers within this group, however, may be very different from each other and exhibit a wide range of values, meaning they are likely to behave differently in different situations. For instance, a producer with minimal debt and significant cash reserves can afford to be less concerned about short-term variations in income than one with high debt payments and lower cash reserves.

Solving

$$(28) \quad \text{Max } 44.12X_1 + 31.67X_2 + 10.01X_3 - 0.002558 \begin{bmatrix} 2885.01X_1X_1 & +157.59X_1X_2 & +409.41X_1X_3 \\ +157.59X_2X_1 & +367.98X_2X_2 & +303.58X_2X_3 \\ +409.41X_3X_1 & +303.58X_3X_2 & +800.59X_3X_3 \end{bmatrix}$$

$$(29) \quad \text{S.T. } X_1 + X_2 + X_3 \leq 1$$

$$(30) \quad X_1, X_2, X_3 \in \{0,1\}$$

gives levels of $X_1 = 1, X_2 = 0, X_3 = 0$, indicating PLC is the preferred choice.

This model was solved repeatedly for different values of \emptyset to find the point at which the levels switched to $X_1 = 0, X_2 = 1, X_3 = 0$, and this occurred when $\emptyset = 0.00495$ indicating ARC-CO only becomes the preferred alternative for producers who place a weight on variability that is at least 1.935 times as high as the average producer. Enrollment numbers indicate this describes approximately 10% of producers.

CONCLUSIONS

The data from this study comes from a specific commodity and county in Texas. The general principles used here, however, can be applied to a wide range

of agricultural production situations. Intuitively, there is often a tradeoff between expected returns and the risk associated with those returns. While the exact methods used in this study could be replicated in other locations, the results highlight important aspects of decision-making under uncertainty and are instructive for producers who don't want to take such a quantitative approach. The individual nature of risk aversion also implies that producers from the same region may end up choosing different options.

Risk is a complex subject, and like all models, this study is a simplification of reality that may omit important details. One of the details not taken into account is the capital reserves possessed by individual producers. For those who can farm profitably without any subsidy, or at least have enough money set aside to farm for several years in a row without receiving a subsidy, PLC is a very attractive choice. The average payout is significantly higher than that of the other available options.

On the other hand, producers with limited resources may find ARC-CO better suits their needs. It pays almost 72% as much as PLC, but it is a much more reliable source of income as it always pays something and usually pays well. For those making loan payments, this is an especially attractive feature.

While STAX may be well suited to other commodities, it is clearly the worst alternative for cotton producers in the area covered by this study.

While this study uses nothing but past data, yearly decisions are often influenced by yield and price expectations for the coming year. Forecasts for both yield and price are readily available, so looking at an expected range of prices and calculating the payoffs for each value in that range may offer an advantage over the methods presented in this paper. The relative merits of these programs also change over time. Several years of drought, as observed from 2022 to 2024 in West Texas, have substantially lowered the five-year Olympic average yield for cotton producers in that region. This has, in turn, has lowered ARC-CO payments, making it a less desirable option. At the same time, trade disputes and higher yields nationally have depressed cotton prices, increasing the likelihood that a PLC payment will be triggered. The results of this study should be viewed with the expectation that actual decisions will be heavily influenced by current market conditions.

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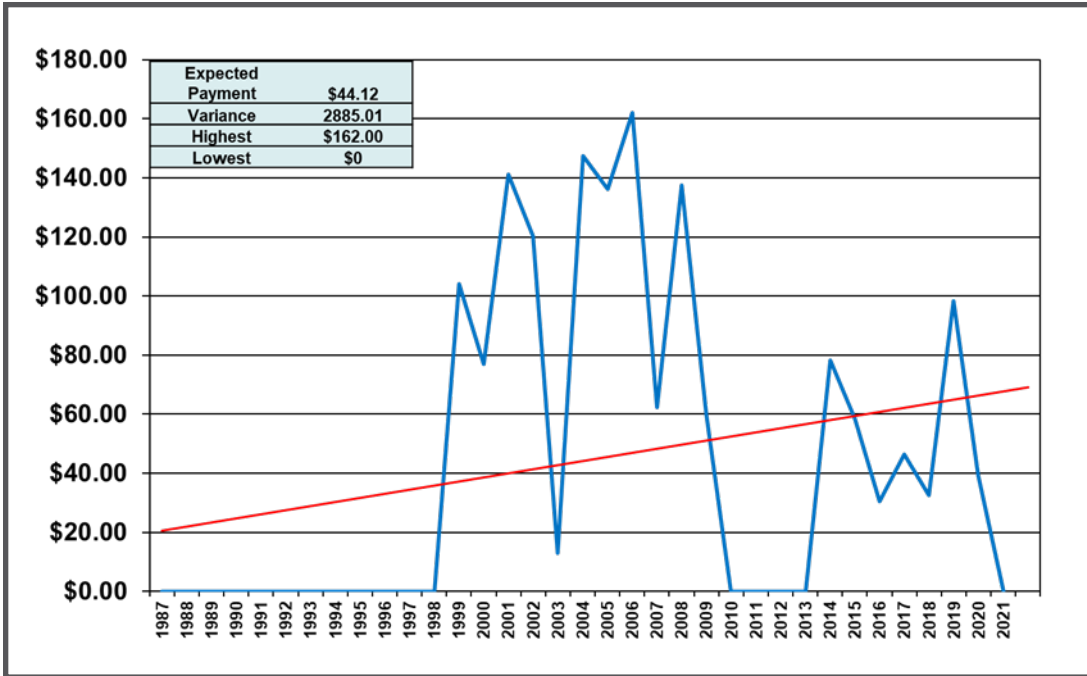


Figure 1. Price loss coverage payments per acre

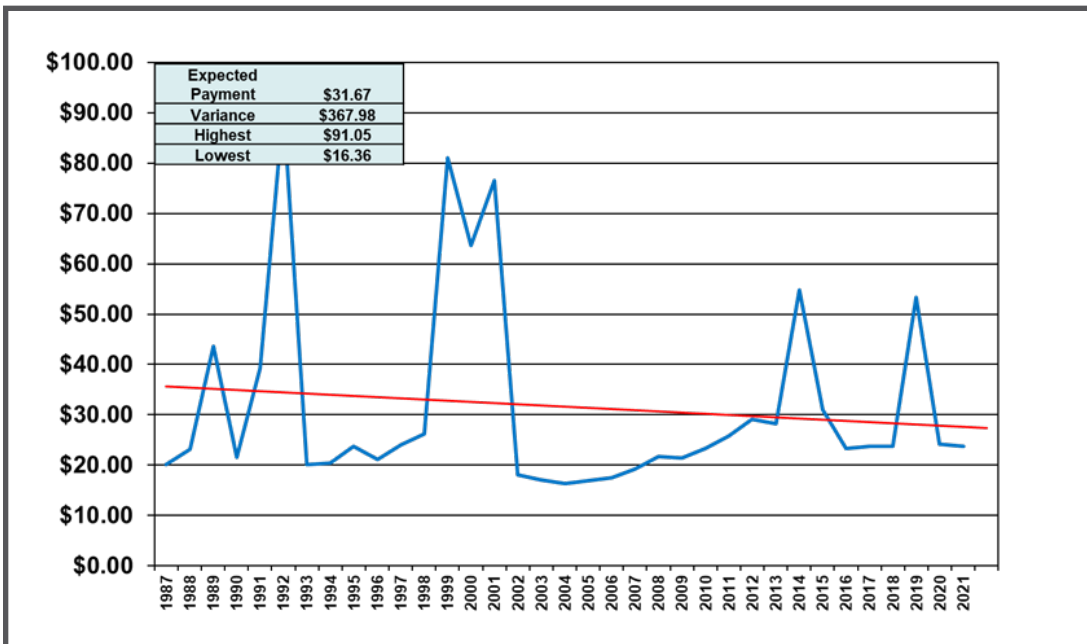


Figure 2. Agricultural risk coverage payments per acre

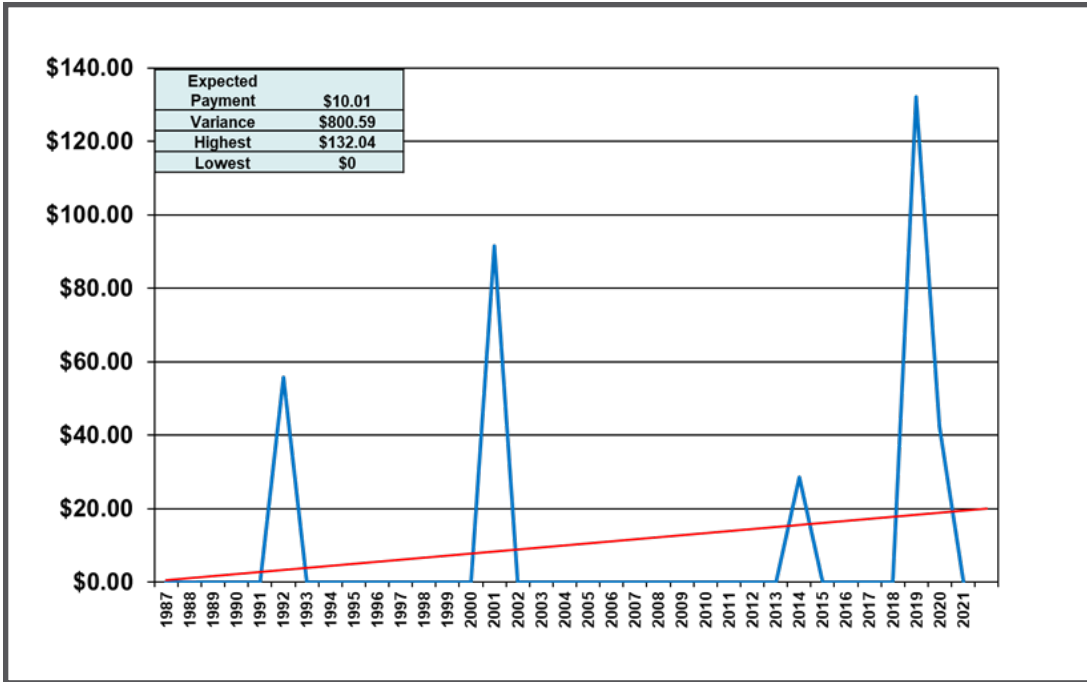


Figure 3. Stax program indemnities per acre

Table 1. Summary Statistics for Farm Program Outcomes

	PLC	ARC-CO	STAX
Average Payment	\$44.12	\$31.67	\$10.01
Variance	\$2885.01	\$367.98	\$800.59
Highest Payment	\$162.00	\$91.05	\$132.04
Lowest Payment	\$0.00	\$16.36	<\$0.00

Table 2. Variance-Covariance Matrix

	PLC	ARC-CO	STAX
PLC	2885.01	157.59	409.41
ARC-CO	157.59	367.98	303.58
STAX	409.41	303.58	800.59

Refining Farmland Appraisals for SGMA and Subsidence Rules in California



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Abstract

California's new subsidence best management practices (BMPs), drafted under the Sustainable Groundwater Management Act, present a turning point for rural appraisal practice. Traditional reliance on past sales and conventional production assumptions is increasingly inadequate where groundwater cutbacks tied to critical head thresholds may abruptly shorten the economic life of orchards. This paper assesses how BMPs complicate the application of cost, sales comparison, and income approaches and provides guidance on integrating hydrologic indicators,

groundwater sustainability criteria, and regulatory risk into appraisal reports.

INTRODUCTION

Farmland, which usually makes up over 80% of a farm's balance sheet assets, has an annual turnover of 2% (USDA Economic Research Service, 2025; Rempel et al., 2024). This makes accurate appraisals essential for effective capital allocation in production agriculture. These valuations enable growers to use land as collateral for financing operations and expansion, help lenders set loan covenants and amounts, and enable investors to measure returns, benchmark performance, and raise additional capital.

In California, the crucial role of orchard appraisals is especially critical for almond and pistachio growers, who are facing unprecedented financial and capital devaluation challenges. During the 2010s, high grower nut prices led to extensive new plantings, often in regions that were unduly dependent on groundwater. The additional acreage led to an increase in supply, which, combined with a stronger U.S. dollar and rising interest rates, has since decreased nut prices and farm incomes. Compounding these pressures, the 2014 Sustainable Groundwater Management Act (SGMA) requires local agencies in critically overdrafted basins to achieve groundwater sustainability by 2040. The combined effects of low nut prices and SGMA's restrictions on orchards overly dependent upon groundwater caused almond and pistachio values to decline by 31.4% and 30.0%, respectively, from the start of 2023 through the second quarter of 2025, according to the National Council of Real Estate Investment Fiduciaries' (NCREIF) Farmland Index (National Council of Real Estate Investment Fiduciaries, 2025).

Rural appraisers can employ three primary methodologies to support an opinion of current farmland values: the cost approach, the sales comparison approach, and the income approach. Under most market conditions, these methods

offer reliable and economically justifiable price signals. However, the draft Subsidence Best Management Practices (BMPs) recently published by the Department of Water Resources (DWR) present significant challenges to traditional valuation practices and assumptions. These BMPs suggest that groundwater agencies establish a location-specific critical head¹ threshold, continuously monitor groundwater levels, and curtail pumping when necessary to protect aquifer health. The subsidence BMP suggests that in areas prone to subsidence (i.e., where the groundwater level is below the critical head, and the aquifer has significant clay and/or silt deposits), routine groundwater extraction may need to halt altogether. During drought, when surface water allocations decrease, groundwater access will likely hinge on the proximity of the groundwater level to the critical head, regardless of water banking reserves. Implementation of the subsidence BMP may lead to land repurposing at higher rates than previously expected, increasing the importance of the highest and best use analysis.

Subsidence was a foundational component of SGMA when the legislation was first adopted in 2014. The law explicitly identifies land subsidence as one of six “undesirable results” that must be avoided in groundwater basins. Despite the now decades-old reference point, few, if any, appraisers have addressed this specific risk in post-SGMA valuation reports, understandably so, given the complexity of the situation. However, it is undeniable that these restrictions affect orchard values and create subtle issues with the typical way appraisers employ the three valuation approaches. For example, it is not inconceivable that failure to meet critical head levels could shorten the average estimated economic life of improvements on water-insecure land (cost approach), just as it is likely this situation renders many historical sales non-comparable (sales comparison approach). It widens the spread between the discount rate used for land with more secure or senior surface water rights and the rate used for land dependent on less secure or junior water rights and groundwater pumping. Additionally, appraisers should adjust their nut price forecast higher in future years to reflect anticipated reductions in almond and pistachio acreage and the consequent reduction in supply (income approach).

This paper examines how current appraisal practices may fall short under the new subsidence BMPs and offers practical adjustments to help appraisers produce land price estimates that better reflect today’s emerging market realities.

OVERVIEW OF ALMONDS AND PISTACHIOS IN CALIFORNIA

California currently produces over 75% of the world’s almonds and more than half of global pistachios. Almond production is highly concentrated in California, with seven counties in the Central and Southern San Joaquin Valley accounting for over 80% of the domestic output. Pistachio production is even more concentrated, with five counties accounting for over 95% of the total.

California almond and pistachio acreage steadily grew by a compound annual growth rate (CAGR) of 2.0% and 5.2%, respectively, from 1980 to 2003 (see Figures 1 and 2). In 2004, the NCREIF Almond and Pistachio Indices achieved record-high capital returns of 8.8% and 9.1%, respectively, along with record-high total returns of 36.4% and 25.9%. This marked the start of 12 years of extraordinary returns, with almonds and pistachios generating annualized income of 16.3% and 22.0%, respectively, and annualized combined income and appreciation returns of 26.8% and 31.8%, respectively. In response to the high returns, growers expanded, and the CAGR of new almond and pistachio plantings accelerated to 5.8% and 9.6%, respectively, between 2004 and 2021.

Almond and pistachio acreage increased by 71.9% and 134.4%, respectively, from 2004 to 2014. Unfortunately, the added tree nut acreage, which both increased the water demand (almonds typically need 4 acre-feet per acre [af/a] annually to maximize yields, while pistachios require 3.5 af/a) and hardened the reliance and demand for groundwater during periods of drought, occurred during an unusually prolonged, dry period. For example, between 2007 and 2013, South-of-Delta agricultural contractors (SODAC) received an average of 39.2% of their surface water rights allocation (U.S. Bureau of Reclamation, 2025). Then, in 2014 and again in 2015, SODAC received a 0% allocation. In response to reduced surface water availability, production agriculture relied on groundwater, which contributed to chronic groundwater overdraft and caused domestic wells to run dry, land to subside, and saltwater to intrude into coastal aquifers; as a result, the State passed SGMA in 2014.

In 2025, almond acreage was estimated to be just under 1.5 million acres, while pistachio acreage was estimated at 620,000 acres. This indicates that almond and pistachio growers have added a net total of 388,833 and 361,220 acres, respectively, since 2014, when the State of California passed SGMA. Technically,

almond growers added 562,634 acres between 2014 and 2021 but have since removed 173,801 acres.

The removal of acreage reflects challenging market conditions that began to deteriorate when the relative strength of the U.S. dollar increased in 2016. California exports roughly 75% and 70% of almond and pistachio production, respectively, so the stronger dollar reduced the relative purchasing power of its foreign consumers. Additional challenges arose in 2018, when the Trump Administration enacted steel and aluminum tariffs under Section 301, and major trading partners imposed retaliatory tariffs that stifled exports and placed downward pressure on nut prices (Carter and Steinbach, 2022; Congressional Research Service, 2019). COVID-induced supply chain disruptions also hindered shipments, which resulted in relatively higher ending stocks, placing downward pressure on output prices. The recent bout of inflation increased cultural costs, and the consequent rise in interest rates increased borrowing costs and placed downward pressure on farmland values and profitability.

Overlying these market dynamics was the continual increase in production, brought about by the previous expansion of acreage. While almond production peaked in 2020, pistachio production is expected to set a record in 2025 (see Figures 3 and 4). Additionally, Figures 5 and 6 portray the impact of SGMA on almond and pistachio capital returns in 2023 and 2024. The significant reduction—the value of capital in the NCREIF Almond and Pistachio Indices has fallen 31.4% and 30.0%, respectively, from the first quarter of 2023 through the second quarter of 2025—is a strong indication that appraisers in California began writing down capital values to reflect both curable and incurable economic obsolescence.

Going forward, due to SGMA regulations, California almond and pistachio acreage are expected to contract. In 2024, there were 103,792 acres of pistachios and 143,863 acres of almonds, entirely dependent upon groundwater sitting atop critically overdrafted high-priority groundwater basins. Given the BMP on subsidence, this acreage is likely to be removed from production in the coming years. There is also a considerable amount of acreage in water districts that may need to be removed to halt subsidence and bring basins into sustainability. The reduction of these acres will likely result in a lower supply of almonds and pistachios. This economic actuality stands in stark contrast to many recent industry estimates that seem to ignore the expected reduction in acreage caused by the implementation of SGMA, such as the estimate that pistachio “acreage will top 811,000 acres

and production will reach 2.08 billion pounds in 2031” (Tootelian, 2023).

REGULATORY FRAMEWORK: SGMA, SUBSIDENCE BMPS, AND CRITICAL HEAD THRESHOLDS

Historically, landowners in California have controlled groundwater resources, and access to groundwater was largely unregulated. Many basins faced chronic overdraft, causing subsidence, reduced groundwater storage capacity, deteriorating groundwater quality, and wells drying up (Ayres et al., 2021).

On September 16, 2014, California Governor Brown signed a trio of legislative bills into law collectively known as the Sustainable Groundwater Management Act (California Governor’s Office 2014). In the bill’s signing message, he noted, “A central feature of these bills is the recognition that groundwater management in California is best accomplished locally...The State’s primary role is to provide guidance and technical support on how to plan for a more sustainable future and to step in on an interim basis when, but only when, local agencies fail to exercise their responsibilities as set forth in this legislation.”

In accordance with the legislation, SGMA requires the establishment of Groundwater Sustainability Agencies (GSAs), which develop and implement Groundwater Sustainability Plans (GSPs). A GSP is a roadmap for a basin to achieve sustainable groundwater management within a 20-year timeframe. The legislation defines “sustainable groundwater management” as “the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results” (California Water Code § 10721(v), 2025). The six undesirable results were listed as significant and unreasonable: 1) groundwater level declines, 2) groundwater storage reductions, 3) seawater intrusion, 4) water-quality degradation, 5) land subsidence, and 6) interconnected surface-water depletions.

Subsidence in the SGMA context is the sinking of the Earth’s surface. When heavy groundwater pumping lowers water levels in or near sand-and-gravel aquifers, the water pressure in nearby fine-grained clay and silt layers drops. With less internal support, those layers bear more of the overlying weight, and their grains are squeezed together. This aquifer-system compaction can cause the Earth’s surface to sink.

SGMA asks GSAs “to avoid or minimize subsidence” because it can decline the capacity and reliability of water, transportation, and community infrastructure, all while permanently degrading the aquifer itself (California Department of Water Resources, 2025a). Even modest levels of subsidence can cause aqueducts and canals to lose freeboard and gradient, resulting in costly retrofitting or even rerouting. Roads, pipelines, and rail can experience cracking and misalignment. Subsidence can also increase lift requirements for wells, leading to higher energy costs, pump failures, and contributing to the failure of domestic wells (California Water Commission, 2025; Bartolino and Cunningham, 2003).

Subsidence and groundwater overdraft continue to affect agricultural regions in California. Following the fifth-driest water year (October 1, 2019, to September 30, 2020) on record in 2020, California experienced its second-driest water year in 2021 (California Department of Water Resources, 2022). During the drought, areas in the southern San Joaquin Valley experienced subsidence at rates up to 1 foot per year (California Department of Water Resources, 2025b). SGMA legislation defined the “minimum threshold” for land subsidence during the planning and implementation period to be “the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results” (State Water Resources Control Board, 2025). Substantial interference is defined by GSAs through a series of Sustainable Management Criteria.

Subsidence since the enactment of SGMA has led to significant consequences. For example, Nemati et al. (2025) found that from 2015 to 2021, ongoing land subsidence in California’s San Joaquin Valley caused by excessive groundwater pumping for irrigation slowed the growth of nearby home values. Overall, the subsidence eliminated an estimated \$1.44 to \$1.87 billion in residential property value.

Additionally, the California Aqueduct Subsidence Program has dedicated \$2.3 billion to repair active and anticipated subsidence-related damages to the California Aqueduct (\$288 million), San Luis Canal (\$582 million), Friant-Kern Canal (\$924 million), and the Delta-Mendota Canal (\$562 million) (California Department of Water Resources 2025,a).

On July 24, 2025, in the wake of continued, active subsidence and the mounting pile of capital required for remediation, the DWR released a draft of the Best Management Practices on Managing Land Subsidence in California and a related video, “The Role of Critical

Head in Managing Land Subsidence” (California Department of Water Resources, 2025c; California Department of Water Resources, 2025d). While the subsidence BMP is not a regulation, it does serve as a guide to GSAs as they implement SGMA and is likely to result in changes to the approach to subsidence by GSAs.

The document provides a technical overview of subsidence and provides what GSAs should include in their GSPs to halt or minimize subsidence. Perhaps more importantly to the valuation industry, it is a strong signal to agricultural appraisers in California that the elements of comparison and valuation techniques are at a pivotal juncture. Extraordinary assumptions can no longer be relied on for a workaround, and even sales data selection will become a heavily scrutinized valuation focus. The subsidence BMPs suggest that GSAs establish a location-specific critical head groundwater level, continuously monitor groundwater levels, and curtail pumping when necessary to protect aquifer health. In areas prone to subsidence (i.e., the groundwater level is below the critical head), routine groundwater extraction may need to halt altogether. During drought, when surface water allocations decrease, groundwater access may hinge on the proximity of the groundwater level to the critical head, regardless of the overall water budget or sustainable yield. This means that some properties will exist for which irrigated agriculture will simply no longer be a long-term endeavor, irrespective of whether water can be purchased or pumped. Fundamentally, the dynamics of groundwater allocations may change, and with that, some properties with strong water security will rise in the “balance and supply” tide, while others will sink.

One significant implication of DWR’s subsidence BMP is that some GSAs will need to operate at de facto sustainable-subsidence conditions well before 2040—setting very tight minimum thresholds around critical infrastructure to curb overdraft now—because any ongoing subsidence that substantially interferes with land uses may lead to an undesirable result *today* and will need to be addressed well before 2040. Regardless of how a GSA has defined undesirable results, to avoid or minimize further subsidence, DWR suggests that the best management practice for groundwater level management in areas experiencing subsidence is to raise groundwater levels above the critical head as high and as quickly as possible.

IMPLICATIONS AND ADJUSTMENTS FOR FARMLAND APPRAISALS

For appraisers, the new subsidence BMP emphasizes the increasing need to go beyond traditional static market evidence and include forward-looking risk adjustments into valuation models. Critical head groundwater levels introduce a binary risk factor—where land either maintains viability for permanent plantings or becomes effectively unsuitable for irrigated agriculture—that cannot be fully captured by historic comparable sales or generalized yield assumptions. Consequently, the scope of appraisal work extends beyond documenting orchard condition and yield potential. Appraisers must also consider how regulatory exposure and basin-level groundwater governance impact long-term viability. Doing so calls for the incorporation of hydrologic indicators, anticipated compliance with local Groundwater Sustainability Plans, and the practical limits imposed by nearby infrastructure. Since location-specific critical head levels are not yet widely available, ignoring these factors can result in valuations that overstate the economic life of the orchard, apply unrealistically low capitalization rates, and misrepresent the operational and investment risks assumed by lenders, growers, and institutional investors. The role of critical head groundwater levels and subsidence data, while emergent, needs immediate attention by the valuation community.

Appraisers should consider ways to adapt traditional methods to account for new regulatory, hydrological, and market realities. The new subsidence BMPs will challenge appraisers to tailor best practices within each valuation approach in order to capture the risks posed by SGMA, subsidence, and critical head groundwater levels. Below are some best-practice suggestions and guidance for appraiser consideration.

Cost Approach:

- *Recognize external obsolescence.* Adjust replacement cost models not only for SGMA-related water curtailments and subsidence but also for basin-level critical head levels, which may shorten the economic life of orchards even if they are physically sound. Unlike general external obsolescence that is economically driven and can reverse with improved market conditions, this obsolescence is more likely incurable.
- *Caution in using a cost to cure analysis.* Use current bid prices for well drilling, orchard removal, and replanting but consider whether replacement

is feasible at all if critical head levels become binding within the basin.

- *Depreciation analysis.* Factor in functional obsolescence tied to water stress, e.g., orchards on marginal soils or within areas already flagged as subsidence “hot spots.”

Sales Comparison Approach:

- *Expand the definition of comparables.* Be on the lookout for sales where critical head values influenced pricing, as buyers may now apply steep discounts to properties with higher vulnerability. The opposite is also true. Strategic buyers may identify areas with higher water security that are more likely to remain above minimum thresholds and value properties commensurately higher. Sale verification should include this level of questioning.
- *Time adjustments.* Apply short-term, data-driven adjustments, recognizing that new subsidence BMP requirements (e.g., zero-subsidence suggestion) can shift market perception much faster than historical sales would suggest.
- *Verify motivation.* Pay close attention to whether sales occurred due to regulatory tightening or threshold-triggered water cutbacks, as these circumstances affect how representative a sale is of broader market value. This is true on both ends of the market spectrum as buyers, and especially investors, purchase properties based on anticipated shifts in water security. The terms “knowledgeable buyer and knowledgeable seller, both acting in their own best interest” are more important now than ever.

Income Approach:

- *Model realistic biological yields.* Reduce production forecasts in areas where groundwater levels are near or beneath critical head levels because growers may face abrupt groundwater use restrictions. Also consider the potential impact of reduced yields on future pricing models.
- *Model realistic nut prices.* SGMA will significantly decrease water availability for irrigation, leading to lower annual production of almonds and pistachios. With reduced supply, prices are expected to rise to ration demand.
- *Sensitivity testing.* Include threshold-based scenarios (e.g., “if the basin drops below X feet, water use is curtailed by Y%”) to show the binary nature of risk. For an example, see Figure 7.

- *Capitalization rates.* Add risk premiums for properties in basins where the groundwater level is near or at the localized critical head levels because these orchards carry disproportionate investment risk.

The inherent risk of groundwater curtailment due to subsidence introduces a measurable layer of regulatory and operational uncertainty that directly affects the stability and durability of agricultural income streams. When applying a built-up capitalization rate, the analysis properly starts with a base rate derived from sales of comparable farmland that share similar location, soils, crop type, and physical features but are situated in less water-constrained areas with minimal risk of subsidence. Incremental risk premiums are then added to this base rate to account for potential pumping restrictions, well shutdowns, or mandatory mitigation measures, recognizing these factors as a form of external obsolescence not fully reflected in historical income performance. Support for the individual risk components can be drawn from cost studies on well replacement and mitigation expenses, legislative and regulatory reports detailing subsidence enforcement mechanisms, risk assessments published by agricultural lenders and institutional investors, and, as enough transactions occur, market-derived data from the sale of water-constrained properties.

Understanding the Reliability of Water Analysis

The reliability of an appraisal's water analysis depends heavily on the quality of available data. Establishing a clear hierarchy of preferred data sources ensures that appraisers rely on the most credible evidence possible while providing consistent, defensible conclusions. Therefore, within the appraisal framework, water analysis should be approached with a ranking system based on the quality of the data. The most reliable information—the “best” data—comes from independent, third-party experts, such as water security reports prepared by respected water rights attorneys, hydrologists, or consultants, as well as proprietary for-fee resources like LandIQ. These sources are most likely to explicitly address critical head levels, providing appraisers with defensible evidence about basin sustainability. However, we recognize that this level of water analysis might be too expensive for the average appraisal client, so we also need to consider alternative options.

The second tier of reliability could include owner-prepared or water district analyses, provided these incorporate reliable underlying data and acknowledge

groundwater level conditions. Where neither of these levels of data is available, the appraiser must then provide their own water analysis, ensuring it is logical, transparent, and supported to the greatest extent reasonably available.

It is important to note that as GSAs work to implement the subsidence BMP, there may be a lag in establishing a standardized critical head measurement that an appraiser can reference. In those GSAs where this critical head threshold is not available, an alternative risk assessment metric is the relationship between current experienced subsidence levels and the subsidence minimum threshold established in the GSP. By comparing the subsidence rate at or near a property with the established minimum threshold for subsidence, appraisers can begin to understand the relative subsidence risk of the property. In GSAs with approved GSPs, the difference between the minimum threshold for subsidence and the current amount and rate of subsidence is an indicator of when or if subsidence-related management actions may be required. In GSAs without approved GSPs, appraisers can take the same approach but should recognize that the minimum threshold in the GSP may not be representative of the ultimate minimum threshold. At a minimum, appraisers should compare threshold groundwater levels for the subject basin to historical patterns, then form an opinion on whether proximity to the critical head represents a risk or an enhancement to value. Table 1 provides a clearer visual of how an appraiser might identify and analyze the available data used to assess water security.

Once the water security determination has been established by analysis of the available data, the next step is to apply that information directly within the appraisal framework by using critical head level trends to establish a supported element of comparison with which to compare sales data. This is an important step when the market lacks sufficient sales data within a specific basin, and data from outside these basins or even GSAs must be used. Figure 7 offers an illustration of possible market support for a “water security” element of comparison. This chart shows how groundwater levels trend toward the critical head level, with clear “viable” and “high-risk” zones, however, this is only a sample. Actual data would need to be plugged in for each basin or GSA.

Reconciliation of the Three Approaches

In agricultural markets where water security and subsidence risk are the primary drivers of long-term

viability, reconciliation of the valuation approaches takes on heightened importance. The renewed focus on critical head thresholds intensifies the need for thoughtful weighting, as they can abruptly shift a property's profile from high-value to nearly non-viable. Additional considerations for a well-supported reconciliation may focus on higher water secured areas (well above minimum thresholds):

- The income approach generally carries the most weight, as future productivity can be modeled with confidence when there is ample buffer above critical head levels.
- The sales comparison approach is also reliable where active transactions exist, since buyers should recognize and pay premiums for properties with a margin against threshold risk.
- The cost approach serves as a supportive role, particularly for newer plantings in stable basins.

These considerations might also involve lower water secured areas (near or below minimum thresholds):

- The sales comparison approach may offer the most reliability if there are knowledgeable participants, and sales reflect threshold-induced discounts. However, care is required to confirm whether such sales are distress-driven.
- The income approach must rely on critical head groundwater level-based scenarios, showing the binary drop in viability when groundwater use restrictions are triggered. The probability of this happening would be another consideration.
- The cost approach often has little weight, since replacement is uneconomic if water allocations are restricted, regardless of investment.

Figure 8 illustrates an example of how the relative weighting of the cost, sales comparison, and income approaches shifts depending on whether a property is located in a high or low water security area.

Appraisers should explicitly state whether critical head levels are a binding or emerging factor in the subject's basin. Appraisal reconciliation must not only balance the reliability of employed methodologies but also frame the value conclusion in terms of groundwater level vulnerability, ensuring that stakeholders understand whether the risk is remote, looming, or immediate.

Changing Regulatory Priorities

SGMA is a regulatory framework designed to bring groundwater basins into sustainability without undesirable results. The framework itself may adapt to changing circumstances. As Paul Gosslin, the DWR Deputy Director of Sustainable Groundwater Management, said, "Looking ahead 15-plus years from now, no plan will look the same as it does today, including approved plans" (Souza, 2025). Therefore, appraisers must remain vigilant to the evolving regulatory landscape, particularly as the DWR adjusts the benchmarks for groundwater sustainability. GSAs initially interpreted SGMA requirements as avoiding or slowing down subsidence by 2040-2042. However, DWR's recent BMPs have refined that mandate—now requiring zero subsidence—or mitigation to pay for subsidence impacts—and suggesting subsidence may need to be managed well before the 2040-2042 SGMA sustainability deadline (California Department of Water Resources, 2025a).

This shift represents more than a technical adjustment, it has the potential to alter the risk profile for properties in affected basins. Critical head levels become even more consequential, as reaching them may trigger immediate regulatory responses rather than gradual cutbacks. For appraisers, this means:

- Revisiting highest and best use conclusions in basins approaching thresholds, since land once viable for permanent crops may transition to dryland, grazing, open space, or other alternative uses such as solar or urban development.
- Treating critical head groundwater level proximity as external obsolescence, to be recognized in both cost and income analyses.
- Communicating with clarity that valuations are subject to rapid revision as subsidence BMP requirements and groundwater level monitoring data evolve.

In short, critical head groundwater levels and the evolution of SGMA underscore that water security must now be considered a dynamic, binary risk factor in agricultural appraisal. Forward-looking valuation models that integrate critical head groundwater levels and subsidence data will provide the most reliable guidance to lenders, investors, and landowners navigating California's shifting agricultural landscape.

DISCUSSION AND CONCLUSION

California's new subsidence guidelines will most likely change the ground rules for farmland appraisal. Reliance on old sales (and potentially sales many would not consider "old") and static yield assumptions may no longer suffice in income analysis. Once a basin approaches its critical head level, the viability of orchards can shift from stable to untenable almost overnight. For that reason, water security should be treated as a primary driver of value.

This shift also forces appraisers to rethink highest and best use because regulatory-enacted restrictions that materially limit water availability can render an existing agricultural use no longer legally permissible or financially feasible, prompting a change in highest and best use away from water-intensive production. In such cases, the reproduction cost of irrigation infrastructure and permanent plantings may no longer be economically justified if those improvements cannot be reliably utilized or supported by a lawful water supply, resulting in functional or external obsolescence. Likewise, the economic life of existing improvements may be shortened to account for such restrictions. Concurrently, the income stream associated with the prior use may become unstable or insufficient to meet market return requirements, failing the test of maximum productivity. The revised highest and best use may therefore shift to a lower-intensity agricultural use, partial fallowing, grazing, or non-irrigated open-land use that better aligns replacement cost support with achievable, regulation-constrained income.

Therefore, in areas where groundwater is near or below critical thresholds, permanent crops may not represent a long-term option. Reports need to state clearly when water insecurity shortens the useful life of orchards or points the land toward transitional or alternative uses. Each valuation method must be adapted: the cost approach should reflect external obsolescence tied to SGMA rules, the sales comparison approach must consider water reliability as an element of comparison, and the income approach should run "what if" scenarios to account for abrupt curtailments in pumping.

Carrying out these adjustments requires a hierarchy of data sources. Independent reports from hydrologists or GSAs are best, but district or owner data may be necessary where more substantial evidence is unavailable. Whatever the source, the assumptions and limits of the data must be spelled out in the report. This clarity enables appraisers to adjust the

weight they assign to the three approaches—leaning more heavily on income and sales evidence where water is secure and giving less weight to cost when replacement is unrealistic due to basin constraints.

In closing, current and future appraisal practices are challenged with keeping pace with SGMA and the DWR's push toward zero subsidence. Despite an apparent lack of data, every valuation should at least consider a subject's water outlook, test income against threshold scenarios, and recognize external obsolescence where water limits cut short orchard life. Developing a straightforward way to communicate water risk—such as a rating system—could strengthen the credibility of reports. By keeping pace with regulatory changes and folding those requirements into their valuation methods, appraisers can provide opinions of value that hold up better under scrutiny. Doing so provides lenders, investors, and landowners with a clearer understanding of how new rules impact risk, enabling them to make informed decisions in an environment where policies are continually evolving. In the end, it is the appraiser—armed with insight, discipline, and foresight—who takes the lead in translating uncertainty into clarity, becoming an indispensable guide for stakeholders navigating agriculture's most complex water and land challenges.

FOOTNOTE

1 Critical head is the minimum groundwater level an aquifer system can sustain without triggering permanent compaction of its clay layers and subsidence of the Earth's surface.

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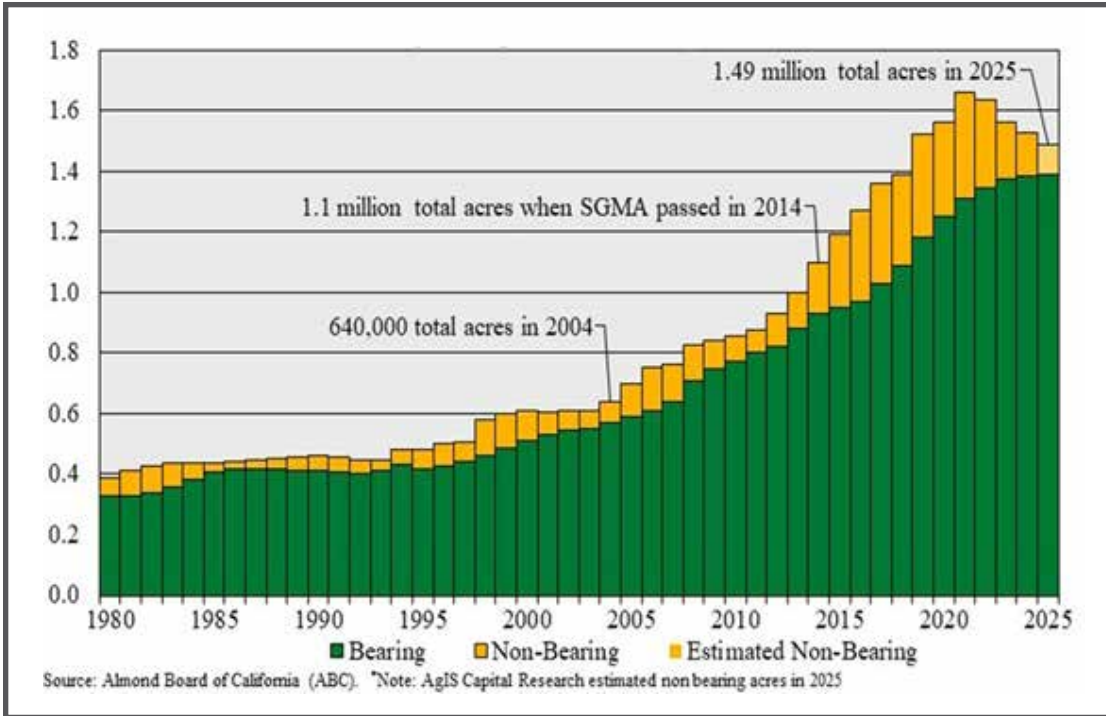


Figure 1. California almond bearing and non-bearing acreage*: 1980 to 2025, million acres

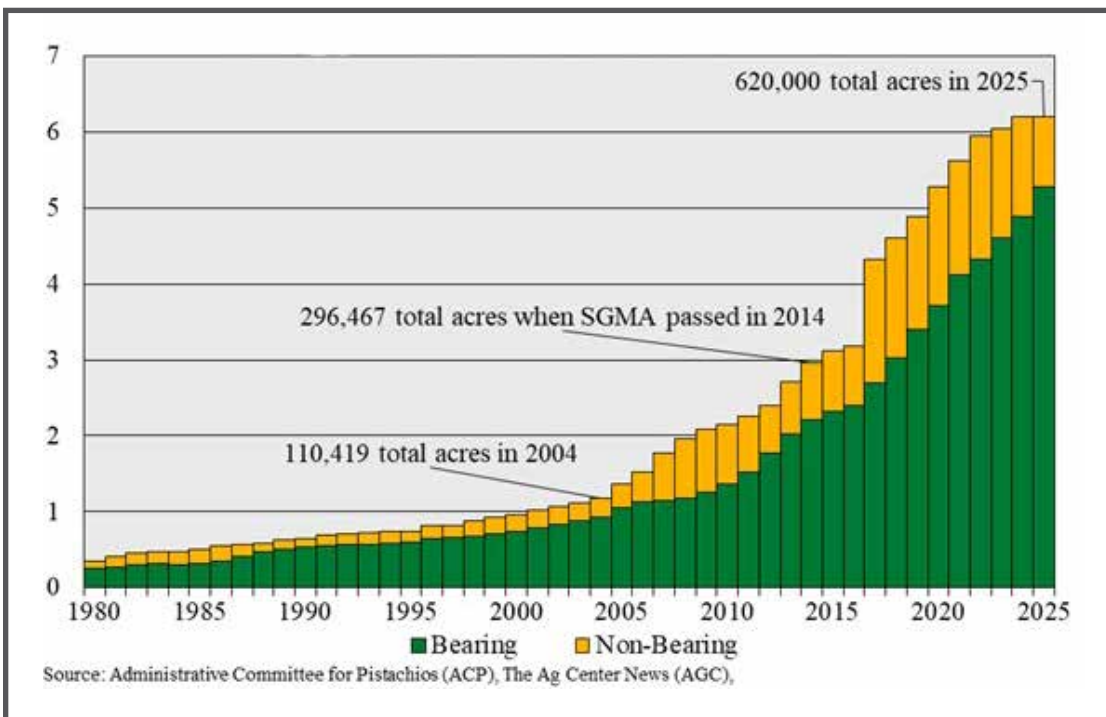


Figure 2. California pistachio bearing and non-bearing acreage: 1980 to 2024, hundred thousand acres

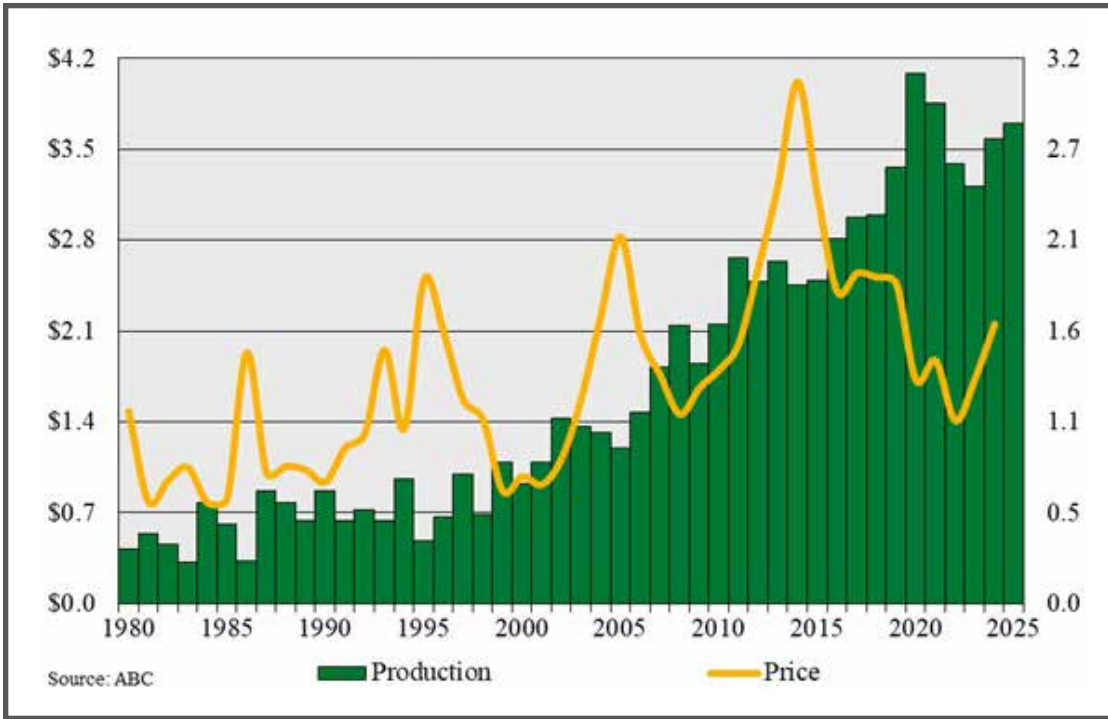


Figure 3. California almond price and production: 1980 to 2025, dollars per pound, billion pounds

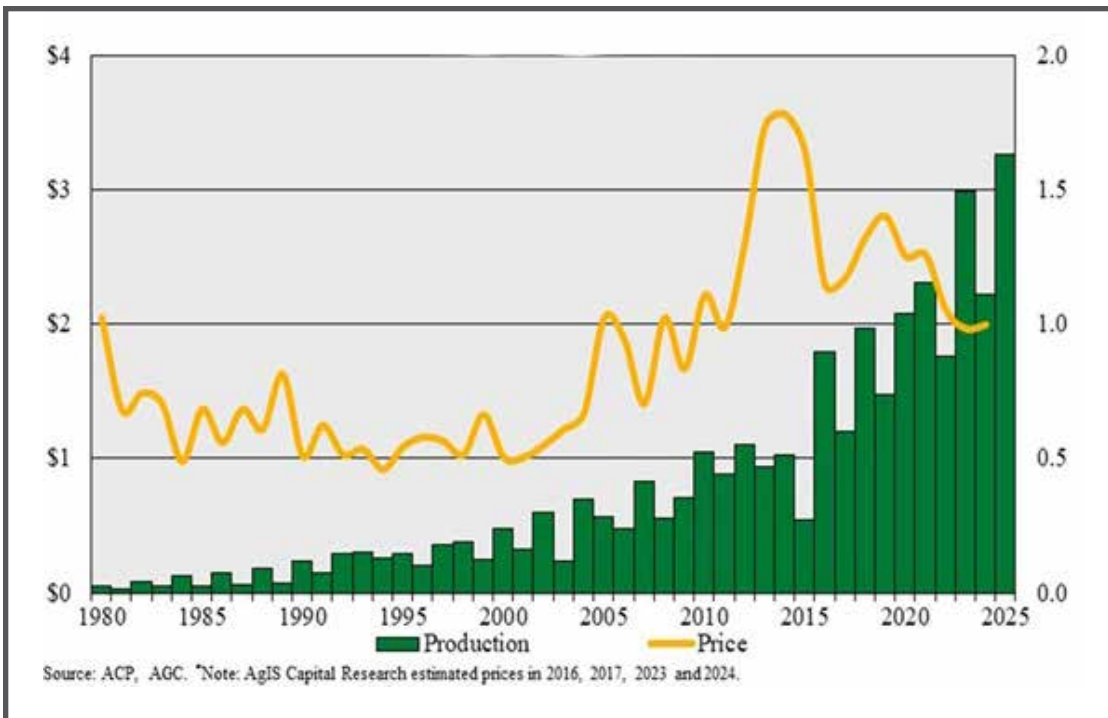


Figure 4. California pistachio price and production: 1980 to 2025, dollars per pound*, billion pounds

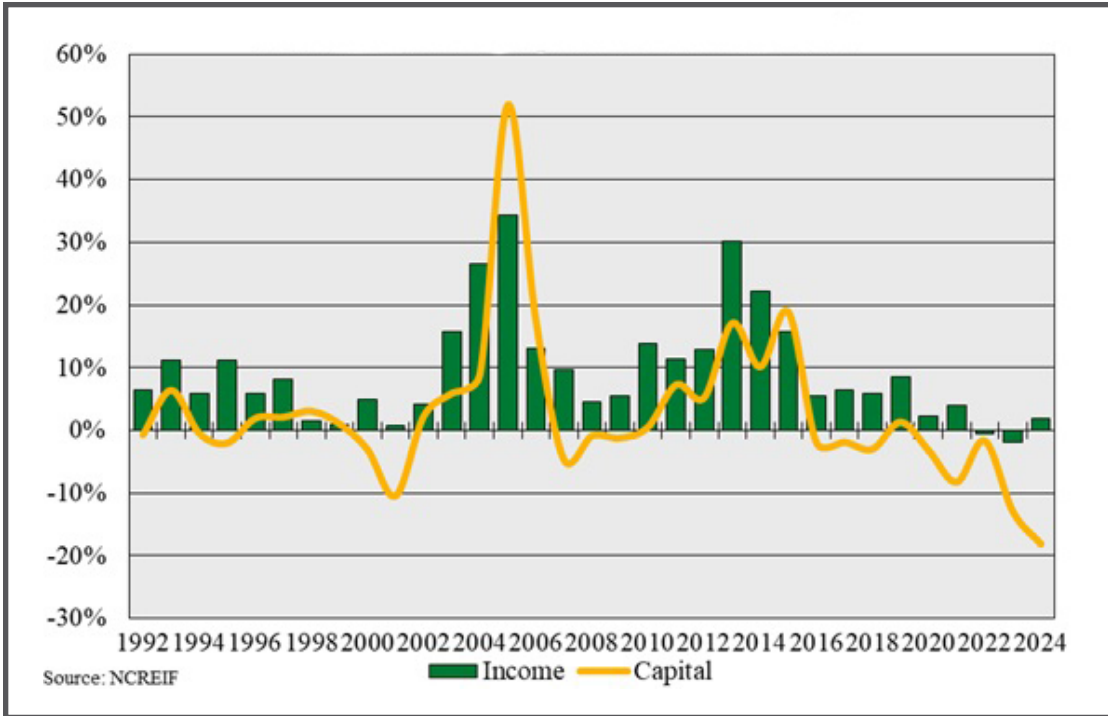


Figure 5. NCREIF Almond Index annual income and capital returns: 1992 to 2024

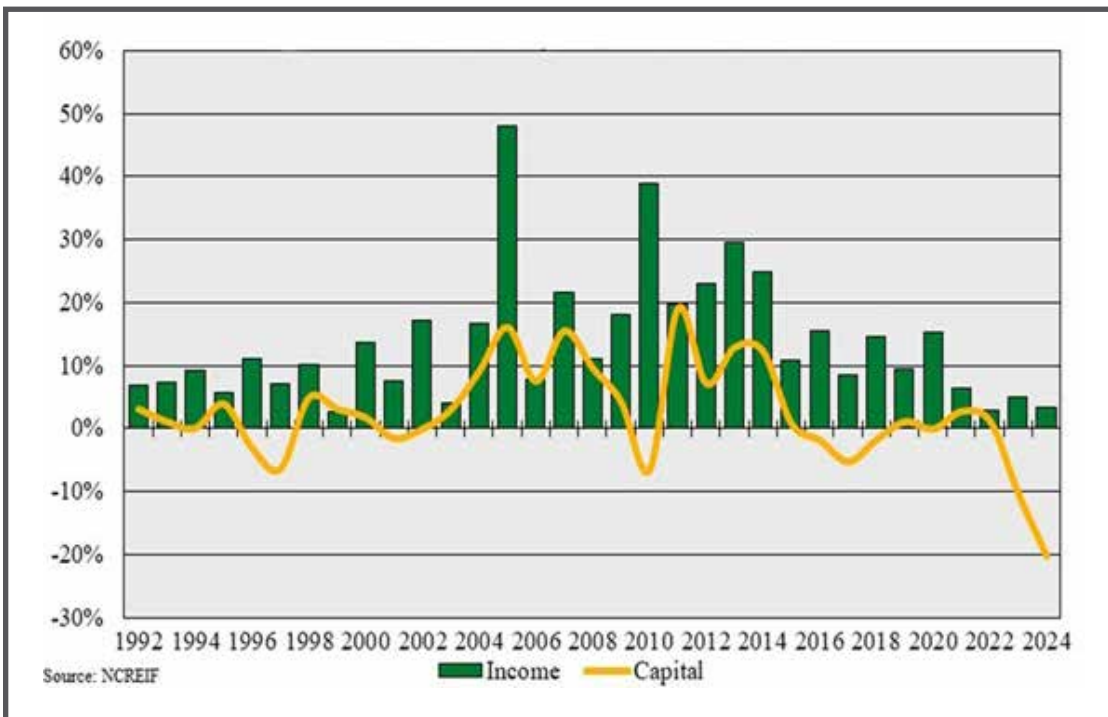


Figure 6. NCREIF Pistachio Index annual income and capital returns: 1992 to 2024

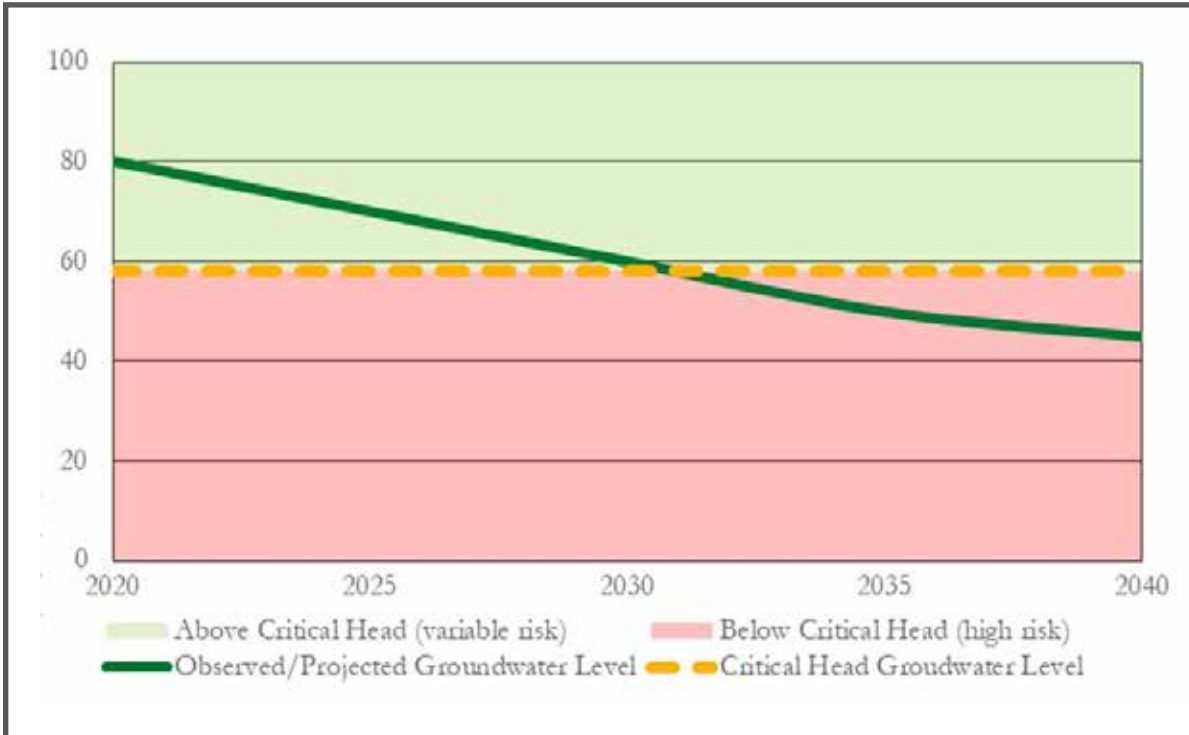


Figure 7. Visualizing critical head risk: 2020 to 2040, groundwater elevation in feet

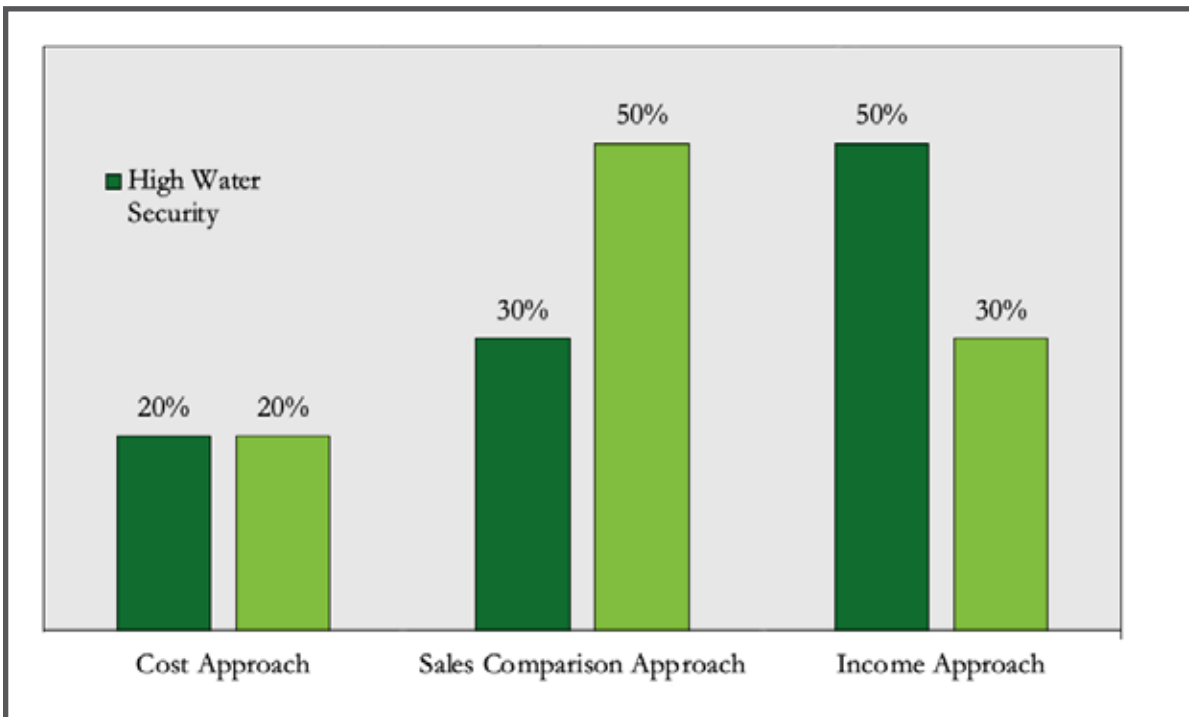


Figure 8. Reconciliation weighting by water security: relative weight (0% = low, 100% = high)

Table 1. Ranking the Reliability of Data sources for Use in Appraisals

Rank	Data Source	Reliability	Use in Appraisal
1	Independent third-party expert reports (e.g., water rights attorneys, hydrologists, LandIQ)	Highest; most defensible in appraisal reports	Primary basis for water security conclusions
2	Owner-prepared or water-district analyses with reliable data	Moderate; credible if supported by reliable underlying data	Supplemental basis when expert data is unavailable
3	Appraiser-prepared water analysis	Lowest; must be logical, transparent, and clearly supported with readily available information	Minimum threshold analysis when no other data exists

Helping Agricultural Managers Bargain for Better Sales Prices



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Abstract

A large percentage of agricultural commodity sales are transacted via private negotiation. Research suggests sellers are disadvantaged when negotiating because of the lack of information on private transactions and risks they face, especially after incurring production costs. Finding ways to better seller outcomes is important for their financial welfare and overall market efficiency. We examine what bargaining strategies offer the most promise for improving seller outcomes. Our results indicate encouraging sellers to make the first move with a high offer—and making small concessions during negotiation—best helps them improve sale price. Additionally having an alternative sale outlet if the current negotiation fails improves their outcome.

INTRODUCTION

Many managers selling agricultural products negotiate privately with buyers for prices. Nearly 33% of agricultural products sold (on a dollar value basis) are marketed through privately negotiated contracts (Whitt, 2022). A growing body of research conducting economic experiments in a laboratory

setting indicates that sellers involved in privately negotiating commodity trades face risks and resulting bargaining behaviors that reduce their sales outcomes (Menkhaus, Phillips, and Bastian, 2003; Menkhaus et al., 2007; Phillips et al., 2014; Bastian, 2019; Bastian et al., 2021). Empirical research in agricultural commodity markets also confirms sellers are at a disadvantage when negotiating privately with buyers (Courtois and Subervie, 2015; Shokoohi, Chizari, and Asgari, 2019; Sogn-Grundvåg and Zhang, 2022).

One risk that significantly disadvantages sellers when bargaining for prices occurs when they incur production costs prior to any promise of revenue—this is called advance production risk (Bastian et al., 2021). Examples where agricultural managers have incurred production costs and may have inventory on hand prior to negotiating price include cattle (fed and feeder), many field crops, and even some specialty crops (Menkhaus, Phillips, and Bastian, 2003; MacDonald, 2015; Whitt, 2022). Under advance production risk, when sellers enter negotiations with buyers, they risk not receiving revenue from the sale to cover production costs if an agreement is not reached (Sabasi et al., 2013; Menkhaus et al., 2007). Given this risk, sellers often make concessions during bargaining and accept lower trade prices rather than risk losing all their production costs or face quality deterioration before finding another buyer (Bastian et al., 2021). Research has found sellers receive prices nearly 7-10% below competitive prices because of this risk (Menkhaus, Phillips, and Bastian, 2003; Rahman et al., 2019).

One potential way to increase market efficiency and help agricultural sellers overcome their bargaining disadvantage during private negotiations with advance production risk is through improved bargaining strategy information or training. This has been found to be effective in other settings outside agricultural markets where sellers do not face advance production risk (e.g., Nadler, Thompson, and Boven, 2003; Movius, 2008; Zerres et al., 2013; Baber, 2022)¹. Negotiation theory and research suggest certain strategies can increase individual outcomes, e.g., having information about the product that value negotiation partners place on the good (e.g., sellers knowing the maximum price buyers would be willing to pay or the value below which they would walk away from the negotiation) (Fisher, Ury, and Patton, 2011), making an aggressive first offer during negotiations (e.g., Ritov, 1996; Galinsky and Mussweiler, 2001; Krause et al., 2006), making few concessions during negotiations (e.g., Hüffmeier et al., 2014), spending more time actively negotiating (e.g., Phillips et al., 2014; Jones Ritten et al., 2020), and having an outside option if the current negotiation fails (known as the

best alternative to a negotiated agreement, or BATNA) (e.g., Pinkley, Neale, and Bennett, 1994; Subramanian, 2010; Brady, Inesi, and Mussweiler, 2021), all of which have been found to increase individual negotiation outcomes². If agricultural sellers knew about and used these tactics during negotiations, they may be able to negotiate better prices for their products.

However, previous interviews with western producers indicate that they feel like they don't have much bargaining power during private negotiations and don't often use these negotiation tactics. In direct interviews with agricultural producers, Bastian et al. (2018) find that they often let buyers make the first move during negotiations, and if they did try to make the first move, only about half indicated they tried to start with an offer price higher than their target price. Further, producers reported that they felt they needed to accept the bid from the buyer, rather than risk a failed negotiation and having to find another buyer, thus they did not make many small concessions or spend much time negotiating. Bastian (2019) analyzes bargaining strategy indicators of agribusiness professionals (comprised largely of producers) participating in negotiation experiments and finds that only 27% made the first move in the negotiation, averaged about two counteroffers during negotiation, and on average made larger concessions per counteroffer than buyers when in the seller role. Further, Bastian et al. (2018) find no evidence that agricultural producers generally have a BATNA in place, such as another buyer arranged in case the current negotiations fail.

Although research suggests that agricultural producers do not currently use the tactics that could help their bargaining outcomes, these sellers want information and training on these strategies, since they believe it will help them in negotiating market transactions (Bastian et al., 2018). It should be noted that extension resources focused on various aspects of negotiation for agricultural professionals have recently been developed (Bastian et al., 2022). One module specifically focused on sales prices is available, and it generally discusses many of the strategies tested here, but at the time of this writing, no published research exists testing their effectiveness when sellers face advance production risk.

We conduct research using bargaining experiments in which sellers face advance production risk to test if sellers can receive better prices using these recommended strategies. Sellers receive various bargaining strategy information in each of five bargaining rounds, then we examine the impacts of these information treatments on both seller and buyer

outcomes. We also examine the effects other factors such as gender, risk preference, or previous negotiation experience have on the bargaining outcomes in these experiments, given past research findings (Muthoo, 1999; Herbst and Schwartz, 2011; Steinel, Abele, and De Dreu, 2007; Cooper and Roth, 2015; Rausser and Simon, 2016; Jones Ritten et al., 2020). Based on our results, we conclude with a discussion regarding which strategies show the most promise for helping agricultural managers negotiate better sales prices.

METHODS AND DATA

We use economic experiments to achieve our research objective.

Experiments

The use of laboratory economic experiments provides a controlled environment to investigate the influences of strategy information on bargaining outcomes (Davis and Holt, 1993), and research has indicated that the behavior of participants in these types of experiments mimics the behavior seen when actual agricultural producers participate (Bastian, 2019; Nagler et al., 2013).

Our experiments followed standard practices in experimental economics (Plott, 1982; Davis and Holt, 1993), and we provided participants with significant cash payoffs based on their performance, which has been found to motivate participants to behave rationally (Friedman and Sunder, 1994). Participants could make between \$20 to \$120 for a two-hour session, but the average was \$70. Participants were given a pre- and post-questionnaire asking about their bargaining experience and confidence about their bargaining outcomes. Once the post-questionnaire was completed, the participants were paid in cash based on their earnings during the bargaining rounds and allowed to leave.

Bargaining Round Descriptions

Bargaining round one: base treatment. In bargaining round one, buyers were only informed of the resale value they would receive for the unit they were bargaining for, while sellers were only informed of their unit cost for that period. Sellers were informed that if they did not sell their unit during bargaining in any of the rounds, they would lose the full cost of production when tallying their earnings. This created the advance production risk described previously. After reviewing this information, the five-minute clock started, and bargaining began. After the five minutes were up, buyers and sellers filled out their respective record and earnings sheets.

It should be noted that in each bargaining round after the sellers' unit costs were changed and the buyers' resale values were changed, the value difference between the seller's cost and buyer's resale value remained the same. This kept the participants from forming an expectation about what the negotiated price should be each time and avoided anchoring on the previous round price.

Bargaining round two: seller knows buyer's resale value. Treatment 2 provided additional information about the buyer to the sellers. Sellers were given the following information: "The average buyer can resell this unit you have for sale for this amount: \$XX. Your unit cost of production for the unit you have for sale this bargaining period is: \$XX." Buyers only had access to their resale value and did not receive information on the seller's unit cost, giving added bargaining information only to sellers.

Producer interviews have indicated that sellers want better information about what their product is worth to buyers (Bastian et al., 2018), and negotiation research indicates that knowing information about your trading partner's value improves individual and joint negotiation outcomes (Fisher, Ury, and Patton, 2011). This treatment was designed to help sellers by providing them with the maximum price buyers should be willing to pay for a unit.

Bargaining round three: having a sale alternative or BATNA. The information in Treatment 2 regarding buyer resale value was not given to sellers in Treatment 3, but sellers were told the following: "If you do not negotiate a sale price with this buyer, another buyer will purchase this unit from you. You will be paid \$XX for this unit if you do not negotiate a sale price with this buyer." Sellers were guaranteed earnings of \$5 if they failed to agree upon a price with the buyer, which represented a BATNA for sellers only.

Past research has found that if negotiators know their potential alternatives and related consequences, it can improve their outcomes as they are less concerned about the outcome if the current negotiation fails (e.g., Subramanian, 2010). These alternatives help sellers set a higher reservation value (i.e., the lowest amount a seller would be willing to sell their product for) than without a BATNA, which should increase seller earnings (Pinkley, Neale, and Bennett, 1994; Subramanian, 2010).

Bargaining round four: make high offer and many small concessions. In Treatment 4, buyers again received information regarding their resale value, and

sellers knew their unit cost. In this round, sellers also received the following information: “*You should make a very high first offer. During negotiation, make many small concessions rather than a few large ones. This strategy has been shown to increase the price sellers receive.*”

The very high first offer creates an anchoring effect, which leads to an advantage for sellers, resulting in the negotiation going in their favor and bettering their outcomes (Ritov 1996; Galinsky and Mussweiler, 2001; Krause et al., 2006). Hüffmeier et al. (2014) find that small concessions in negotiation lead to better outcomes than that of few large concessions. Research has called this a “patient” bargaining strategy (Phillips et al., 2014; Jones Ritten et al., 2020), and is thought to lead to better outcomes because sellers are sending buyers the signal that they intend to make a large profit and will not give up any more value than they deem necessary (Hüffmeier et al., 2014).

Bargaining round five: buyers and sellers receive overview of negotiation strategy. Prior to bargaining, both buyers and sellers listened to a presentation by an expert in negotiation, outlining the basics of optimal negotiation strategy. The presentation included general information on strategies found to improve individual negotiation outcomes, including reservation values, BATNAs, opening offers, and guidelines for making concessions (Druckman, Zechmeister, and Solomon, 1972; White and Neale, 1991; Sebenius, 1992; Ritov, 1996; Galinsky and Mussweiler, 2001; Krause, Terpend, and Petersen, 2006; Subramanian, 2010; Hüffmeier et al., 2014; Phillips et al., 2014).

Treatment 5 offered a way to test the potential cumulative effect of asymmetric information sellers received in Treatments 2 through 4 to both buyers and sellers receiving the same information. Zervas et al. (2013) tested unilateral versus bilateral information treatments across a base and information treatments and found that unilateral information was effective in changing outcomes for those in seller roles, but pairs receiving bilateral information were able to improve joint outcomes.

DATA ANALYSIS

Once all the bargaining rounds were completed, participants filled out the post-questionnaire and were then paid in cash based on their cumulative earnings in the experiment. All data from the pre- and post-questionnaires, as well as the record sheets and bargaining outcomes, were entered into an Excel spreadsheet for analysis. Data were recorded for 110

participants (55 buyers and 55 sellers), generating 550 earnings data points (275 bargaining round earning amounts for sellers and for buyers).

Descriptive statistics were calculated for pre- and post-questionnaire responses as well as demographic characteristics. Additionally, frequencies were estimated for responses to select Likert-scale questions to understand participant perceptions about bargaining power and the impact of information received during the experiment. We generally calculate these descriptive statistics for the total sample as well as by agent role to understand potential differences between buyers and sellers. We conducted chi-square tests to test for differences in frequencies using the PROC FREQ procedure in SAS (SAS, 2016a). While descriptive statistics and chi-square tests provide useful insights, we use a multivariate regression model for both buyers and sellers.

Our data likely exhibit issues found in panel data, and we correct for that using a procedure called a Heteroscedastic Autocorrelation or HAC estimator (Petersen, 2009; Newey and West, 1994; SAS, 2016b).

RESULTS

We first analyze the pre- and post-questionnaire responses of participants.

Descriptive Statistics

In the interest of brevity, we focus on the participants' feelings toward their marketing and price negotiation abilities and strategies as found in the pre- and post-questionnaires. In particular, we focus on some key findings that relate to their satisfaction with their knowledge of negotiating price, if they perceive buyers having an advantage over sellers in a private negotiation, if as sellers they try to offer a higher price than their target price, and as sellers if they try to not spend too much time bargaining (for full statistics detail see Appendix: Detailed Statistics Table, Table 1).

When comparing the satisfaction of participants' knowledge of negotiating prices from the pre- to post-questionnaire, the participants who selected “strongly agree/agree” significantly increased (Figure 1), with sellers increasing by around 40 percentage points and buyers by 44 percentage points from pre- to post-experiment. There was also a significant increase in the percentage of participants selecting “strongly agree/agree” from the pre- to post-questionnaire for believing buyers have an advantage over sellers in private negotiation (Figure 2). The largest increase from

the pre- to post-questionnaire occurred with buyers, increasing by about 42 percentage points for “strongly agree/agree” to buyers having an advantage over sellers, while the increase for sellers was 19 percentage points.

The majority of participants strongly agreed/agreed that as a seller, they tried to offer a higher price than their target price both before and after the experiment. The percentage of participants strongly agreeing/agreeing did significantly increase for all participants and by agent roles when compared to the pre- and post-questionnaire. The greatest increase was from those in the seller role, with a 22 percentage points increase from 76% to 98%, who strongly agree/agree that they offered a higher price than their target price (Figure 3). There was a general increase from the pre- to post-questionnaire in participants strongly agreeing/agreeing that as a seller, they tried to make the first offer, yet this increase was only found to be statistically significant for the participants in the buyer role, which increased 4 percentage points (Figure 4). In the pre-questionnaire, when asked whether as a seller, participants tried not to spend too much time bargaining, there was an even spread across the Likert scale. After the experiment, statistically more participants “strongly disagreed/disagreed” with that statement than before the study, with sellers’ disagreement increasing by 18 percentage points and buyers’ disagreement increasing by 16 percentage points (Figure 5). Overall, these results suggest changes occurred amongst participants related to their perceptions regarding price negotiation after completing the experiment and the information treatments.

Multivariate Regression

We conduct separate multivariate regressions for sellers and buyers to capture the influence of multiple variables on earnings during the bargaining experiments related to potential information impacts. Using earnings as the dependent variable, we analyze the effects of information received in the bargaining treatments or rounds coded as dummy variables. The regressions also include risk preference and previous experience as a seller or buyer, as these are variables that have been proven to affect earnings in private negotiation (Muthoo, 1999; Herbst and Schwarz, 2011). We separate the experience for sellers and buyers for the regressions to avoid multicollinearity as the agents’ experiences as sellers and buyers are highly correlated. Moreover, we include gender as a variable, given that past research finds differences in gender behavior related to negotiation in both buyer and seller roles (Jones Ritten et al., 2020). We code men as a 0 and

women as 1; these treatment effects, along with the gender and risk preference effects, are presented in Table 1.

It is important to note that Treatment 1 buyers do better than sellers on average, capturing over 50% of the available surplus (\$20) and supporting the notion that without additional information, sellers are at a disadvantage when bargaining privately in the face of advance production risk. In Treatments 2 and 3, the information provided to sellers did not lead to statistically different earnings for sellers (Table 1), suggesting that knowledge of the buyer’s resale value for the unit (Treatment 2) did not have a significant impact on sellers’ ability to bargain for more of the available surplus. While the impact is not statistically significant, we do see an increase in sellers’ earnings when they were given a BATNA, and Treatment 3 has a significant and negative effect on earnings for buyers accordingly. This suggests that sellers having a BATNA did allow them to negotiate for outcomes that ultimately reduced buyers’ earnings.

When sellers received information indicating they should make a “high first offer” and “make many small concessions rather than few large concessions” when negotiating (Treatment 4), results indicate this resulted in a significant increase in earnings for sellers and a significant decrease in buyers’ earnings. Further, Treatment 5, where both buyers and sellers received a presentation that provided an overview of negotiation strategy, resulted in the opposite effect on earnings for sellers and buyers than Treatment 4, with buyers regaining their bargaining advantage. Yet, it is important to note that the parameter estimates show the relative advantage that Treatment 4’s information had on increasing seller earnings was larger than the decrease in seller earnings in Treatment 5. Giving the bargaining strategy information to sellers in Treatment 4 increased sellers’ earnings by \$4.91 (buyers’ earnings decreased by \$4.80), but providing information to both buyers and sellers in Treatment 5 caused sellers’ earnings to decrease by \$1.98, while buyers’ earnings increased by \$2.04.

Finally, we note that we do not find statistically significant differences in earnings based on risk preference, gender, or experience when participating in the experiment, suggesting that information received during the bargaining experiments alone was the most important factor in determining earnings.

We further analyze the individual versus cumulative effects of treatments on earnings using F-tests on the regression coefficient from Table 1 to investigate if parameter estimates are different across treatments

other than the base (Table 2). All treatment effects were significantly different than one another at the 1% level, besides the difference between Treatments 2 and 5, which indicates that the information generally had different magnitudes of impacts. Since Treatments 2 through 4 provide information only to sellers, and Treatment 5 provides information to both buyers and sellers, we compare the cumulative effects of Treatments 2 through 4 with that of Treatment 5 to find that the difference in effects on earnings is significant at the 1% level. Overall, the sum of differences for Treatments 2 through 5 indicate nearly a net \$3 increase in seller earnings. Compared to the no strategy information (Treatment 1, baseline), this amounts to a cumulative effect of a nearly 9% earnings improvement compared to what sellers would have received if the surplus proportion had been the same as Treatment 1.

DISCUSSION

Past research indicates that the unique risks agricultural sellers typically face during private negotiation together with sellers having limited information about techniques to improve their negotiation outcomes puts them at a disadvantage when bargaining over the sale price of their products with a buyer (Menkhaus, Phillips, and Bastian, 2003; Courtois and Subervie, 2015; Bastian, 2019; Shokoohi, Chizari, and Asgari, 2019).

A comparison of pre- and post-questionnaire responses indicates that participants felt they had improved their knowledge about negotiation and bargaining strategies after completing the experimental session. Our results show that when sellers are told to make the first offer, make a high first offer, and make many small concessions during bargaining, it has a relatively large positive impact on their earnings. Utilizing these bargaining strategy techniques, sellers on average were able to receive most of the available surplus during negotiations. Our results are consistent with past literature, indicating that making a very high first offer creates an anchoring effect and making multiple small concessions signals sellers' intentions to improve their earnings to buyers (Ritov, 1996; Galinsky and Mussweiler, 2001; Krause, Terpend, and Petersen, 2006; Hüffmeier et al., 2014). However, it is important to note that in past research, sellers did not face advance production risk, i.e., sellers incurred production costs prior to bargaining. Sellers also experienced a positive influence on earnings when given a BATNA, though it was not statistically significant. Interestingly, buyers experienced a statistically significant negative impact on their earnings when sellers were given a BATNA, suggesting

that sellers were able to extract surplus from buyers. Although these strategies led to better outcomes, sellers were unable to carry over this benefit when strategic negotiation information was given to both sellers and buyers. However, the cumulative effect of these strategies was positive for sellers overall.

Overall, these results suggest that producers should focus on developing a BATNA along with taking a strategy of making the first offer and making small concessions during bargaining. Moreover, our results support the notion that focus group communications regarding producers' general negotiation behavior as reported in Bastian et al. (2018) does not put agricultural sellers in the best bargaining position. Additionally, producers should be aware of the impact that advance production risk can have on their willingness to make concessions during negotiation.

FOOTNOTES

- 1 While price risk management tools such as futures, options, and price risk insurance products exist to help agricultural sellers, we are focused here on finding information to help sellers bargain for sales prices when negotiating with a buyer privately.
- 2 It should be noted that in the research literature discussed previously, sellers did not face advance production risk, thus, it is an open question as to whether these tactics will ultimately improve agricultural seller outcomes. Hence we conducted this research.

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Figure 1. Participants indicating their satisfaction with their negotiation knowledge



Figure 2. Participants indicating belief in buyers having bargaining advantage



Figure 3. Participants indicating sellers should offer higher than target price

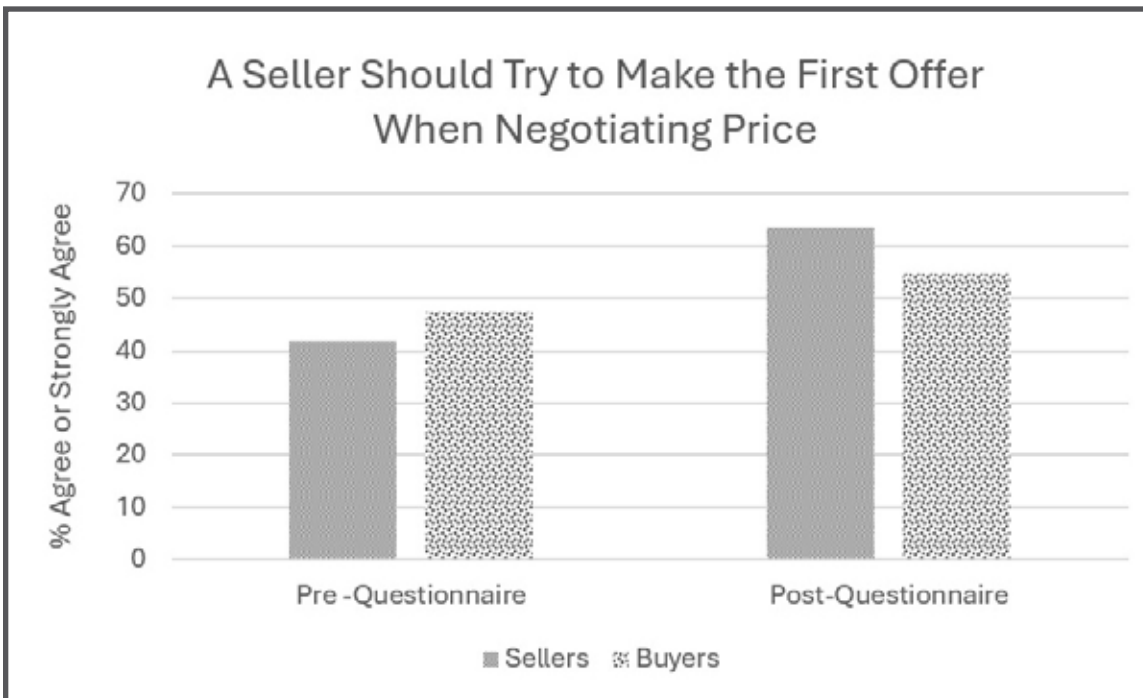


Figure 4. Participants indicating sellers should make the first offer

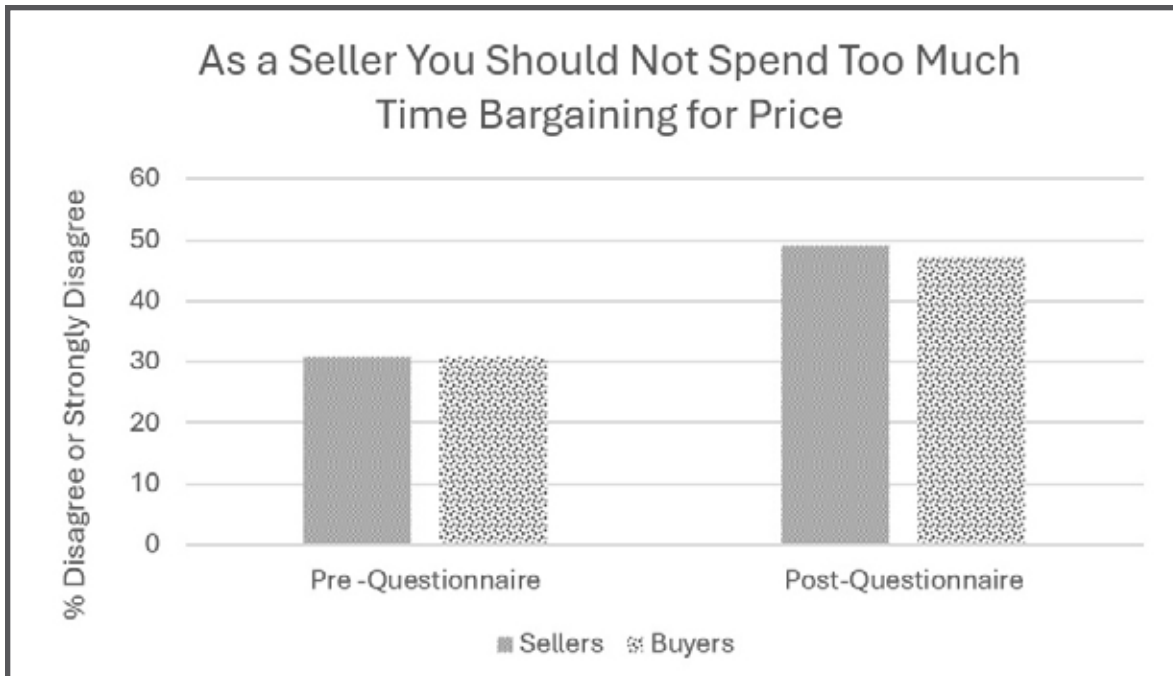


Figure 5. Participants indicating thoughts on time spent bargaining

Table 1. Multivariate Regression of Earnings (in dollars) for Participant Sellers and Buyers in the Bargaining Experiments		
Variables	Seller N= 270	Buyer N=270
	Estimate (standard error)	Estimate (standard error)
Intercept (Base; no info)	8.364 (1.326)***	10.445 (1.655)***
Treatment 2 (RV to sellers)	-1.519 (1.043)	1.556 (0.993)
Treatment 3 (BATNA)	1.593 (0.979)	-1.963 (0.969)**
Treatment 4 (Strategy info to sellers)	4.907 (1.225)***	-4.796 (1.126)***
Treatment 5 (Strategy presentation to all)	-1.982 (1.176)*	2.037 (1.159)*
Risk Preference	0.280 (0.276)	0.072 (0.413)
Gender	0.089 (0.781)	-0.943 (0.942)
Experience as Seller/Buyer	0.023 (0.134)	0.076 (0.108)
R-Square	0.158	0.164

Notes: If standard errors are denoted by *, then the parameter is significant at the 10% level, if ** at the 5% level, and if *** at the 1% level. If not denoted by an asterisk, then there is no reportable significance. RV stands for redemption value, i.e., this is the value of the unit to the buyer in that treatment. BATNA stands for best alternative to a negotiated agreement—this was the alternative value sellers could receive in treatment 3 if they did not come to agreement with buyers.

Table 2. Analysis of Individual versus Cumulative Effects of Treatments on Earnings (in dollars) for Participant Sellers and Buyers in the Bargaining Experiments from the Multivariate Regression Coefficients

	Seller	Buyer
Treatment 2 (RV to Sellers) = Treatment 3 (BATNA)	15.22***	17.19***
Treatment 2 (RV to Sellers) = Treatment 4 (Seller strategy info)	35.70***	28.80***
Treatment 2 (RV to Sellers) = Treatment 5 (Strategy presentation to all)	0.18	0.17
Treatment 3 (BATNA) = Treatment 4 (Seller strategy info)	11.15***	6.70***
Treatment 3 (BATNA) = Treatment 5 (Strategy presentation to all)	11.52***	14.01***
Treatment 4 (Seller strategy info) = Treatment 5 (Strategy presentation to all)	35.25***	44.30***
Treatment 2 + Treatment 3 + Treatment 4 = Treatment 5	9.27***	13.42***

Notes: Reported statistic is an F-value. If denoted by ***, then the parameter is significant at the 1% level. RV stands for redemption value, i.e., this is the value of the unit to the buyer in that treatment. BATNA stands for best alternative to a negotiated agreement—this was the alternative value sellers could receive in treatment 3 if they did not come to agreement with buyers.

APPENDIX: DETAILED STATISTICS TABLE

Table A1. Feelings of Experiment Participants Toward Price Negotiation Abilities and Strategies Based on Pre- and Post-Questionnaires							
Question	Response	All Participants		Seller Participants		Buyer Participants	
		Pre	Post	Pre	Post	Pre	Post
Satisfied with knowledge of negotiating price	SD/D	37.27%	12.73%	43.64%	14.55%	30.91%	10.91%
	Neutral	35.45%	21.82%	32.73%	23.64%	38.18%	20.00%
	SA/A	23.64%	65.45%	21.81%	61.81%	25.46%	69.09%
	N/A or DK	3.64%	0.00%	1.82%	0.00%	5.46%	0.00%
	Chi-square	48.658*** (0.0021)		33.203** (0.0321)		46.137*** (0.0043)	
Buyers have an advantage over sellers	SD/D	33.63%	15.46%	25.46%	23.63%	41.82%	7.27%
	Neutral	24.55%	17.27%	25.45%	14.55%	23.64%	20.00%
	SA/A	35.46%	65.46%	41.81%	60.00%	29.09%	70.91%
	N/A or DK	6.37%	1.82%	7.28%	1.82%	5.46%	1.82%
	Chi-square	45.669** (0.0334)		42.435* (0.0657)		44.106*** (0.0074)	
As seller, offer a higher price than my target price	SD/D	4.55%	1.82%	3.64%	1.82%	5.46%	1.82%
	Neutral	10.91%	2.73%	14.55%	0.00%	7.27%	5.45%
	SA/A	76.36%	89.09%	76.37%	98.18%	76.36%	80.00%
	N/A or DK	8.18%	7.28%	5.45%	0.00%	10.91%	12.72%
	Chi-Square	95.907*** (<0.0001)		13.661* (0.0910)		83.264*** (<0.0001)	
As seller, try to make the first offer	SD/D	19.10%	20.91%	18.18%	21.82%	20.00%	20.00%
	Neutral	25.45%	13.64%	29.09%	14.55%	21.82%	12.73
	SA/A	44.55%	59.10%	41.82%	63.63%	47.27%	54.55%
	N/A or DK	10.91%	6.37%	10.91%	0.00%	10.90%	12.72%
	Chi-square	43.988 (0.1693)		19.912 (0.7018)		51.383** (0.0464)	
As seller, try to not spend too much time bargaining	SD/D	30.91%	48.18%	30.91%	49.09%	30.91%	47.28%
	Neutral	30.00%	22.73%	30.91%	27.27%	29.09%	18.18%
	SA/A	28.18%	22.73%	29.09%	23.64%	27.27%	21.81%
	N/A or DK	10.91%	6.37%	9.09%	0.00%	12.72%	12.72%
	Chi-square	100.507*** (<0.0001)		37.004** (0.0437)		74.461*** (0.0002)	

Notes: Data for this table come from questionnaire responses of participants in bargaining training experiments. Likert-scale responses included the following: strongly disagree (SD); disagree (D); neutral; agree (A); strongly agree (SA); no answer (NA); or don't know (DK). Chi-square statistics are reported, and the numbers in parentheses below them are significance probabilities. If the reported statistic is denoted by *, then the statistic is significant at the 10% level, if denoted by ** at the 5% level, and *** at the 1% level.

Comparing the Recent Base Update with Competing Proposals



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Abstract

Considering that income support provisions have been decoupled from production in all farm bills since the Federal Agriculture Improvement and Reform Act of 1996, base acres are no longer reflective of planted acres in the United States. Several alternatives have been discussed to better align base acres with current plantings. To comprehensively evaluate the alternatives, this study undertook a national analysis utilizing public data from the United States Department of Agriculture's Farm Service

Agency (USDA-FSA). The results highlight winners and losers across different crops and regions.

INTRODUCTION

Since the Federal Agriculture Improvement and Reform Act of 1996 (also known as the 1996 Farm Bill) was signed into law, Title I safety net programs have been decoupled from production. In other words, program payments do not depend on production decisions and are paid on each covered commodity's base acres rather than planted acres. Base acres represent a farm's historically planted acreage of covered commodities, a list that includes barley, canola, chickpeas, corn, crambe seed, dry peas, flaxseed, grain sorghum, lentils, mustard seed, oats, peanuts, rapeseed, rice, safflower, seed cotton, sesame seed, soybeans, sunflower seeds, and wheat, and do not necessarily reflect what the farm is currently planting (USDA-FSA, 2025a). The United States Department of Agriculture's Farm Service Agency (USDA-FSA) uses base acres for making payments and determining program eligibility under Title I of the 1996 Farm Bill. Since the concept of base acres was established in the mid-1980s, farmers have only had three opportunities to modify their crop base acres: 2002, 2014, and only for cotton in 2018. Over time, producers have been given the flexibility to plant for the market rather than for government payments on those acres for which they have crop base. Certain Title I payments, i.e., Agriculture Risk Coverage (ARC) and Price Loss Coverage (PLC), if triggered, are paid on base acres, which may not match planted acres.

Throughout the prolonged farm bill negotiations that preceded passage of the One Big Beautiful Bill Act (OBBBA) in July 2025, numerous recommendations emerged on how a base acre update should be handled. Since changes to base acres can substantially affect USDA-FSA program payments under ARC and PLC, many of these proposals were driven by stakeholders seeking favorable outcomes for their members, including:

- a mandatory base update determined by current plantings as proposed by the National Corn Growers Association;
- a mandatory base update determined by establishing base acres using a two-year rolling average of planted acres; and
- a voluntary addition of new base acres if the five-year average of plantings on a farm is greater than the current base, where the addition of new base acreage is capped at 30 million acres nationwide, as adopted in the OBBBA.

BACKGROUND

The concept of base acres was established in the Food Security Act of 1985 (also known as the 1985 Farm Bill) to create an efficient, equitable, flexible, and predictable basis on which farm program payments could be made. In the 1985 Farm Bill, base acreage was calculated as the rolling average of the five years preceding the given crop year (Glaser, 1986), with subsequent years held at the initial levels developed in 1985. In 1996, the concept of freedom to farm was introduced, and the Federal Agriculture Improvement and Reform Act of 1996 (also known as the 1996 Farm Bill) renamed base acres as contract acreage and decoupled payments from production (Young and Shields, 1996).

The Farm Security and Rural Investment Act of 2002 (also known as the 2002 Farm Bill) reinstated base acres and provided the opportunity to update them. Decoupled payments and planting flexibility continued, but the bill reintroduced two income support programs: direct payments (DP) and counter-cyclical payments (CCPs) (albeit decoupled from production). The bill allowed farmers a one-time voluntary opportunity to align base acres more closely with current plantings. Owners were given five options under the 2002 Farm Bill (Young, 2008): 1) retain the contract acreage used for the 1996 Farm Bill, 2) retain contract acreage used for the 1996 Farm Bill and add maximum eligible oilseeds, 3) retain contract acreage used for the 1996 Farm Bill and add minimum eligible oilseeds, (4) retain contract acreage used for the 1996 Farm Bill and add some combination of eligible oilseeds, or (5) change the base to the four-year average of planted and considered planted acres¹ from 1998 to 2001. The failure to select automatically enrolled owners in the first option.

The Agricultural Act of 2014 (also known as the 2014 Farm Bill) again allowed a voluntary option to update bases and was determined by using the average of

planted and considered planted acres on the farm for each covered commodity during the 2009 through 2012 crop years. Electing to update base acres only changed the base distribution among the program crops on the farm, though, not the total base acres (USDA-ERS, 2025): if owners did not elect to reallocate, they retained the existing base acreage for their farm. In a major change from previous farm bills, the 2014 Farm Bill removed upland cotton as a covered commodity due to the World Trade Organization's (WTO) ongoing cotton case, a decade-long dispute between the United States and Brazil that found certain support payments to U.S. farmers for cotton were not consistent with WTO commitments. As a result of upland cotton no longer being a covered commodity, the base acres for upland cotton were renamed generic base acres, which could be annually assigned to other covered commodities based on plantings throughout the life of the 2014 Farm Bill. If the land was idled, then the producer would not receive government support for those acres. The primary Title I commodity support programs included in the 2014 Farm Bill were:

- PLC, an income support program that triggers when commodity prices fall below the statutory reference price.
- ARC, a shallow-loss program that triggers when crop revenue falls below a benchmark based on historic revenue. Specifically, losses are paid if annual revenue for the commodity falls below 86% of the calculated benchmark, not to exceed 10% of the benchmark.

The Bipartisan Budget Act of 2018 brought upland cotton producers back into Title I protection as seed cotton and addressed the elimination of generic base acres. On farms where no covered commodities were planted from 2009 to 2015, the generic base acres on the farm became an unassigned crop base that was ineligible for PLC and ARC payments. If a producer planted covered commodities on their farm from 2009 to 2012, owners were given two options to convert this generic base to seed cotton or another covered commodity base (USDA-FSA, 2018):

- Option 1, the higher of 80% of the generic base acres on the farm or the average acres of seed cotton planted and considered planted during the 2009 through 2012 crop years, not to exceed the total generic base acres on the farm. (Note: in option 1, any unconverted generic base became unassigned crop base and were ineligible for PLC and ARC payments.)

- Option 2, allocate the generic base in proportion to the acres of seed cotton and other covered commodities planted and considered planted during the 2009 through 2012 crop years. (Note: Option 2 did not result in any unassigned crop base.)

The failure to select an option automatically enrolled owners in Option 1.

Among several improvements to the farm safety net, 2025's OBBBA included provisions to update base acres beginning with the 2026 crop year. Given the role of base acres in the calculation of PLC and ARC payments, it is relevant and timely to examine the potential effects of the OBBBA on U.S. base acres.

The objective of this analysis is to evaluate the impact each of the three base acre updating alternatives would have on commodity base acres by county as compared to current base acres. The results highlight likely winners and losers across different crops and regions, with special attention given to the provisions of the OBBBA as it will become effective for the 2026 crop.

DATA AND METHODOLOGY

Data for this analysis was collected from USDA-FSA, which requires landowners enrolled in Title I programs to provide information on the specific crops and acres that were planted annually. The following county data was obtained for all covered commodities and counties from USDA-FSA for use in evaluating the three scenarios relative to the current base acres: 1) 2021 base acre data and 2) 2019 to 2023 crop year planted and considered planted data (USDA-FSA, 2025b; USDA-FSA, 2025c). It is important to note that the county base acre data was collected from the 2021 program year, which reflects changes resulting from enactment of the Bipartisan Budget Act of 2018. Since that time, base acres have not been allowed to change except for eliminations resulting from cropland moving to a nonagricultural use. While farm-level data would be preferred, evaluating base acres as they're updated at the county level is the best alternative as the USDA-FSA data is only published by county.

New base acres for each of the counties with reported USDA-FSA planted acres and bases were calculated using three alternative methods. As a reminder, the base acre scenarios are:

- **Scenario 1:** the National Corn Growers Association's mandatory base update.

- **Scenario 2:** the rolling average approach.
- **Scenario 3:** the OBBBA method.

The first two scenarios provide context for the OBBBA approach. This analysis focused on the nine covered commodities that represent more than 95% of base acres: barley, corn, seed cotton, oats, peanuts, sorghum, soybeans, and wheat. Base acres for the other 14 of the 23 covered commodities, such as canola, sunflower, and sesame, were not analyzed in this study.

Scenario 1 was calculated by taking a five-year Olympic average of planted and considered planted acres for the crop years 2019 to 2023. The two-year lagged Olympic average was calculated by dropping the highest and lowest observations in the data and averaging the remaining three observations to determine the base acres for the 2026 crop year. Under Scenario 1, total base acres in the county were allowed to increase or decrease depending on the differences in recent plantings patterns and the current baseline. Under this scenario, crop years in which a covered commodity was not planted were included as zero.

Scenario 2 was calculated by taking a two-year average of planted and considered planted acres, and as in Scenario 1, implementing a two-year lag. In determining the two-year rolling average for counties, crop years in which a covered commodity was not planted were included as zero. Using a two-year rolling average would allow for base acres to change each year during the life of a farm bill rather than having to wait for a base acre change in subsequent bills. Therefore, to display the effects of a dynamic calculation, the following baselines for the 2024, 2025, and 2026 crop years were, respectively, calculated by averaging the planted and considered planted acres from 2020 and 2021, 2021 and 2022, and 2022 and 2023.

The new total base acres in the counties for 2024 were allowed to increase or decrease as the planting patterns changed compared to the current base acres, and the following two years' base acres were subsequently allowed to change compared to the prior years' base acres.

Scenario 3 takes a systematic approach in determining new base acres, with two important caveats to note: 1) a reduction in total base acres is not allowed under this method, and 2) the increase in base acres is to be capped at 30 million nationwide (Munch, Ayoub, and Parum, 2025). The 30-million-acre cap in the OBBBA refers to all FSA-covered commodities, but for the purposes of this study, only the nine major covered

commodities were considered. In Scenario 3, if the baseline was greater than the five-year average of planted and considered planted acres for crop years 2019 to 2023, then the base acres were not changed. However, if current base acres were less than the five-year average of planted and considered planted acres from crop years 2019 to 2023, then the following steps were used to calculate the additional base:

1. The current base acres were subtracted from the five-year average of planted and considered planted acres from crop years 2019 to 2023.
2. The potential additional base acres calculated in Step 2 were aggregated across all counties for each of the nine commodities.
3. If Step 2 was:
 - a. less than or equal to 30 million acres, then the additional baseline would be equal to Step 2.
 - b. greater than 30 million acres, then the portion of additional acres retained would be equal to the 30-million-acre cap divided by the total from Step 2.

If Step 3a was employed, the total new bases acres for the 2026 crop year were calculated by summing the current baseline and the aggregation of acreage from Step 3. If Step 3b was employed, the total new base acres for the 2026 crop were calculated by summing current base acres and the proportion of the aggregation of acreage from Step 2. In determining the five-year average under this scenario, crop years in which a covered commodity was not planted were included as zero.

RESULTS

The results will be presented as 1) quantitative changes in base acres by commodity and 2) aggregated geographical effects. The purpose of examining quantitative effects is to determine which crops experience the largest and smallest changes relative to current base acres. The purpose of examining the aggregated geographical effect is to provide a visual representation of the changes in county base acres across the U.S.

There was a significant amount of speculation that base updating will result in the Northern U.S. region benefitting substantially more than other regions, leading to another motivation for examining the aggregated geographical effect. The changes in base for each of the nine crops that were analyzed in this

study were calculated for U.S. counties and displayed in maps. Each map applies a red-to-white-to-green color scale, where red represents negative change, white indicates little to no change, green represents positive change, and if gray areas appear, that means no data was available for those counties.

Scenario 1

Under Scenario 1, the total base acres for the nine covered commodities analyzed in this study decreased by 10,320,134 acres, a 3.89% decrease compared to current base acres. In terms of percent change from the current to new base acres, the commodities losing base acreage, from the largest to the smallest percentage decline, were barley, peanuts, sorghum, rice, wheat, oats, cotton, and corn. Soybeans were the only commodity to exhibit an increase in base acres under this scenario (Table 1). It is apparent that while wheat and corn bases would decline the most in absolute terms, on a percentage basis, barley would lose over half of its base, while peanuts, sorghum, and rice would lose almost 40% of their current base acres. Implementing Scenario 1 would result in 10.3 million fewer acres of base relative to current base acres, which would in turn reduce the number of acres on which farmers across the U.S. would receive Title I program benefits.

Figure 1 displays the county-level aggregated absolute change between the current base acres and the method applied in Scenario 1. The largest reductions in base acres occur in the Northern Great Plains (particularly in Montana, South Dakota, and Colorado) and the West (Washington, Oregon, and California). Although the gains are less pronounced, moderate increases are evident in the Corn Belt into Texas and Louisiana. These patterns suggest that Scenario 1 generally moves base acres toward corn- and soybean-producing areas and away from wheat (Montana, Colorado, and Washington) and rice (California) production areas, consistent with the results in Table 1. Overall, the takeaway for Scenario 1 is the static characteristics of base acre updating that will create downside risks for most U.S. producers.

Scenario 2

The 2024 total base acres for the nine covered commodities analyzed in Scenario 2 in this study decreased by 10,124,574 acres, a 3.82% decrease compared to current base acres. In terms of percent change from the current to new base acres, the commodities losing base acreage, from the largest to the smallest percentage decline, were barley, peanuts,

rice, sorghum, wheat, cotton, oats, and corn. Soybeans again were the only commodity to gain base (Table 2).

To show the dynamic calculation of Scenario 2, Tables 3 and 4 were created to illustrate the calculated base acres for 2025 and 2026 relative to the previous year's base acres; the absolute and percent change relative to current base acres are also presented. As seen in Table 3, directly moving into a rolling average (i.e., from 2024 baseline to 2025 baseline) has vastly different results than those in Table 2, a difference that can be attributed to the large gap between the current base acres and current plantings. However, the changes shown in Table 3 are a more realistic representation of what rolling average base changes would look like. When comparing the calculated 2025 base acres to the previously calculated 2024 base acres, the total base acres increased by 455,120 acres, a 0.18% increase. The largest percent decline in base acres, ordered from largest to smallest percentage decline, were oats, rice, peanuts, and corn. Alternatively, the largest percentage increase in base acres, ordered from largest to smallest percentage increase, were cotton, barley, soybeans, sorghum, and wheat.

Table 4 shows changes between the new calculated 2026 base acres and the previously calculated 2025 base acres for Scenario 2. Total base acreage increased by 1,242,258 acres, a 0.49% increase. The largest percent decline in base acres, ordered from largest to smallest percentage decline, were cotton, soybeans, sorghum, and oats. Alternatively, the largest percentage increase in base acres, ordered from largest to smallest percentage increase, were barley, wheat, peanuts, corn, and rice.

Figure 2 is similar to Figure 1, considering Scenario 2 calculated the new base acres by utilizing a two-year average with a two-year lag. Scenario 1 calculated the new base acres by utilizing a five-year Olympic average with a two-year lag, which equates to a three-year average after dropping the highest and lowest crop year plantings. The differentiating factor is that Figure 2 displays the county-level aggregated absolute change between the current base acres and the new base acres for the crop year 2024, not 2026. Moderate increases are evident in the Corn Belt down through Texas and Louisiana. The absolute change between current and proposed base acres in 2024, like Figure 1, suggests base acres would move toward corn- and soybean-producing areas, again consistent with Table 2.

Figure 3 displays the county-level absolute change between the 2024 base acres and the new base acres

calculated for crop year 2025 in Scenario 2. Overall, there were small gains and losses in counties across the U.S., meaning that no region experienced large-scale increases or decreases. In fact, most changes fell within the 100- to 50,000-acre loss or gain categories accordingly. Compared to the previous figures, a greater number of counties experience little to no change (white counties), with the regions that most clearly exhibit this limited change in the Rocky Mountains and Eastern Seaboard. The contrast between Figures 2 and 3 highlights that while adopting a new baseline modification system led to larger losses up front, due to gaps between current base acres and current plantings, the magnitude of the effect diminishes over time as the base acres stabilize.

The county-level aggregated absolute change between the 2025 base acres and the new base acres for crop year 2026 for Scenario 2 is displayed in Figure 4. Like Figure 3, the calculated base acres show small impacts as the observed changes reflect moving toward recent plantings. The most notable shifts occur in the state of Arkansas, where a combination of gains and losses may reflect changes in recent planting decisions. Across the remainder of the country, most changes fall within the 100- to 50,000-acre loss or gain categories.

While Table 2/Figure 2 have many similarities with Table 1/Figure 1, the drastic difference between Scenarios 1 and 2 is due to the static characteristics of Scenario 1 and the dynamic characteristics of Scenario 2. When moving past Table 2/Figure 2 to Table 3/Figure 3 and Table 4/Figure 4, it is apparent that unlike Scenario 1, there are, for the most part, no major winners or losers in every situation. There are undulations in plantings, and that is reflected by the two-year moving average base acreage calculation. While the methodology in Scenario 2 might be the best attempt at allowing base acres to be an accurate representation of planted acres, it is the costliest when considering the high administrative cost due to yearly updating.

Scenario 3

For Scenario 3, Table 5 shows an increase of 30 million acres for the total base acres for the nine covered commodities analyzed in this study. Considering that the potential additional base acres aggregated across all counties for each of the nine commodities was 43,841,715 million acres, each of the commodities' additional base acres (by county) were prorated by 31.6% to bring the increase in base acres to exactly the 30-million-acre cap. Essentially, all calculated bases

were multiplied by $(1.0 - 0.316) = 0.684$ to determine the prorated base acreage for each commodity. Overall, all commodities experienced increases in base acres, and the increases, in order from the largest to the smallest percentage, were soybeans, oats, cotton, sorghum, corn, peanuts, wheat, barley, and rice. Corn, soybeans, and wheat together accounted for 91.3% of the additional 30 million base acres.

Figure 5 displays the county-level aggregated absolute change between the current base acres and the base acres resulting from the method applied in Scenario 3. As expected, given the nature of Scenario 3, no areas experienced decreases, in fact, most experienced significant increases. The largest gains in base acres were concentrated in the Corn Belt down to Louisiana and the Great Plains all the way to Texas and California, but there were also several counties with little to no change.

SUMMARY AND CONCLUSIONS

This study undertook a national analysis of the impacts of three alternative methods of updating base acres for nine covered commodities. The first two scenarios had similar changes in total base for each of the commodities, which is likely due to using similar calculations. While the 2024 base acre calculation for Scenario 2 more or less equates to that of Scenario 1, Scenario 2 results in a stabilization of crop bases in the 2025 and 2026 crop years. In terms of most base acres gained, Scenario 3 is the clear-cut winner, which benefits U.S. producers due to a 30-million-acre increase in base acres across the country.

Undoubtedly, one can say with confidence that Scenario 3 would be preferred by growers for the nine crops covered in this analysis (barley, corn, cotton, oats, peanuts, rice, sorghum, soybeans, and wheat). It may also help explain why policymakers tend to shy away from mandatory base acre updates in favor of voluntary approaches, particularly those with no downside risk for producers.

Considering the relevance and importance of base acreage in the calculation of PLC and ARC payments, lawmakers created and passed the OBBBA with the goal of providing farm program protection for up to 30 million additional acres. Notably, the finding that 91.3% of the additional 30 million base acres comes from corn, soybeans, and wheat creates a bridge between the quantitative and geographical results

as a large majority of these commodities are grown in the Corn Belt, Midwest, Great Plains, and along the Mississippi River Delta. As for the practical outcomes, when compared to other alternatives that had been under consideration, the method contained in the OBBBA offered the highest net benefits, given constrained congressional funding, while avoiding permanent adverse impacts on producers, resulting in the greatest benefits for all U.S. producers and stakeholders.

FOOTNOTE

1. Considered planted acres include those acres that were prevented from being planted or failed.

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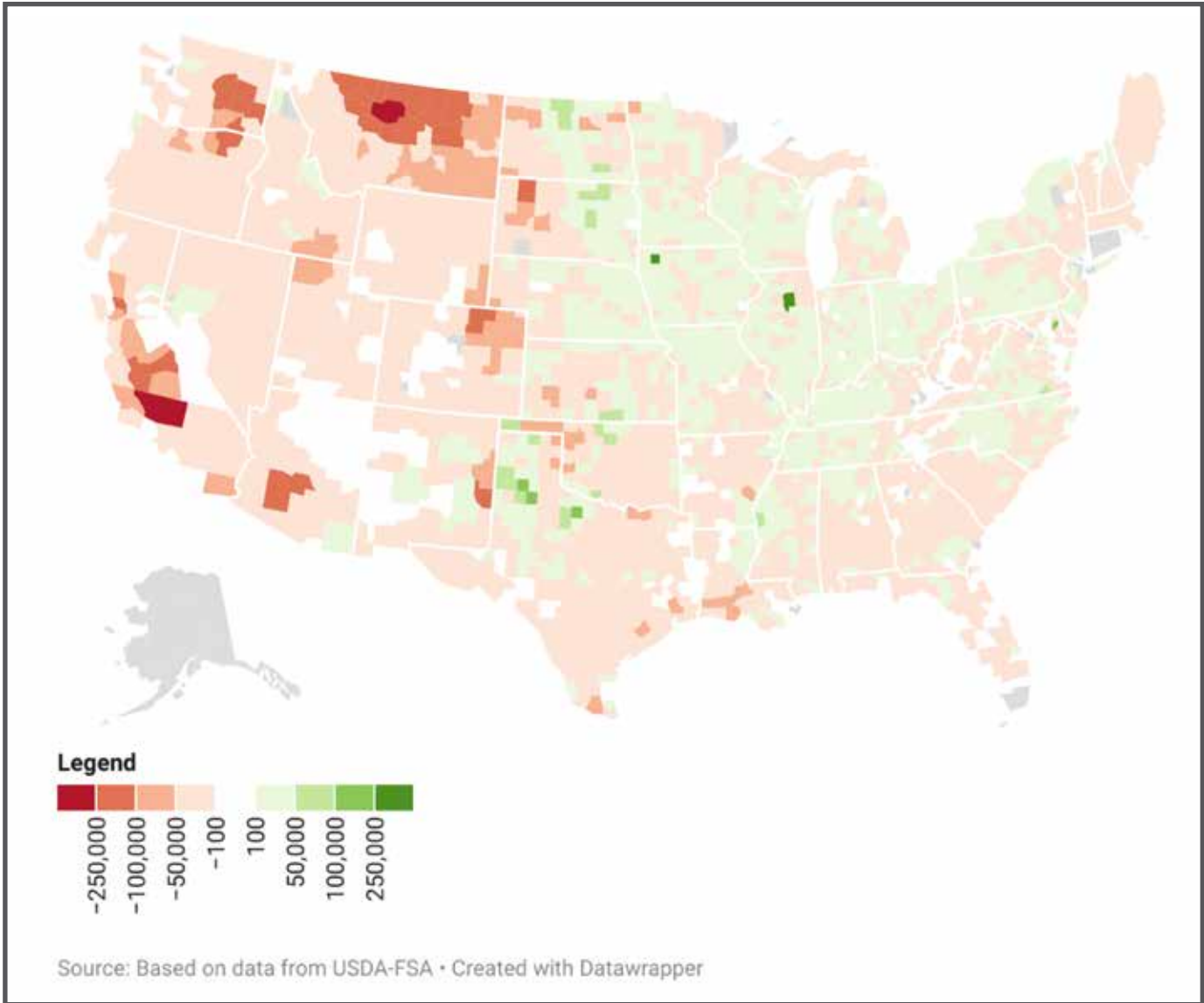


Figure 1. Absolute change in acres from implementing Scenario 1 (red represents negative change, white indicates little to no change, green represents positive change; gray means no data was available for those counties)

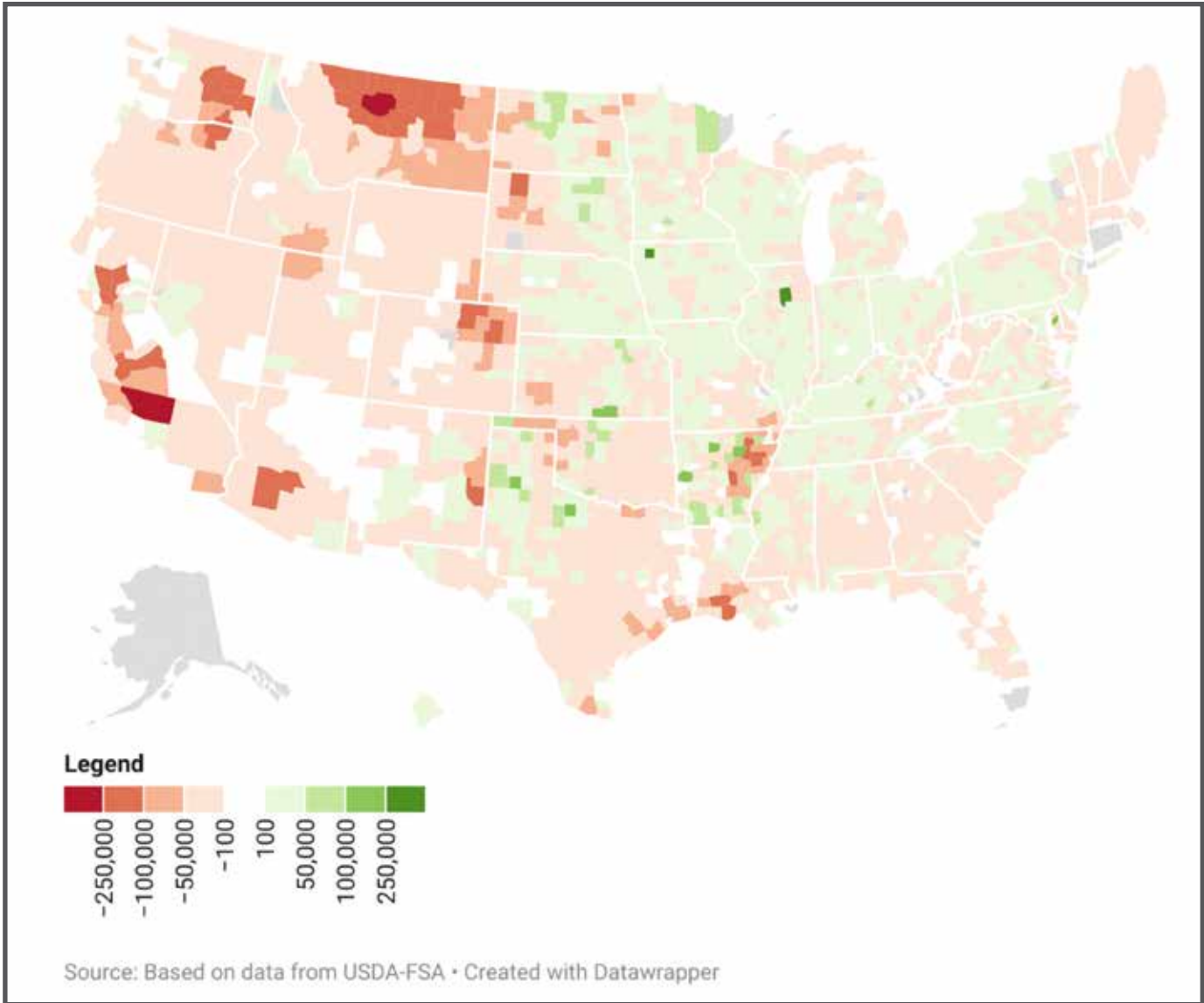


Figure 2. Absolute change in acres from implementing Scenario 2 (2024) (red represents negative change, white indicates little to no change, green represents positive change; gray means no data was available for those counties)

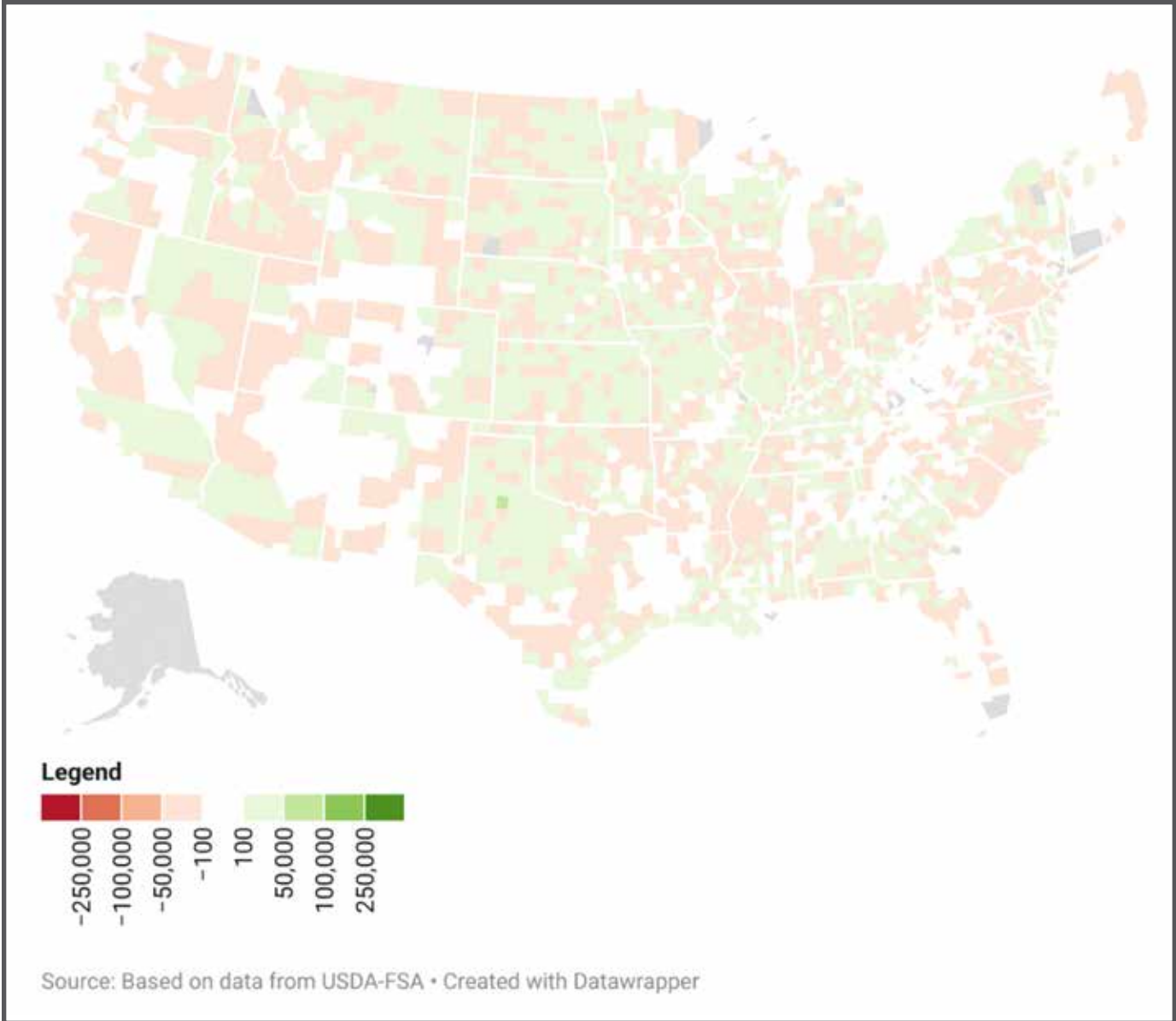


Figure 3. Absolute change in acres from implementing Scenario 2 (2025) (red represents negative change, white indicates little to no change, green represents positive change; gray means no data was available for those counties)

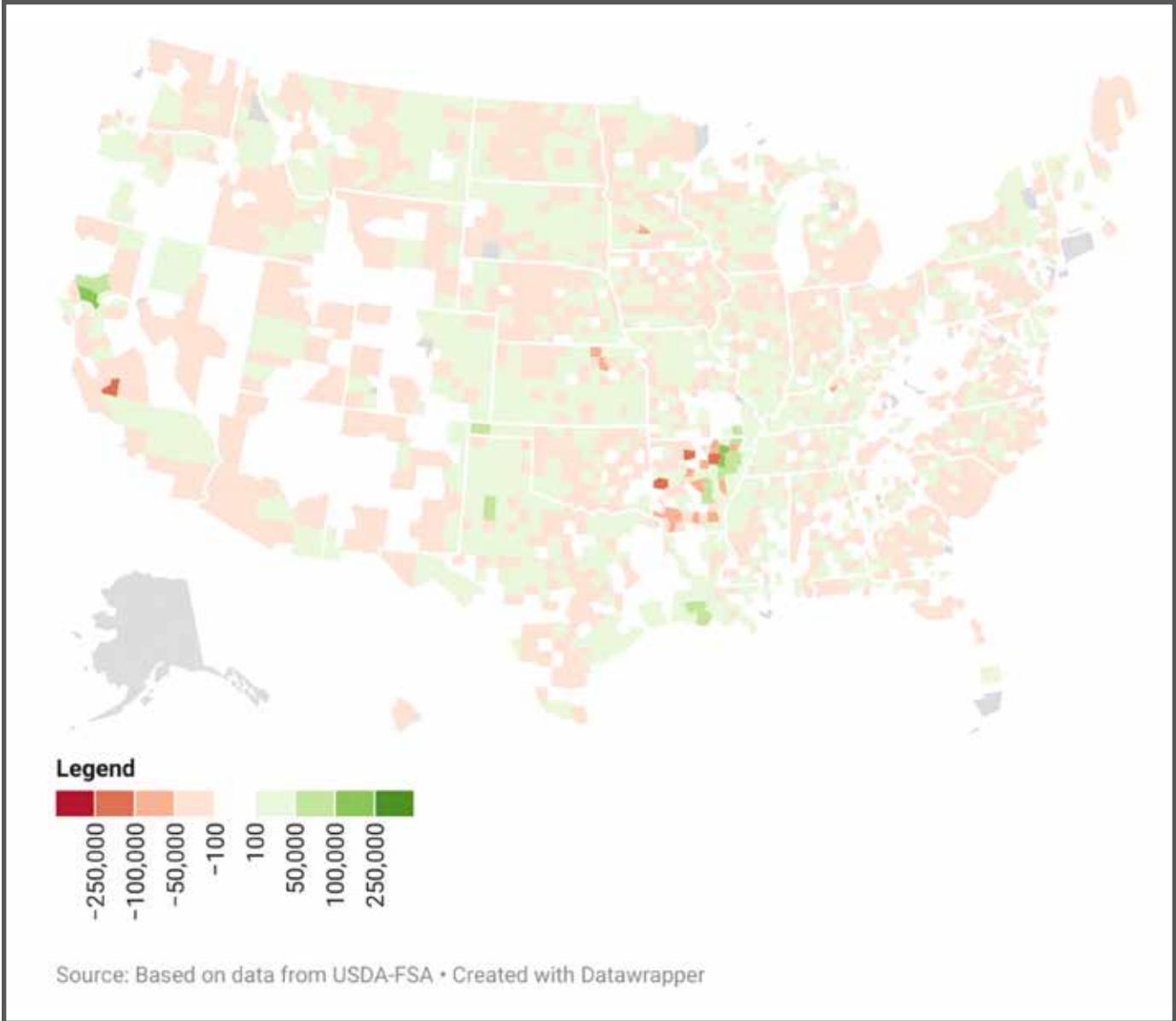


Figure 4. Absolute change in acres from implementing Scenario 2 (2026) (red represents negative change, white indicates little to no change, green represents positive change; gray means no data was available for those counties)

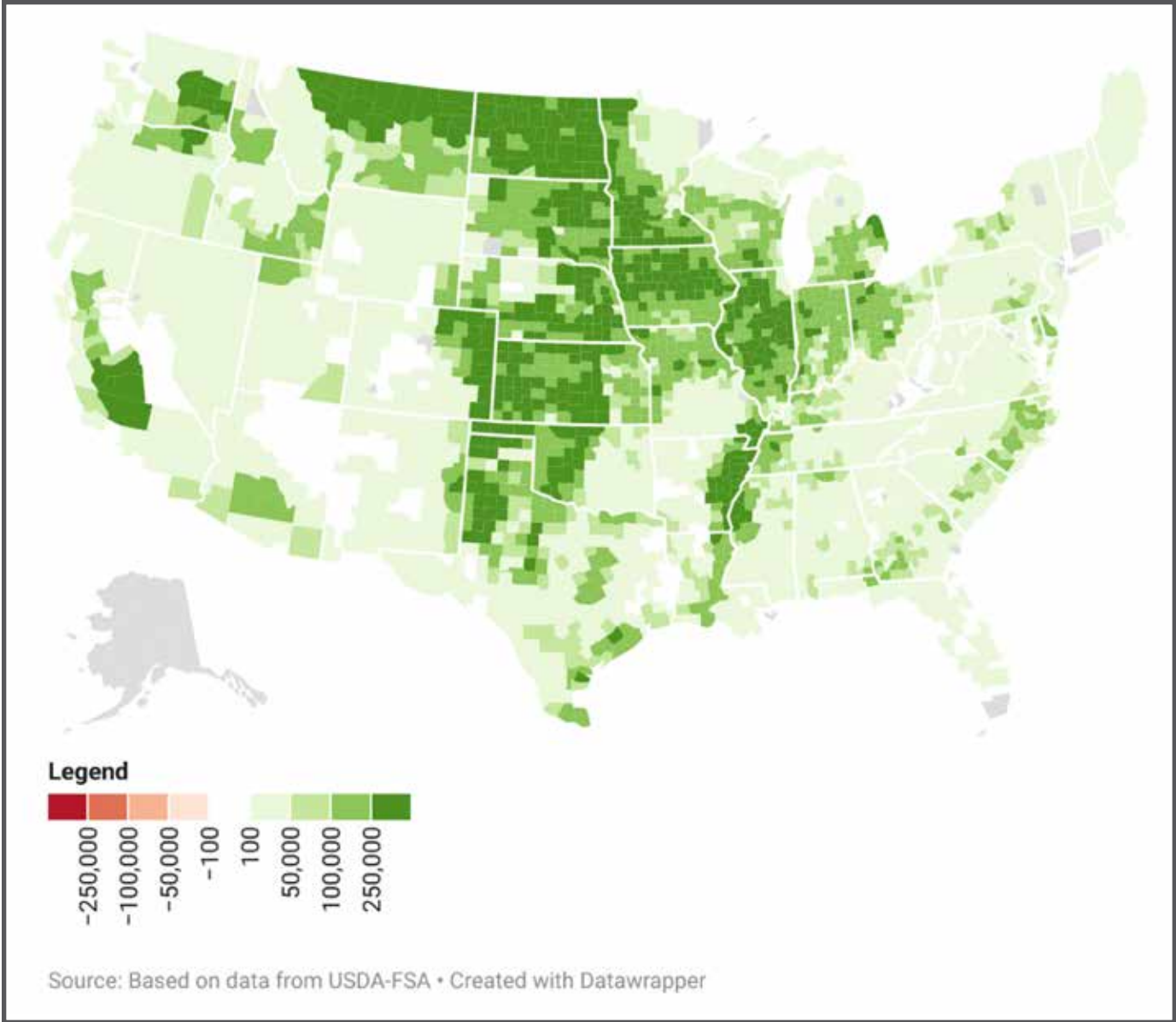


Figure 5. Absolute change in acres from implementing Scenario 3 (red represents negative change, white indicates little to no change, green represents positive change; gray means no data was available for those counties)

Table 1. Change in Baseline After Implementing Scenario 1

Commodity	Current Base (acres)	New Base (acres)	Absolute Change (acres)	Change (%)
Barley	6,205,846.32	2,703,618.47	(3,502,227.85)	-56.43%
Corn	100,021,635.68	93,693,487.87	(6,328,147.81)	-6.33%
Cotton	13,821,087.49	12,004,669.04	(1,816,418.45)	-13.14%
Oats	2,651,978.40	2,090,472.64	(561,505.76)	-21.17%
Peanuts	2,562,814.15	1,550,497.54	(1,012,316.61)	-39.50%
Rice	5,008,456.20	3,095,004.89	(1,913,451.31)	-38.20%
Sorghum	9,826,429.06	5,985,369.07	(3,841,059.99)	-39.09%
Soybeans	55,444,234.92	84,155,590.30	28,711,355.38	51.78%
Wheat	69,475,951.94	49,419,590.00	(20,056,361.94)	-28.87%
Totals	265,018,434.16	254,698,299.82	(10,320,134.34)	-3.89%

Table 2. Change in Baseline After Implementing Scenario 2 (2024)

Commodity	Current Base (acres)	2024 Base (acres)	Absolute Change (acres)	Percent Change (%)
Barley	6,205,846.32	2,625,582.55	(3,580,263.77)	-57.69%
Corn	100,021,635.68	93,434,490.36	(6,587,145.32)	-6.59%
Cotton	13,821,087.49	11,628,056.05	(2,193,031.44)	-15.87%
Oats	2,651,978.40	2,269,717.87	(382,260.53)	-14.41%
Peanuts	2,562,814.15	1,628,635.41	(934,178.74)	-36.45%
Rice	5,008,456.20	3,227,818.12	(1,780,638.08)	-35.55%
Sorghum	9,826,429.06	6,388,453.60	(3,437,975.46)	-34.99%
Soybeans	55,444,234.92	85,063,510.29	29,619,275.37	53.42%
Wheat	69,475,951.94	48,627,596.23	(20,848,355.71)	-30.01%
Totals	265,018,434.16	254,893,860.50	(10,124,573.66)	-3.82%

Table 3. Change in Baseline After Implementing Scenario 2 (2025)

Commodity	2024 Base (acres)	2025 Base (acres)	Absolute Change (acres)	Change (%)
Barley	2,625,582.55	2,756,301.81	130,719.26	4.98%
Corn	93,434,490.36	91,025,159.79	(2,409,330.58)	-2.58%
Cotton	11,628,056.05	12,309,933.60	681,877.54	5.86%
Oats	2,269,717.87	2,018,713.47	(251,004.40)	-11.06%
Peanuts	1,628,635.41	1,518,757.64	(109,877.77)	-6.75%
Rice	3,227,818.12	2,901,831.71	(325,986.41)	-10.10%
Sorghum	6,388,453.60	6,499,194.90	110,741.30	1.73%
Soybeans	85,063,510.29	87,086,000.70	2,022,490.41	2.38%
Wheat	48,627,596.23	49,233,086.53	605,490.30	1.25%
Totals	254,893,860.50	255,348,980.15	455,119.65	0.18%

Table 4. Change in Baseline After Implementing Scenario 2 (2026)

Commodity	2025 Base (acres)	(2026) New Base (acres)	Absolute Change (acres)	Change (%)
Barley	2,756,301.81	2,935,899.09	179,597.28	6.52%
Corn	91,025,159.79	92,251,344.00	1,226,184.21	1.35%
Cotton	12,309,933.60	11,924,984.91	(384,948.68)	-3.13%
Oats	2,018,713.47	2,018,162.67	(550.80)	-0.03%
Peanuts	1,518,757.64	1,546,709.10	27,951.45	1.84%
Rice	2,901,831.71	2,922,206.19	20,374.48	0.70%
Sorghum	6,499,194.90	6,385,103.96	(114,090.94)	-1.76%
Soybeans	87,086,000.70	85,323,524.39	(1,762,476.31)	-2.02%
Wheat	49,233,086.53	51,283,303.70	2,050,217.17	4.16%
Totals	255,348,980.15	256,591,237.99	1,242,257.85	0.49%

Table 5. Change in Baseline After Implementing Scenario 3

Commodity	Current Base (acres)	New Base (acres)	Absolute Change (acres)	Change (%)
Barley	6,205,846.32	6,292,860.01	87,013.69	1.40%
Corn	100,021,635.68	105,524,564.11	5,502,928.43	5.50%
Cotton	13,821,087.49	15,284,700.70	1,463,613.21	10.59%
Oats	2,651,978.40	2,960,565.03	308,586.63	11.64%
Peanuts	2,562,814.15	2,653,459.12	90,644.97	3.54%
Rice	5,008,456.20	5,034,180.26	25,724.06	0.51%
Sorghum	9,826,429.06	10,454,844.65	628,415.59	6.40%
Soybeans	55,444,234.92	75,251,486.13	19,807,251.21	35.72%
Wheat	69,475,951.94	71,561,774.17	2,085,822.23	3.00%
Totals	265,018,434.16	295,018,434.16	30,000,000.00	11.32%

Returns, Risks, and Legacies: Understanding Farmland as an Investment Asset



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Abstract

Farmland has long been both an agricultural resource and a financial asset, yet recent decades have seen new actors and investment logics reshape U.S. farmland markets. Drawing on interviews with landowners, appraisers, farm managers, lenders, and brokers in Iowa, this study examines how stakeholders interpret farmland as an investment. Findings highlight five themes: land's stability and tangibility, evolving return expectations, investor diversity, rental market dynamics, and the role of technology. Results reveal heterogeneity in motivations and practices and suggest implications not only for market behavior but also for extension programming that supports diverse landowners and investors.

INTRODUCTION

Farmland in the United States, particularly in the Midwest, has long held a dual identity: it functions both as a productive agricultural asset and as a durable financial investment. Over the past two decades, both identities have evolved. Non-operating landowners, financial investors, and urban capital are increasingly active in the market, drawn by farmland's reputation as a hedge against inflation, a tangible store of wealth, and a stable source of rental income (Lins, Sherrick,

and Venigalla, 1992; Rubens, Bond, and Webb, 1989; Fairbairn, 2017; Lavelle and Yamamoto, 2024; Moss, 1997). These dynamics are especially pronounced in Iowa, where over half (58%) of farmland is leased, and 55% is owned by non-operators, including many who have never farmed (Tong and Zhang, 2023). Investors now account for roughly one-quarter of recent transactions, a group that includes out-of-state individuals, recreational purchasers, and financial entities (Chandio, 2024). These shifts signal a broader decoupling of land ownership from agricultural production.

The 2008 financial crisis, coinciding with the ethanol boom, marked a turning point for farmland investment. As financial markets collapsed and interest rates reached historic lows, farmland emerged as a relatively low-volatility asset with long-term appreciation potential. Values surged to historic highs, first post-crisis, then again during the COVID-19 pandemic. While land remains desirable for its inflation-resistant qualities, recent inflationary pressures and rising interest rates are dampening demand. This means that, for buyers, the focus is shifting from raw appreciation to net purchasing power and cash flow viability.

In this evolving context, understanding how diverse stakeholders approach farmland investment is increasingly important. Buyers today include retired producers seeking annuities, heirs managing estates, local operators looking to expand, and outside investors driven by portfolio strategy. Their motivations range from legacy preservation to income generation, and these differences shape both transaction behavior and long-term land use. For professionals involved in valuation, lending, management, or brokerage, recognizing this diversity is essential for interpreting market signals and advising clients.

To examine how stakeholders interpret farmland as an investment, we conducted in-depth interviews with professionals engaged in Iowa's farmland markets, including appraisers, farm managers, landowners, and brokers. Using thematic coding and analysis, we identified five key themes that shape investment behavior: (1) the perception of land as a stable, long-term asset; (2) return expectations; (3) investor diversity and motivations; (4) rental market dynamics; and (5) the emerging role of technology in operational strategy. These themes reflect both financial and relational dimensions of investment and reveal how farmland is understood and negotiated in practice.

The findings offer insight into how market participants balance risk, return, and access, and how evolving

buyer types and investment logics influence farmland value and tenure. By grounding these insights in the lived experience of professionals, this study contributes to broader discussions on land market transformation and provides practical guidance for those navigating the increasingly complex intersection of agriculture and finance.

METHODOLOGY

This study employed a semi-structured interview approach to gain in-depth insights into participants' experiences, perceptions, and expectations regarding Iowa's farmland markets, with a particular focus on land as an investment. Recognizing the importance of domain expertise for this topic, we targeted individuals occupying diverse professional roles within the land market, including appraisers, farm managers, landowners/farmers, lenders, and real estate professionals such as auctioneers and brokers.

We selected Iowa as the study site due to its agriculturally dominant land market and limited institutional or foreign ownership, shaped in part by regulatory restrictions (Renshaw et al., 2024; Taylor et al., 2023; Wang et al., 2024), and its relevance to a needs assessment aimed at informing extension programming and research. Through purposive sampling, we began by identifying 19 individuals with publicly visible roles in the land market through public-facing domains (e.g., websites and membership in key land organizations). This was followed by snowball sampling, wherein participants referred additional contacts with relevant experience.

In total, 10 individuals agreed to participate, representing the full range of targeted roles: two landowners/farmers, two rural appraisers, two farm managers, two auctioneers, one real estate agent, and one agricultural lender. Participants were located across different regions of Iowa and included three women and seven men. Table 1 details the distribution of investment-related quotations by participant. While the sample size is relatively small, it spans key roles in the Iowa land economy and offers depth of insight from highly experienced participants. Findings are not intended to be statistically generalizable but rather to offer grounded, contextualized insights into the investment dimensions of the Iowa land market.

Each participant completed a 60- to 90-minute interview conducted via WebEx. Interviews followed a semi-structured guide (Appendix A). We asked participants about land values, investment motivations, rental practices, financial constraints,

non-farmer investor activity, and perceived changes in the market over time. We used follow-up “why” and “how” questions to encourage participants to elaborate on their experiences and interpretations.

All interviews were audio recorded with participant consent and transcribed verbatim. We lightly edited the quotes used in the analysis for clarity and maintained anonymity by using pseudonyms and removing all identifying references. Transcripts were coded thematically using a structured codebook developed by the research team. An inductive content reduction approach was used following Mayring (2014), with two separate coders completing preliminary coding of the same two interviews before collaboratively comparing, refining, and developing final codes. These were used by one coder for the remainder of the interviews. While multiple themes were identified, for the purposes of this article, we focus on the financial theme, which encompasses eight subcodes related to investment logic: land as an investment, returns, non-farm investors, renting, the cost of farming, new technology, limited non-farmer knowledge, and land market trends. We organize our discussion around five key findings, which are considered within these subcodes, forming the core of the Results and Discussion section.

RESULTS AND DISCUSSION

This section presents the key themes that emerged from interview data and coded responses related to farmland as an investment. While the long-standing appeal of farmland as a stable asset is widely acknowledged, the motivations, expectations, and behaviors of different investor types vary considerably. Analysis revealed the following five core ideas:

1. The traditional view of farmland as a tangible, long-term investment.
2. The evolving structure of returns from cash flow vs appreciation.
3. The role of investors in the farmland market.
4. How investor presence influences rental dynamics and return expectations.
5. The influence of technology on farmland management and investment potential.

These themes are detailed in Table 2 alongside representative quotations. They correspond to eight subcodes, also summarized in Table 2, with their relative distribution illustrated in Figure 1.

Figure 1 displays the proportional distribution of investment-related quotations across all the subcodes for the analysis. Of the 127 coded references pertaining to farmland investment, each segment of the pie chart represents the share attributed to a specific subcode. This visualization illustrates the relative emphasis placed on different investment aspects by participants, with larger segments indicating greater thematic prominence. It is imperative to remember, though, that the importance does not necessarily correlate with how many times a theme is mentioned. Table 2 then classifies these eight subcodes into five core findings, each of which is detailed below.

Land as a Tangible, Long-Term Investment

Across interviews, participants consistently describe agricultural land as a tangible, long-term investment vehicle that offers stability, moderate returns, and a low-risk profile. Many landowners and professionals express a preference for farmland over more volatile financial assets, citing its physical nature, consistent historical performance, and capacity to generate both rental income and long-term appreciation.

Respondents were asked to compare farmland to other asset classes such as stocks, bonds, or certificates of deposit. One participant remarks, “[You’re] not going to lose your farm, just physically lose it like you can with stocks” (ID 102), illustrating a broader perception that land is a secure, durable store of wealth. Another participant notes, “It’s a very stable investment tool... it is needed to grow and produce food... it truly is a legitimate asset” (ID 112), highlighting farmland’s perceived fundamental value as a productive and physical resource. While participants often framed farmland as uniquely secure, this reflects perception more than certainty. In practice, farmland can and has been lost under financial strain, as seen during the 1980s farm crisis or when owners are forced to sell or mortgage land to cover debts or long-term care costs. The distinction is that farmland generally liquidates more slowly than other assets, reinforcing its reputation for stability even if it is not immune to loss.

Farmland’s durability also appeals to those seeking passive income or retirement security. One participant explains, “It’s safe... I don’t think it’s a moneymaker... but it just makes that little 3% without me doing anything. It’s kind of a passive income” (ID 116). This statement reflects a broader sentiment that farmland may not always outperform other investments in the short term but provides predictable, steady returns

over time, especially through cash rents and land appreciation.

The long-term viability of farmland as an asset also appears closely tied to its relatively low vacancy rate and its essential function within agricultural and food systems. As one respondent puts it, *“If it’s a highly productive piece of ground... it tends to have a very low vacancy rate, unlike commercial properties”* (ID 112). This reliability, combined with limited supply and location-specific utility, reinforces its position as a long-hold asset in diversified investment portfolios.

Several participants highlight land’s role as a multigenerational asset, describing transitions in ownership and the evolution of investment motivations over time. For example, one individual notes, *“I bought it for investment... I also farm. So do you put me in the farmer bucket?”* (ID 108). This blurring of operational and investment identities speaks to how land can function simultaneously as a financial instrument and an independent occupation.

Returns: Cash Flow vs. Appreciation

Many participants further emphasize the dual-income structure of farmland: appreciation over time and periodic income through mechanisms such as cash rent. While most acknowledge that land may not deliver rapid returns, its capacity to combine steady rental income with long-term capital gains positions it as a unique asset class within investment portfolios.

Respondents frequently characterize annual farmland returns as modest yet reliable. Several quote typical annual returns of 2-3%, matching the current capitalization rate for Iowa of 2.4% (Chandio, 2024; Johanns, 2025) and U.S. cropland 2.4% (USDA NASS, 2025). This figure is echoed throughout the interviews, with variations depending on location, land quality, and lease structure. One participant reflects on historical return patterns, stating, *“The top end of land in the ‘80s was \$1,600 an acre... now we’re looking at \$20,000. But the cap rate has gone from 4-5% down to 2%”* (ID 114).

This decline in capitalization rates is an outcome of rising land values and the market’s shift toward appreciation-driven returns. Many interviewees note that while annual returns from rent may appear low, they are often balanced by long-term appreciation. However, there has also been a tone of caution noting that much of the return has recently come from appreciation rather than income, which has implications for liquidity and access to value without divestment. Comparisons of farmland returns with

other asset classes reinforce this perspective. Zhang and Duffy (2022) show that whether farmland or equities provide the higher long-run return depends heavily on the timing of entry and sale, with farmland outperforming in some decades and the stock market in others.

Several participants draw comparisons to equity markets and alternative assets. While some perceive farmland as underperforming relative to stocks in certain years, especially in terms of dividend yield, others see this as offset by farmland’s lower volatility and inflation-hedging capacity. One interviewee explains, *“We made a 20% dividend on stock. But land is a secure, appreciating asset with a dividend, too, it’s just long term”* (ID 108). This combination makes farmland especially attractive for risk-averse investors or those seeking portfolio diversification.

Importantly, rent structures influence perceptions of return. Participants differentiate between owner-operators and absentee landlords, with the latter often seeking fixed, competitive cash rents that support income goals. In some cases, cash rent expectations are shaped by investor expectations. Offering favorable cash rents to investors also secures a producer’s bid to farm their next land purchase, creating a relationship. As one broker observes, *“An investor wants a certain return—they’ve promised their investors a specific yield”* (ID 109). These expectations can place upward pressure on rental rates, though several respondents also point out that cash rent tends to lag commodity prices and overall market shifts.

Investor Diversity and Motivations

Participants describe an increasingly diverse range of landowners in Iowa’s farmland market, reflecting a broader shift in the composition of buyers. While producer-owners remain active, particularly in certain geographies, several respondents highlight the growing presence of non-operating landowners, including legacy heirs, institutional buyers, and lifestyle-driven investors, each bringing different expectations, investment strategies, and levels of engagement with the agricultural sector. To better illustrate these distinctions, Table 3 summarizes five prominent landowner profiles that emerged from the discussions with the participants: legacy heirs, strategic producers, local diversifiers, outside investors, and recreational buyers.

Legacy heirs often inherit land without a strong connection to agriculture or the local community. They typically live out of state and rely on professionals

such as attorneys, appraisers, or farm managers to handle transactions and leases. For many, farmland represents a monetizable asset or an estate management challenge. This group often prioritizes liquidation or passive income, with limited attention to agronomic or local dynamics. These also tend to be the landowners who might care the most about the capitalization rate and how it compares to alternative investments. In contrast, strategic producers tend to be highly engaged in farming operations and view land as both a production input and a financial instrument. Participants express long-term goals such as intergenerational wealth building, operational expansion, and retirement security.

Local diversifiers represent a middle ground. These buyers often include small- to medium-sized farmers, semi-retired professionals, or landowners with priorities to agriculture who are seeking asset diversification and local legacy. Their engagement in farming is typically mediated through rental arrangements. As one participant describes, “*Local investors... might be business owners looking to diversify their investment pool, maybe know the local farmers in the area*” (ID 112). This group tends to balance personal and financial goals, and may value proximity, aesthetics, or local relationships as much as return on investment.

Institutional buyers, such as agricultural investment funds, retirement portfolios, and external real estate groups, remain limited in Iowa due to regulatory restrictions on corporate ownership (National Agricultural Law Center, 2025a, 2025b). Nonetheless, several respondents observe increased activity by such entities in neighboring states and note the influence of non-institutional investors on pricing expectations within Iowa. These buyers typically pursue land for its long-term portfolio value, targeting consistent returns through passive ownership models and professional management arrangements. Research shows, however, that investor presence is not expected to significantly increase the overall expected value of farmland; instead, relative to Illinois, where institutional investors are permitted, farmland transactions in Iowa appear to undervalue lower-quality land, while higher-quality land may command a premium (Chandio et al., 2025).

While concerns about the displacement of local ownership are common, some producers describe more neutral or even favorable outcomes when investors enter the market. In cases where farmers are unable to purchase land directly, investor acquisitions may temporarily preserve access via leases, allowing operators to continue farming and potentially acquire

the land later. A participant notes a conversation with an interested farmer stating, “*I wasn’t ready to buy it. An investor bought it, and I ended up getting to farm it. If down the road that investor decides to sell that farm, chances are he is going to come to me first, and I’ll be ready*” (ID 109). This suggests that institutional participation may, under certain conditions, support continuity in agricultural production, even when ownership transitions outside the local community.

Lastly, recreational buyers prioritize lifestyle or amenity-based motivations, such as hunting, scenic views, or rural living. Though typically disengaged from production agriculture, they compete for parcels in areas near urban centers or with natural features.

Rental Market Dynamics and Investor Behavior

Interview responses highlight how investor behavior intersects with farmland rental dynamics, particularly in ways that reflect earlier-discussed differences in return expectations and investor types. Participants describe a rental market shaped as much by financial targets as by social norms, producing outcomes that do not always align with conventional economic logic.

A consistent theme across interviews is that cash rental rates often lag behind broader market shifts, particularly during periods of declining commodity prices. Participants attribute this stickiness to the reluctance of producers to release rented land, even when it no longer yields a sufficient margin. This behavior reflects a broader strategy among farmers who prioritize continuity of access, sometimes absorbing short-term losses to preserve long-term operational scale. This cultural pattern reinforces long-standing tenant-landowner relationships and reduces turnover but may also inhibit market responsiveness.

At the same time, non-operating and investor landlords often set rent levels based on income expectations tied to their acquisition costs or target returns. As one interviewee notes, “*Some groups state that they want to see land rent go up every year*” (ID 112). These expectations often result in rental benchmarks that are out of step with current commodity price conditions. Some participants report that investor-purchased land may command higher rent not due to its inherent productivity but because of the financial yield needed to justify the purchase price. These dynamics are particularly prevalent in areas where investor buyers or well-capitalized individuals are active.

Farm managers play a key role in mediating between absentee owners and tenants. Several respondents note that professional managers often serve as the conduit through which investors' expectations are translated into lease structures. A participant notes, "Maybe [rich out-of-state landowners] contact the farm management companies and say, 'Do you have somebody who would want to [rent that land]?' There are people in the farm management companies who work with those big investors to buy land" (ID 116). As investor ownership grows, particularly among those less embedded in local communities, these intermediaries become essential in balancing financial performance with tenant retention.

Producers, in turn, may accept high or even marginally profitable rental terms in hopes of remaining competitive for future land opportunities. As a producer, "You need to be on your toes, always selling yourself and your farming operation to outside investors because these people will notice that" (ID 109). While this strategy can sustain farm access in the short term, it contributes to broader concerns about land access, profitability, and generational turnover. This rental pressure lowers capitalization rates and may also favor larger or more established operators, contributing to the consolidation of land ownership.

Overall, this reflects an increasing and more recent separation of land ownership from farm operation, which participants also associate with generational transition and capital intensity. As more farmland transfers to non-operating heirs or investment-oriented buyers, leasing becomes the dominant mode of access, and rent pricing reflects both economic and relational dimensions. In this context, rental markets serve as a key interface between the investment logic of landowners and the production logic of operators.

Technology and Investment-Driven Diversification

While not a central focus across all interviews, several participants highlight the role of technology in shaping modern farm operations and influencing how tenants manage their land. Some respondents reference the use of drone-based technologies and other farm-level innovations that align with broader trends in precision agriculture, particularly where cost savings or operational efficiency are involved.

These technologies are primarily framed as tools for cost control, enabling operators to optimize the use of fertilizers and chemicals and reduce labor needs. One participant notes, "People are using drone technology more for scouting and now even in

spraying crops... and it's paying off as far as the cost of that technology" (ID 112). For tenants, these efficiencies may support stronger lease bids or improve long-term viability on rented ground, easing some of the pressure on relatively lower capitalization rates.

In a smaller subset of cases, technology enables alternate revenue streams, particularly in livestock operations. For example, one respondent highlights the installation of methane digesters among dairy producers, which provide additional income from energy capture or waste management services: "A number of dairy producers have actually installed methane digesters... it's another way to capture additional revenue" (ID 101). While still limited in scope, such investments reflect how operational innovation can expand income potential beyond crop or livestock sales (Moon, Chandio, and Feng, 2025).

Respondents note that although these technologies can influence net returns, they are not always reflected in land valuations, particularly if improvements are tied to tenant operations rather than to the land itself. As discussed earlier, income remains the primary basis for many investor assessments, and appreciation is often dissociated from day-to-day management.

DISCUSSION

This study contributes to growing research on the financialization of farmland by examining how various stakeholders in Iowa understand, value, and engage with land as an investment. While previous scholarship has documented rising land values, investor participation, and structural changes in land tenure (Tong and Zhang, 2023; Hendricks and Er, 2018; Gunnoe, 2014), few studies have focused on the nuanced perspectives of those directly involved in land transactions, management, and production at the local level. Drawing on interviews with landowners, appraisers, farm managers, and agricultural professionals, this research sheds light on how investment logics are expressed, contested, and negotiated within farmland markets.

Findings echo the prevalent view that agricultural land is perceived as a relatively low-risk, long-term asset. Participants consistently highlight land's tangibility and multigenerational appeal, aligning with prior studies showing that farmland serves as both a financial instrument (Zhang and Duffy, 2022) and an intergenerational wealth transfer (Bigelow, Borchers, and Hubbs, 2016; Krultz et al., 2024; Langemeier, 2021). At the same time, the economic rationale for land investment has shifted—rather than relying solely on

income from cash rents, many investors, particularly non-operating owners, prioritize appreciation as the primary source of return. This reflects broader trends, where capital gains from farmland have outpaced operating profits in recent years, and capitalization rates have declined substantially.

Interview data also show a diversification of landowner types, including legacy heirs and outside investors, who participate in land markets with varying levels of agricultural engagement and return expectations. These actors bring distinct motivations that affect how land is valued, managed, and transferred. Rental rates can reflect a mix of market-based returns and social relationships. Producers may offer high rents to maintain land access, even when it is not financially optimal in the short term. Conversely, investors, especially those represented by funds or outside management, enter with specific return expectations, which contribute to rising rental benchmarks and reinforce capital-driven logic in lease arrangements. These dynamics point to a partial decoupling of land ownership and agricultural production.

Although discussed less extensively, technology appears as a supporting theme in this evolving investment landscape. Drone applications, automated management tools, and, in some cases, methane digesters are being used to improve efficiency or generate alternative revenue streams but are not yet fully reflected in how land is appraised or marketed. As others have argued, technological adoption often lags behind market models (Schimmelpfennig and Ebel, 2016; Khanna et al., 2024), especially when improvements are tenant-specific rather than landowner-based (Gao et al., 2018; Sawadgo et al., 2021).

These findings also point to structural pressures that shape who can own land and how it is managed. Rising capital requirements for machinery, inputs, and land mean that even established producers often forgo purchases in favor of renting, which preserves liquidity but reduces tenure security and discourages long-term investments in improvements such as tiling or conservation practices. At the same time, technology adoption has raised operating costs and contributed to farm consolidation, increasing both the scale and risk of individual operations. Many of these technological and conservation investments are often not fully capitalized into land values, in part because appraisers lack reliable public information on their presence in comparable sales. This highlights the need for ongoing research at the intersection of investment, technology, and conservation.

As farmland markets in Iowa and beyond continue to evolve, this study provides timely insight into how local actors interpret and navigate land investment. Rather than portraying landowners as a homogenous group of farmers or investors, the findings emphasize heterogeneity in motivations, strategies, and levels of engagement. These distinctions are particularly important for appraisers, farm managers, extension specialists, and policymakers who are tasked with understanding land value, lease structures, and rural development.

The financialization of farmland is not a uniform process but one shaped by regional regulations, land tenure histories, and interpersonal relationships. Future research may build on this work by examining how these trends differ across regions, asset classes, or institutional environments, and by quantifying the impact of investor-driven purchases on long-term land access and agricultural resilience. An additional avenue of inquiry lies in translating these findings into practice, particularly how they might inform extension personnel as they develop educational programs to address the needs of landowners, investors, and producers navigating this evolving landscape.

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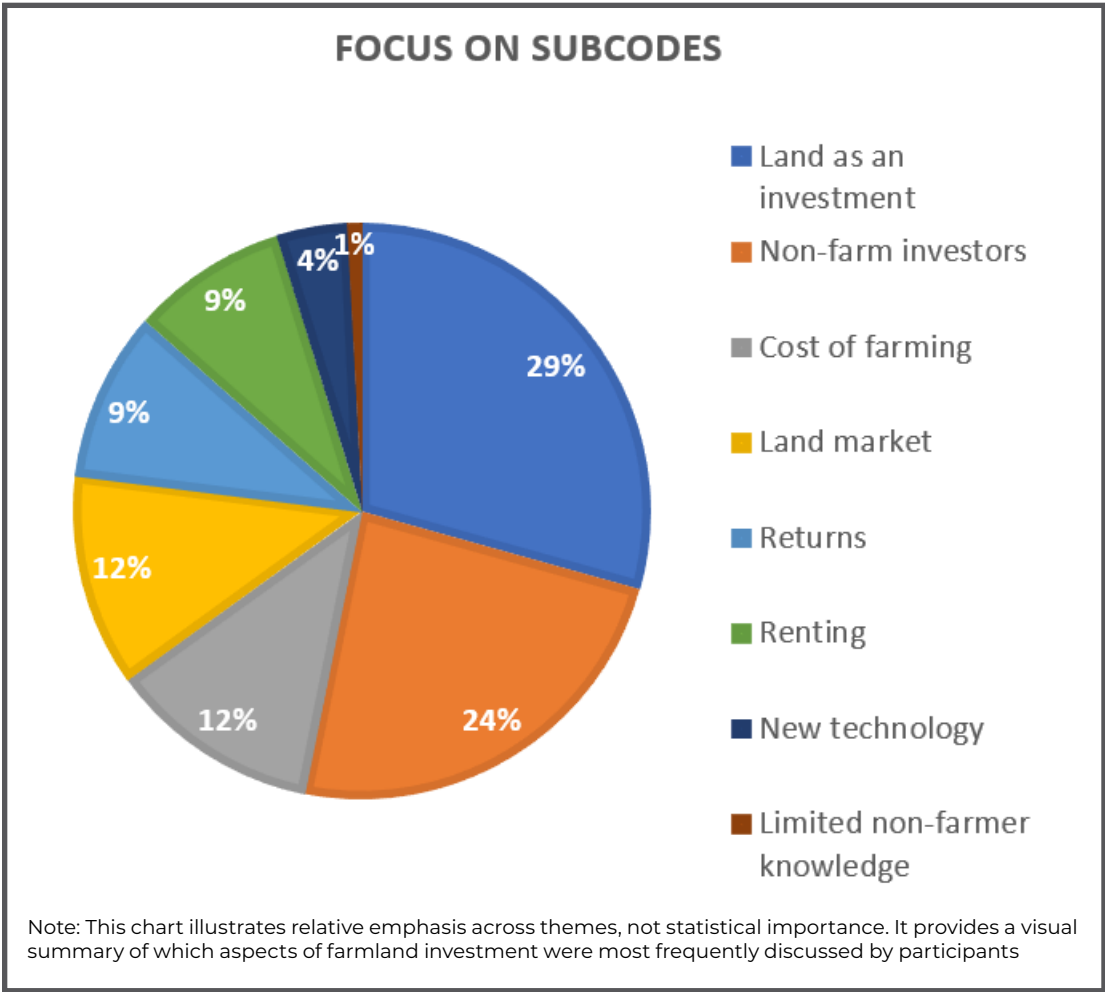


Figure 1. Distribution of investment-related quotations across subcodes

Table 1. Distribution of Investment-Related Quotations by Participant		
Participant ID	# of Unique Quotes	# of Quotes by Subcodes
ID 101	6	10
ID 102	5	5
ID 108	21	22
ID 109	9	11
ID 110	10	11
ID 112	13	19
ID 113	10	14
ID 114	8	9
ID 116	11	14
ID 117	10	12
Total Quotes	103	127

Note: This table shows the number of quotations coded to investment themes for each participant, indicating variation in emphasis across interviewees.

Table 2. Investment Subcodes and Representative Quotations

Theme	Sub Themes	#mentions out of 127 (#unique participants)	Description	Example Quote	Second Example Quote
Land as a Tangible, Long-Term Investment	Land as an investment, Land market	52 (all)	Farmland is perceived as a stable, inflation-resistant asset with long-term appreciation.	"[You're] not going to lose your farm, just physically lose it like you can with stocks... land has definitely outdone gold." (ID 102)	"If you don't understand farmland, you don't understand it's a long-term hold appreciation with a dividend return. So, they see the two-and-a-half percent dividend, and it's like, 'Well, this is horrible. I don't want to invest in this.' " (ID 108)
Investor Diversity and Motivations	Non-farm investors, Limited non-farmer knowledge	31 (8)	Investors range from farmers and heirs to institutional funds and recreational buyers.	"A lot of them, they've never been to Iowa. They don't know anything about the farm. It was great grandpa's farm, I don't care. I can make \$12 million." (ID 116)	"Local investors... might be local business owners looking to diversify their asset pool. There's certainly been an increase in ... those smaller tracts ... that have some recreational pasture ground that wouldn't be split off" (ID 112)
Returns: Cash Flow vs. Appreciation	Returns, Cost of farming	27 (all)	Current cap rates have decreased, while appreciation remains strong.	"It's positive, but it keeps going down. ... When I first started, we were looking at a 4 to 5% cap rate... Today, we're down [to] around 2%." (ID 114)	"Since the mid to late 2000s, ... roughly more of the return has come from appreciation than it has from income as a percentage." (ID 113)
Rental Market Dynamics and Investor Behavior	Renting, Non-farm investors	41 (9)*	Investor expectations influence rental rates; rent adjustments often lag market shifts.	"[Producers] think, 'If I give this guy \$400 an acre, that will make it work... he can get his 3.5 to 4% and when [the outside investor] buys the next [farm], I may have to do the same, but maybe that third one, I won't.' It's a thought process, but they're looking at getting more dirt to farm." (ID 109)	"[Cash rental rates] always seem to lag behind a year or two because nobody wants to give up the land they're farming. So they end up leaving [rents] at too high a price until the banker steps in and says, 'You're paying too much.' " (ID 117)
Technology and Investment	New technology	6 (5)	Innovative technologies provide new revenue streams and cost savings.	"A number of dairy producers have actually installed methane digesters on their farm. It's another way for them to be able to capture some additional revenue that they never would have in the past." (ID 101)	"People are using drone technology more for scouting and now even in spraying crops... I mean, I don't think we're replacing the standard sprayer by any means ... but I think one of the things that makes them attractive is the cost, savings." (ID 110)

Note: This table organizes the eight subcodes into five core findings, with illustrative quotations. *Non-farm investor theme is counted repetitively for this category due to topical overlap.

Table 3. Profiles of Iowa Farmland Owners/Investors Identified by Participants

Investor Type	Description	Typical Motivation	Ag Engagement	Representative Quotes
Legacy Heir	Inherits land, often lives out-of-state, limited ag knowledge, emotionally detached	Monetize inheritance, simplify estate, or seek high returns with low involvement	Low	"A lot of them, they've never been to Iowa. They don't know anything about the farm. It was great grandpa's farm, I don't care. I can make \$12 million." (ID 116)
Strategic Producer	Actively farms and views land as a long-term investment or retirement tool	Secure operational control, build equity, intergenerational wealth	High	"Well, I bought it for investment. I want the annuity when I get it paid off for retirement. I also farm. ... So do you put me in the farmer bucket?" (ID 108)
Local Diversifier	Local business owners or semi-retired individuals looking for a tangible asset	Diversification, local legacy, semi-passive returns	Mixed	"Local investors... might be local business owners looking to diversify their investment pool... [buying] cropland [with] some recreational pasture ground..." (ID 112)
Outside Investor	Large-scale buyers (e.g., ag funds, retirement portfolios, or wealthy out of state landowners), often external	Portfolio balance, inflation hedge, stable return targets	Very Low	"We have some ag funds out here right now... they're buying for their outside investors. They want a certain return." (ID 109)
Recreational Buyer	Purchases land for non-ag use: hunting, scenery, lifestyle	Rural amenity, second home, personal enjoyment	Low	"I just sold one to a guy from [Florida], 1.3 million, wants to be close to Des Moines and wants hunting ground... No production..." (ID 108)

Note: This table summarizes five prominent landowner/investor profiles, and highlights their motivations, behaviors, and implications for the farmland market.

APPENDIX A: QUESTIONNAIRE (RELEVANT QUESTIONS FOR THIS MANUSCRIPT)

1. How has land performed as an investment over the years in your experience?
2. How does land as an investment compare to other assets, like stocks or bonds, moving forward?
3. Have you noticed any significant changes in the types of buyers or landowners (e.g., larger corporations, foreign investors, younger farmers)?
4. Could you share any notable examples of changes in buyer demographics?
5. What do you think is driving these changes?
6. How do you think precision agriculture and other technological advancements (e.g., automation, data-driven farming) are affecting how people view land as an investment?
 - a. You can talk about a specific technology or generally, as you prefer.
7. How has technology impacted the value of land?
8. What role do you see this playing out in the future?
9. Is there anything else you would like to add that we haven't covered, but is important to understand Iowa's land markets?

Enhancing Crop Insurance Decisions with Data-Driven Tools



By Enil Serrano, Grant Gardner, and Hunter Biram

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Abstract

Farmers face growing production and price risks that traditional Farm Service Agency (FSA) programs and crop insurance only partially address. This article reviews existing decision tools and introduces the Crop Insurance Decision Maker (CIDM), a web-based platform that uses stochastic simulations to project expected net revenues across insurance products and coverage levels. By incorporating farmer risk preferences and county-level data, CIDM improves transparency and supports more informed enrollment in FSA and crop insurance programs. Case studies demonstrate how CIDM enhances risk management decisions, balancing income stability with financial resilience.

INTRODUCTION

Farm managers, appraisers, and agricultural lenders recognize that farm income is closely tied to the safety net provided by federal programs. The Farm Service Agency's (FSA) commodity programs, including Agriculture Risk Coverage (ARC) and Price Loss Coverage (PLC), and the Federal Crop Insurance Program, administered by the USDA's Risk Management Agency (RMA), form the backbone of farm risk management (Rosch, 2022; USDA, 2024). ARC and PLC protect against shallow losses resulting from price or revenue declines, while crop insurance¹ offers deeper coverage of farm-level yield and revenue risks, often up to 85% of expected income (USDA-ERS, 2025; USDA-RMA, 2024). Together, these tools influence farm profitability, creditworthiness, and land values.

Decisions about which commodity program to elect (ARC or PLC) and what crop insurance product and coverage level to purchase are not straightforward. Outcomes depend heavily on local yields, market conditions, and individual risk preferences. As a result, universities, extension programs, and private firms have developed various decision-making tools to guide farmers through these choices (Coppess et al., 2019; Edwards et al., 2024; Maples, 2024; Biram, 2024). These tools have improved transparency and adoption, but they often differ in scope and analytical detail, which can limit their ability to incorporate local conditions and producer-specific risk preferences (DeLay et al., 2020).

This article builds on the existing literature by introducing the Crop Insurance Decision Maker (CIDM), a free, web-based tool designed to simplify program and insurance decisions while also serving an educational purpose. CIDM combines stochastic simulations with county- and farm-level data to project expected net revenues under multiple scenarios. By presenting results graphically, the tool not only helps producers identify the options that best fit their risk preferences but also illustrates how program and insurance choices shape revenue outcomes. In doing so, it complements existing tools while making the underlying trade-offs more transparent and accessible to producers, lenders, and appraisers alike (Goodwin and Hungerford, 2015; Maples et al., 2022).

FSA PROGRAM AND CROP INSURANCE BACKGROUND

Federal commodity programs provide a primary safety net for U.S. producers, and their interaction is central to farm management and lending decisions, with implications for income stability considered in agricultural land appraisal. Commodity programs, such as ARC and PLC, are administered by the FSA and protect against shallow losses from price and revenue declines, while the Federal Crop Insurance Program, administered by the RMA, provides more individualized protection against yield and revenue risks at the farm level (Rosch, 2022; USDA, 2024; USDA-RMA, 2024).

ARC operates at either the county or farm level. ARC-County (ARC-CO) triggers payments when county revenue falls below 86%² of a benchmark, while ARC-Individual (ARC-IC) compares actual versus benchmark revenue for all crops on a farm unit. PLC, similarly, makes payments when the marketing year average price falls below a reference price and only provides price protection. Both programs apply to historical base acres rather than planted acres, which limits their ability to cover farm-level variability (Paulson et al., 2024).

Figure 1 illustrates recent enrollment patterns across ARC and PLC, showing the apparent differences in program choice by commodity. For example, corn and soybeans tend to favor ARC-CO due to yield variability, whereas wheat farms tend to split the middle. In regions with stable yields, producers often favor PLC for its price protection. Where yields are more variable, producers tend to choose ARC, since revenue coverage inherently accounts for yield risk. Very few producers enroll in ARC-IC, because it aggregates revenue across all covered crops on a farm, similar to a whole-farm insurance policy, meaning strong performance in one crop can offset losses and reduce potential payments for another.

Crop insurance complements federal commodity programs by covering deeper losses, primarily through individual farm-level products regulated by the RMA. Producers may also purchase optional county-based supplemental endorsements, including the Supplemental Coverage Option (SCO) and Enhanced Coverage Option (ECO), which provide area-based coverage above an underlying individual insurance policy by covering a portion of the deductible. These endorsements expand the range of available risk management tools but are designed to supplement, rather than replace, individual coverage.

This study focuses on individual farm-level yield and revenue crop insurance products, which account for the majority of producer participation in the Federal Crop Insurance Program (Turner et al., 2023). Among these products, the most commonly selected policies are Yield Protection (YP), Revenue Protection (RP), and Revenue Protection with Harvest Price Exclusion (RP-HPE). Figure 2 presents 2024 crop insurance enrollment, showing that most producers enroll in RP or YP, with fewer selecting RP-HPE. While SCO and ECO are an important component of the broader crop insurance portfolio, they are not included in the analysis that follows.

Over time, crop insurance enrollment has expanded dramatically, from about 90 million acres in 1981 to nearly 500 million acres in 2022. Figure 3 highlights this growth and shows how policy reforms, such as the 1994 Federal Crop Insurance Reform Act, helped shift producers away from reliance on ad hoc disaster payments and toward federally supported insurance (Barnett and Coble, 1999; Chite, 2000). At the same time, the mix of insured acres has shifted, with forage and specialty crops gaining share relative to row crops (USDA-RMA, 2024). Insurance liabilities have also grown, underscoring the financial scale of the program and its stabilizing role for both producers and agricultural lenders (Figure 4).

The rationale for crop insurance over free disaster aid lies partly in accountability and incentives. Research shows that disaster payment programs are more susceptible to fraud and moral hazard, while insurance programs increase producer awareness of risk exposure and discourage unsustainable cropping practices (Barnett and Coble, 1999). At the same time, agriculture faces new and compounding risks—from climate extremes and pest outbreaks to geopolitical disruptions such as the Russia-Ukraine war, drought-driven supply chain bottlenecks at the Panama Canal, and attacks on cargo ships in the Red Sea—that highlight the need for structured, rules-based protection (Goyal et al., 2024; Rao, 2010).

For practitioners, these trends underscore the importance of joint program elections and insurance decisions, with outcomes contingent upon local yields, market conditions, and individual risk tolerance. The complexity of choices—encompassing coverage levels, unit structures, product types, and FSA program elections—creates a demand for decision-support tools that can tailor analysis to farm-level conditions. Tools such as CIDM, as well as others developed by universities and extension services, build on this foundation by integrating local yield/price correlations and risk preferences, making the trade-offs between

program benefits, premiums, and indemnities more transparent.

CROP INSURANCE AND A FARM PROGRAM DECISION-MAKING TOOL

Building on this need, producers and their advisors increasingly rely on decision-support tools to guide ARC/PLC elections and crop insurance decisions. Developed by universities, extension programs, and private firms, these tools range from simple Excel spreadsheets to sophisticated online calculators. Their primary purpose is to help farmers evaluate potential program payments, premium costs, and expected revenues across alternative risk management strategies.

Beyond guiding individual choices, these tools play an important educational role in the farm economy. By illustrating how coverage levels, deductible amounts, and program elections impact potential losses and indemnity payments, they enable producers to develop financial literacy, enhance policy understanding, and better comprehend their risk exposure (Kostyuchenko et al., 2015). In this sense, tools not only provide “answers” but also foster a more transparent decision-making process for producers, lenders, and appraisers.

Academic and extension programs have been leaders in this space. Texas A&M’s Agricultural and Food Policy Center developed the ARC/PLC Decision Aid, while Iowa State and Kansas State have created spreadsheet tools to compare historical program outcomes and evaluate future enrollment choices (Agricultural and Food Policy Center, 2025; Coppess et al., 2019; Reid, 2019; Gaku et al., 2024). Similarly, universities such as Mississippi State and Michigan State offer tools to help producers weigh program trade-offs (Maples, 2024; LaPorte & Sears, 2025). Iowa State’s Ag Decision Maker provides detailed crop insurance comparisons (Edwards et al. 2024), and Kansas State has developed calculators for supplemental coverage options (Ifft 2024). Other land-grant universities also contribute—for example, Iowa State’s ARC/PLC methodology resource (Plastina et al., 2025) and North Dakota State’s ARC/PLC payment calculator (Swenson and Haugen, 2024). Table 1 summarizes several widely used academic tools for FSA program decisions, while Table 2 highlights tools tailored to crop insurance coverage decisions.

Private companies and ag-tech firms have also invested heavily in decision-support platforms.

AgriLogic Insurance Services utilizes data-driven models for area, individual, and hybrid-based products (AgriLogic Consulting, 2024). Global Ag Risk Solutions has introduced cost-of-production insurance, which covers direct inputs and gross margins, thereby extending protection beyond yield or revenue alone (Global Ag Risk Solutions, 2024). Farmers Edge integrates precision agriculture with insurance decision-making, enabling producers to utilize real-time field data to optimize inputs and evaluate coverage strategies (Farmers Edge, 2024). These tools bring innovation but are often proprietary, tied to specific products, or come at a higher cost to producers.

Across both academic and private decision-support tools, a common limitation emerges: most emphasize expected returns while giving comparatively less attention to risk preferences, a critical factor in how individual producers value income stability relative to higher but riskier outcomes. As Smith, Outlaw, and Tufts (2017) emphasize, effective risk management begins with identifying the specific risks a producer seeks to reduce, followed by consideration of insurance plan type, production practices, yield exclusion options, unit structure, coverage level, and premium subsidization. The ultimate objective is therefore not only to maximize expected returns but also to ensure that coverage strategies align with a farm’s financial resilience, management objectives, and long-term goals. By incorporating farm-level risk modeling, tools can support more accurate farm-level analysis despite not requiring farm-specific data, while still facilitating discussion of key trade-offs.

Both academic and private industry tools exhibit additional structural limitations that further constrain meaningful engagement. Many academic tools rely on Microsoft Excel spreadsheets, which can be difficult for users without spreadsheet familiarity and often restrict use in group, classroom, or advisory settings. Moreover, most university-developed tools evaluate FSA programs and crop insurance separately, with a heavy emphasis on FSA programs due to their relative simplicity at the county level. This separation limits opportunities to explore how combined program selections affect whole-farm risk and to discuss interactions across risk management choices. While private industry has expanded upon these tools, access frequently requires paid subscriptions or service fees, which can restrict their use for exploratory analysis, education, and broader extension outreach.

Our review of existing decision-support resources highlights both meaningful progress and persistent

gaps. Producers have access to a wide range of university-developed and industry tools, yet these resources often require trade-offs between usability and analytical depth, with many prioritizing simplicity, spreadsheet-based platforms, or expected-value metrics. As summarized in Tables 1 and 2, most tools focus on either FSA programs or crop insurance in isolation and rarely incorporate stochastic modeling, local yield/price relationships, or explicit measures of risk preference. As a result, these tools often function as calculators of expected payments rather than as platforms for evaluating how alternative choices align with producer-specific risk attitudes.

CIDM was developed to build on the strengths and address the limitations identified in this review. Existing decision tools typically rely on static assumptions for prices and yields, requiring users to manually specify a limited set of scenarios they consider plausible. In contrast, CIDM provides a free, non-Excel, web-based interface that integrates both FSA and crop insurance programs within a single framework and evaluates a full stochastic distribution of price and yield outcomes with associated probabilities.

By incorporating stochastic simulations, local yield/price correlations, and certainty equivalents, CIDM allows producers and the professionals who advise them to evaluate alternatives not only in terms of expected revenues but also through structured discussions of risk exposure, revenue stability, and alignment with individual risk preferences and long-term management objectives. To our knowledge, no other tool provides farm-level program and insurance comparisons based on expected values derived from an explicitly modeled stochastic distribution of prices and yields.

IMPROVING CROP INSURANCE UNDERSTANDING WITH CIDM

In practice, crop insurance decisions remain difficult for producers to navigate. Policies are complex, agents may not always communicate options clearly, and outcomes hinge on local yields, market prices, and premium costs (DeLay et al., 2020). CIDM was designed to address these challenges by offering a free-to-use, web-based platform that simplifies program and insurance choices while incorporating local data into the analysis.

CIDM evaluates three major Multi-Peril Crop Insurance (MPCI) products—YP, RP, and RP-HPE—as well as a “no insurance” scenario. Users enter basic information

about their operation (crop, county, irrigation practice, and unit structure), and the tool produces graphs showing expected net revenues per acre under multiple coverage levels.

CIDM is built on a stochastic simulation framework that draws on historical yield data from USDA’s National Agricultural Statistics Service (NASS) and price data from CME Group futures contracts and Barchart.com. For each crop and county, the model generates 10,000 possible yield/price outcomes by resampling from historical yield distributions and combining them with projected and harvest futures prices (Miranda, 1991; Biram et al., 2022). To ensure realism, the simulation incorporates correlation modeling between yields and prices using a copula function. When USDA-RMA provides state-level yield/price correlations, these are applied directly. When such data are not available, empirical correlations are estimated from long-run historical series (1960–2022). This copula-based approach, following Goodwin and Hungerford (2015), ensures that CIDM reflects systemic risk, for example, the tendency for prices to rise in years with poor yields or fall during bumper crops.

For each simulated outcome, CIDM calculates farm revenue under alternative coverage levels and program choices, taking into account producer-paid premiums, indemnity payments, and FSA program benefits. The simulation outputs are then summarized as expected net revenues, which are presented graphically to allow side-by-side comparisons across insurance products and program elections. In this way, CIDM functions not only as a decision-support tool but also as an educational resource, illustrating for producers, lenders, and appraisers how coverage-level and product choices can influence income variability, downside risk, and overall financial stability.

Figure 5 reports expected net revenues for non-irrigated corn in Campbell County, Kentucky, under basic units and ARC enrollment across alternative crop insurance coverage levels. Expected net revenues are negative in the absence of crop insurance and at coverage levels below 60%, indicating substantial downside risk for producers who do not purchase adequate insurance protection. Expected net revenues increase monotonically with higher coverage levels and become positive beginning at 65% coverage, highlighting the financial value of increased insurance guarantees.

Differences in expected net revenues across insurance products are relatively small. YP generates the highest expected net revenues at all coverage levels, but the magnitude of this advantage over RP and RP-HPE

is modest. At higher coverage levels (80% and 85%), gains in expected net revenues are accompanied by higher producer-paid premiums, reflecting the increased out-of-pocket costs required to secure greater coverage.

Although Figure 5 shows negative expected net revenues on average in the absence of crop insurance, this result should not be interpreted as evidence that corn production is unprofitable or should be avoided in Campbell County. Rather, the figure reflects expected outcomes for the 2025 crop year, which was characterized by relatively low commodity prices. In this context, the CIDM results underscore the role of crop insurance in mitigating downside risk and smoothing farm income during periods of unfavorable market conditions.

It is additionally important to note that YP often appears more favorable in the 2025 expected net revenue comparisons because it carries lower premium costs than revenue-based products. The trade-off is that YP only protects against yield losses and does not adjust guarantees if harvest prices rise. By contrast, RP provides protection against both yield and price declines and increases guarantees when harvest prices exceed projected levels, while RP-HPE offers similar protection at a lower cost by excluding that upward adjustment. As a result, the differences between RP and RP-HPE are often relatively minor, unless harvest prices rise substantially, in which case RP provides more protection.

In this example, however, 2025 corn prices were already low going into the crop year, leaving relatively little revenue to protect against further declines. While RP would provide more protection if prices increased at harvest, CIDM also accounts for the typical price drops that occur at harvest, which further limits the added value of RP and RP-HPE in this case. This context helps explain why YP compared favorably in net revenue terms, since the added price coverage in RP and RP-HPE did not generate much additional benefit relative to their higher premiums. The Christian County example therefore shows that coverage-level decisions can matter more than product choice, since premiums drive the main differences. However, in years with greater expected price variability, RP may become the better product choice because it protects against both yield and price risk. CIDM makes these differences transparent by using county-specific yield data and price/yield correlations, allowing producers and their advisors to see whether coverage level or product choice is the more important decision lever in their area.

The power of CIDM is further demonstrated in Figures 6 and 7, which compare expected 2025 revenue distributions with and without crop insurance in Christian County, Kentucky. In the uninsured scenario (Figure 6), the distribution of expected net revenues is wide and skewed, with a 31% chance of financial loss ranging from $-\$1$ to $-\$800$ per acre. While average net revenue is positive ($\$136$ per acre), the range of possible outcomes is large, leaving the farm exposed to severe downside risk in poor yield or price years. By contrast, Figure 7 shows results under a 75% RP policy with optional units. Here, the probability of some loss is slightly higher (34%), but the severity of losses is dramatically reduced, limited to $-\$1$ to $-\$200$ per acre. At the same time, expected or average net revenue rises to $\$160$ per acre. This narrowing of the revenue distribution reflects how crop insurance reshapes risk exposure, cutting off catastrophic outcomes while maintaining upside potential. For a producer with debt obligations or tight cash flow, this stability may be the difference between default and survival.

This trade-off illustrates why crop insurance decisions must be evaluated beyond averages. Without insurance, farms may enjoy higher upside in good years but face the possibility of devastating losses. With insurance, premiums reduce long-run returns slightly, but income stability improves significantly. For lenders, this distinction is central to credit risk assessment. For appraisers, insured revenue streams are an important indicator of land value stability; for farm managers, CIDM helps ensure coverage strategies align with the farm's financial resilience and tolerance for risk.

CASE STUDY: A KENTUCKY GRAIN PRODUCER'S INSURANCE EXPERIENCE

The importance of CIDM can be illustrated through the experience of a Kentucky grain farmer who has consistently purchased crop insurance from 2008 to 2024. Table 3 summarizes the producer's annual premiums, indemnities, and FSA program payments across this 17-year period. On average, the farmer paid just over $\$18,000$ per year in crop insurance premiums. As is typical with crop insurance, indemnity payments varied widely over time, with some years generating substantial payouts and others providing none at all (USDA-RMA, 2024).

During "normal" years—including 2008, 2010, 2014, 2017 through 2019, and again in 2022 and 2023—the farmer received no indemnities despite paying

significant premiums. In these years, crop insurance felt like a net cost. However, in years of widespread losses, the program provided critical support. In 2009 and 2013, indemnities were large and far exceeded the farmer's annual premium costs, stabilizing the farm's finances and covering operating costs that would otherwise have been at risk.

Looking across the full 2008–2024 period, the producer's long-run loss ratio was 95%, meaning indemnities received were nearly equal to total premiums paid in. This outcome is consistent with actuarial fairness as designed by the Federal Crop Insurance Program (Coble et al., 2010). Still, the distribution of benefits was uneven: in most years, crop insurance produced a net cost, while in a handful of years, it delivered significant financial support that preserved solvency.

FSA commodity program payments provided additional support during this period, as shown in Table 3. In years when indemnities were absent or small, ARC and PLC payments helped offset premium costs and smooth income. This underscores the complementary relationship between farm programs and crop insurance: insurance protects against large, farm-specific yield and revenue shocks, while FSA programs provide a stabilizing baseline against systemic price or revenue declines (Rosch, 2022; USDA, 2024).

From the farmer's perspective, the uneven pattern of returns created skepticism about the value of crop insurance. In most years, premiums felt like wasted dollars, but in the worst years, indemnities were the difference between financial survival and distress. This mirrors the broader producer sentiment documented in earlier research, which emphasizes that farmers often weigh the annual cost of premiums against the rare but critical role of indemnities in catastrophic years (Barnett and Coble, 1999; Paulson et al., 2024).

For practitioners, the lessons are clear. Lenders benefit from insurance enrollment because indemnities improve repayment capacity in loss years, reducing credit risk. Appraisers can interpret insured revenue streams as signals of long-term income stability, which influences land values. Farm managers can use these insights to help clients design coverage strategies that balance annual costs with protection against catastrophic losses.

CIDM extends these lessons into a forward-looking framework. By simulating thousands of yield and price outcomes, CIDM shows producers what this Kentucky

farmer lived through over 17 years: insurance is often a cost in good years but a financial lifeline in bad ones. The tool makes these trade-offs transparent, helping producers and their advisors tailor decisions to the unique financial and agronomic conditions of each farm.

CONCLUSION

Farm producers today manage risk in an environment shaped by volatile commodity markets, shifting policy supports, and increasing weather and global uncertainties. ARC and PLC provide a baseline of protection against shallow losses, but crop insurance fills deeper gaps by covering farm-level yield and revenue risks. Together, these programs influence not only farm income but also creditworthiness, land values, and long-term financial stability.

The results presented here highlight important takeaways for practitioners. For producers, coverage-level decisions often have a greater effect on expected net revenues than product selection, though revenue-based products such as RP provide additional protection when price variability is high. For lenders, crop insurance enrollment improves repayment capacity by reducing the likelihood of severe income shortfalls. For appraisers, consistent program participation and insured revenues provide stronger signals of land value stability. The Christian County example and Kentucky farmer case study both illustrate the reality that premiums may feel costly in most years, but indemnities in disaster years are indispensable in sustaining farm operations.

CIDM adds value not only as a decision aid but also as an educational tool. By making the trade-offs of crop insurance transparent and visually illustrating how coverage levels, products, and program elections alter financial outcomes, CIDM enhances producer understanding and supports better communication between farmers, lenders, and appraisers. In this way, CIDM builds financial literacy while informing real-world choices.

Looking ahead, agriculture will face continued challenges—from climate extremes and pest pressures to trade disruptions and geopolitical shocks—that will test the resilience of farm businesses and rural credit markets. Meeting these challenges will require more than federal safety nets alone. The synergy between public programs and innovative decision-support tools is essential, providing the flexibility, transparency, and resilience that producers, lenders, and appraisers need

to manage risk effectively and ensure the long-term stability of the agricultural sector.

Practitioner Access: CIDM is available as a free, web-based decision-support tool intended for use by agricultural producers, extension professionals, and advisors. The tool can be accessed at <https://hunterbiram.shinyapps.io/CropInsuranceDecision2025/> and does not require specialized software, spreadsheet expertise, or paid subscriptions. Users input basic operation-level information, including location, crop, irrigation practice, and program selections, after which CIDM generates expected net revenue distributions and certainty equivalents across crop insurance and FSA program combinations. The tool is designed to support exploratory analysis and education rather than to prescribe a single optimal decision. Housing of the tool is subject to change but will be available on University of Kentucky and University of Arkansas Agricultural Economics websites in the future. The tool currently functions for Arkansas and Kentucky, but the authors are open to collaboration and growing use of the tool via partnerships other universities as well as industry partners.

FOOTNOTES

- 1 Federal crop insurance is subsidized, with premium support historically ranging from 38% to 80%, depending on coverage level and unit structure. On average, the government has covered about 63% of total premiums, leaving producers responsible for roughly 40% out of pocket (USDA-ERS, 2024). Recent policy changes under the One Big Beautiful Bill (OBBB), enacted in July 2025, increased premium support for most farm-level policies, further reducing producer-paid costs. While these subsidies lower the cost of coverage below actuarially fair rates and encourage broad participation, the farmer-paid share remains a significant annual expense that must be weighed against potential indemnities and the complementary protection offered by FSA programs.
- 2 The One Big Beautiful Bill Act (OBBBA) increased the ARC-CO revenue guarantee from 86% to 88%.

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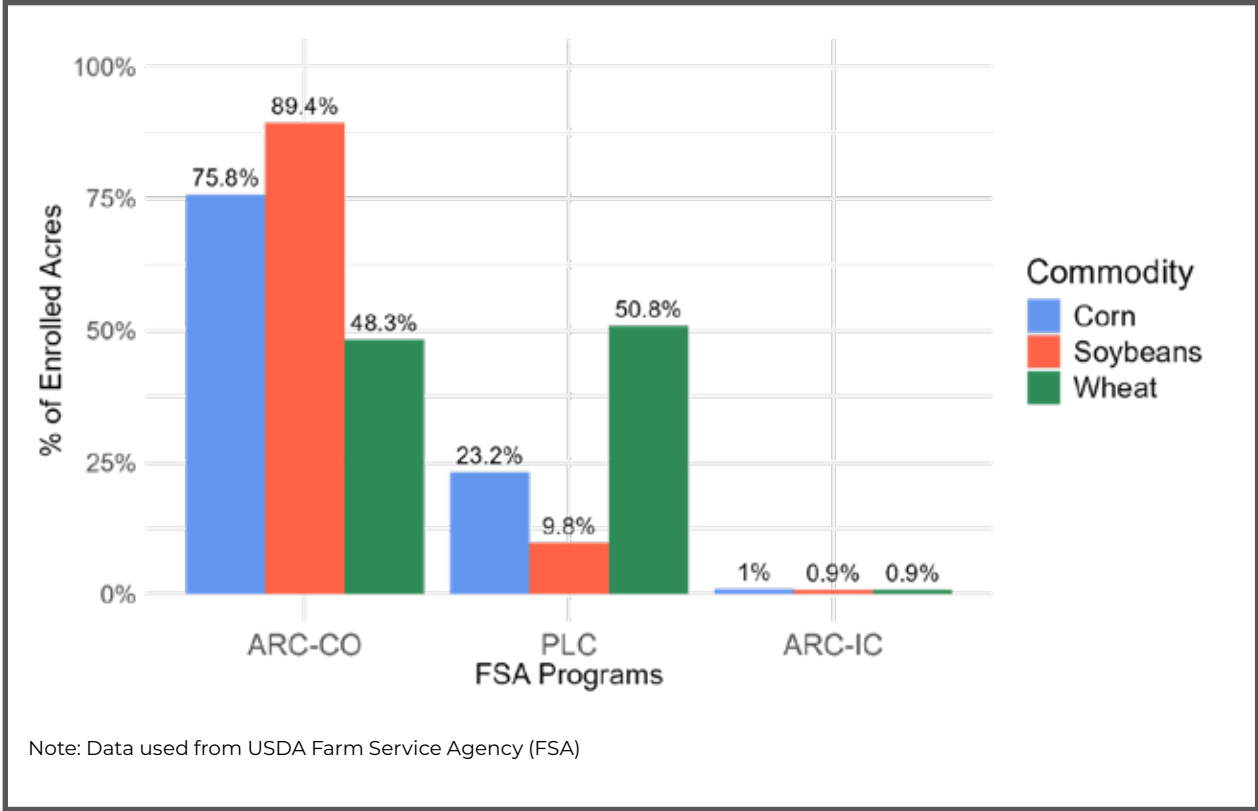


Figure 1. United States Enrolled Base Acres by FSA Program and Commodity, 2024 (%)

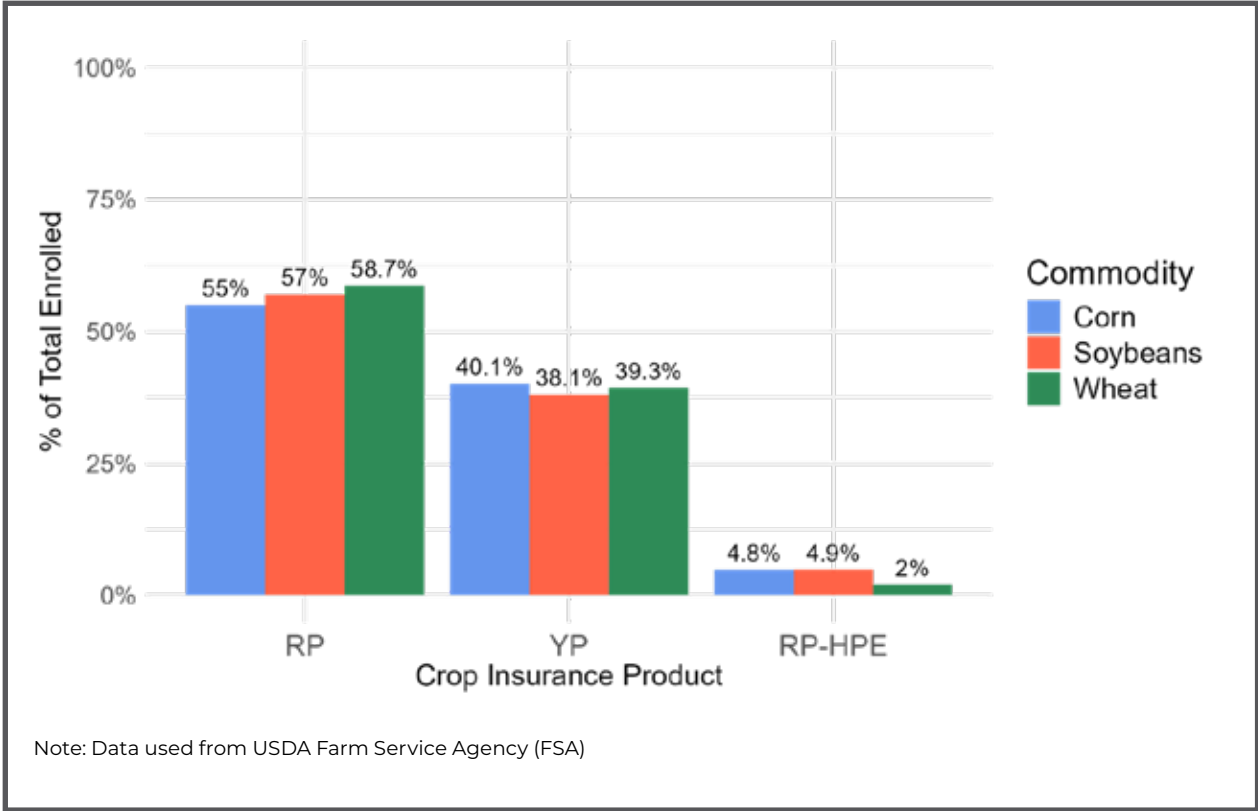


Figure 2. United States Crop Insurance Enrollment by Product and Commodity, 2024 (%)

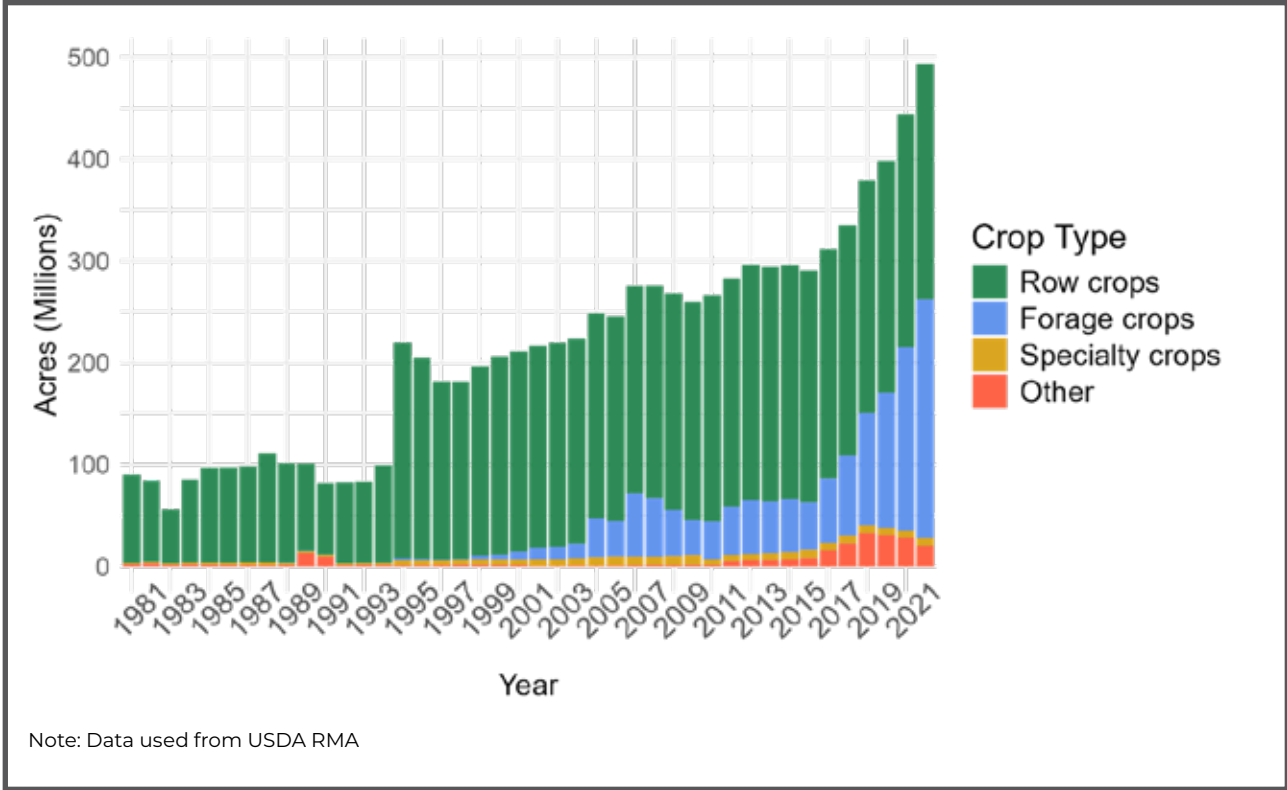


Figure 3. Trends in the United States Federal Crop Insurance Program Net Reported Acres by Commodity Type, 1981-2021

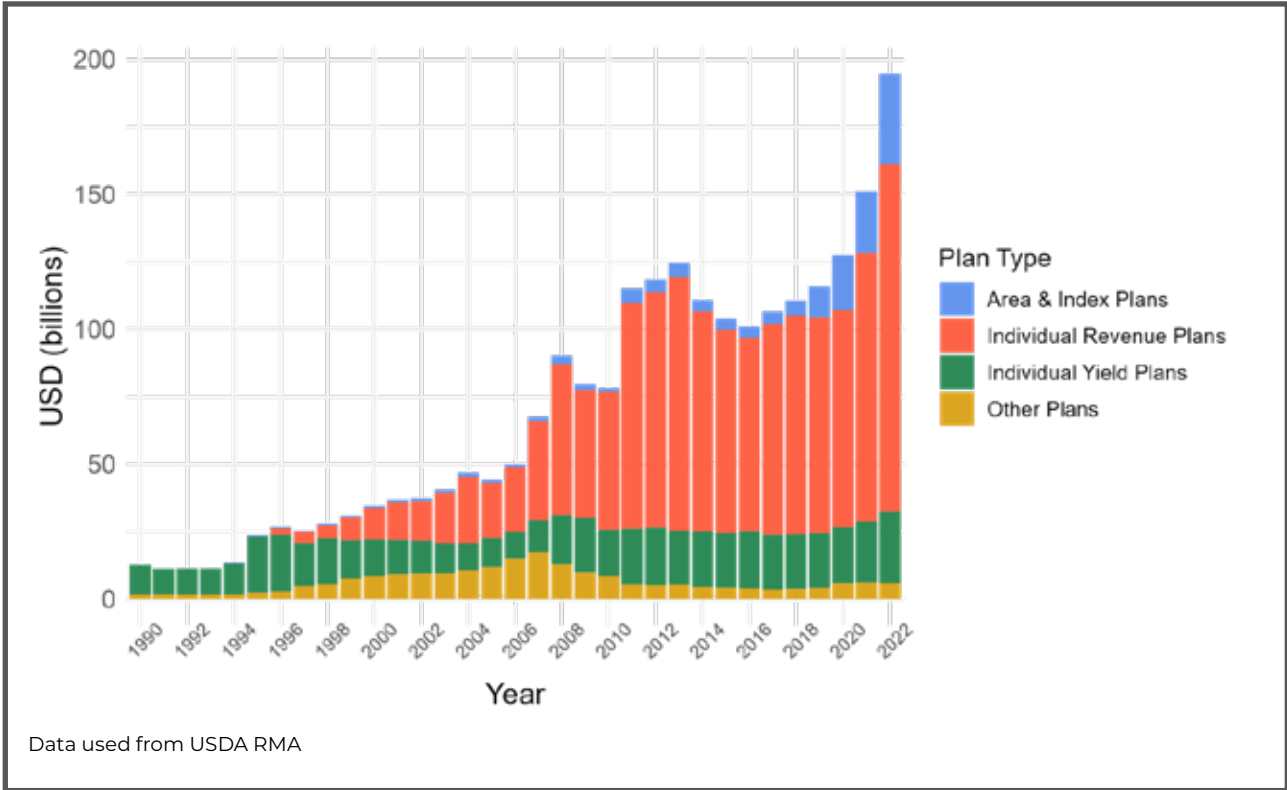


Figure 4. United States Federal Crop Insurance Program Liability by Policy type, 1990-2022

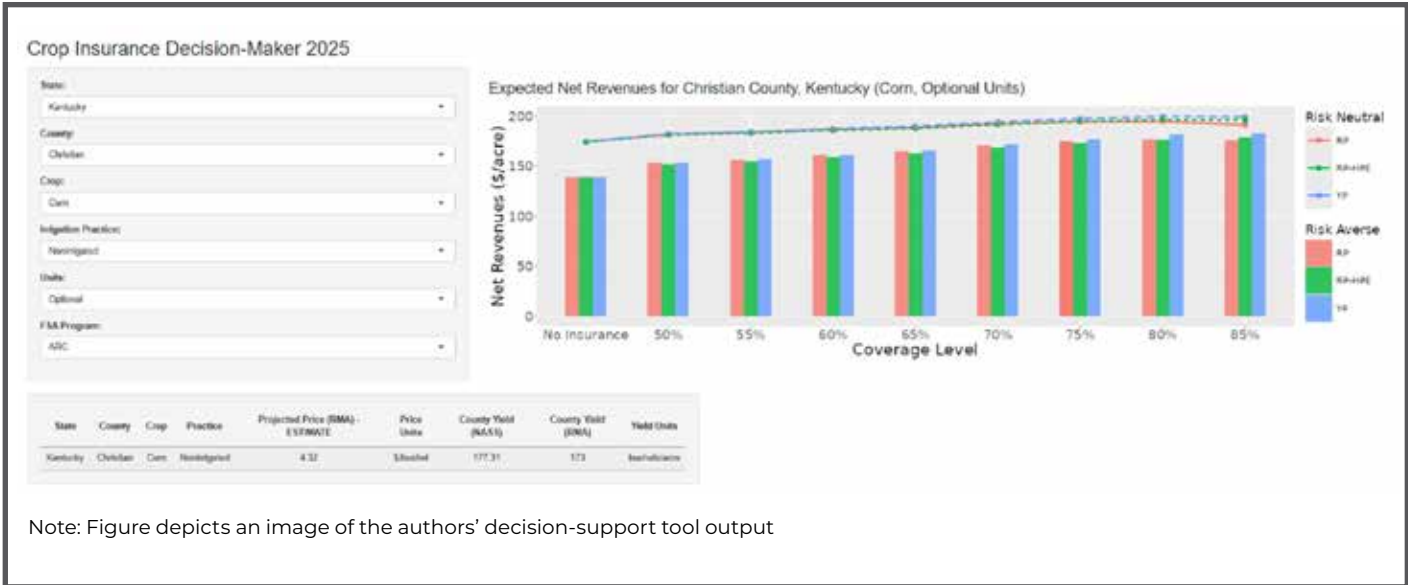


Figure 5. CIDM Web Application Tool

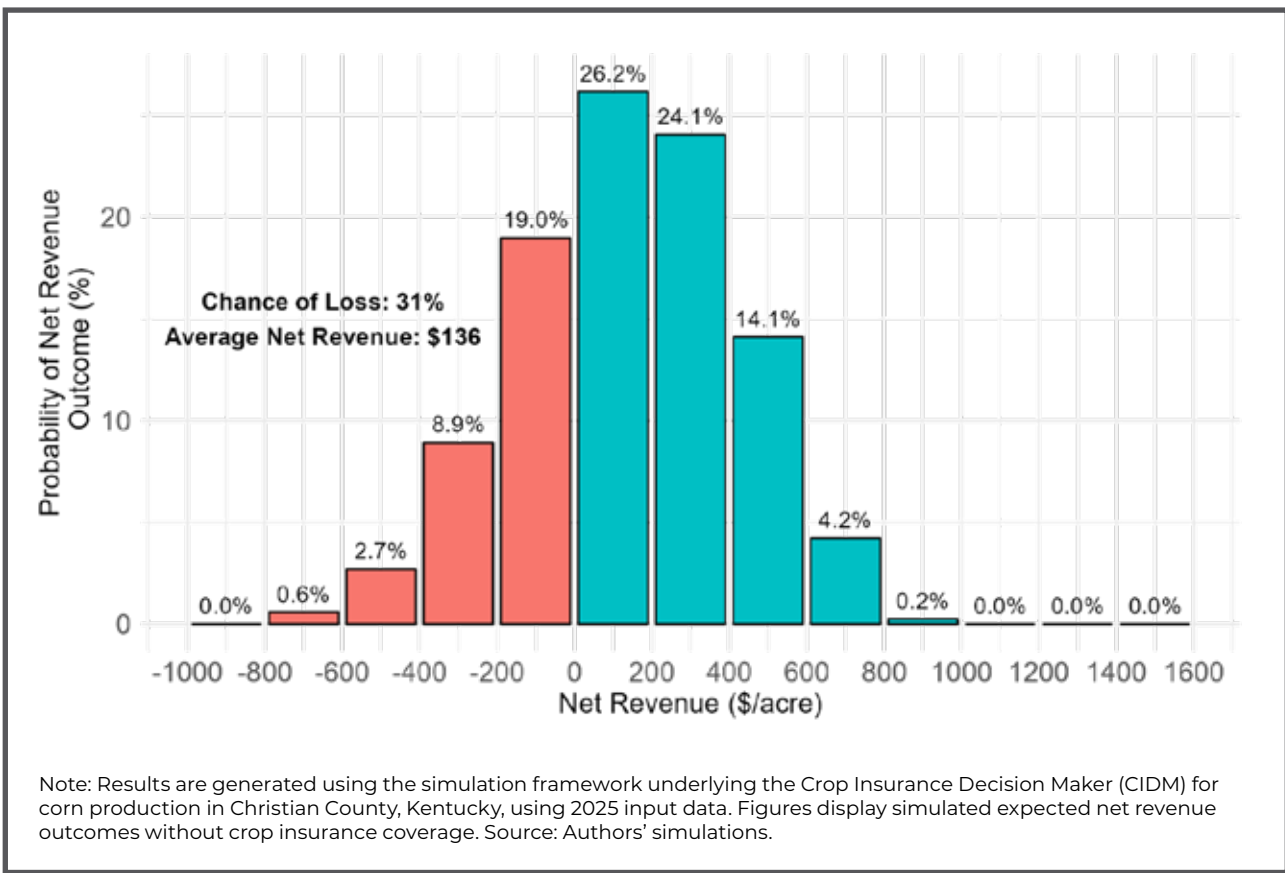


Figure 6. Expected Net Revenue Distribution without Insurance for Corn in Christian County, Kentucky, 2025

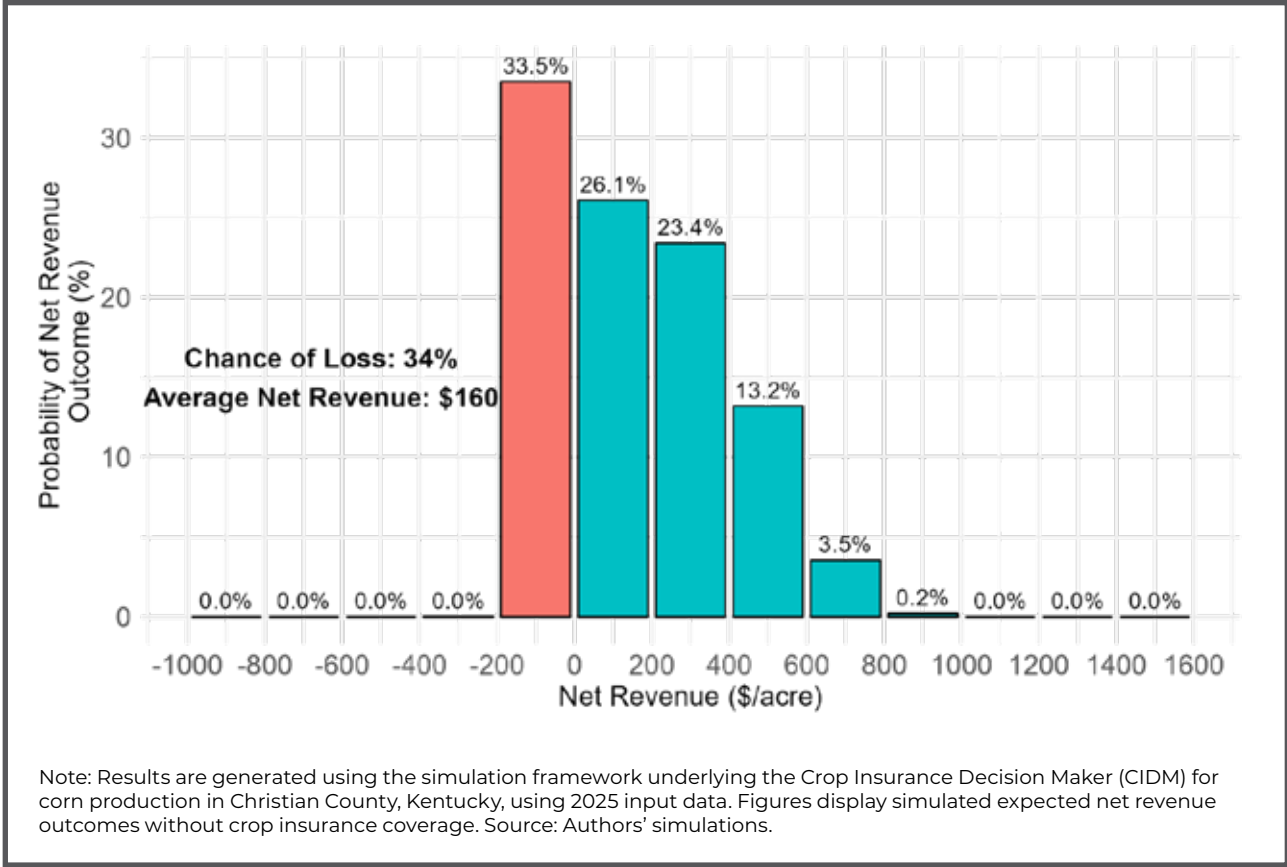


Figure 7. Expected Net Revenue Distribution with a 75% Revenue Protection for Corn in Christian County, Kentucky, 2025

Table 1. Comparison of Universities' FSA Decision-Making Tools for Farm Program Enrollment

Characteristics	University of Illinois	Iowa State University	Kansas State University	Michigan State University	Mississippi State University
Platform Type	Online Web-based	Excel Spreadsheets	Excel Spreadsheets	Excel Spreadsheets	Online Web-based
Commodities	Corn, Soybeans, and Wheat	Corn and Soybeans	Corn, Wheat, Soybeans, Sorghum / Other crops, and more are found in a separate tool	Corn, Soybeans, and Wheat	Corn, Soybeans, and Wheat
Payment Program Included	ARC-CO and PLC	ARC-CO and PLC	ARC-CO, PLC, and SCO	ARC-CO and PLC	ARC-CO and PLC
Regional Focus	Nationwide-County Level	Iowa- County Level	Nationwide- County level	Michigan State-County level	Mississippi State-County Level
Method of Payment Estimation	Option to choose between projected prices, USDA projected prices, series of low but realistic prices, series of high but realistic prices, and MYA prices by the Congressional Budget Office	Reported and projected prices from USDA Farm Service Agency and Risk Management Agency to project payments at the county level	County FSA and RMA yields and thus represent the average county-level payouts, not individual payouts.	Based on assumptions about county yields and national market prices	Estimated payment accounts for yield and price risk based on a 10,000 simulation of potential price and yield combinations.
Includes What-If scenarios	Yes, it lets the user choose payment, method, and calculations	No	No	No	Selection of price volatility. Provides scenario probability of expected payment and no payment.
Notes	Payments are made using the base acres in place of actual planted acres on the FSA farm.	Payments are calculated for non-irrigated corn and soybeans base acres by county.	Analysis doesn't account whether a producer has base acres for the crop being produced. ARC and PLC only pay out on base acres.	County yields can be adjusted by entering different yields directly or adjusting their percentage. A default for 86% of county yields is available to demonstrate scenarios of significant yield loss.	The information provided is for educational purposes and to be used as a guide. This decision tool accounts for uncertainty and reports expected payments based on a 10,000 scenario simulation.
Visual Graphs/ Charts	Yes. provides a graph for the payments and payment distributions.	No	One of the tools compares PLC and ARC-CO payments	No	No
Combination of FSA and Crop Insurance	No	No	No	No	No

Note: Other crops include but are not limited to canola, large and small chickpeas, dry peas, crambe, flaxseed, lentils, mustard seeds, oats, rapeseed, rice (long grain, med/short grain, temperate japonica), safflower, sesame, sunflower

Table 1. Comparison of Universities' FSA Decision-Making Tools for Farm Program Enrollment (Continued)

Characteristics	University of Missouri	North Dakota State University	Ohio State University	Texas A&M University
Platform Type	Excel Spreadsheets	Excel Spreadsheets	Excel Spreadsheets	Online Web-based
Commodities	Corn, Soybeans, and Wheat	Barley, Canola, Corn, Soybean, Sorghum, Wheat / Other Crops	Corn, Soybeans, and Wheat	Barley, Canola, Corn, Cotton, Sorghum, Peanuts, Soybeans, and Wheat / Other Crops
Payment Program Included	Arc-CO, ARC-I, and PLC	ARC-CO and PLC	Arc-CO, ARC-I, and PLC	ARC-CO and PLC
Regional Focus	Nationwide- County level	Minnesota, North Dakota, South Dakota, and Montana- County level.	Nationwide- County level	Nationwide-County Level
Method of Payment Estimation	Farmers input their own FSA price PLC yields, marketing year average prices (national price)	2024 Marketing year average (MYA) and average county yields	Farmers input their own FSA PLC yields, marketing year average prices (national price)	Characterizes probabilities of different levels of expected FSA payments. Based on 500 possible future realizations of market prices and county yields.
Includes What-If scenarios	Allows what if scenarios for individual county-based yields and prices.	No	Allows what if scenarios for individual county-based yields and prices.	Yes, insert assumed County yields to calculate ARC payments for all trials in the simulation
Notes	Users can change the market year prices by using a crop price model that estimates price 1,000 times for variation. The price used is the average of those trials.	Only applicable for farms which have all base acres physically located in one county. Will only calculate ARC-CO using non-irrigated yields.	Users can change the market year prices by using a crop price model that estimates price 1,000 times for variation. The price used is the average of those trials.	Values displayed in the results will not match the payments you might calculate using single specific price and yield realizations. To see the likelihoods of different levels of payments, click on an individual expected payment
Visual Graphs/ Charts	Yes. Annual payments, performance section, program design and illustration.	No	Yes. Annual payments, performance section, program design and illustration.	No
Combination of FSA and Crop Insurance	No	No	No	No

Note: Other crops include but are not limited to canola, large and small chickpeas, dry peas, crambe, flaxseed, lentils, mustard seeds, oats, rapeseed, rice (long grain, med/short grain, temperate japonica), safflower, sesame, sunflower

Table 2. Comparison of Universities' Crop Insurance Decision-Making Tool

Characteristics	University of Illinois Urbana-Champaign	Iowa State University	Kansas State University	University of Arkansas
Platform Type	Excel Spreadsheets (Fast Tools) and Online Web-Based	Excel Spreadsheets	Excel Spreadsheets	Online Web-based
Commodities Included	Corn, Soybeans, and Wheat	Soybeans and Corn	Corn, Soybeans, Grain Sorghum, and Wheat	Corn, Soybeans, Medium and Long grain Rice
Coverage Options	RP, RP-HPE, YP, SCO, and ECO	RP, RP-HPE, and YP	SCO and ECO with RP, RP-HPE, and YP	Margin Protection
Regional Focus	Illinois, Alabama, Arkansas, Florida, Georgia, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin at the county level.	Manually type County and State	Nationwide-county level	Nationwide- county level
Coverage Levels	50% - 85%	50% - 85%	50% - 85%	70%-95%
Unit Structure	Enterprise, Basic, and Optional	No option to choose	No option to choose	No option to choose
Visual Graph/ Charts	No	No	No	Yes, provides a visual breakeven price and protection factor for the chosen coverage level.
Notes	Actual Production History (APH) yield is based on the last ten years of yields with substitutions made for low yields.	Directs user to the Farmdoc Premium Calculator to find estimated premiums.	Payments are determined by multiplying the SCO or ECO Payment Rate (if positive) by the SCO or ECO Protection, respectively	The user should note that positive values of net indemnity imply the producer does not owe any money on their Margin Protection policy and may use this dollar amount to pay their operating loan note or pay for a producer premium on a different purchased policy.

Table 3. Crop Insurance and Federal Program Payments for a Representative Producer in Kentucky (2008-2023)

Year	Crop Insurance Cost (\$)	Indemnity Payments	Government Payments
2023	\$17,769	\$ -	\$ -
2022	\$27,875	\$ -	\$ -
2021	\$22,619	\$4,786	\$2,456
2020	\$17,868	\$8,703	\$75,586
2019	\$18,504	\$ -	\$109,849
2018	\$19,941	\$ -	\$4,690
2017	\$20,434	\$ -	\$21,226
2016	\$17,618	\$1,556	\$2,254
2015	\$17,365	\$1,536	\$11,678
2014	\$18,169	\$ -	\$33,888
2013	\$23,933	\$212,545	\$46,886
2012	\$18,277	\$2,112	\$71,200
2011	\$20,367	\$14,911	\$45,894
2010	\$4,816	\$ -	\$117,998
2009	\$16,006	\$36,632	\$35,799
2008	\$14,740	\$ -	\$31,955
Total	\$296,301	\$282,781	\$611,359
Average	\$18,519	\$17,674	\$38,210
Loss Ratio	95.44%		

Updating Labor Efficiency and Productivity Benchmarks



By Megan N. Hughes, Chelsea Plummer, and Michael R. Langemeier

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Abstract

Labor is a significant expense for crop farms. This paper updates labor efficiency and labor productivity benchmark values using financial data from a sample of non-irrigated crop farms in Kansas. Based on a five-year farm-level average from 2020 to 2024, the mean labor efficiency was 19%, and the mean labor productivity was \$577,739. Farms with both a below average labor efficiency

and above average labor productivity have an average labor efficiency of 12.6% and an average labor productivity of \$801,420.

INTRODUCTION

Agricultural labor productivity has been steadily increasing in the United States from 1948 to 2017, with farm output per labor hour increasing by a factor of around 17 (Wang et al., 2022). Changes in labor productivity can be driven by changes in human capital, factor intensity, and technological change (Wolla, 2017), for example, increasing the human capital per worker through training programs or physical capital per worker through new equipment purchases can increase labor productivity. Improvements in technology can also drive improvement in labor productivity, since these factors are considered complements. Muger, Langemeier, and Featherstone (2012) decomposed the drivers of change in productivity and found that technical efficiency and factor intensity drove an increase in Kansas labor productivity from 1993 to 2007.

Labor productivity, a measure of the value of farm production (VFP) per worker, directly influences both profit margins and labor costs. Labor efficiency, calculated by dividing labor costs by VFP, provides further insight into the labor costs of additional VFP. Combining these measures allows farm managers to assess labor management on their operation. It is important to routinely revisit and update benchmark values for labor productivity and efficiency such that when used by producers, these tools match the current conditions in which producers operate.

Labor efficiency and productivity are positively correlated with better farm financial outcomes. Early benchmarks were generated using Illinois farm records from 1944-1946, and the quintile of farms with the lowest labor expenditure were observed to have higher farm earnings (Johnston, 1951). Pairwise correlations between optimal labor efficiency, labor productivity, and individual measures of profitability and financial efficiency were found to be significant (Langemeier,

2018). Labor efficiency and labor productivity are also positively correlated with better farm financial outcomes in the aggregate (Yi and Ifft, 2019).

Langemeier (2018) provides benchmark values for labor productivity and labor efficiency. In this paper, we update these values and find similar results regarding the relationship between the labor measures and both farm profitability and efficiency. We find that benchmark values for labor efficiency have increased slightly, representing a slight decline in efficiency compared to the benchmark values introduced by Langemeier (2018), but labor productivity has increased. We also present benchmark values based on farm size as measured by VFP.

METHODS

Benchmark values for labor efficiency and labor productivity are calculated using the definitions presented in Table 1. Labor efficiency can be considered as the total cost of labor per dollar of output. The lower the labor efficiency, the fewer resources used per dollar of output. Likewise, labor productivity can be considered as the output per worker. A producer would aim to *minimize* labor efficiency and *maximize* labor productivity.

To understand the trends in labor measures, we calculate five-year averages of demographic and financial characteristics for each farm in the sample. Following Langemeier (2018), benchmark values for 2020-2024 are calculated by sorting farms into two groups: above average (top quartile) and below average (bottom quartile). The above average group includes the farms that had both a below average labor efficiency and an above average labor productivity. The below average group consists of farms that had both an above average labor efficiency and below average labor productivity. We then sort farms into quartiles based on VFP and provide average values of labor efficiency and labor productivity for each quartile. The VFP quartiles allow us to subset farms by size, which might provide a more representative alternative benchmark value.

Correlation coefficients are calculated between select farm demographic and financial variables. These values allow us to assess statistical relationships between labor efficiency and productivity as well as farm characteristics and financial position. The farm demographic variables included were operator age, total acres, crop intensity, land tenure (percent acres owned), and VFP. Crop intensity is calculated

by dividing the harvested acres by the crop acres. Profitability measures included net farm income (NFI), the profit margin ratio, and the rate of return on assets. Financial efficiency measures included the asset turnover ratio, total expense ratio, and the operating expense ratio.

DATA

For this analysis, we use data from the Kansas Farm Management Association (KFMA) and follow their definitions for benchmark and financial ratio calculations. Table 2 contains the included variables and descriptive statistics for each over the period used to generate benchmarks, 2020-2024. The average labor efficiency and labor productivity were 18.7% and \$577,739, respectively, and the average total acres were 1,889. Average VFP and NFI were \$902,181 and \$185,784, and the average profit margin ratio and rate of return on assets were 0.045 and 0.029. The average asset turnover ratio, total expense ratio, and operating expense ratio were 0.343, 0.817, and 0.694.

We focus on *non-irrigated crop farms*, defined as operations with greater than 80% of crop labor allocated to dryland crops. To be included in the sample, farms needed to have continuous data for the five-year period over which averages were calculated. Table 3 shows each period for which benchmark values were calculated and the number of farms included in that period. For example, a farm might be included in the period from 2005 to 2009 but excluded from the 2010 to 2014 calculation if no data were available for 2011.

KFMA uses a standard operator cost per year to compute operator labor. To manage differences in accounting for labor between business organization structures (e.g., sole proprietor versus corporation), any operator wages paid by a corporation are excluded from operator cost calculations. Unpaid family labor is calculated as the number of months worked multiplied by half the operator labor cost. The number of workers is a measure of operators, hired employees, and family members. KFMA economists report the number of workers as the fraction of the year that they work, so a half-time employee would be recorded as 0.5 workers.

Figure 1 and Figure 2 show the trends in average total labor cost and number of workers per operation for farms included in the study. Total labor cost has shown a consistent upward trend over the past 20 years, with unpaid family labor remaining steady over that same time; hired labor has increased slightly; and operator

labor has increased steadily, driving much of the rise in total cost. The number of workers has increased but has remained within a range of 0.2 workers throughout the period. Figure 3 shows the distribution of the number of workers for the sample. The median number of workers is 1, representing one full-time operator.

Figure 4 illustrates the distribution of VFP for farms in the sample. The first frame, *distribution of value of farm production*, illustrates the value in reporting labor measures by VFP quartile, as the distribution of VFP is right-skewed, with a long tail of higher VFP farms. Benchmarking against the mean would cause middle-of-the-pack farms to appear below average, as the large values pull the mean upward. Accounting for this skew by breaking the sample into quartiles when reporting benchmarks allows farm managers to make more accurate comparisons for their operation.

The second frame, *labor efficiency by VFP quartile*, illustrates how labor efficiency is distributed across quartiles. The average labor efficiency decreases as VFP increases, and the distributions are also tighter as VFP increases. Conversely, the third frame, *labor productivity by VFP quartile*, shows that as VFP increases, labor productivity also increases. We can also see that the bottom quartile has a tighter distribution than the highest quartile.

ANALYSIS

Labor ratios were calculated as the average of farm-level five-year averages from 2005 to 2024 (Table 4). Labor efficiency remained fairly stable over this period, ranging from a low of 19% from 2020-2025 to a high of 21% from 2015-2019. Labor productivity trended upward from a low of \$300,528 in 2005-2009 to \$577,739 from 2020-2024. A dip in labor productivity, coupled with an increase in labor efficiency, is observed from 2015-2019, which is reflective of the agricultural economy during that period.

The correlation coefficients and their relative interpretation are reported in Table 5. All variables behaved as expected, with “favorable” labor measure outcomes having statistically significant correlation to favorable profitability and financial efficiency values. We find that labor efficiency and labor productivity are highly correlated, with a coefficient of -0.75. As labor productivity increases, labor efficiency decreases.

Total acres, crop intensity, and VFP are correlated with positive labor outcomes. As each of these

characteristics increases, labor efficiency decreases and labor productivity increases. As operator age and the percentage of acres owned increases, we see the opposite effect: labor efficiency values increase and labor productivity decreases. Higher expenditure on machinery, measured by crop machinery costs and investment per acre, are also found to be weakly correlated with favorable labor measure values.

Benchmark values are reported in Table 6 and Table 7. Table 6 reports the benchmarks generated from the 2020-2024 sample. Labor efficiency and productivity averages for the below average group are 27.8% and \$371,912, respectively. In the above average group, labor efficiency and labor productivity are 12.6% and \$801,420, respectively. Table 7 reports the average labor measures for farm subsets based on VFP quartile. The relationship between VFP and labor measures is, again, evident as labor efficiency decreases, and labor productivity increases with an increase in VFP.

DISCUSSION

Compared to Langemeier’s 2018 above average benchmark values, labor efficiency has worsened (increased) by 3.5% (note that an increase to this value represents a decline in efficiency, hence we use the term “worsened”). Labor productivity, however, has increased by around \$150,000, indicating that farms are generating more dollars of output per worker. For the below average benchmark values, labor productivity has increased by approximately \$170,000. The labor efficiency benchmark improved (decreased) by 2.8%. This represents a subtle narrowing in the gap between above and below average farms in terms of labor efficiency. Table 8 compares the 2018 benchmark values to the newly calculated 2024 benchmark values.

Labor benchmarks can be used by farm managers in a variety of settings. Considering whether to add an employee or whether to invest in new technologies are both cases where understanding labor utilization is necessary. In the case of a sole proprietor wanting to add a full-time employee, the operator should compare VFP to the labor productivity benchmark. A VFP of at least \$1.6 million, or double the labor productivity benchmark, would indicate there is room to hire a full-time employee. Labor benchmarks can also be used to evaluate previous decisions—for example, how did the labor benchmarks change following an asset purchase? If they decline or remain stable, there may be changes necessary to better utilize the labor force.

Farm managers can also use these benchmarks to evaluate labor use in relation to other major costs components. If the labor efficiency ratio is high, a farm manager might look at whether machinery costs are also high. As there can be trade-offs between labor machinery costs, higher labor costs that enable lower machinery costs are not necessarily a cause for concern, but when both labor and machinery costs are high, this may indicate the presence of inefficiencies that should be addressed.

CONCLUSION

In this paper, benchmark values for two labor measures, labor efficiency and labor productivity, are examined using a sample of non-irrigated crop farms in Kansas. Favorable labor efficiency and productivity values are found to be correlated with favorable profitability and financial efficiency ratios. Farms that are bigger, have a higher crop intensity, own a smaller percentage of their acres, and have a higher expenditure on machinery are also found to have more favorable labor efficiency and labor productivity values. The relationship between labor measures and profitability and financial efficiency underscores the importance of benchmarking labor measures for farm managers.

Benchmark values based on farms with a both below average labor efficiency and an above average labor productivity are developed. The labor efficiency benchmark value is a measure below 12.6%, and for labor productivity, the benchmark value is a measure above \$801,000. This represents an improvement

in labor productivity but a slight decline in labor efficiency compared to 2018 benchmark values. These results are consistent with past findings that changes in labor productivity are driven primarily by factor intensity and technical efficiency. Increased mechanization is reflected in increased labor productivity due to the complementary nature of labor and technology in agriculture. However, gains in technology may or may not be reflected in labor efficiency. The updated benchmarks offer farm managers a reference point for making informed decisions related to labor utilization on their operation.

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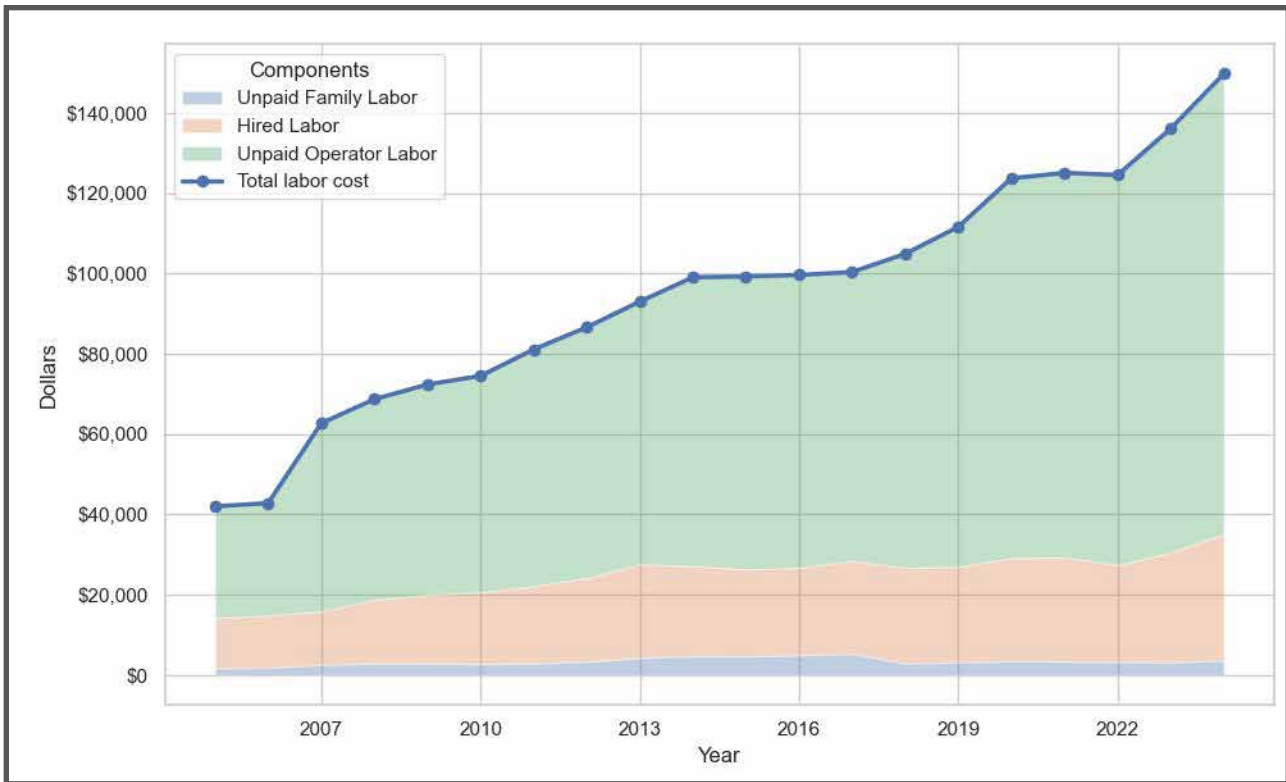


Figure 1. Average total labor cost by component

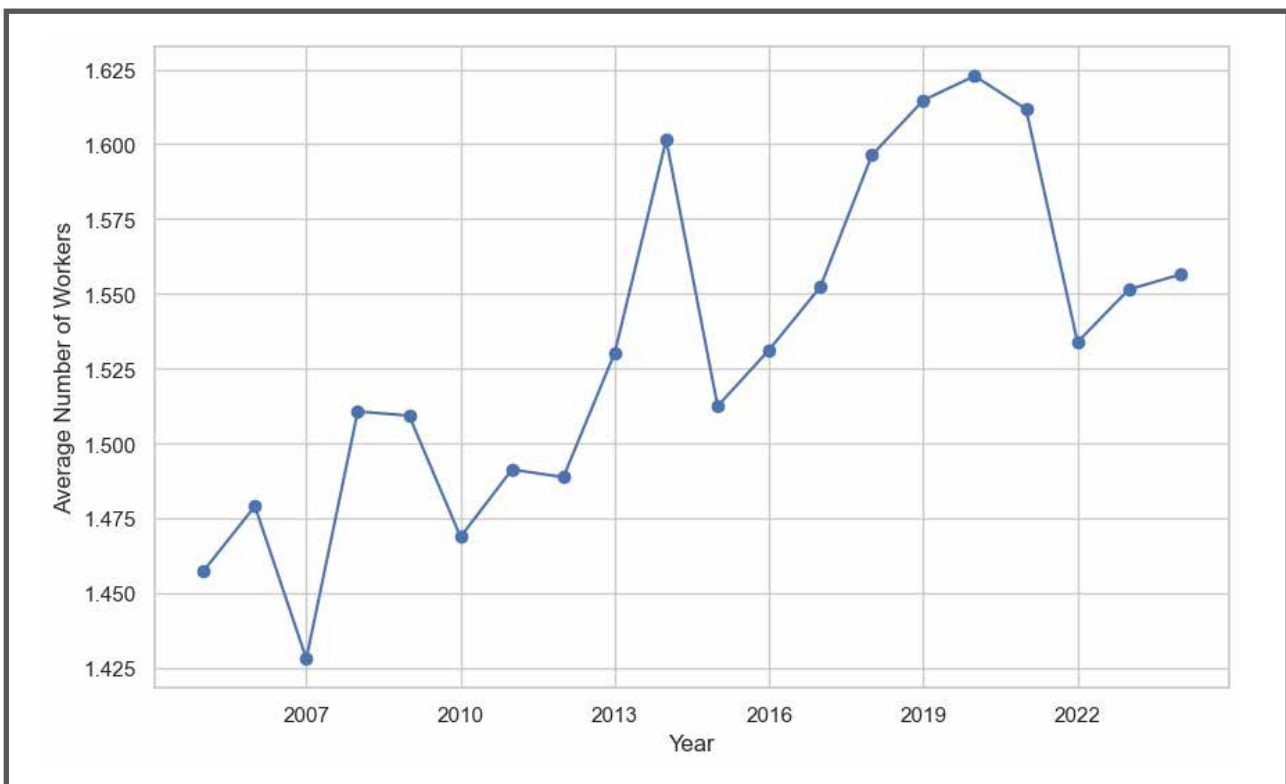


Figure 2. Average number of workers by year

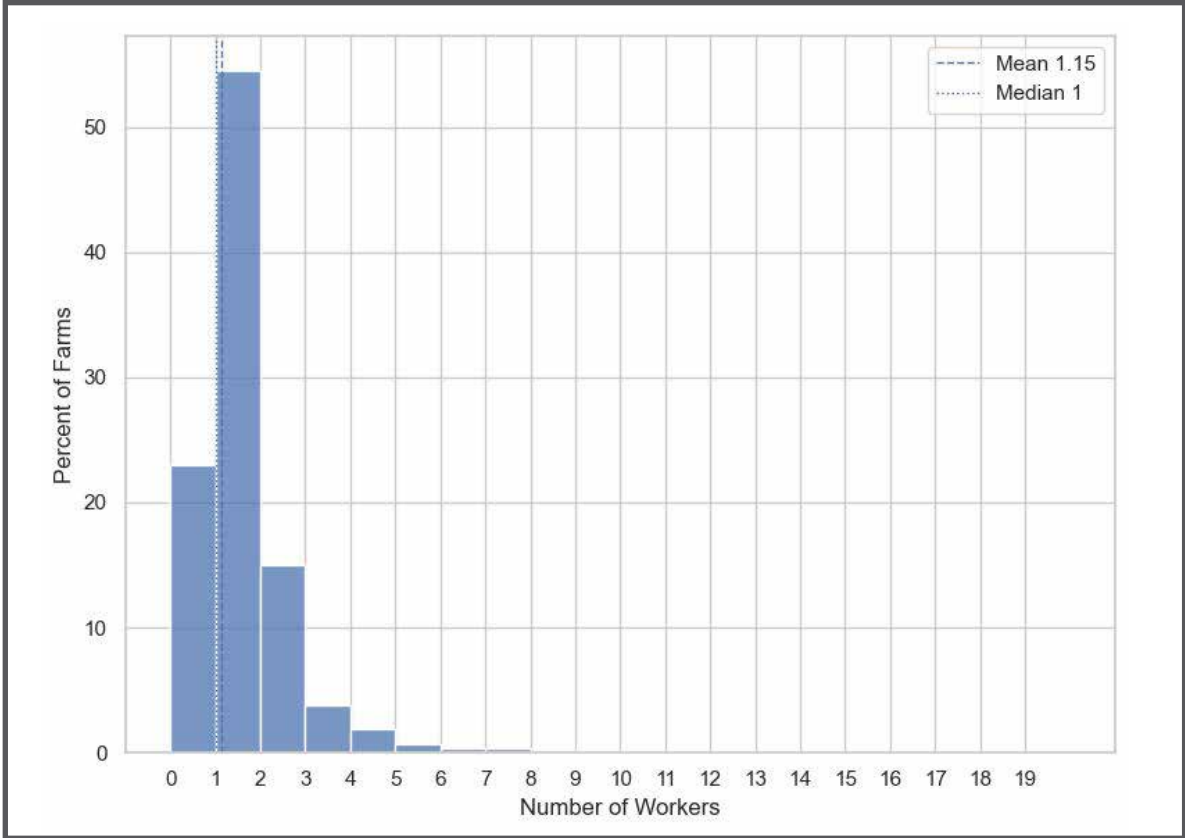


Figure 3. Distribution of number of workers

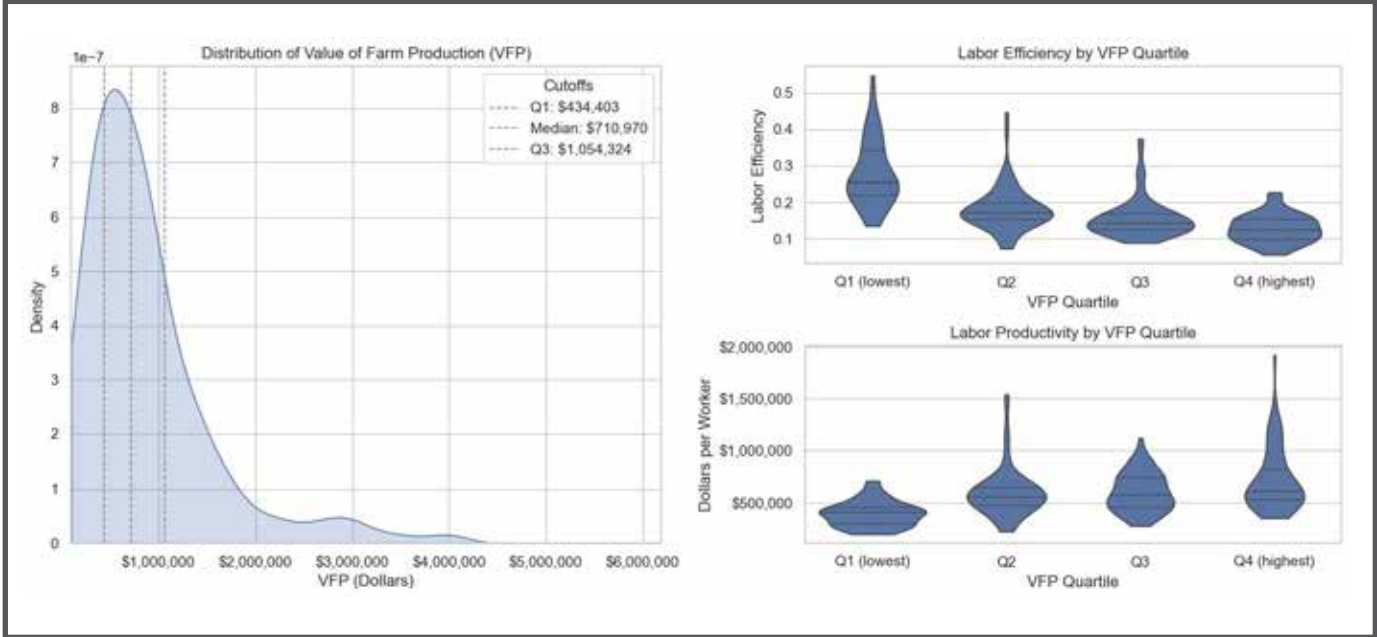


Figure 4. Distribution of VFP, distribution of labor efficiency, and labor productivity by VFP quartile

Table 1. Labor Benchmarks Calculations

Ratio	Calculation
Labor Efficiency	$\left(\frac{\text{Total Labor Cost}}{\text{Value of Farm Production}} \right)$
Labor Productivity	$\left(\frac{\text{Value of Farm Production}}{\text{Number of Workers}} \right)$

Table 2. Descriptive Statistics for Included Variables

Variable	Mean	Std Dev
Labor Efficiency	0.187	0.097
Labor Productivity	577,739	280,160

Farm Demographics

Operator Age	61.06	13.16
Total Acres	1889	1351
Crop Intensity	0.892	0.247
Percent Acres Owned	0.320	0.266
Value of Farm Production (VFP)	902,181	804,667

Profitability

Net Farm Income (NFI)	185,785	299,568
Profit Margin Ratio	0.045	0.232
Rate of Return on Assets	0.029	0.091

Financial Efficiency

Asset Turnover Ratio	0.343	0.259
Total Expense Ratio	0.817	0.189
Operating Expense Ratio	0.694	0.167

Machinery Expenditure

Crop Machinery Investment per Acre	348.41	202.42
Crop Machinery Cost per Acre	124.71	56.60

Table 3. Sample Size by Benchmarking Period

Year	Farms in Sample
2005–2009	599
2010–2014	504
2015–2019	355
2020–2024	271

Table 4. Averages (5-Year) for Labor Benchmarks

Time Period	Average Labor Efficiency (st. dev)	Average Labor Productivity (st. dev)
2005–2009	0.17 (0.15)	\$300,528 (186,320)
2010–2014	0.17 (0.11)	\$438,785 (220,993)
2015–2019	0.21 (0.14)	\$406,371 (197,829)
2020–2024	0.19 (0.14)	\$577,739 (280,160)

Table 5. Correlation Coefficients Between Select Variables and Labor Measures

Variable	Labor Efficiency	Labor Productivity
Labor Efficiency	-	-0.746***
Labor Productivity	-0.746***	-
<i>Farm Demographics</i>		
Operator Age	0.266***	-0.263***
Total Acres	-0.469***	0.346***
Crop Intensity	-0.322***	0.306***
Percent Acres Owned	0.213***	-0.217***
Value of Farm Production (VFP)	-0.493***	0.400***
<i>Profitability</i>		
Net Farm Income (NFI)	-0.423***	0.380***
Profit Margin Ratio	-0.698***	0.466***
Rate of Return on Assets	-0.522***	0.452***
<i>Financial Efficiency</i>		
Asset Turnover Ratio	-0.261***	0.302***
Total Expense Ratio	0.152**	-0.106*
Operating Expense Ratio	0.187***	-0.117*
<i>Machinery Expenditure</i>		
Crop Machinery Investment per Acre	-0.179***	0.141**
Crop Machinery Cost per Acre	-0.210***	0.195***

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

Table 6. Labor Benchmarks Based on 2020-2024

	Below Average	Above Average
Labor Efficiency	27.8%	12.6%
Labor Productivity	\$371,912	\$801,420
Number of Farms	94	108

Table 7. Labor Benchmarks by VFP Quartile

VFP Quartile	VFP Range	Average Labor Efficiency	Average Labor Productivity
Q1 (Lowest)	\$0-\$434,402	27.9%	\$394,688
Q2	\$434,403-\$710,969	18.2%	\$594,436
Q3	\$710,970-\$1,054,324	15.7%	\$600,415
Q4 (Highest)	> \$1,054,324	12.9%	\$721,750

Table 8. Historical Comparison of Labor Benchmarks

	Below Average		Above Average	
	2018	2024	2018	2024
Labor Efficiency	30.6%	27.8%	9.10%	12.60%
Labor Productivity	\$202,808	\$371,912	\$650,116	\$801,420
Number of Farms	272	94	272	108

Marketing Corn and Soybeans Using a Portfolio of Strategies



By Olivia Reynolds, Grant Allyn, James Mintert, and Michael Langemeier

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Abstract

We estimate returns to six corn and soybean crop marketing strategies using cash corn and soybean prices from the northeast Indiana and southwest Indiana crop reporting districts along with Chicago Board of Trade corn and soybean futures prices from the 2004 through the 2023 crop marketing years. Strategies are compared

to a baseline strategy of making all cash sales at harvest time. Risk/return frontiers are estimated for each crop and location using a Target MOTAD model. Results confirm that a variety of optimal marketing strategy portfolios can be used to substantially increase prices above those available at harvest time.

INTRODUCTION

Corn and soybean sales are an important income source for U.S. farmers. In 2024, U.S. producers planted 90.6 million acres of corn and 87.1 million acres of soybeans resulting in U.S. corn production of 14.87 billion bushels and soybean production of 4.37 billion bushels (USDA, 2025). Corn and soybean prices received by U.S. farmers throughout the year can vary substantially, thereby contributing to farm income variability. For example, weekly cash corn prices for the northeast Indiana crop reporting region ranged from an average high of \$5.35/bushel to an average low of \$3.35/bushel during the 2023 crop marketing year, which began the first week of September 2023 and concluded the last week of August 2024. Unsurprisingly, U.S. farmers rank marketing risk as one of the biggest risks they face (Thompson et al., 2019).

Farmers can employ a multitude of strategies to market their farm's crop production to enhance their farm's income and/or reduce risk. However, choosing which strategy (or strategies) to pursue when marketing their crop production is a daunting task because of the uncertainty regarding how prices might fluctuate within the crop marketing year. Previous research by Edwards et al. (2020) examined the returns to storage of corn and soybeans following harvest in Indiana using state-level average cash price data covering the 1988-1989 through the 2017-2018 marketing years. Edwards et al. focused on comparing returns to storing corn and soybeans that were hedged in the futures market vs. unhedged storage,

and results indicated that storing both crops on Indiana farms can be a profitable crop merchandising strategy. Strategies examined in their study included 1) storage following harvest with futures hedges placed at harvest time, 2) storage following harvest without futures hedges in place, and 3) using new crop futures contracts to place futures hedges in the spring at planting time, storing the crop at harvest time, and simultaneously rolling hedges forward to a deferred futures contract that expires near the end of the crop storage season. Allyn et al. (2024) updated and extended Edwards et al.'s work by reviewing results for six corn and soybean marketing strategies using cash prices for a more specific region, southwest Indiana, over the 2004-2005 to 2022-2023 crop marketing years. Strategies included 1) fall cash sales without hedging; 2) fall cash sales hedged in the spring planting season; 3) hedging in the spring planting season, then storing unhedged from harvest until late spring; 4) storing at harvest unhedged and selling in the cash market in mid-spring; 5) storing at harvest and simultaneously hedging in a deferred futures contract and selling in the cash market in mid-spring; and 6) hedging in the spring planting season, storing at harvest and simultaneously rolling the hedge forward to a deferred futures contract and selling in the cash market in mid-spring. Allyn concluded that, on average, placing a short hedge in May during planting season, offsetting the hedge in October, and storing unhedged until late in the storage season provided the highest net sale price over the course of the study period. However, results indicated that no single marketing strategy generated the highest net sale price every year for corn or soybeans. Both Edwards and Allyn recommended that instead of selecting a single marketing strategy to pursue when merchandising their crop production, corn and soybean producers should consider using a portfolio approach that combines various strategies into a marketing strategy portfolio. Lenfestey et al. (2024) examined a portfolio of marketing strategies for a southeast Indiana case farm and traced out a risk/return frontier using a downside risk model.

This research examines the trade-off between net return and downside risk and compares results from various corn and soybean marketing strategies with prices received during the typical harvest month of October. Unique to this study is the estimation of optimal portfolios of marketing strategies and comparisons across two distinct marketing regions. The strategies employed by Allyn et al. are used to identify optimal marketing strategy portfolios for farms in northeast Indiana and southwest Indiana. Although there are some differences across the two regions, results confirm that managers seeking

to improve returns should consider storing both corn and soybeans until late spring to capture the improvement in basis that typically occurs. Which portfolio of strategies a farm manager should choose depends on their risk preferences. Higher risk, higher return corn marketing strategies were more oriented toward placing hedges in May, lifting hedges in the fall, and then storing corn unhedged from harvest until June. Lower risk, lower return corn strategies relied more on hedging until cash sales are made in June. Similarly, higher risk, higher return soybean portfolios were oriented toward placing hedges in the spring, lifting hedges in the fall, and then storing soybeans unhedged until June. Lower risk, lower return soybean portfolios were oriented more toward storing soybeans unhedged with relatively small percentages of soybeans hedged prior to delivery in June. Importantly, all the optimal marketing strategies rely heavily on storing corn and soybeans until late spring to capture improvements in basis.

DATA AND METHODS

All the historical corn and soybean cash market and Chicago Board of Trade (CBT) futures price data used in this study were obtained from DTN's ProphetX database (DTN ProphetX, 2024). Price data spanned the 2004-2023 crop years for each crop. Wednesday settlement prices were used to compute monthly averages.

Several key assumptions were made to conduct the analysis. First, to take advantage of available on-farm storage, it is assumed that if corn and soybeans are placed in storage, they will be stored until June of the year following harvest. Second, monthly averages were calculated using Wednesday price data within each month to compute monthly averages by year for both cash and futures prices. This implies that producers following these strategies would only need to make a small number of sales per month to emulate the monthly averages used in this analysis. Fourth, October cash price averages were assumed to be representative of sales made at harvest and were also used to calculate on-farm storage opportunity costs until June. Fifth, pre-harvest corn and soybeans sales were made using the average of May futures settlement prices for December CBT corn futures and November CBT soybean futures prices, respectively, and then offset using October averages of the same futures contracts. Sixth, hedges for corn and soybeans stored from October to June were placed each year using October averages for July CBT corn and soybean futures contracts of the following year, respectively, and then offset using June averages for the same

contracts. Seventh, June average cash prices were used to simulate cash market sales for corn and soybeans coming out of storage in June.

Many corn and soybean farms already have on-farm storage facilities available and, as a result, this study assumes an existing on-farm storage facility is used to store corn and soybeans. Grain quality is also assumed to be maintained throughout the storage season. Utility and repair costs from 2023-2024 for a northeast Indiana farm's grain storage facilities were used to estimate variable costs per bushel stored. The cost of repairs and utilities for the entire eight-month storage season averaged \$0.09/bushel for both corn and soybeans. The analysis held the \$0.09/bushel grain storage system repair and utility costs constant throughout the 20-year period. The USDA's Commodity Credit Corporation's (CCC) borrowing rate for each year was obtained from the USDA's Farm Service Agency and was used to calculate the opportunity cost of having capital invested in corn and soybean inventories during the storage period. Since U.S. farmers can obtain low-cost financing of inventories from USDA, the CCC borrowing rate represents a lower bound for the opportunity cost of having dollars invested in inventories. The CCC's average interest rates for each year were determined by averaging the monthly interest rate from October to June, then this rate was used in the opportunity cost calculations for the eight-month storage period. The storage season evaluated in this study was limited to an eight-month season from harvest in October to delivery in June of the next calendar year for all the storage strategies. The total carrying charge was computed by adding the opportunity cost of capital invested in corn and soybean inventories to the repairs and utilities cost. The total carrying charge was then subtracted from results for the four corn and soybeans strategies that included storage to obtain net sale prices for each strategy.

Six possible marketing strategies were evaluated for both corn and soybeans. Strategies 1 and 2 assumed corn and soybeans were sold in October, while Strategies 3-6 assumed an eight-month storage season with cash sales made in June. Strategy 4 assumed that the crops were unhedged but stored until June. October is a key harvest month for both corn and soybeans in Indiana, and June crop sales take advantage of a seasonal tendency for prices to rise in the spring. June is also near the end of the storage season for many farms in the Midwest. Strategies 2, 3, 5, and 6 utilize futures market hedges where the sales of CBT futures contracts are used as a temporary substitute for cash market sales that will take place at

a later date. The study assumes unlimited funds are available to fund futures margin accounts.

Strategies 1 and 2 do not utilize grain storage. In Strategy #1, *Fall Cash Sale*, the commodities are sold during harvest in October at the October Wednesday average cash price. In Strategy #2, *Spring Hedge, No Storage*, a short hedge is placed in May on December CBT futures for corn and November CBT futures for soybeans then offset in October. In October, the grain is sold at the October Wednesday average cash price. The net sale price includes the gain or loss on the hedge plus the October cash price.

Strategy #3, *Spring Hedge & Roll, Storage*, places a short hedge in May using the December CBT contract for corn and the November CBT contract for soybeans, then offsets this initial hedge in October. The futures market hedge is rolled forward by selling July CBT futures contracts in October for both commodities, and the corn and soybeans are placed in storage. Finally, the corn and soybeans are sold at the June Wednesday average cash price, and hedges are offset at the same time. The net sale price is a combination of the gains or losses on the hedges and the June cash price, less the total carrying charge.

Strategy #4, *Unhedged & Storage*, places grain in storage at harvest in October. In June, the grain is delivered for the cash price. This strategy does not use the futures market to hedge sales. The net sale price is the average Wednesday June cash price, less the total carrying charge.

Strategy #5, *Fall Hedge & Storage*, places a short hedge during harvest in October using the July futures and simultaneously places the grain in storage. The corn and soybeans are sold in June at the Wednesday average cash price, and the July CBT futures hedges are offset at the same time. In this strategy, corn and soybean sales are hedged during the storage season but are not hedged during the growing season. The net sale price is a combination of the gain or loss on the hedge and the June cash price, less the total carrying charge.

Strategy #6, *Spring Hedge, Store Unhedged*, places a short hedge in May during planting and then offsets the hedge in October using the December CBT contract for corn and the November CBT contract for soybeans. The grain is placed in storage in October until delivery in June and sold at the June Wednesday average cash price. Strategy #6 uses a hedge during the growing season but stores the grain unhedged during the October-June storage season. The net

sale price is a combination of the gain or loss on the hedge and the June cash price, less the total carrying charge.

To estimate optimal portfolios of marketing strategies, we employ the Target MOTAD model. Target MOTAD models can be used to maximize returns subject to a limit on the total negative deviations from a target. Lenfestey et al. (2024) used a Target MOTAD model to examine the trade-offs between net returns and downside risk for a simulated farm based in southeast Indiana. We apply the same model to maximize the marketing year prices received for corn and soybeans in both northeast and, separately, southwest Indiana over the 2004-2023 crop years, subject to a downside risk constraint. The constraint applied is limiting the number of deviations below that region's October average cash price for corn and soybeans, respectively. Each annual downside risk constraint compares a target net return to the actual net returns for the optimal portfolio of marketing strategies. Annual negative deviations are then summed. This sum is divided by the number of years and then used as the x-axis on return/risk charts.

In all portfolio models, there are trade-offs between risk, as measured by the total negative deviations below the target, and prices received. Riskier solutions generate higher prices while less risky solutions provide lower prices. To generate a frontier of optimal strategies for given levels of risk, the constraint that computes the total negative deviations below the target price is relaxed. Solutions that fall below the frontier either provide a lower net price at the same level of risk or the same net price at a higher level of risk.

Tables 1 and 2 highlight the average October and June cash prices for corn and soybeans in northeast Indiana, respectively, from 2004-2023. These tables also indicate the average price change from October to the following June, which corresponds to the storage period examined in this research. On average, cash prices for both crops rise from fall harvest lows to late spring, although there is a lot of variability from year-to-year. The cash price averages suggest a positive gross return to unhedged storage is possible, although the year-to-year variability implies there is notable downside risk.

Tables 3 and 4 focus on the average change in December CBT corn futures contract prices and November CBT soybean futures contract prices from May to October of the growing year. The results indicate that, on average, futures contract prices

decline from May to October for both corn and soybeans. Unsurprisingly, there is a lot of year-to-year variability around the mean results for both crops.

RESULTS AND DISCUSSION

Individual strategy results reported here focus on calculations using data from northeast Indiana. Allyn et al. provides comparable individual strategy results for southwest Indiana covering the 2004-2022 crop years. Table 5 summarizes results for the corn marketing strategies. Examining 20 years of returns for the six corn strategies in northeast Indiana, Strategy #1 resulted in the lowest net sale price of \$4.18/bu., while Strategy #6 provided the highest average net sale price of \$4.90/bu. The average price generated by Strategy #6 was \$0.23/bu. higher than the average net sale price of any other strategy.

Corn Strategy #2 *Spring Hedge, No Storage* provided an average net sale price of \$4.41/bu., while Strategy #1 *Fall Cash Sale's* average price was \$4.18/bu. For producers who do not have on-farm storage, Strategy #2 yielded the highest average net sale price in 15 out of 20 grain marketing years. On average, Strategy #2 provided a net sale price that was \$0.23/bu. higher than Strategy #1 *Unhedged Fall Cash Sale*.

Figures 1 and 2 provide year-by-year results of the strategies without storage and strategies with storage, respectively. Strategy #6 *Spring Hedge, Store Unhedged* produced the highest average net sale price of \$4.90/bu. However, it is important to recognize that Strategy #6 was only the top strategy in four out of the 20 years analyzed, and no strategy provided the highest net price in every year.

Table 6 provides the average northeast Indiana net sale prices for soybeans following Strategies #1-6 while Figures 3 and 4 provide the year-by-year returns. Strategy #6 provided the highest net price while Strategy #1 provided the lowest net price. Although the *Spring Hedge, Store Unhedged* strategy yielded the highest average price, there were three years when it provided the lowest price of any strategy. Like corn, no single strategy provided the highest net price during the 20 years studied.

Since no single marketing strategy was clearly preferred, optimal corn and soybean marketing portfolios were estimated for both northeast Indiana and southwest Indiana. Results from the corn and soybean marketing strategies were used to estimate Target MOTAD models where the constraint used

was the October cash price. Model solutions provided optimal strategy portfolios at various risk levels where the risk was identified as the number of times the strategy provided a net price below the October average cash price. Figures 5-8 summarize the Target MOTAD results for corn and soybeans in both Indiana regions. The composition of the portfolios at each point on the charts is highlighted with text that denotes the percentage of the portfolio committed to each strategy.

When compared to the October cash price, all of the corn and soybean marketing portfolios provided a higher net price. To simplify the discussion, strategies with the smallest negative deviations from the October cash price are characterized as “lowest risk,” while strategies with the largest negative deviations from the October cash price are characterized as “highest risk.” The lowest risk corn portfolio provided net prices that were \$0.39/bu. and \$0.65/bu. higher than the October cash price in northeast and southwest Indiana, respectively. The highest risk corn portfolios provided net cash prices that were \$0.71/bu. and \$0.84/bu. higher than the October cash price in northeast and southwest Indiana, respectively. Similarly, the lowest risk soybean portfolios yielded net prices that ranged from \$1.33/bu. above the October cash price in northeast Indiana to \$1.26/bu. in southwest Indiana. The highest risk soybean portfolios provided returns that were \$1.69/bu. and \$1.67/bu. higher than the October cash price in northeast and southwest Indiana, respectively. Results demonstrate that when compared to a baseline strategy of selling at harvest, Indiana corn and soybean producers can choose from a variety of marketing portfolios that are likely to provide a higher net sale price, all of which require use of storage.

Interestingly, there were some similarities but also some differences in the composition of optimal corn marketing strategy portfolios in the two Indiana market regions. The lowest risk corn strategy in northeast Indiana was weighted heavily toward the spring hedge and roll strategy (Strategy #3, 45%) and fall hedge with storage strategies (Strategy #5, 41%), with the spring hedge and store unhedged filling out the portfolio (Strategy #6, 14%). All three of those strategies make it possible for producers to capture improvements in basis following harvest while limiting exposure to futures price declines. In southwest Indiana, however, the lowest risk strategy did not rely as heavily on hedging to avoid futures price declines. Instead, it emphasized leaving a significant portion of corn unpriced until cash sales were made in June (Strategy #4, 41%). Additionally, 60% of the

corn in this portfolio was not hedged from October to June, leaving it exposed to potential futures price declines during the storage season while still making it possible to capture corn basis increases. At the other end of the spectrum, the highest risk corn marketing portfolios in both regions were very similar, devoting a very small percentage of sales to the spring hedge and roll strategy (Strategy #3), with nearly all sales committed to the spring hedge then store unhedged strategy (Strategy #6). The gain in price from adopting the riskiest vs. the least risky corn marketing portfolio was \$0.32/bu. in northeast Indiana but was only \$0.19/bu. in southwest Indiana. In both regions, the most important takeaway is that storing corn after harvest to capture improvements in basis by either storing corn that has been hedged, or simply storing corn unhedged, is likely to generate a positive return.

Somewhat surprisingly, the lowest risk soybean marketing strategies in both regions emphasized storing soybeans until June without putting hedges in place prior to making cash sales. In northeast Indiana, the model allocated 91% of soybean marketings to Strategy #4, *Unhedged with Storage*, compared with 77% committed to this strategy in southwest Indiana. This stands in contrast to the highest return, highest risk strategy, which allocated nearly all of soybean marketings to the spring hedge followed by unhedged storage until June (Strategy #6) in both northeast and southwest Indiana. The gain in price from adopting the riskiest vs. the least risky soybean marketing portfolio was \$0.36/bu. in northeast Indiana compared to \$0.41/bu. in southwest Indiana.

CONCLUSIONS

Six corn and soybean crop marketing strategies were evaluated using cash corn and soybean prices from the northeast Indiana and southwest Indiana crop reporting districts along with CBT corn and soybean futures prices from the 2004-2023 crop marketing years. No single strategy provided the best return for either crop or location across the 20 years of data examined. Importantly, some strategies proved capable of providing the best returns in some years while providing the worst returns in other years. These results provided the impetus to examine a portfolio of marketing strategies using a Target MOTAD model that minimized deviations below the October cash price average for each crop and location. When compared to a baseline strategy of making all cash sales in October, all the optimal portfolios of strategies improved returns substantially.

Farm managers seeking to improve net sale prices for corn and soybeans can do so by storing both crops until the spring following harvest since none of the optimal portfolios included cash sales at harvest time in October. The opportunity to capture basis improvements that typically occur in the two markets examined was a key driver in optimal portfolio selection, so managers should pay close attention to local basis patterns. Second, managers should consider adopting a portfolio of marketing strategies to help improve returns while also reducing risk. Strategies that include placement of hedges in the spring can capture seasonal strength in corn and soybean futures prices. However, managers should be cognizant that those strategies can also expose farms to more risk in years when futures prices rally during the growing season. When choosing a portfolio of strategies, managers should carefully examine the historical negative deviations below the October cash price associated with the various strategy portfolios and choose according to their willingness to expose their farm operation to downside price risk. Finally, farms without storage facilities could use estimated returns from this research to analyze the potential profitability of constructing on-farm storage.

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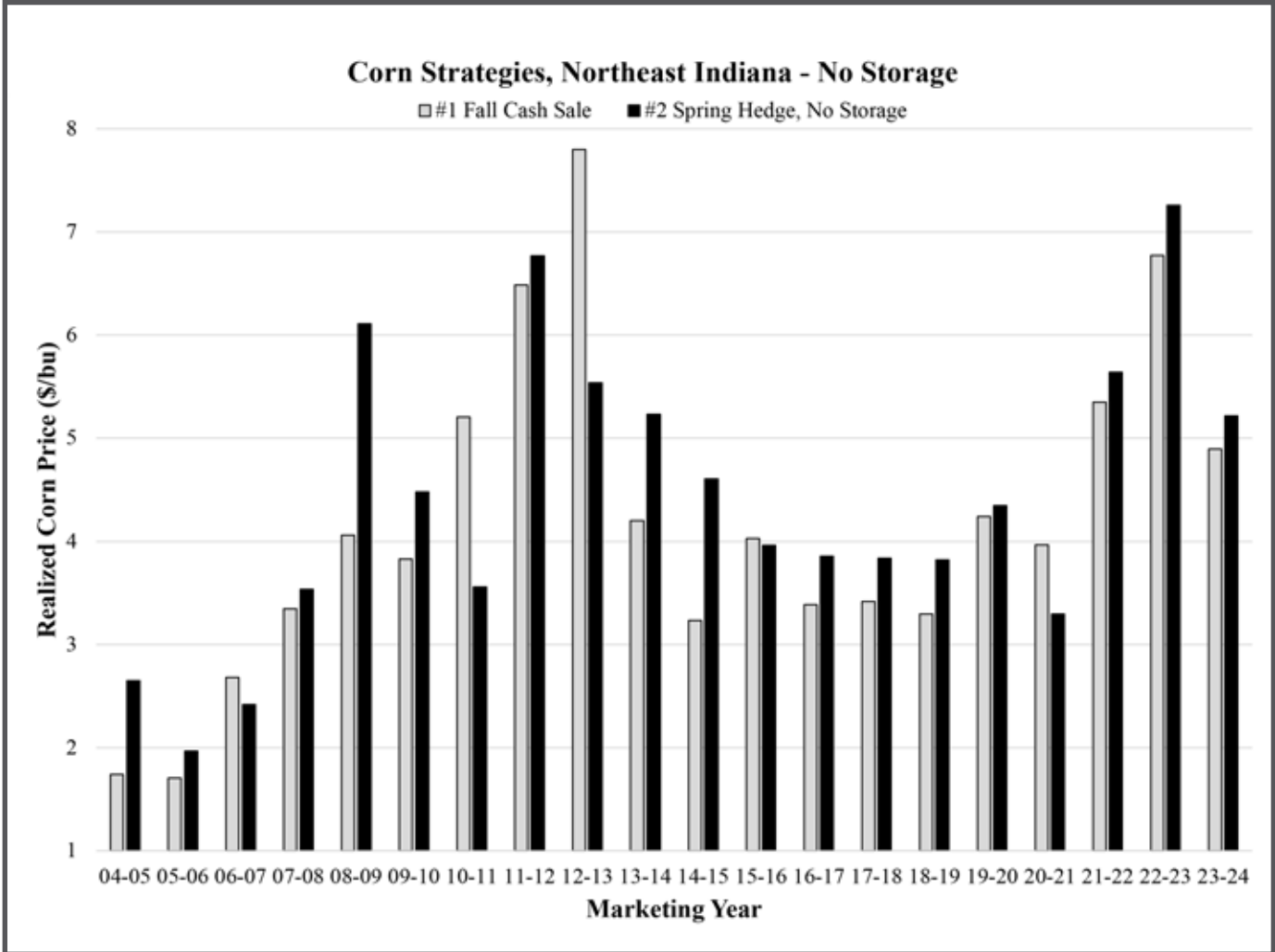


Figure 1. Net sale prices for corn marketing strategies without storage, northeast Indiana, 2004-2023

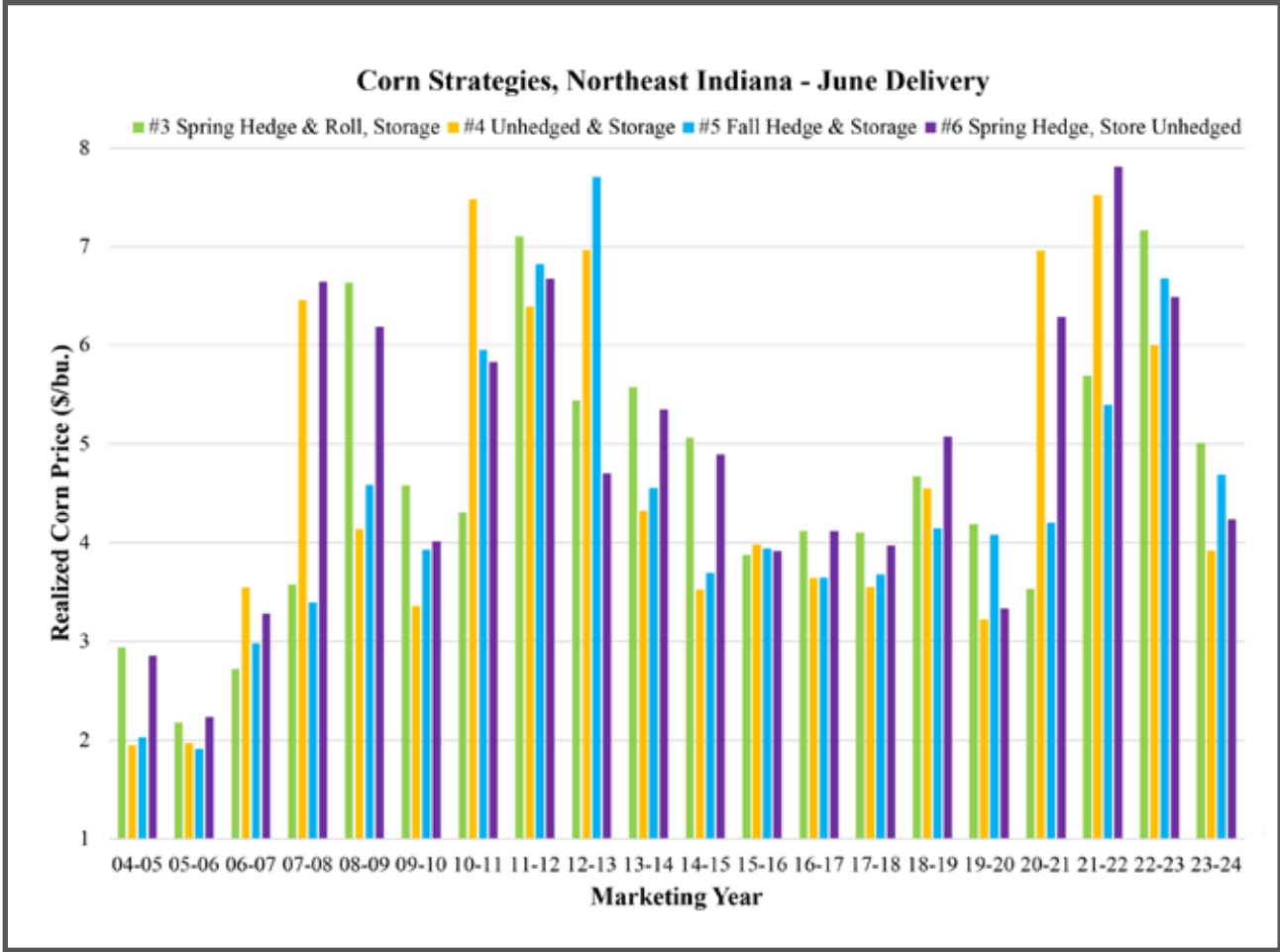


Figure 2. Net sale prices for corn marketing strategies with storage, northeast Indiana, 2004-2023

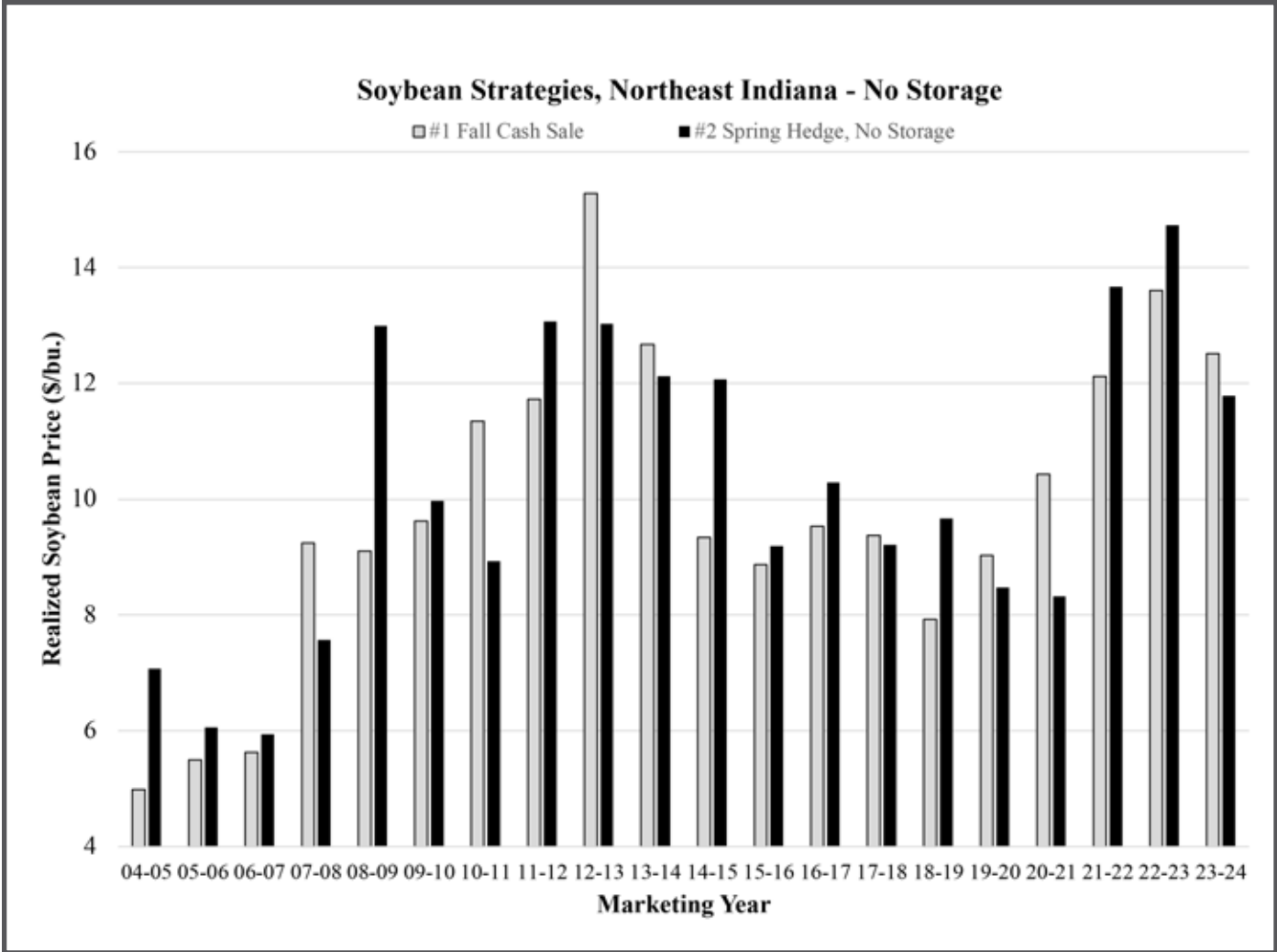


Figure 3. Net sales prices for soybean marketing strategies without storage, northeast Indiana, 2004-2023

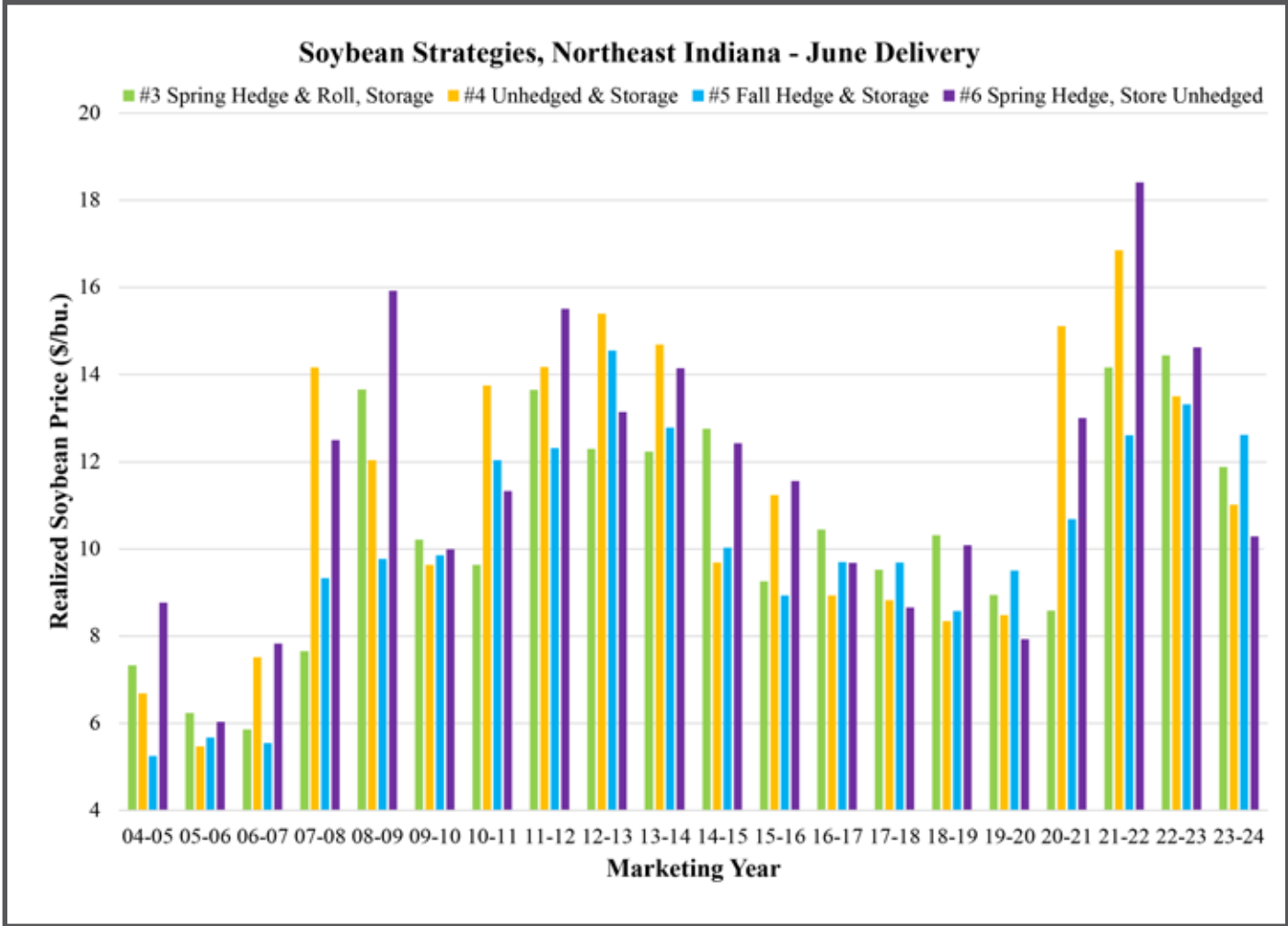


Figure 4. Net sales prices for soybean marketing strategies with storage, northeast Indiana, 2004-2023



Figure 5. Historical NE Indiana corn marketing strategy portfolio returns, 2004-2023 crop years



Figure 6. Historical SW Indiana corn marketing strategy portfolio returns, 2004-2023 crop years



Figure 7. Historical NE Indiana soybean marketing strategy portfolio returns, 2004-2023 crop years



Figure 8. Historical SW Indiana soybean marketing strategy portfolio returns, 2004-2023 crop years

Table 1. Average Northeast Indiana Cash Corn Prices, 2004-2023 Crop Years

Time Frame	Average (\$/bu.)	Minimum (\$/bu.)	Maximum (\$/bu.)
October Cash Price	\$4.18	\$1.70	\$7.80
June Cash Price	\$4.83	\$2.09	\$7.65
Range (June-October)	\$0.65	-\$0.88	\$3.29

Table 2. Average Northeast Indiana Cash Soybean Prices, 2004-2023 Crop Years

Time Frame	Average (\$/bu.)	Minimum (\$/bu.)	Maximum (\$/bu.)
October Cash Price	\$9.89	\$4.98	\$15.28
June Cash Price	\$11.53	\$5.81	\$17.04
Range (June-October)	\$1.63	-\$0.76	\$5.28

Table 3. Average Change in December CBT Corn Futures Prices from May to October, 2004-2023 Crop Years

Time Frame	Average (\$/bu.)	Minimum (\$/bu.)	Maximum (\$/bu.)
December Futures Price in May	\$4.49	\$2.29	\$7.34
December Futures Price in October	\$4.26	\$2.03	\$7.50
Range (May-October)	-\$0.22	-\$2.05	\$2.26

Table 4. Average Change in November CBT Soybean Futures Prices from May to October, 2004-2023 Crop Years

Time Frame	Average (\$/bu.)	Minimum (\$/bu.)	Maximum (\$/bu.)
November Futures Price in May	\$10.47	\$6.18	\$14.93
November Futures Price in October	\$10.15	\$5.25	\$15.36
Range (May-October)	-\$0.32	-\$3.88	\$2.41

Table 5. Net Sale Prices for Six Corn Marketing Strategies, Northeast Indiana, 2004-2023

Strategy	Average Net Sale Price (\$/bu.)
#1 Fall Cash Sale	\$4.18
#2 Spring Hedge, No Storage	\$4.41
#3 Spring Hedge & Roll, Storage	\$4.63
#4 Unhedged & Storage	\$4.67
#5 Fall Hedge & Storage	\$4.40
#6 Spring Hedge, Store Unhedged	\$4.90

Table 6. Net Sale Prices for Six Soybean Marketing Strategies, Northeast Indiana, 2004-2023

Strategy	Average Net Sale Price (\$/bu.)
#1 Fall Cash Sale	\$9.89
#2 Spring Hedge, No Storage	\$10.21
#3 Spring Hedge & Roll, Storage	\$10.46
#4 Unhedged & Storage	\$11.28
#5 Fall Hedge & Storage	\$10.14
#6 Spring Hedge, Store Unhedged	\$11.60

The Value of Castration: Analyzing Bull Discounts in Feeder Cattle



By Shelby A. Sumner and Kellie Curry Raper

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Abstract

It is crucial for cattle producers to understand how management practices influence market prices for their livestock. This paper assists cow-calf producers by providing insights into the financial implications of the castration decision prior to marketing feeder cattle. Using data from Oklahoma feeder cattle auctions, this study quantifies the impact of marketing feeder cattle as bulls on prices across weight categories. The results indicate an average bull discount of \$11.69 per hundredweight that remains constant as animal weight increases, translating into per-head revenue losses ranging from \$35 to \$111 depending on animal size.

INTRODUCTION

Calf management decisions made by cow-calf producers, such as vaccinating, weaning, dehorning, and castrating, have been shown to significantly influence sale prices at auction. Feeder calves that are healthy, preconditioned, and ready to enter the next production phase typically command price premiums, especially when these practices reduce risk and labor for buyers. Beyond management, phenotypic attributes such as breed, color, frame size, and muscling also play a critical role in determining value. These combined factors highlight the importance of understanding how both observable traits and management practices shape market outcomes for cow-calf producers.

This research addresses a key economic question for cow-calf producers: How does weight class influence the price discount applied to bulls compared to steers in the feeder cattle market? While it is widely understood that lack of castration can affect market value, the extent to which this effect varies by animal weight remains unclear. This lack of weight-specific data leaves producers without a clear understanding of the financial trade-offs associated with castration timing or omission. The objective of this study is to quantify the price differential between bulls and steers sold as feeders across various weight classes, using hedonic¹ regression² analysis of market data collected across Oklahoma auctions. In the study, we consider the slate of attributes that impact price, but with special attention to price differences between steers and bulls. By isolating the impact of castration on market price by weight class while controlling for other attributes, this research provides practical, evidence-based insights that support producers in making more profitable herd management decisions.

BACKGROUND AND LITERATURE REVIEW

Cow-calf producers are faced with making a multitude of decisions that could impact animal health, productivity, and the market prices received for their cattle. Understanding the financial implications of different management decisions can help ranchers make more profitable choices. For example, these

management decisions could include whether to follow a certification program's protocol, which vaccinations to administer or omit, and whether or when to castrate.

Multiple studies have identified price discounts for non-castrated male feeder cattle (e.g., Ward, Ratcliff, and Lalman, 2007; Peel et al., 2023). Research conducted through Texas A&M AgriLife Extension found that cattle prices in South Texas are “significantly higher for steers than for bull calves” and that those differences were higher as animal weight increased. Average per-head price differences for castrated, implanted males were \$25 per head for animals weighing 350 to 500 pounds, \$30 at 550 pounds, and \$154 at 750 pounds (Russell, 2015). These price differences reflect that earlier castration is known to induce less stress and to result in better performance and weight gain as calves move through the beef supply chain (Waters, 2022). Additionally, many buyers may prefer to pay a premium to avoid castrating the animal themselves, especially for larger cattle as this can also pose a human safety risk. While these results are informative, the study did not isolate the value of castration while holding other cattle characteristics and management attributes constant or separately from the value of implants. Williams et al. (2012) estimated individual market values of vaccinating, weaning, preconditioning, and other attributes for feeder cattle at Oklahoma auctions, including a discount of \$5.77 per hundredweight for bulls sold as feeder cattle compared to steers with the same attributes otherwise. Other studies have used similar modeling to estimate bull discounts ranging from \$1.81 to \$7.39 per hundredweight (e.g., Schulz et al., 2010; Massey et al., 2011; Peel et al., 2023).

While several studies have examined price impacts of castration in feeder cattle, those studies either assess price differences between steers and bulls by weight without accounting for differences in other characteristics or estimate a bull discount per hundredweight without examining whether that discount differs by feeder cattle weight. As a result, producers lack research-based guidance on how the timing and implementation of castration may influence sale price relative to animal weight. This study seeks to fill that gap by quantifying the feeder cattle market discount associated with intact males compared to steers across feeder cattle weight categories while also considering the market values of other cattle attributes.

CONCEPTUAL FRAMEWORK

In competitive cattle markets, market prices reflect the qualities of the animal and the risks buyers expect to face. Bulls typically bring lower prices as feeder cattle than steers because buyers expect more work, more risk, and lower performance from intact males. Castrating a calf before sale reduces these concerns for buyers as those cattle are more likely to be less aggressive, less risky to handle, and more likely to perform better in feedlots. When buyers see a bull come through the sale barn, they factor in the extra time, labor, and health risks they may face and lower their bids accordingly. In this way, the market discount for bulls reflects how buyers value castration and the reduced risk that comes with it.

The size of the animal can also change how buyers view that discount. Castrating a larger animal typically means more stress for the calf, higher chances of health problems, and greater safety concerns for the handler. Thus, the bigger the animal, the more buyers may discount the price if it has not yet been castrated. This raises the question of whether and how that bull discount differs for different weight categories when price is measured in dollars per hundredweight and how the bull discount is reflected when price is measured in dollars per head. This study uses a hedonic pricing model to estimate the contribution of individual characteristics to overall sale price. As part of that model, we estimate the bull discount by weight class and determine whether discounts differ across weights. By focusing on the price difference between bulls and steers across weight classes, producers have a clearer picture of how castration timing and animal size affect their price received at market.

DATA

The study utilizes feeder cattle auction data collected in Oklahoma feeder cattle markets. Data were collected between Fall 2021 and Fall 2024 at seven sale barns across Oklahoma for cattle weighing between 300 and 950 pounds. A total of 4,948 lots were recorded, with 4,129 steer lots and 819 lots containing bulls. For this study, data on heifer lots was omitted. Table 1 reports the number of steer and bull lots by weight category and indicates that the percentage of bull lots declines as the average feeder cattle weight increases.

Figure 1 shows the ratio of lots containing bulls to total lots by location. One location recorded fewer than 5% of male lots containing bulls, while two locations

reported over 30% of male lots contained bulls. The other four locations had bull lots ranging from 10% to 17% of total male lots.

In addition to castration status, the dataset includes physical attributes and management practices for each lot. Physical traits recorded include color, frame, fleshiness, muscling, and average weight of cattle in the lot. Management practices include whether lots were vaccinated, weaned, certified, and dehorned at the time of sale. Other variables recorded include lot size, sale location, season, and year. These variables allow for control of both animal- and market-level factors that may influence sale price, improving the accuracy of the estimated price discount associated with bulls relative to steers.

METHODOLOGY

To control for changes in market conditions across marketing periods, a reference price is used to calculate a price basis, i.e., price differential for each lot in the dataset based on the sale date. This price differential, $P_{DIFF(i,t)}$ is calculated as:

$$P_{DIFF(i,t)} = P_{LOT(i,t)} - P_{750lb(t)}$$

where $P_{LOT(i,t)}$ is the price received in dollars per hundredweight by individual lot i on sale date t , and $P_{750lb(t)}$ is the associated weekly average price in dollars per hundredweight for 700- to 750- pound steers sold at OKC National Stockyards for the week that includes sale date t .

This adjustment accounts for general market variability and allows for more meaningful comparisons across years, seasons, and locations. While the price basis standardizes price comparisons across the dataset, we also include year, season, and location variables as controls in our econometric model to further account for temporal and regional effects. All effects are still interpreted as changes in price per hundredweight.

Price differences between bulls and steers across weight categories are first examined using analysis of variance (ANOVA) tests to compare average price basis values between bulls and steers within each weight class. These tests help determine whether observed differences in average prices between castrated and intact males are statistically significant within specific weight ranges, without yet accounting for other characteristics.

We then estimated a hedonic pricing model using Stata data analysis software to account for additional animal characteristics and management practices not captured in the ANOVAs. The hedonic model isolates the contribution of individual traits to sale price across a range of physical attributes and management practice attributes and, by design, interprets the value of an attribute's contribution in dollars per hundredweight. The model also includes controls for lot size, sale location, year, and season to address broader market influences. The general hedonic model is:

$$P_{DIFF} = f(\text{LotSize, AverageWeight, Sex, Vaccination, Certification, Weaning, Color, Horns, Muscling, Fleshiness, Frame, Season, Location, Seller Announced, Health, BrahmanInfluence, Year})$$

The primary variables of interest in this analysis are castration status—specifically, whether the lot sold was sold as bulls or steers—and weight category. In addition to examining the overall price effect of not castrating, the model includes interaction terms between weight category and bull status. These interaction terms allow us to determine whether the price discount associated with bulls changes depending on animal weight. By estimating the value of each trait while holding others constant, the model provides a clearer understanding of how the timing and implementation of castration affect market prices across different weight classes.

RESULTS

ANOVA results are reported in Table 2 and indicate that the difference in average price basis between bulls and steers is statistically significant at the 95% confidence level across all weight categories. Additionally, the size of the discount associated with bulls increases as weight class increases. It is important to note that calves sold as bulls often lack other value-added management practices as well, which can influence price independently and may contribute to the overall discount observed. The ANOVA analysis conducted here does not control for those differences or other differences in feeder cattle attributes, aside from castration.

Table 3 reports the hedonic model's estimated parameters that capture the value of premiums and discounts for lot characteristics, physical traits, and management practices included in the model, highlighting their individual contributions to sale price. Direction and magnitude of impacts are similar to previous studies.

Both average weight and lot size are modeled as quadratic relationships with respect to sale price. This is similar to studies done by Peel et al. (2023), Williams et al. (2012), and Brorsen et al. (2001). Figure 2 illustrates the feeder cattle price slide estimated here; recall that our sample includes feeder cattle weighing between 300 and 950 pounds. Figure 3 illustrates the price premium associated with larger lot sizes in this sample—in this case, the lot size premium peaks at 90 head and, while still substantial, begins to decrease at that point. The quadratic form captures how price effects taper as average weight and lot size increase, reflecting typical market behavior.

Other results from the hedonic model in Table 3 are similar to previous studies. All values represent the value in dollars per hundredweight of that attribute or characteristic. The results indicate statistically significant premiums for fully vaccinated cattle (\$3.22) and weaning (\$7.08) but discounts for horned cattle (-\$9.06) and discounts for lots other than black cattle, ranging from -\$6.31 to -\$30.82, depending on breed or hide color. Relative to cattle with medium muscling, light muscled cattle are discounted heavily at -\$22.08 and medium-thick and thick cattle receive modest premiums of \$6.08 and \$7.48, respectively. Medium-large frame cattle are discounted -\$4.98 relative to large frame cattle, and cattle sold in the spring bring \$14.47 more per hundredweight on average than those marketed in the fall. The location variables indicate both location premiums and discounts relative to the reference barn. Announcing the seller yields a premium of \$2.64, unhealthy cattle (lame, visible eye issues, cough, etc.) are discounted heavily (-\$68.77). Note that these are typically calves that have been pulled out of a bigger lot of cattle at the buyer's request and are auctioned again individually. Cattle with no Brahman influence receive higher prices at an average rate of \$14.24. Year variables are relative to 2021 and indicate a slight decrease for 2022 at -\$3.52 and increases for both 2023 and 2024 as expected, at \$15.62 and \$24.45, respectively.

Recall that the impact of intact males on price is captured in two ways in the model, including an overall discount per hundredweight for lots including bulls as well as interaction terms between that discount and different weight classes to determine if that value is different as weight changes. The overall discount for bull lots is significant, with the model estimating a discount of \$11.69 per hundredweight for bulls relative to steers. However, the interaction terms between bull status and weight class that measure differences from the overall bull discount are not statistically significant for any weight class (500-pound base), indicating that

the bull discount of \$11.69 per hundredweight holds across weight classes. However, that does not mean that the lost value from marketing feeder cattle as bulls is the same across weight classes since the total value lost per head from not castrating still increases as animal weight increases. The estimated total value lost per head can be calculated as the bull discount multiplied by the boundaries of the individual weight classes. As shown in Table 4, the estimated loss in value for bulls in the 300-pound weight class ranges from \$35.07 to \$46.64, while bulls in the 800-pound plus weight class are estimated to lose between \$93.52 and \$111.05 per head.

Table 5 presents the net return on investment from castrating feeder calves, calculated by combining the per-head revenue losses from Table 4 with the average castration cost of \$5.28 per head (Sahs, 2022). Net returns represent the avoided revenue loss from castration minus the cost of the procedure and increase with animal weight. For example, 300- to 399-pound calves have a net return of \$29.79 to \$41.36 per head, while 800- to 950-pound calves show net returns of \$88.24 to \$105.77 per head. Return on investment (ROI) is then calculated as $ROI = (\text{Net Return}/\text{Cost}) \times 100$. These estimates demonstrate that castration is economically beneficial across all weight classes, with the financial advantage growing as calves get heavier, providing producers with a concrete measure to evaluate the cost-effectiveness of castration.

It is important to note that the cost of castration is assumed to be constant at \$5.28 per head across all weight classes, based on the best available estimate from previous research (Sahs, 2022). In practice, castration costs may increase with animal weight as the procedure becomes more physically demanding and time-intensive for larger calves. However, because the economic benefit of castration also increases with weight, the ROI expressed as a percentage of cost may increase more slowly than represented here or may remain relatively stable across weight classes, even if actual costs are somewhat higher for heavier animals.

CONCLUSION

The findings of this study reinforce the willingness of the market to pay premiums (or discounts) for specific management practices in cow-calf operations. Specifically, the results underscore why extension specialists encourage producers to adopt practices such as vaccination, certification, dehorning, and castration. These practices not only improve calf health

on the cow-calf operation, but they also enhance marketability by reducing the risk of potential health costs, lower performance, and death loss faced by buyers—factors that are directly reflected in sale prices.

While the ANOVA results confirmed a statistically significant average price discount for bulls relative to steers across all weight categories, those results do not account for any other differences in cattle attributes or management characteristics. However, the hedonic model estimates that bulls receive an average discount of \$11.69 per hundredweight after any differences in other attribute and management differences are considered. Although the discount per hundredweight is estimated to be constant across weight classes, the value lost per head increases substantially as animals get heavier. These findings illustrate that delaying castration can result in significant revenue losses, especially for producers marketing larger calves.

Although the bull discount is constant on a per hundredweight basis, the resulting revenue loss per head increases as animal weight increases. This suggests that delayed castration or no castration may be less costly for lighter-weight calves but becomes increasingly expensive for producers marketing heavier feeder cattle. These results support extension recommendations that emphasize early castration as a risk management practice, both from a health and performance perspective and from an economic returns perspective. Future research using this same hedonic approach and dataset could extend the analysis to include heifers, allowing for direct comparisons of price differentials among heifers, steers, and bulls by weight class.

FOOTNOTES

- 1 “Hedonic” refers to the hedonic hypothesis that goods are valued for their utility-bearing attributes or characteristics (Rosen, 1974).
- 2 Hedonic regressions deconstruct an item’s price into the item’s attributes and characteristics and examine how each characteristic or attribute contributes to the item’s overall value (Sopranzetti, 2015).

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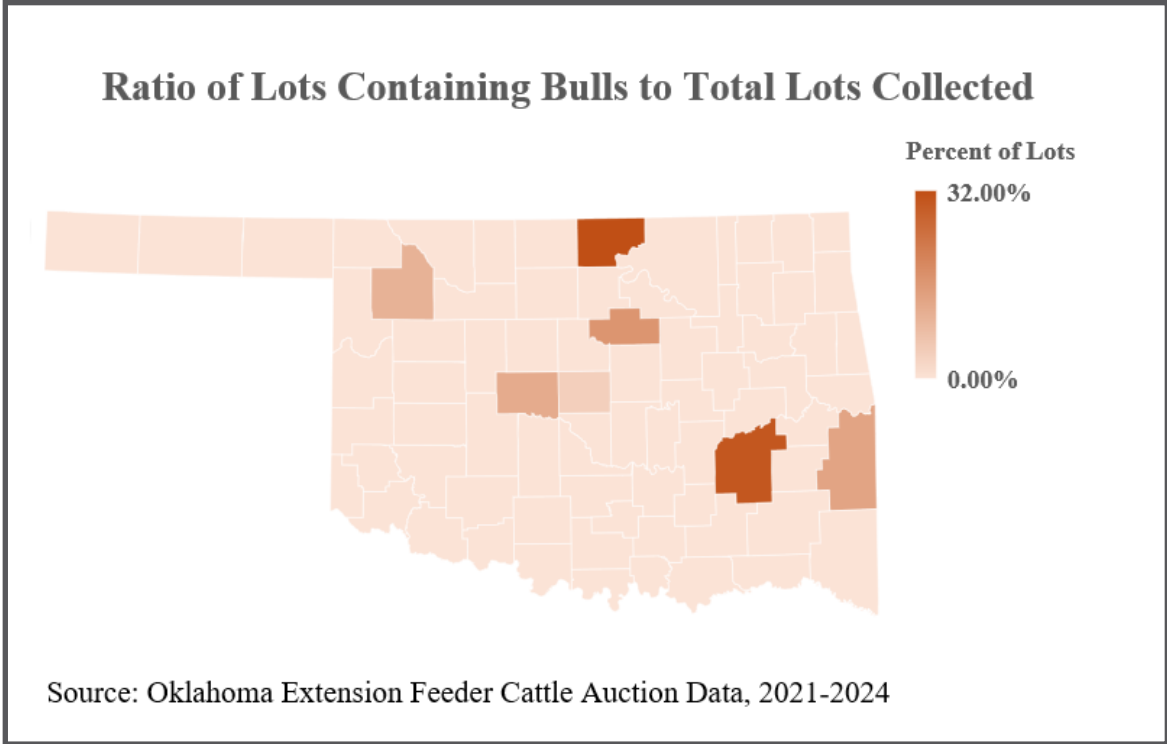


Figure 1. Ratio of lots containing bulls to total lots collected by location, selected Oklahoma Auctions, 2021-2024

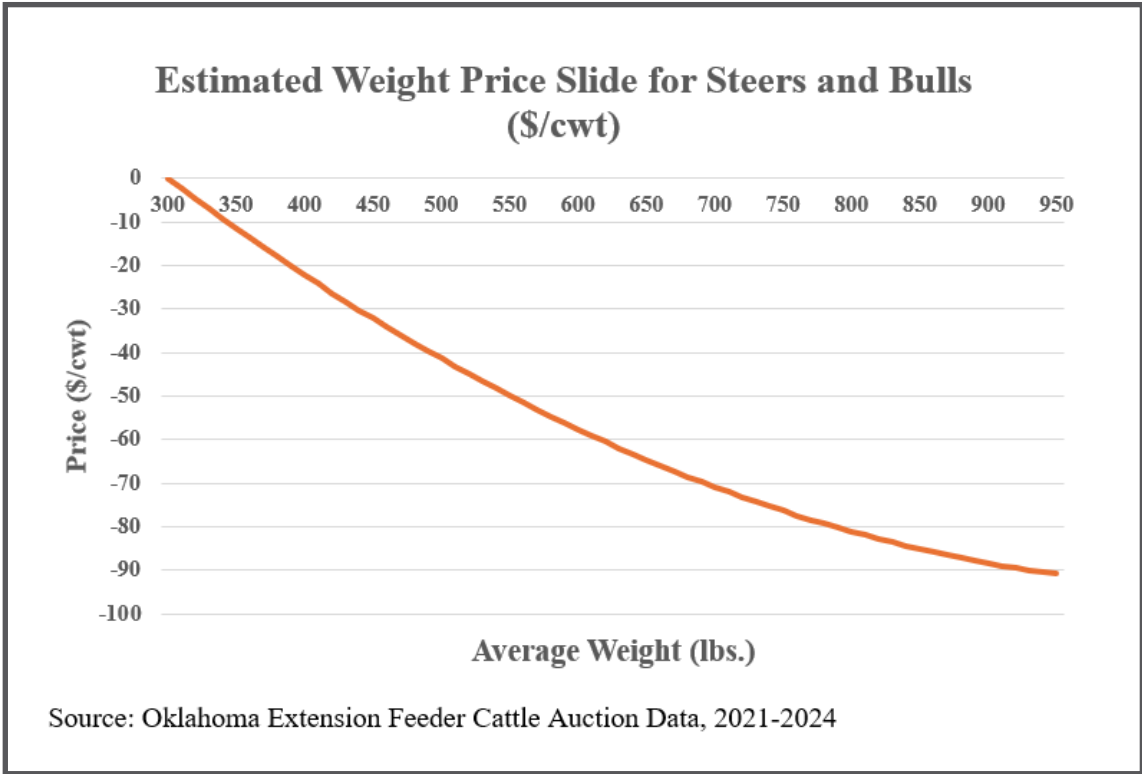


Figure 2. Estimated weight price slide for steers and bulls (\$/cwt), selected Oklahoma auctions, 2021-2024

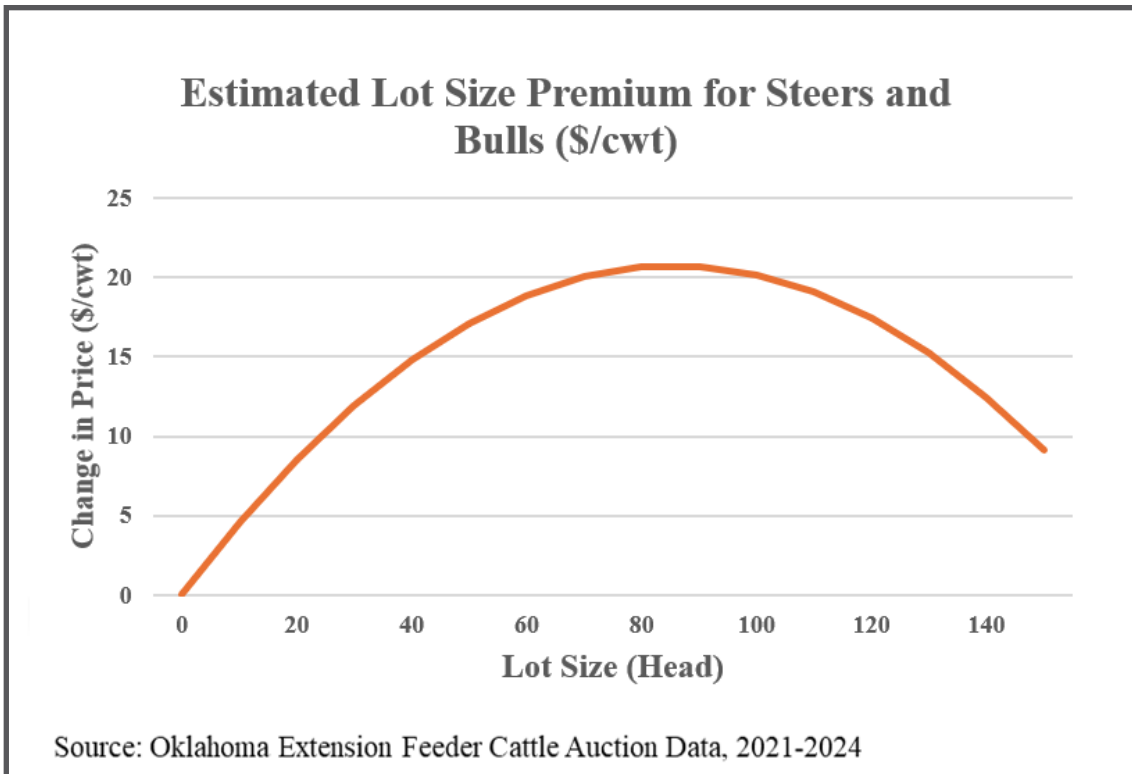


Figure 3. Estimated lot size premium for steers and bulls (\$/cwt), selected Oklahoma auctions, 2021-2024

Table 1. Number of Male Feeder Cattle Lots by Castration Status and Weight Category						
Castration Status	Weight Category (lbs.)					
	300-399	400-499	500-599	600-699	700-799	800-950
Bulls & Mix	122	228	223	164	52	30
Steers	413	832	1120	909	553	302
% Bull Lots	23%	22%	17%	15%	9%	9%
Total Lots	535	1060	1343	1073	605	332

Source: Oklahoma Extension Feeder Cattle Auction Data, 2021-2024

Table 2. ANOVA Comparison of Price Basis Between Steer and Bull Lots			
Weight Category	Steers	Bulls & Mix	Difference in Basis (\$/cwt)
	Average Price Basis (\$/cwt)	Average Price Basis (\$/cwt)	
300-399lbs	\$37.55	\$20.02	17.53*
400-499lbs	\$26.90	\$7.17	19.73*
500-599lbs	\$12.22	-\$13.22	25.44*
600-699lbs	-\$3.17	-\$27.48	24.31*
700-799lbs	-\$10.34	-\$37.01	26.67*
800-950lbs	-\$16.04	-\$54.42	38.38*

*Statistically significant at the 95% confidence level.

Source: Oklahoma Extension Feeder Cattle Auction Data, 2021-2024

Table 3. Hedonic Parameter Estimates for Lot Characteristics, Traits, and Practices (\$/cwt)

Variable	Premium Estimate	Discount Estimate	p-value
Head	\$0.48*		0.00
Head squared		-\$0.00*	0.00
Average Weight		-\$0.33*	0.00
Average Weight squared	\$0.00*		0.00
Bulls		-\$11.69*	0.00
Bulls*Weight Category (base: Bulls*500wt)			
Bulls*300wt		-\$1.24	0.65
Bulls*400wt	\$2.78		0.20
Bulls*600wt		-\$0.99	0.68
Bulls*700wt		-\$2.22	0.54
Bulls*800wt		-\$5.82	0.21
Vaccination (base: No Vac)			
Limited Vaccination	\$2.56		0.14
Vaccinated	\$3.22*		0.00
Certification (base: No Cert)			
Integrity Beef	\$1.71		0.43
MacVac		-\$1.20	0.53
OQBN	\$1.32		0.36
Other Cert	\$7.27		0.07
Weaned	\$7.08*		0.00
Horns		-\$9.06*	0.00
Hide Color (base: Black)			
Black Mixed		-\$1.07	0.24
Dairy/Longhorn		-\$30.82*	0.00
Hereford		-\$19.13*	0.00
Mixed High Quality		-\$6.31*	0.00
Mixed Low Quality		-\$28.89*	0.00
Red		-\$7.12*	0.00
Red Mixed		-\$5.57*	0.00
White/Gray		-\$9.85*	0.00
Other		-\$12.30*	0.00
Muscling (base: Medium)			
Light		-\$22.08*	0.00
Medium-Thick	\$6.08*		0.00
Thick	\$7.48*		0.00
Fleshiness (base: Average)			
Thin		-\$8.93*	0.00
Fleshy		-\$3.82	0.17
Spring (base: Fall)	\$14.47*		0.00
No Brahman Influence	\$14.24*		0.00
Frame (base: Large)			
Medium		-\$4.98*	0.44
Medium-Large	\$1.08		0.00

**Table 3. Hedonic Parameter Estimates for Lot Characteristics, Traits, and Practices (\$/cwt)
(Continued)**

Variable	Premium Estimate	Discount Estimate	p-value
Location			
Barn 2	\$8.63*		0.00
Barn 3		-\$14.75*	0.00
Barn 4		-\$1.71	0.19
Barn 5		-\$7.09*	0.00
Barn 6		-\$5.14*	0.01
Barn 7		-\$0.01	0.99
Seller Announced	\$2.64*		0.01
Unhealthy		-\$68.77*	0.00
Year (base: 2021)			
2022		-\$3.52*	0.00
2023	\$15.62*		0.00
2024	\$24.45*		0.00

*Statistically significant at the 95% confidence level.

Source: Oklahoma Extension Feeder Cattle Auction Data, 2021-2024

**Table 4. Estimated Value Lost for Lots
Containing Bulls, Relative to Steers (\$/head)**

Weight Class	Value Lost per Head
300-399 lbs.	\$35.07 - 46.64
400-499 lbs.	\$46.76 - 58.33
500-599 lbs.	\$58.45 - 70.02
600-699 lbs.	\$70.14 - 81.71
700-799 lbs.	\$81.83 - 93.40
800-950 lbs.	\$93.52 - 111.05

Source: Oklahoma Extension Feeder Cattle Auction Data, 2021-2024

Table 5. Net Return on Investment for Castrating (per Head)

Weight Class	Cost of Castration* (\$/head)	Net Return on Investment (\$/head)	Net Return on Investment (%)
300-399 lbs.	\$5.28	\$29.79 - 41.36	564 - 783%
400-499 lbs.	\$5.28	\$41.48 - 53.05	786 - 1,005%
500-599 lbs.	\$5.28	\$53.17 - 64.74	1,007 - 1,226%
600-699 lbs.	\$5.28	\$64.86 - 76.43	1,228 - 1,448%
700-799 lbs.	\$5.28	\$76.55 - 88.12	1,450 - 1,669%
800-950 lbs.	\$5.28	\$88.24 - 105.77	1,671 - 2,003%

Sources: Oklahoma Extension Feeder Cattle Auction Data, 2021-2024

*Sahs, 2022

Cattle Buyer Perspectives on the Value of Seller Reputation



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Abstract

Seller reputation has long been considered to impact feeder cattle price by those in the cattle industry, yet from a research perspective, it has proven difficult to quantitatively measure that impact. Physical attributes and management attributes are either observable or certifiable. However, regularly recorded market data does not capture a measure of seller reputation since it is not physically observable. This research reports cattle buyer responses to a survey

designed to characterize those cattle buyers and to begin to understand the market value of seller reputation by eliciting bids for varying layers of management and marketing practices with seller reputation.

INTRODUCTION

Cattle buyers incorporate multiple factors into their willingness to bid for feeder cattle at auction or in a direct sale negotiation. It is well known that both physical characteristics and management attributes impact feeder cattle market prices (e.g., Peel et al., 2024; Williams et al., 2012; Bulut and Lawrence, 2007). Physical factors are generally visible to buyers and include characteristics such as breed, hide color, sex, frame, muscling, dehorning, lot size, and weight. At auction, other management characteristics, such as vaccinations or extended weaning, are not visible at marketing but may be communicated to buyers by the auctioneer. When included as part of a preconditioning program, third-party verification may also be included. This third-party verification of preconditioning through programs such as Iowa Green or Gold Tag, Oklahoma Quality Beef Network, breed associations, or animal health companies increases trust that protocols have been followed. Certification could be a proxy for seller reputation when no prior knowledge exists.

However, one attribute that cannot be accounted for in regular market data is the seller's reputation. It is often considered anecdotally that reputation, either positively or negatively, affects the price that feeder cattle bring at auction. However, it is difficult for researchers to measure, as regularly recorded market data does not capture a measure of seller reputation since it is not physically observable or verifiable through records like third-party programs. Bulut and Lawrence (2007) suggest that reputation has little consequence in feeder cattle markets since most sellers only sell calves annually or biannually and therefore do not have the time to develop a reputation. All other examples and anecdotal evidence suggest that even though most sellers are not marketing more

than a handful of times a year, buyers remember and discuss the results those cattle have achieved in the past. This points to the usefulness of survey work to capture reputation value, building on work done by Boline (2016).

Previous work addressing the influence of seller reputation on feeder cattle price includes Turner, McKissick, and Dykes (1993), a seminal piece of literature in this area of study. They used tele-auction data from Georgia feeder calf sales containing seller information. Using seller information as a proxy for seller reputation, their findings suggest that seller reputation may influence buyers' bids. Schulz, Dhuyvetter, and Doran (2015) examined the effects of reputation and other factors in the state-specific preconditioning programs of Iowa Green and Gold Tag programs, along with regular sale data. Reputation was proxied by attaching seller names with preconditioning information to lots at preconditioned feeder cattle auctions in Iowa. The implicit value of reputation was calculated by measuring premiums or discounts relative to the benchmark price. Approximately 21% of lots brought prices higher than the benchmark price, suggesting a seller reputation premium.

While current literature suggests that black-hided, Angus-influenced calves in large, uniform, lots of preconditioned steers garner the highest relative prices at auction, research on the value of reputation is scarce. Professionals have very little literature to help make straightforward suggestions to producers about the value of maintaining a positive reputation as a feeder calf seller. This research uses survey methods to assess the value of seller reputation by soliciting cattle buyer input directly to estimate the value of seller reputation in feeder calf auctions.

METHODS AND DATA

A survey was designed to determine the value of management and reputation characteristics in cattle by soliciting bids from cattle buyers when different management and reputation characteristics were applied in different combinations to the same set of cattle (Oklahoma State University IRB-24-517). Data were collected via Qualtrics surveys from cattle buyers recruited (1) in-person at sale barns across Oklahoma, (2) through social media, and (3) through direct email recruitment to known cattle buyers. Participants were actively recruited from November 2024 through January 2025. Of 120 total responses, 53 of those were deemed usable. Usable responses were defined as those responses that answered the base bid question and placed a bid on at least some of the nine

different reputation and management combinations presented.

Cattle buyers were first shown a video of a lot of feeder steers in the 500- to 599-pound weight range assessed by USDA's Agricultural Marketing Service (USDA-AMS) as slightly fleshy Medium and Large No. 1 Steers. They were asked to place a bid based on the current market in their location with no further information regarding the cattle. Current USDA-AMS market reports were accessible for reference via active links for buyer reference if needed. Buyers were then asked to bid on the same cattle given varying combinations of management and reputation information, including seller reputation (positive, negative, or unknown), preconditioning (preconditioned or not preconditioned) and preconditioning certification (certified or uncertified). The terms were defined as follows:

- *Positive reputation.* You or someone you know has previously purchased cattle from the seller, and performance and quality were satisfactory.
- *Negative reputation.* You or someone you know has previously purchased cattle from the seller, and the performance and quality were inadequate.
- *Unknown reputation.* You have no previous knowledge of the seller's cattle.
- *Preconditioned.* Management practices on the ranch to strengthen calves' immune systems before calves move to the next production phase.
- *Not preconditioned.* Calves are marketed with no known preconditioning practices implemented beyond castration and dehorning.
- *Certified.* Calves have third-party verification that the bundle of preconditioning practices has been implemented.
- *Non-certified.* Calves are marketed as preconditioned, but without verification.

The nine combinations of these attributes are shown in Table 1.

Buyers were asked to bid on the cattle in the video, assuming the same weight and AMS grade characteristics, but for each reputation and management combination as described in Table 1. In total, buyers placed 10 bids—one for the cattle with no knowledge of management or reputation and then one bid for the cattle for each of the nine possible combinations of management and reputation. In addition to cattle bid questions, buyer questions included:

- Rank questions on the valuation of seller reputation, including personal knowledge of the seller, past performance of the seller's cattle, and preconditioning information;
- Buyer-focused questions like where, how frequently, how many, and for whom they purchase cattle;
- Preferences for purchasing a full truck of cattle of unknown quality or a partial truck of cattle that are of known quality; and
- Demographic questions (age, gender, education).

RESULTS AND DISCUSSION

Demographic questions were asked in order to better understand the perspectives of the survey participants. Of the survey respondents, 2% were female and 98% were male. Figure 1 illustrates cattle buyer age. Percentages across age groups are relatively similar and range from 13% to 24%. The exception is the under-25 age group where there are notably fewer respondents at only 4%.

Figure 2 illustrates that the education level across respondents is relatively evenly distributed, with most respondents holding a bachelor's degree or higher. Respondents with an associate's degree or some college represent 33% of the buyers, while 53% hold a bachelor's degree or higher. Only 14% had a high school diploma or less, making this sample of respondents 86% college-educated.

Forty percent of respondents bought more than 1,000 head of feeder cattle annually, and the majority of cattle buyers indicated that they were buying for personal use. Figure 3 illustrates the breakdown of all buyer motivation responses.

Cattle purchase venue is illustrated in Figure 4, with buyers indicating the percentage of cattle purchased directly and at auction. Each bar represents an individual buyer and the proportion of cattle they purchase from each option annually. Only one buyer purchased all cattle directly from the ranch, as indicated by the single solid blue bar on the left side of the chart, while 33% of buyers purchased all cattle at auction, indicated by the solid orange bars on the right. Bars that are mixed colors indicate that buyers purchased at least some cattle through both the direct purchase channel and through auction markets. Approximately 28% of buyers purchased 60% or more of their annual purchases directly from the

seller. Sixty-three percent of buyers purchased 75% or more of their annual purchases through auction markets. On average across individual buyers in this study, the proportion of cattle purchased at auction is approximately 63%. USDA-AMS reports that in 2024, 67% of feeder receipts were sourced at auctions. While a direct comparison is not possible since the survey does not ask for exact annual head counts but rather a head count range, on average, the numbers would suggest that cattle buyers in this survey source cattle in a manner that would result in similar proportions across purchase options.

Buyers were also asked questions to indicate factors that influence their buying decisions. The survey presented respondents with a list of factors that could affect a seller's reputation and asked them to rank them in order of importance. The list of factors included third-party preconditioning verification, preconditioning announcements at sales, knowledge of the seller, previous performance, and others. The most common first-place answer was the previous performance of cattle bought from that seller. All response rankings are shown in Figure 5. When rankings 1 and 2 are combined, 70% of cattle buyers ranked either the previous performance of a seller's cattle or knowledge of the seller as the most likely to positively impact their cattle purchases. That said, preconditioning announcements and third-party verification are not unimportant, as they also garner significant 1, 2, and 3 rankings.

Finally, the series of bid questions provides insight into feeder cattle buyers' preferences for cattle lots with different management and reputation attributes through both their willingness to bid and differences in the magnitude of bids for specific combinations of attributes. Figure 6 shows the average bid for each lot type as well as the percentage of buyers who chose not to bid on that lot. The highest bids are garnered for the lot with a positive seller reputation and preconditioning management practices that have been third-party certified. Prices decrease steadily as across reputation level and preconditioning levels decrease. A positive reputation generally gains a higher average bid relative to unknown and negative reputations, regardless of the applicable management or certification. Certification of preconditioning does bolster bids for unknown reputation, likely serving as a proxy for reputation when it is unknown. Note that the line represents the percentage of buyers who chose not to bid on that specific combination of management, certification, and reputation. The percentage of no bids is well below 10% for positive reputation cattle regardless of management

characteristics and remains below 20% for options with unknown reputation. However, for all negative reputation options, the percentage of no bids skyrockets to over 50%, that is, over 50% of cattle buyers will not even place a bid on cattle when the seller's reputation is negative.

Those involved in the industry often agree that buying cattle that have a positive outcome is a learned skill that requires practice. Buyers who purchase more frequently and in higher volumes have more opportunities to hone these skills. Figure 7 sorts buyers into sizes according to annual purchases, with those purchasing less than 200 head per year considered small-volume buyers and those purchasing greater than 200 head per year considered large-volume buyers. In Figure 7, average bids by buyer size are shown for each lot type. Bids are relatively close between large- and small-volume buyers except for lots with a negative reputation, where large buyers substantially decrease their maximum bid amounts, but small-volume buyers do not. Recall from Figure 6 that 50% of buyers will choose not to bid at all on cattle when the seller's reputation is negative. In addition, p-values are reported for tests of equal means between large- and small-volume buyers for each lot type. When p-values are less than 0.10, we can say with 90% confidence that the average bids are different between large- and small-volume buyers. For two of the three negative reputation options, the p-value is 0.05 or less, indicating with 95% confidence that the small-volume buyer and large-volume buyer bids are statistically different, with small buyers bidding more for negative reputation cattle than large-volume buyers. This is another indicator of how a negative reputation can decrease a buyer's willingness to bid for cattle.

Finally, cattle buyers were asked to choose whether, when purchasing feeder cattle, they would rather partially fill a truck with cattle of known quality or purchase a full truck of cattle of unknown quality. Figure 8 indicates that 85% of buyers said they would rather buy a partially full truck of cattle of known quantity than a full truck of unknown quality, that is, they would choose quality over quantity, even when it may mean they are paying full shipping costs for a partially empty truck. This is a powerful indicator of how much quality matters to cattle buyers.

SUMMARY AND CONCLUSIONS

Results from this survey increase our understanding of cattle buyer preferences and behavior with respect to seller reputation as well as preconditioning practices and third-party verification of those

practices. Cattle buyer responses indicate that reputation does influence the price they are willing to pay and, importantly, whether they are willing to bid at all on a specific lot of cattle. Simply put, reputation is an important component of price and influences a buyer's willingness to take risks on your cattle. A positive reputation enhances market prices received by sellers, even when the cattle are certified preconditioned. Conversely, a negative reputation has a negative impact even on certified preconditioned lots. Certification of management practices may be at least a partial proxy for a positive reputation when reputation is unknown because it provides an element of trust.

In the feeder cattle market, the reputation of a seller can be built or broken with every transaction. The cattle industry is interconnected, particularly locally or regionally, and buyers often share information about performance of past purchases. Understanding the reputation your cattle may have with cattle buyers is a helpful marketing tool, so it is important to ask buyers how cattle have performed, look for an honest answer, and strive for continued improvement. Understanding the value of seller reputation in the cattle market can be a powerful incentive to improve calf health management on the ranch and to be intentional in marketing those cattle.

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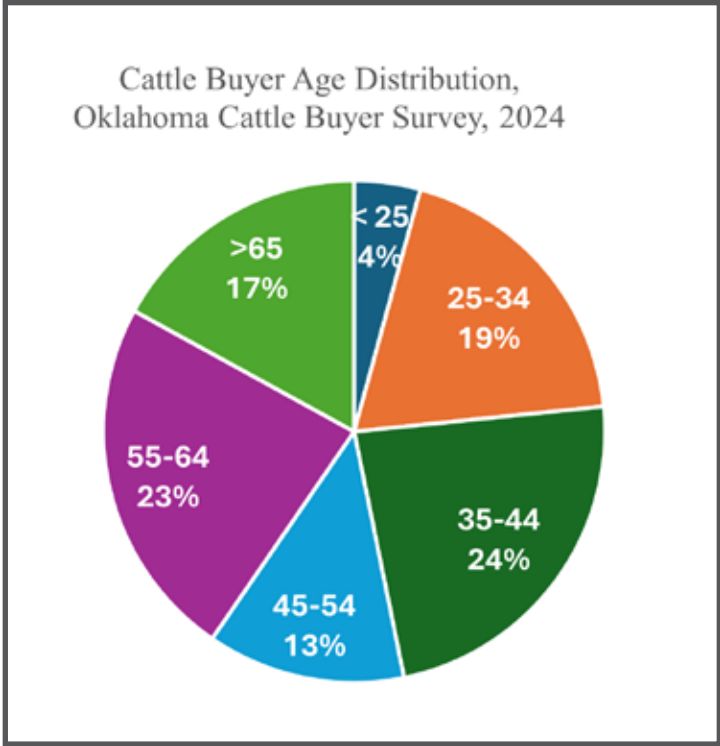


Figure 1. Cattle buyer age distribution, Oklahoma cattle buyer survey, 2024

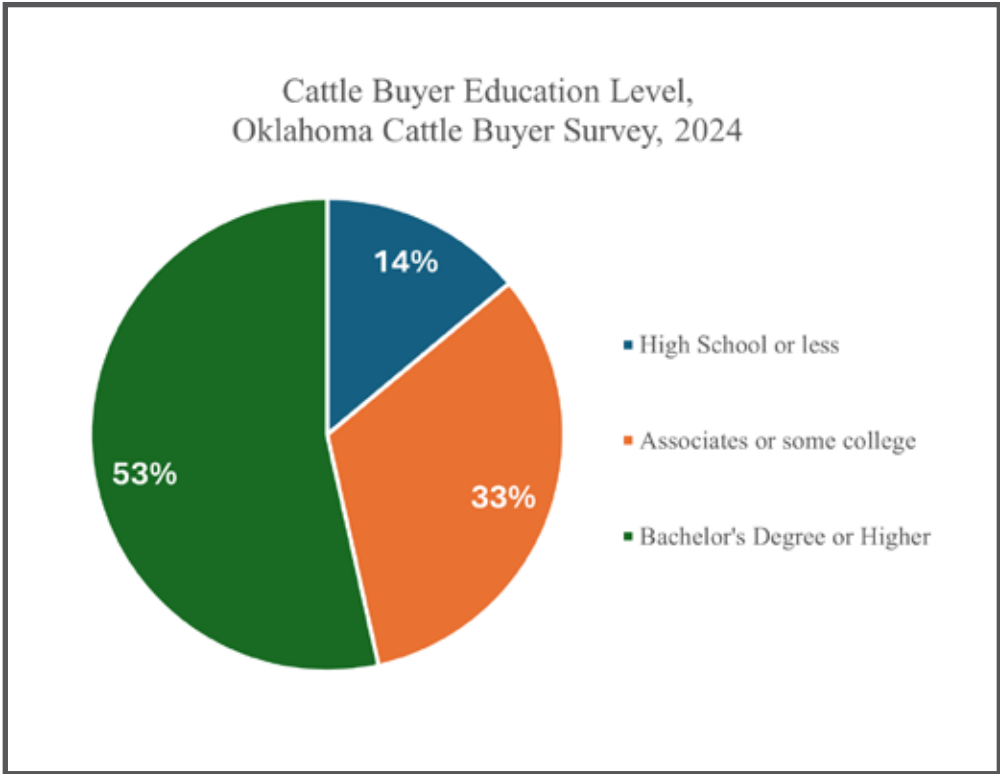


Figure 2. Cattle buyer education level, Oklahoma cattle buyer survey, 2024

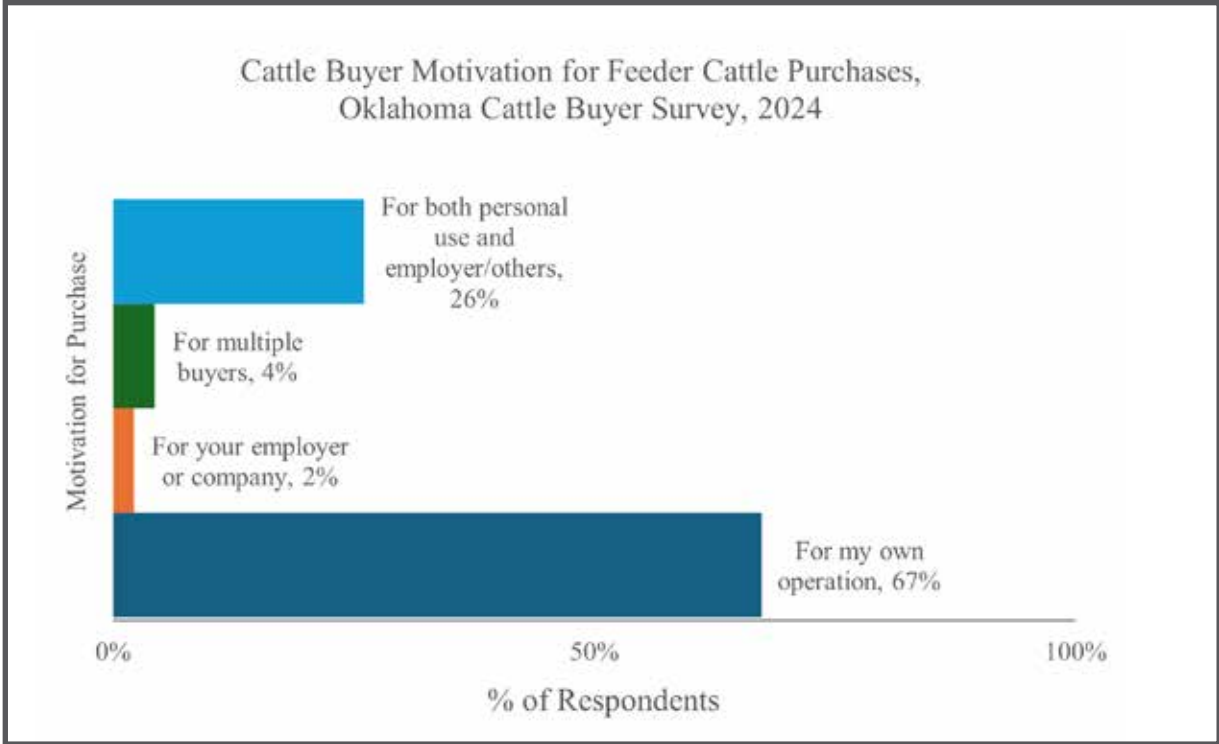


Figure 3. Cattle buyer motivation for feeder cattle purchases, Oklahoma cattle buyer survey, 2024

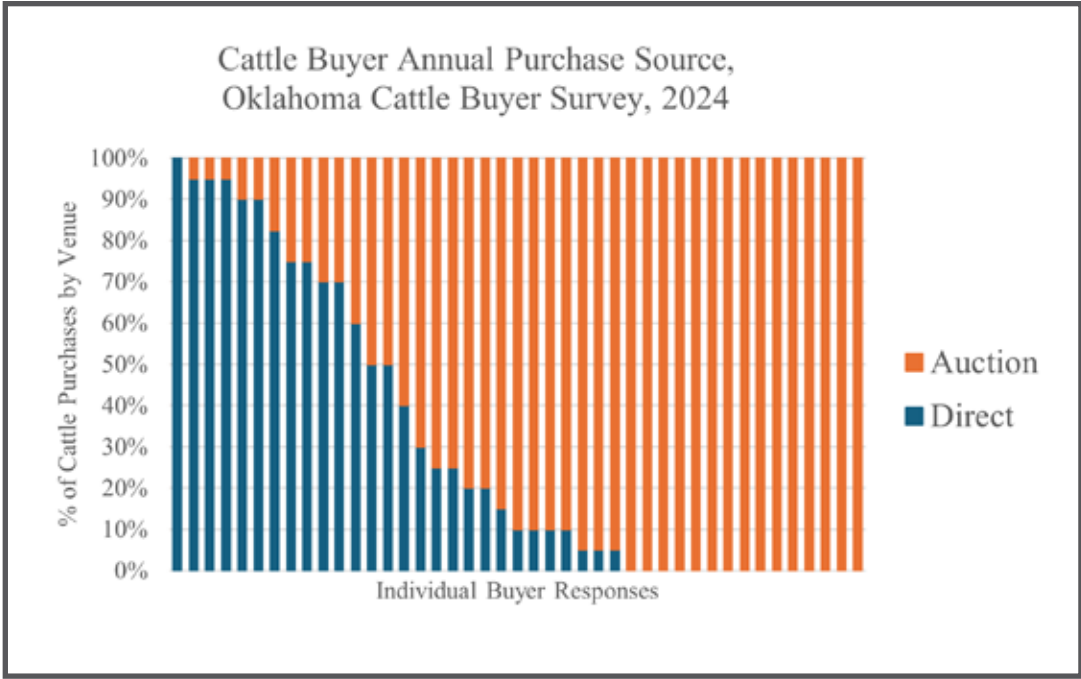


Figure 4. Annual purchase source by individual buyers, direct versus auction, Oklahoma cattle buyer survey, 2024

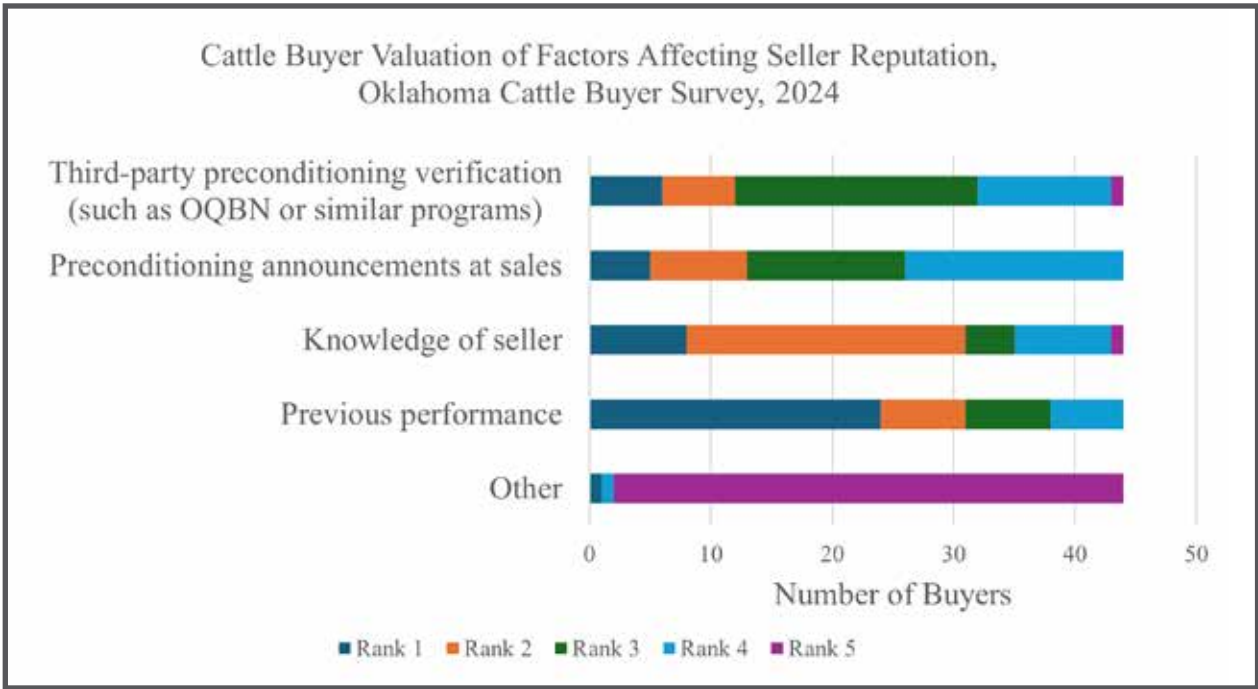


Figure 5. Cattle buyer valuation of factors affecting seller reputation, Oklahoma cattle buyer survey, 2024

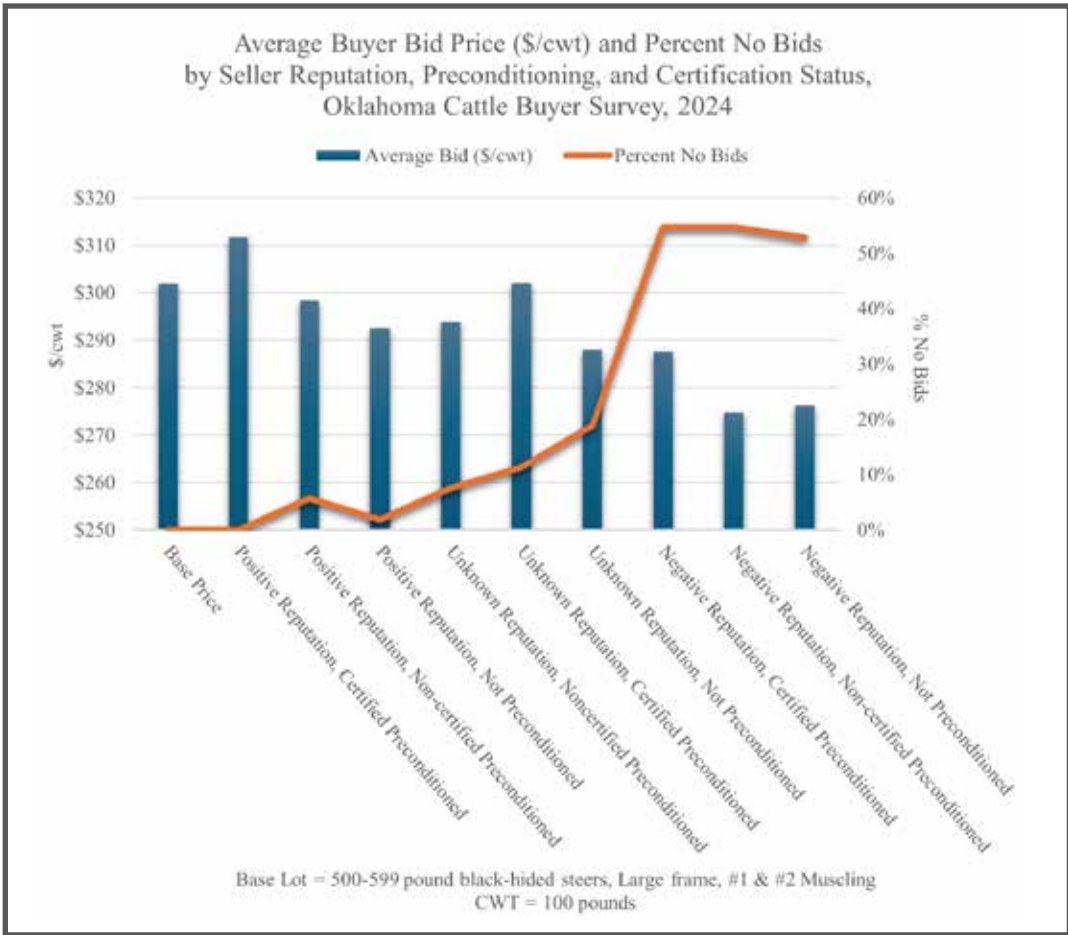


Figure 6. Average buyer bid price (\$/cwt) and percent no bids by seller reputation, preconditioning, and certification status, Oklahoma cattle buyer survey, 2024

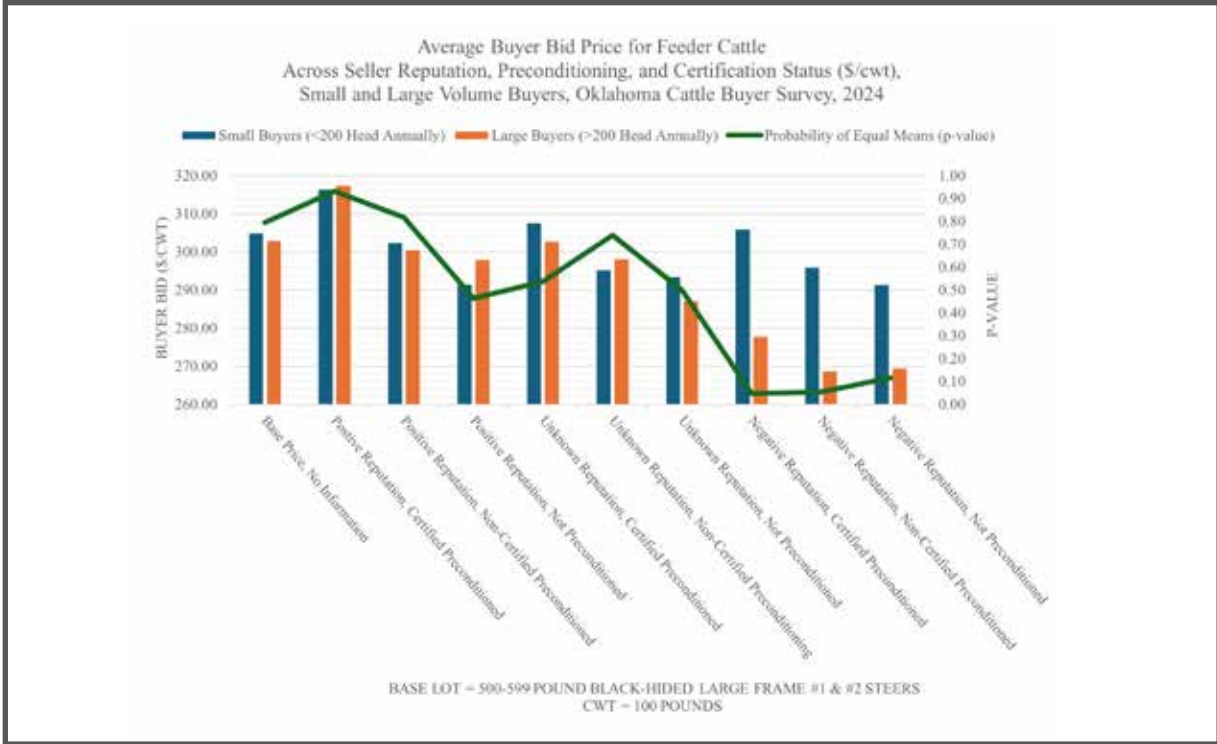


Figure 7. Average buyer bid price for feeder cattle across seller reputation, preconditioning, and certification status (\$/cwt), small and large volume buyers, Oklahoma cattle buyer survey, 2024

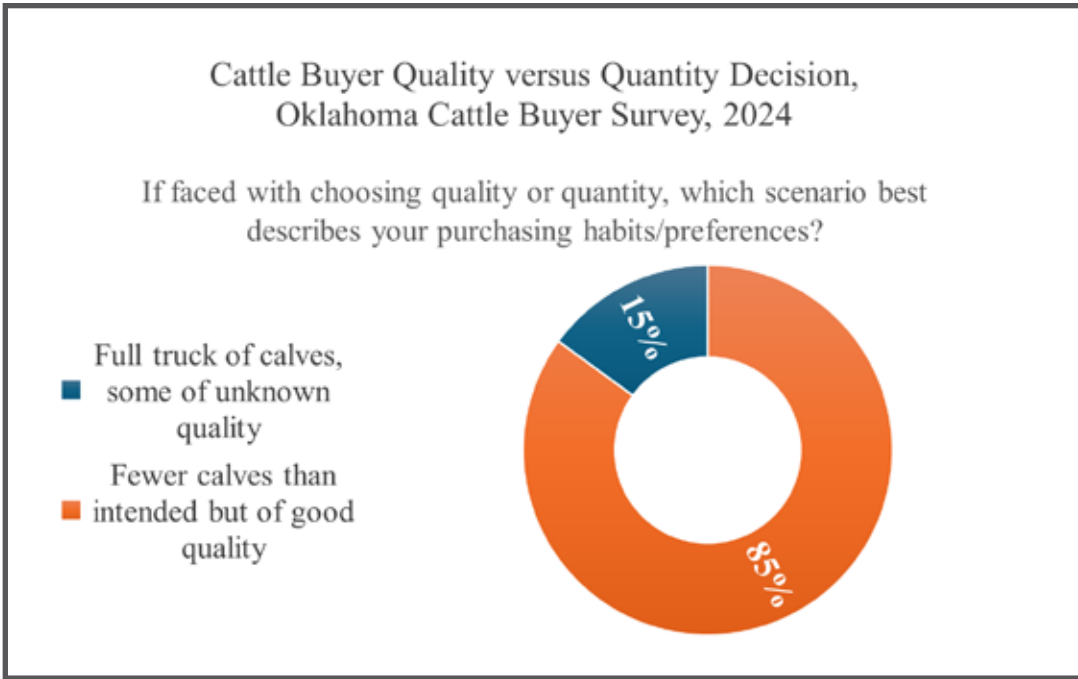


Figure 8. Cattle buyer preference for quality versus quantity in feeder cattle purchases.

Table 1. Feeder Cattle Lot Characteristic Combinations Presented to Cattle Buyers for Bid Solicitation, Oklahoma Cattle Buyer Survey, 2024

Positive Reputation Preconditioned Not Certified	Negative Reputation Preconditioned Not Certified	Unknown Reputation Preconditioned Not Certified
Positive Reputation Not Preconditioned	Negative Reputation Not Preconditioned	Unknown Reputation Not Preconditioned
Positive Reputation Certified Preconditioned	Negative Reputation Certified Preconditioned	Unknown Reputation Certified Preconditioned

A Moderately Brief History of Farm Management: The Changing Language of Rural Property Professionals



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to “farmland,” and terms like “economics,” “analysis,” and “risk” only became common after the mid-1980s. Results are relevant to prospective authors and those interested in the rural property professions.

Acknowledgments

Appreciation for JSTOR maintaining open access archives of the *Journal of the ASFMRA* at <https://www.jstor.org/journal/jasfmra> and to the open-source community, especially the R Core Team and authors of contributed packages. To further the concept of open source, the data and code used for this analysis are available on the author’s Github at <https://github.com/spaceplowboy/JASFMRA2026>. Running the script replicates the analysis and produces the same graphs included in this article. The hope is for others to learn more about programmatically accessing data to conduct their own analyses, then build upon results presented here.

Abstract

The Journal of the ASFMRA has a long history of sharing farm management ideas. A textual analysis of 1,752 articles evaluated language and authorship trends since 1937. Over time, fewer articles were sole-authored, and common title words shifted, reflecting evolving concerns of the profession. Single authorship declined from 80% prior to the 1970s to less than 40% after 1990. While “farm” remained the most frequent title word, the second most common term in the earlier decades, “appraisal,” gave way

INTRODUCTION

The language we use reflects the challenges we face. For nearly a century, articles published by the *Journal of the American Society of Farm Managers and Rural Appraisers* (ASFMRA) have documented the evolution of farm management concerns, from WWII-era policy to the financial crisis of the 1980s to today’s digitization of agriculture. The *Journal of the ASFMRA* (hereafter referred to as “the Journal”) has been one of a very few publications of applied farm management that has continued providing authors with a peer-reviewed outlet. As a result, the membership of the ASFMRA has been endowed with a steady flow of innovative ideas to consider in their professional rural property practices. This mutually beneficial relationship has existed since 1937.

Textual analysis reveals shifting priorities of farm management over time. Building on Griffin and Gammon (2020), who analyzed 330 articles from 2000 to 2019, the current study evaluates a longer time series from 1937 to 2023 of 1,752 articles. In addition to reporting common title words and frequencies of authors and title length, the updated analysis incorporates a type/token ratio (W. Johnson, 1944) and sentiment analysis (Jockers, 2015). While Griffin and Gammon (2020) provided institutional characteristics of authors and emphasized differences between articles relative to the coveted Gold Quill recipients, the current work focuses on broader structural changes in authorship, title construction, and thematic content over eight complete decades using readily available metadata (JSTOR, 2025). Both studies share a commitment to open data, reproducible methods, and

accessible visualization of long-run publishing trends, providing a richer perspective on the evolution of farm management scholarship.

A past-as-prologue historical reflection provides a forward-looking perspective on farm management for the next century. By examining long-term trends, this analysis offers insights into the future of farm management and rural appraisal. To explore these trends, textual analysis techniques are applied to the Journal's article titles and author counts.

Understanding linguistic and structural shifts is not merely a historical curiosity, practical value for today's rural property professionals and prospective authors is provided. For practitioners, recognizing how the profession's language has evolved in response to agricultural crises, technological change, and policy shifts offers insight into emerging areas of expertise that may define the next generation of farm management challenges. For prospective authors, understanding current thematic trends and title construction norms can help position research to address these evolving priorities. By documenting how the Journal's content has tracked major agricultural transformations, from mechanization (Perkins, 1960) to digitalization (McFadden et al., 2023) and from post-war policy to the 1980s financial crisis (Zulauf et al. 2022), this analysis serves as both a retrospective and a compass for future research.

BACKGROUND AND LITERATURE REVIEW

Bibliometric studies of the agricultural economics literature provide useful context for evaluating authorship patterns, thematic evolution, and publication trends within the Journal. Onder and Yilmazkuday (2020) documented long-run shifts in economics publishing, most notably the decline of sole-authored articles and the rise of collaborative work, offering a benchmark for comparing authorship norms in applied farm management. Analyzing 35 years of peer-reviewed economics publications for patterns in co-authorship, they reported a steady reduction in sole-authored articles since 1980 while the proportion of two- and three-author articles increased. Once peaking in the late 1990s, two-author articles remained relatively stable at nearly half of all publications. A measurable proportion of articles with more than three authors appeared after 2000 and became 10% of the literature by 2005 (Onder and Yilmazkuday 2020).

Similar approaches have been applied to agricultural literature. Methodological contributions by Gauffriau (2021) clarified how authorship and publication metrics should be interpreted. A bibliometric review of digital agriculture by Bertoglio et al. (2021) highlights the rapid emergence of new themes in applied agricultural sciences, a pattern that may parallel evolving subject matter in the long publication history of the Journal.

This analysis applies text-as-data methods following the framework established by Gentzkow et al. (2019), who provided a comprehensive review of textual analysis methods in economics. Their approach has become standard practice across disciplines, including the recommendation to focus on single words to validate results through multiple complementary methods rather than relying on a single technique. Collectively, these studies provide the foundation for applying bibliometric and textual-analytic techniques to assess publication trends, authorship patterns, and thematic evolution across ASFMRA's history.

DATA AND METHODS

Data wrangling began with structured metadata from JSTOR (JSTOR, 2025). Following standard text-as-data preprocessing practices (Gentzkow et al., 2019; Silge and Robinson, 2016), author fields were normalized and titles were cleaned by removal of punctuation, prepositions, and filler words. Stemming procedures standardized related terms (e.g., "manage," "manager," "managing" → "management"), and semantic grouping combined variants with shared meaning (e.g., "farmers," "producers," "growers" → "farmer") that preserve semantic content while ensuring comparability across decades (Gentzkow et al., 2019).

The cleaned dataframe was expanded into word- and author-level structures, with titles tokenized into component words for frequency analysis (Jockers and Thalken, 2020). Author lists were unnested to facilitate longitudinal analyses of collaboration trends, with derived variables including co-author and title word counts per article. Word usage dynamics were evaluated across years with lexical dispersion analysis (Phillips, 2008) and measures of vocabulary richness such as type/token ratio (TTR). These procedures provide a multifaceted assessment of the Journal's evolution in article content, authorship structure, and linguistic style over time.

In addition to descriptive statistics and lexical analysis, the structural change analysis (Zeileis et al., 2003) of authorship and title characteristics were evaluated. Breakpoints were estimated for the proportion of

sole-author versus multiple-author articles and average number of title words. Breakpoints identified candidate years when significant shifts occur, segmenting the data into pre-, post-, and transitional phases enabling direct comparison of publication practices across eras.

Data were analyzed using textual analysis procedures (Kosnik, 2015; Jockers and Thalken, 2020; Silge and Robinson, 2016) with the R statistical environment (R Core Team, 2025). The data and R script are publicly available for rural property professionals and other researchers to perform their own evaluations.

ANALYSIS AND RESULTS

Since 1937 the Journal has published 1,752 articles. The most articles published in one year were 37 in 1956 while the least was 7 in 2022. On average, the Journal publishes more than 20 articles per year with a downward trend over time (Figure 1).

After the inaugural year, the total number of authors contributing each year varied from 15 in 1954 to 71 in 2010 (Figure 1). The most authors on a single article were 25, however sole authorship remains the most common followed by two, then three authors. Visual assessment of the number of articles versus authors indicates a recent trend of fewer articles with increasing number of authors over time (Figure 1), thus authors per article has been increasing. The number of authors per article and the prevalence of sole- versus multiple-author contributions are plotted over time (Figure 2); tests for structural breaks detected significant shifts in authorship patterns at various historical cutoffs. The proportion of sole- and multiple-author articles had significant breaks in 1972 and 1993, as prior to the early 1970s, most articles were penned by sole authors. After the 1980s, the proportion of multiple-author articles mirrored the trend set by sole authors during the first half of the time series. Increased proportion of multiple authors may be an artifact of the “publish or perish” pressure put on academics, may represent increasingly complex multi-state funding projects, or may mirror newer interdisciplinary approaches to risk management that are consistent with the findings of Onder and Yilmazkuday (2020).

The most common title length was four tokenized words followed by five then three (Figure 3). The longest title had 16 words, while the shortest titles had one tokenized word. It should be noted that the Journal guidelines restrict titles to be no longer than 10 words.

Significant structural breaks in the number of title words occurred in 1970 and 2005. Before 1970, the average title length was 6.5 words. Title wordiness increased to 9.2 between 1970 and 2005 and has remained 9.5 since 2005, although visual inspection indicated downward trend over the last decade (Figure 4). These breaks align with interdisciplinary research trends, emphasizing the evolving complexity of rural property practices.

Title words were then subjected to frequency analyses across the entire database by decade. The five most common title words tended to dominate the others that had less pronounced differences further down the list (Figure 5). The most common word across all article titles was “farm,” and it remains the most common title word each decade. The words “agriculture,” “appraisal,” “farmland,” and “management” are also in the top five most common token title words.

In addition to examining the entire dataframe as a whole, each decade was evaluated separately to capture transient themes over time exposing additional trends. The second most common word was “appraisal” during the 1940s, 1950s, and 1960s, then “farmland” in the 1970s, 1980s, and 2010s, and “economic” in the 1990s and “analysis” in the 2000s (Figure 6). The word “tax” only appeared as a most common word in the 1980s, the decade when “economics” first appeared as a top three most common title word. The word “risk” only appeared since the 1990s. During the 1970s, the word “analysis” first appeared albeit at the bottom of the list but remains as a top five word since the 1980s.

The dispersion of the most common title words is presented in Figure 7 and sorted such that the most common word, “farm,” is at the top. Frequently used words such as “analysis,” “finance,” and “risk” were not common prior to the 1980s but became more common in recent years. The rise of words such as “finance” and “risk” during the late 1970s temporally aligns with the rapid increase in farmland values (Schurle et al., 2012; Alston, 1986). The word “rural” was common up through the 1970s, then diminished during the 1980s. The word “crop” became more common as farms became less diversified during the early 1960s (Boehlje and Trede, 1977; Hijmans et al., 2016).

The frequency of individual words provides actionable insights into topic categories, but the next section elaborates on the underlying sentiment of title words. Jockers and Thalken (2020) define sentiment as the degree that text evokes positive or negative emotions.

The average annual sentiment was calculated from title words as values greater than zero indicating more “positive” language and negative values suggesting more “negative” language (Jockers, 2015; Jockers and Thalken, 2020). Values near zero are considered neutral or potentially mixed sentiment. For the most part, title words were deemed positive with a downward trend becoming more neutral over time. Sentiment peaked prior to WWII, then had lows during WWII, the late 1970s, the late 1980s, and recently (Figure 8). Post-war uncertainty (Halderman, 1943; S. E. Johnson, 1944), the transition from animal power to mechanization (Perkins, 1960), and rapid farm consolidation (Blase and Hesemann, 1973) likely influenced metrics in the 1940s and 1950s. Retiring farmland and increased reliance on debt from the 1950s through the 1970s (Hanson and Thompson, 1980) may have been a source of lower sentiment toward the end of the decade. The low sentiment scores during the 1980s were likely associated with the farm financial crisis (Drabenstott and Duncan, 1985), but the lingering debt effects continued to influence farm management research during the late 1980s. Alternative to the low sentiment, periods of positive sentiment during the 1990s likely were associated with reduced debt relative to the prior decade. Farm incomes had increased in part due to NAFTA (Fonsah and Hudgins, 2007) and stabilized via farm program subsidies (Wright et al., 2018; Zulauf et al., 2022).

Trends in vocabulary complexity were evaluated by TTR. When TTR was close to 1, most title words were unique, indicating a high lexical diversity; when TTR was closer to 0, title words tended to be repeated and have less diversity. Ratios tended to be greater than 0.6 and increasing over time and consistently greater than 0.7 since the 1960s before peaking in 2017 (Figure 9). It should be noted that lexical analysis was applied across all titles and thus all authors each year such that the metric is not a measure of individual complexity but rather representative of the cohort of authors.

During the time series evaluated by this study, many agricultural innovations were introduced. Hybridization of corn dramatically increased yields relative to open-pollinated varieties, and nitrogen fertilizers became available after WWII (Klemme, 1951). Crop protection chemicals including herbicides and pesticides transformed weed and pest management (Govindasamy and Italia, 1998), reducing labor costs and allowing larger-acreage cropping operations. Farms transitioned from animal power to mechanization (Perkins, 1960), then more specialization replaced diversification (Mayer, 1961), further enabling farm consolidation. Irrigation (Wade

et al., 1981) and conservation efforts (Hanson and Thompson, 1980) became standard practices in many locations. Precision farming (Popp et al., 2002), digital agriculture (Boehlje and Langemeier, 2022), and Big Data (Griffin et al., 2016) developed because of global navigation satellite systems becoming available for civilians. Many, if not most, of these innovations led to fewer but larger acreage farm operations thus increasing absentee landownership, in part, driving the necessity for rural property professionals (Griffin and Baird IV, 2010). When the first issue of the Journal was released, the internet, personal computers, wireless connectivity, satellites, and automated guidance were several decades from reality. Results presented here may help motivate university curriculum and textbook topics for the next generation. Policymakers can assess what topics matter most to practitioners over time.

SUMMARY

Building on the trends identified above, this study highlights the Journal’s evolving language and its implications for rural property professionals. Textual analysis methods quantified what authors have emphasized and how the language of the Journal reflects changing farm management concerns. Spikes in lexical diversity likely correspond to new technologies or shifts in policy. Topic modeling revealed when issues like risk management and taxes became central. Shifts in title words, such as the decline in “rural” and rise of “risk,” signal evolving priorities. This history can help guide the future of farm management research and practice. This textual analysis of 1,752 articles spanning 87 years reveals three fundamental shifts in the Journal’s evolution that carry implications for rural property professionals and future research directions.

First, authorship patterns mirror broader trends in agricultural complexity. Single authorship declined from 80% before 1970 to less than 40% after 1990, with structural breaks identified in 1972 and 1993. This shift reflects increasingly interdisciplinary approaches to farm management challenges and aligns with collaboration trends documented across the economics literature.

Second, the language of farm management has evolved from broad management concepts to specialized technical focus. While “farm” remained the dominant title word, “appraisal” as the second most common term gave way to “farmland” after the 1980s. Terms like “economics,” “analysis,” “risk,” and “finance” only became prominent after the mid-1980s farm financial crisis, with vocabulary complexity steadily increasing through 2017. These shifts signal the

profession's evolution toward quantitative, risk-focused decision frameworks.

Third, sentiment analysis reveals that title language tracks agricultural crises and policy transitions. Sentiment lows during WWII, the late 1970s farmland boom, the 1980s financial crisis, and recent periods correspond to documented periods of agricultural stress, while peaks in the 1990s align with NAFTA-era optimism and expectations of income stability.

For prospective authors, these trends suggest that successful submissions increasingly emphasize specialized production topics, quantitative analysis, and risk management frameworks. For practitioners, the evolution from "management" to "production" and the rise of "economics" and "analysis" reflects the profession's response to larger-scale operations, increased financial complexity, and data-driven decision-making. The next generation of farm management research will likely continue this trajectory, building upon digital agriculture and evolving land tenure arrangements that have driven demand for rural property professionals since the Journal's inception.

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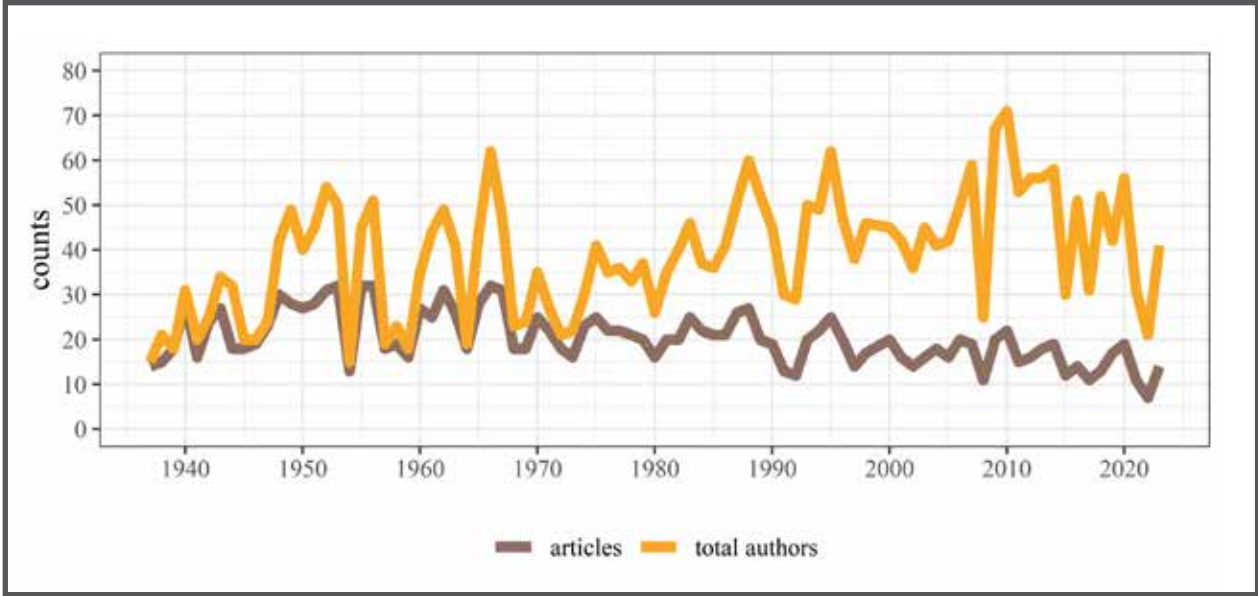


Figure 1. Annual articles published and number of authors

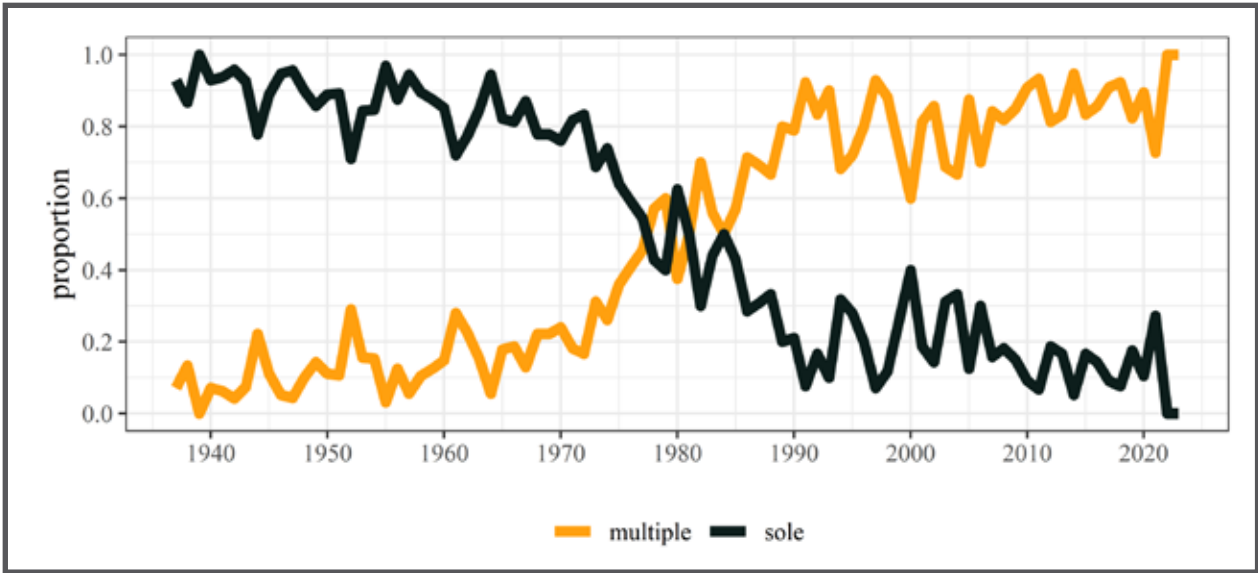


Figure 2. Proportion of sole and multiple-author articles

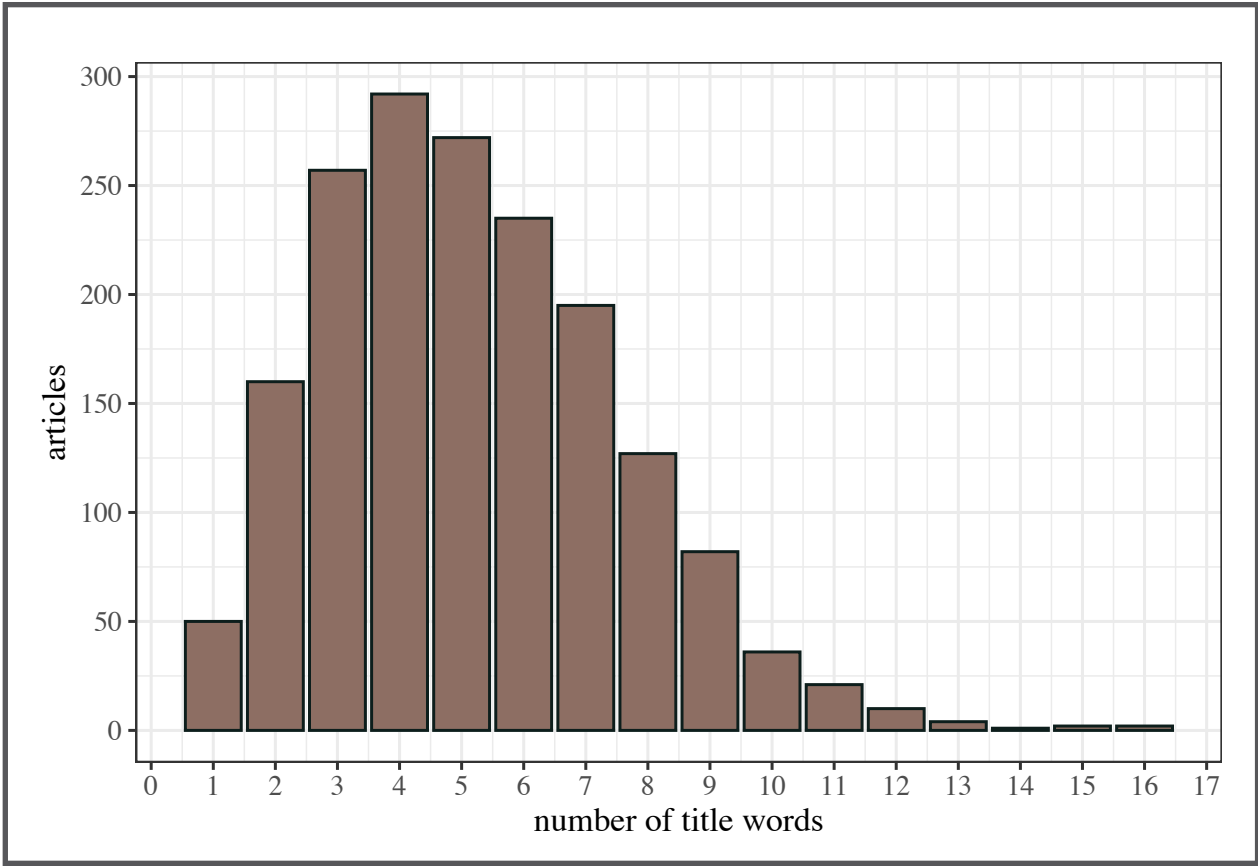


Figure 3. Number of title words per article, 1937 to present



Figure 4. Average number of title words per article

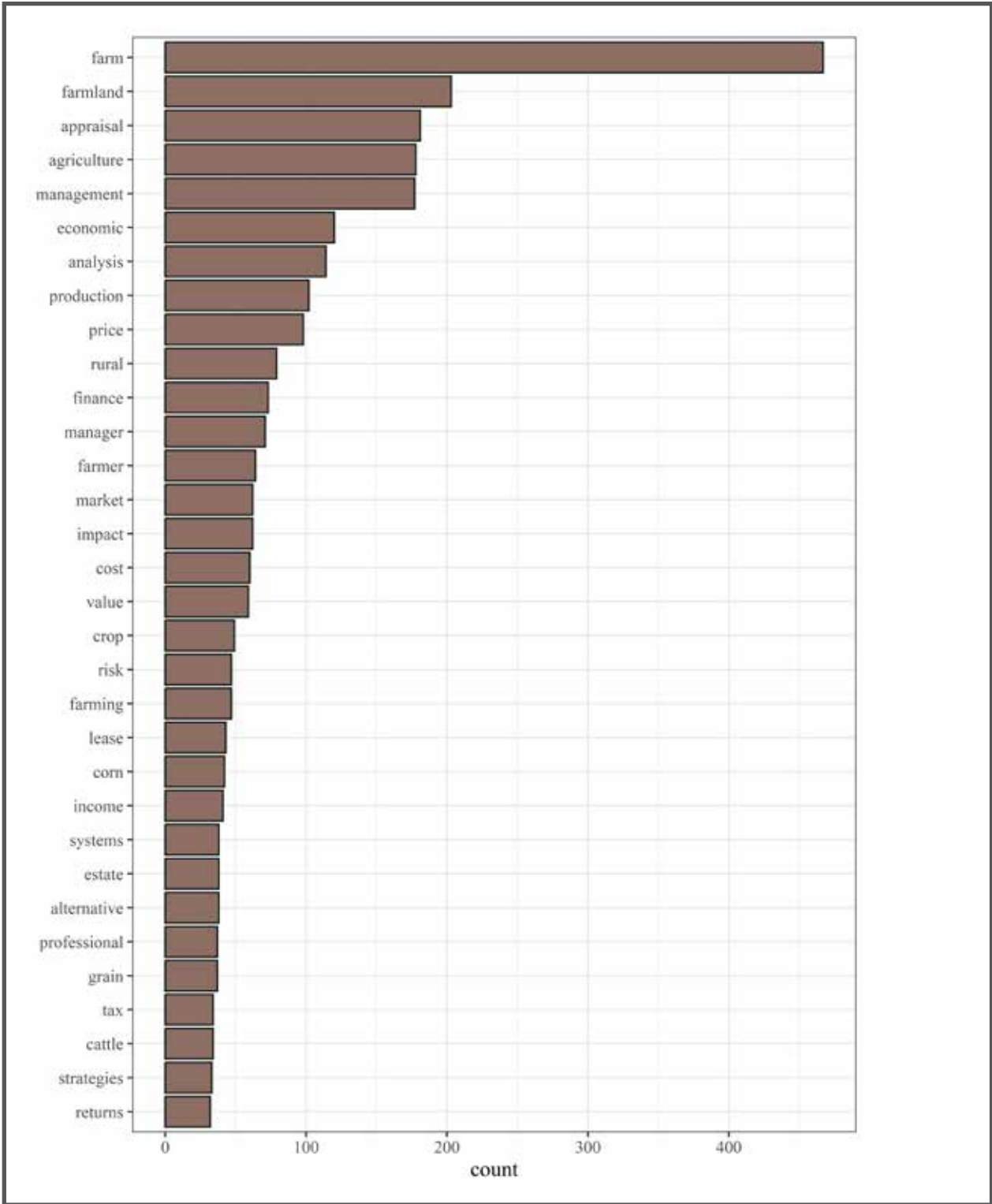


Figure 5. Most common title words, 1937 to 2023

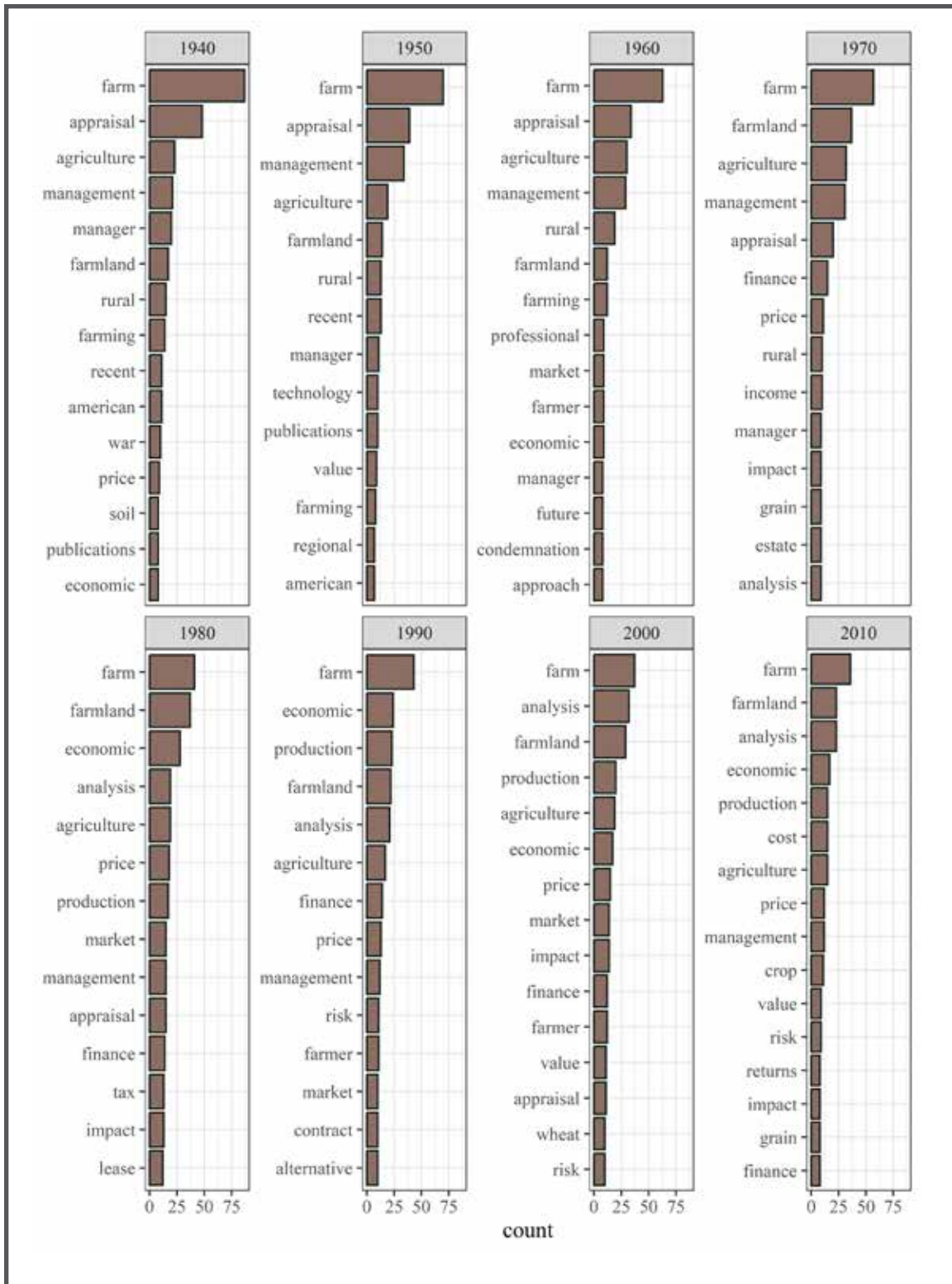


Figure 6. Most common title words by decade

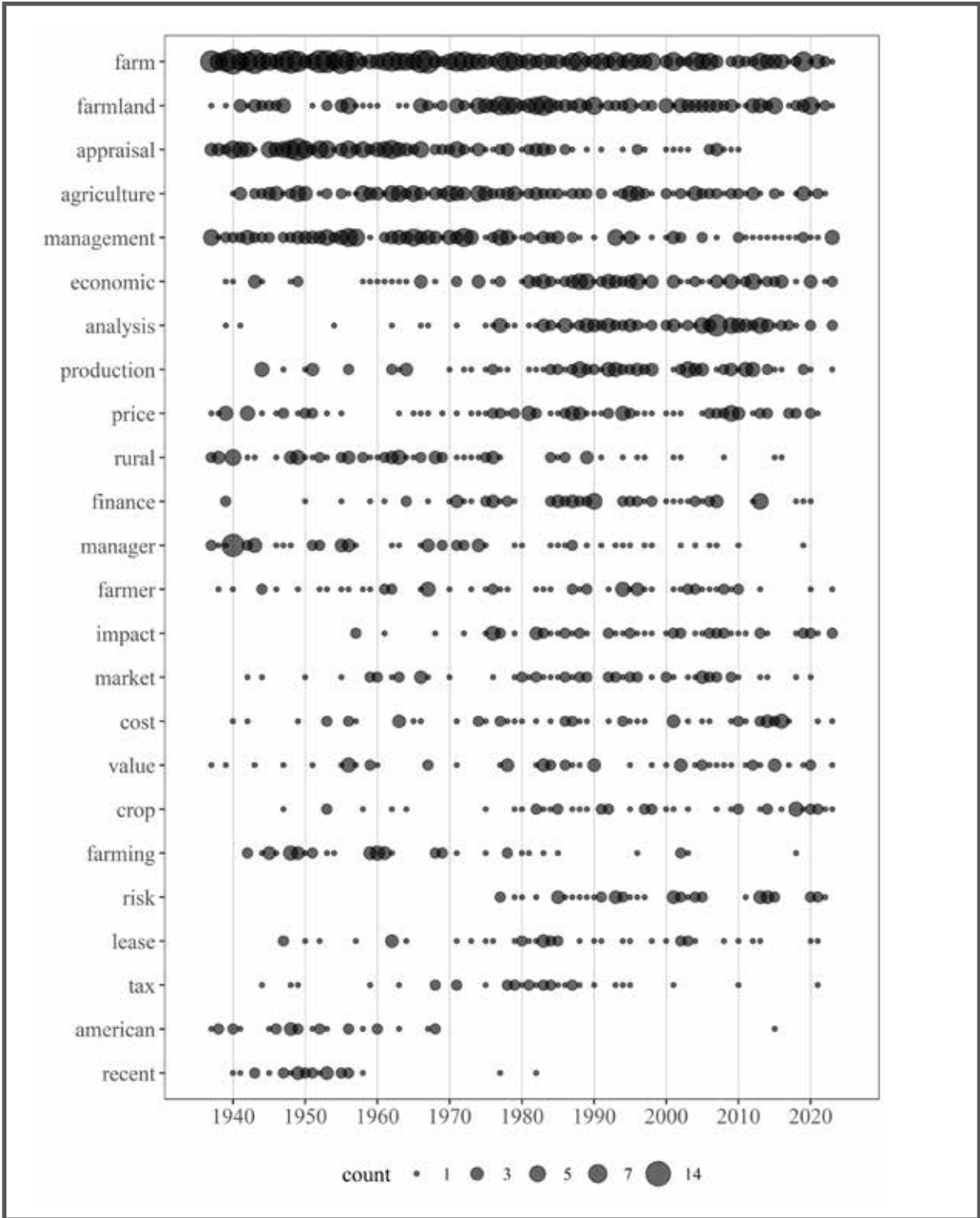


Figure 7. Dispersion of most common title words

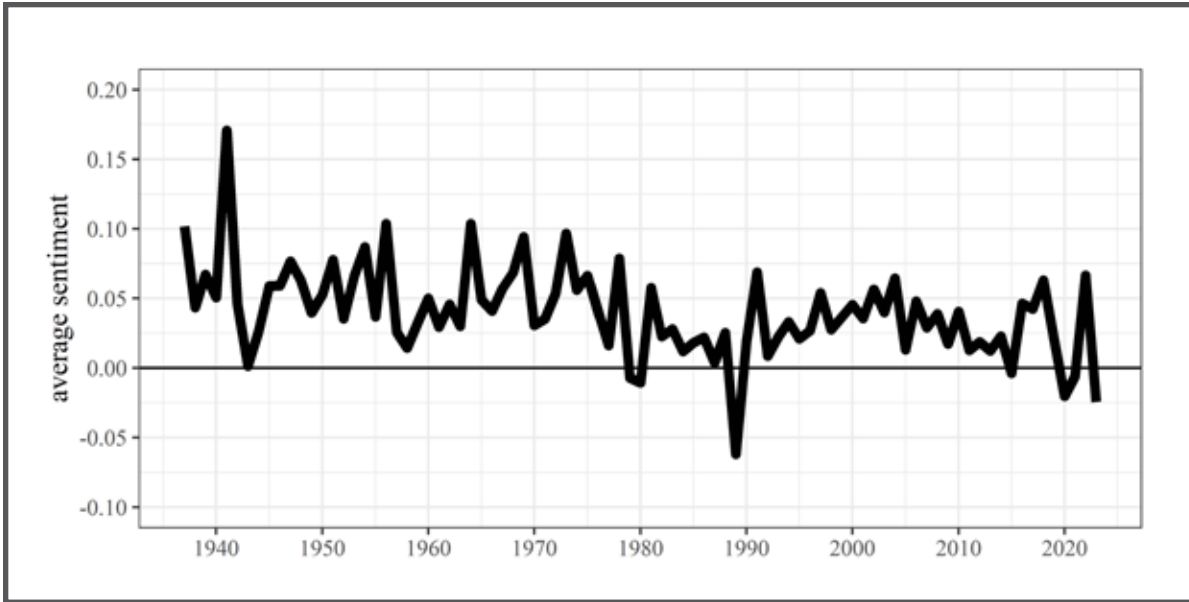


Figure 8. Title word sentiment

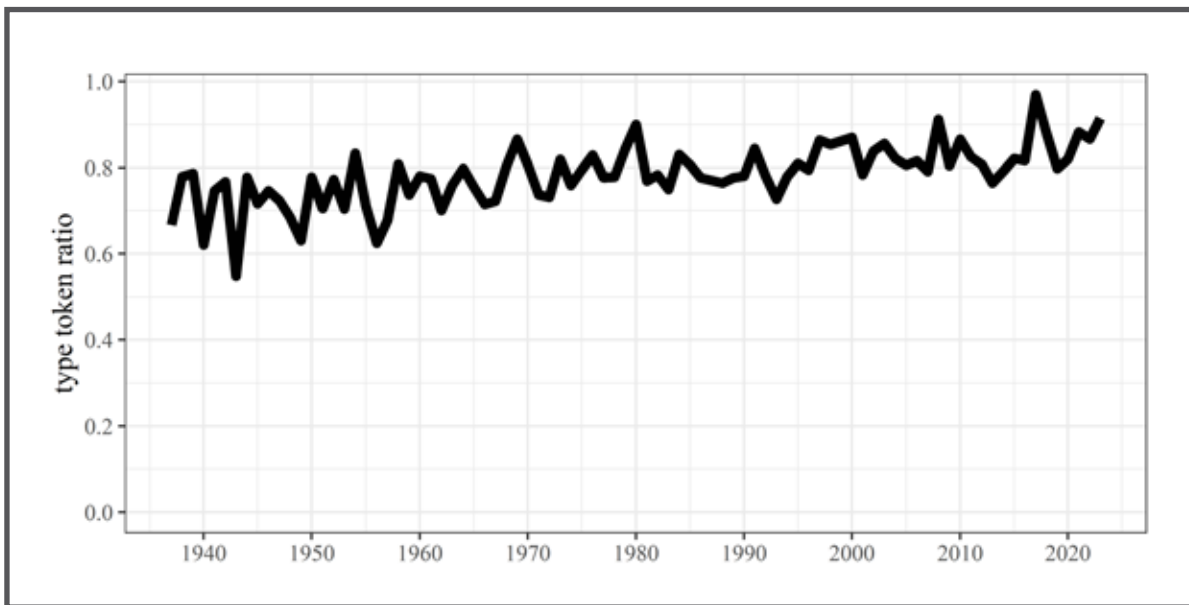


Figure 9. Complexity of title word vocabulary

WASDE Surprises and Futures Prices: What Moves Markets?



By Indira Aitkulova, Emily Balsamo, and Fred Seamon

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Abstract

We examine corn and soybean futures price movements in the periods surrounding the release of the monthly World Agricultural Supply Demand Estimates (WASDE) by the United States Department of Agriculture. Using polling estimations to calculate a degree of “surprise” for each WASDE release, we found statistically significant relationships between U.S. corn and soybean ending stock data and relevant corn and soybean futures intraday price movements post-release, with the nature of correlations changing as time from the release passed. Additionally, directionally correct drift prior to release suggests that we also observed informed trading and/or superior internal research.

INTRODUCTION

The World Agricultural Supply Demand Estimates (WASDE) is a market moving report, a statement evidenced by the robust literature examining its release (Adjemian, 2012; Andersen et al., 2007; Du and Kane, 2019) and by simply observing the price action of corn and soybean futures at 11:00 AM CT on the day of each WASDE release. To examine the report with respect to futures pricing, we use polling and WASDE data going back to 2013, sourced from Reuters, to calculate a degree of “surprise,” or polling error, of relevant WASDE indicators. We first examine patterns in the polling data and surprises, noting that primary WASDE corn and soybean ending stocks polling has not become more or less accurate to each respective day’s release in the last 11 years. It was noted that for some indicators, May and August WASDE surprises demonstrate statistically significant differences from other months, perhaps reflecting the fundamental methodological differences in those reports. We then regressed WASDE surprises against futures pricing at increments of 1 minute, 5 minutes, 30 minutes, and end of the day to note correlations in surprise magnitude and direction with price action, finding directionally intuitive correlations with U.S. new crop corn and soybean ending stock indicators, and correlations changing in nature as time from the WASDE passes. (Throughout our review period, corn and soybean futures markets closed at either 1:15 PM or 1:20 PM, at which time the daily settlement was calculated from a relevant settlement period.) Additionally, we explored those relationships with respect to 11:00 AM and 10:50 AM reference points, finding stronger correlations between surprise magnitude and pricing beginning at 10:50, indicating pre-announcement drift as demonstrated in the literature (Kurov et al., 2014; Bernile, Hu, and Tang, 2014; Andersen et al., 2007). Our research marks a novel contribution to the corpus in two primary ways: we use intraday pricing data to examine immediate effects, and the scope of our research spans from the beginning of the WASDE being released while CME Group corn and soybean futures markets are open.

The WASDE is released by the United States Department of Agriculture (USDA) between the 8th and 12th calendar days each month. The report

contains forecasts for global and domestic supply and use of major commodity crops. The WASDE is a collaborative effort across USDA agencies: domestic field crop data is sourced primarily from the National Agricultural Statistics Service (NASS), the Economic Research Service (ERS) contributes policy and use inputs, and international data is gathered by the Foreign Agricultural Service (FAS). The WASDE is watched closely by industry players and considered a foundational source of regular agricultural market information. Exemplifying the tremendous interest and market-moving potential of the report, the USDA takes great efforts to safeguard the number prior to official release by creating a designated “lock-up” area where windows are sealed, curtains are drawn, and electronic communication is cut off (USDA, 2024). The WASDE has been released at 11:00 AM since January 2013, prior to which it was released at 7:30 AM, during a time of closure for CME Group grains and oilseeds markets. The change from 7:30 AM to 11:00 AM created an opportunity for market participants to trade on the report at the time of its release, resulting in an immediate expression of the report’s information in the form of price discovery.

Prior to each report’s release, estimates of select WASDE indicators are aggregated by market information providers, including Reuters and Bloomberg. There is an assumption among market participants that polling is widely respected and digested by the market prior to release, and thus polling values are “baked in” to relevant market pricing going into the number. Price movement after the release, therefore, would be expected when polling values, which represent market expectation before release, differ significantly from the release values. Moreover, we expect price movement to be directional depending on whether the difference in the actual minus polling numbers represent an expansion or contraction of understood supply or demand, and price movement should be proportional to the degree of new information presented by the release.

The WASDE has been studied extensively. Our research differs from prior research in two significant ways: our research scope begins with the movement of the WASDE release time from 7:30 AM to 11:00 AM and extends into 2024, giving us more than 10 years of data and encapsulates the entire period (to May 2024) during which the WASDE was released in open Chicago Board of Trade (CBOT) grains and oilseeds markets. Notably, the data includes intraday pricing provided directly by the exchange, allowing us to examine the impact of the WASDE immediately post-release and throughout the remainder of the trade date. Relevant prior research was conducted before

2012 (Adjemian, 2012), precluding an examination of immediate market reaction. Without intraday pricing data, other research employs daily returns, resulting in a less nuanced view of the report’s impact.

DATA

This section describes the price and announcement data used in the analysis. Our data is comprised of two distinct data sets: the first, provided by Reuters, contains the date of release, the Reuters polling median, the actual WASDE number, and the prior month’s value. The second set of data is comprised of futures prices surrounding WASDE releases.

WASDE Indicators

WASDE indicators reflect corn and soybean seasonality. In the Midwest, corn and soybeans have only one growing season per year: planting occurs in the spring and harvest in the autumn. After the harvest occurs in September and/or October, corn and soybeans are dried and stored for delivery throughout the calendar year. CME Group corn and soybean futures are physically deliverable, meaning that when a market participant holds open interest into the delivery period for the contract and are matched for delivery, they are obligated to make or take physical delivery of the commodity (Chicago Board of Trade, n.d.). It is physical delivery, or the threat thereof, that tethers these financial products to their underlying physical markets, forcing convergence (Hieronymus, 1977; Fernandes, Kunda, and Robe, 2022).

The listing cycles of CME Group corn and soybean futures reflect the respective crop years of the underlying commodities. Corn is listed for delivery in March, May, July, September, and December; with the latter expiration designated as the beginning of the next new crop year because the supply underlying December corn futures is newly harvested. CBOT soybean futures are listed for January, March, May, July, August, September, and November delivery, with November as the designated first new crop instrument. The WASDE lists new crop and old crop indicators to refer to respective designated marketing years, which span September 1 through August 31 for corn and soybeans.

Not all WASDE releases are created equal. The WASDE releases old crop corn and soybean data only in the months of May through September, with the May report giving the first new crop forecasts for the upcoming crop year, the physical supply of which is at that time, still in the field¹. For example, the May 2023 WASDE released U.S. new crop corn ending

stock and U.S. old crop corn ending stock numbers, with the former referring to an estimation of the ending stocks that will be carried from the upcoming 2023/2024 crop year into the 2024/2025 crop year, and the latter number referring to the ending stocks that will be carried from the 2022/2023 crop year into the 2023/2024 crop year beginning in September 2023. The August WASDE is also of special consideration because the field crop indicators incorporate mid-summer surveys and newly formed yield estimations (Hultman, 2023).

Futures Prices

Our analysis additionally entails intraday pricing of corn and soybean futures listed at the CBOT, a designated contract market within CME Group. Our wider data set includes the opening, high, low, and closing prices for the 10:50, 11:00, 11:05, 11:30 AM minutes, as well as the daily settlement prices and trade volume for all corn and soybean futures instruments traded on WASDE days. This data was supplied directly by CME Group.

Designating Instruments

In choosing which polling results to examine alongside the pricing of which futures instruments, we sought to accurately align physical supply. Table 1 shows which WASDE indicators were examined with respect to the pricing for which futures instrument for data falling in the calendar year 2023, with all other years following analogous seasonal patterns. Yield and output were examined as new crop instruments.

METHODOLOGY

Our research seeks to examine the relationship between WASDE polling, the WASDE release, and futures pricing from a variety of angles. First, we examine trends in our polling data to determine whether polling is becoming more or less accurate, or if polling skews more bullish or bearish (meaning whether pollsters are more likely to overestimate or underestimate supply, respectively). We seek to identify monthly, seasonal, or annual patterns in polling errors, to examine the relationship between polling errors and futures prices in 1-minute, 5-minute, 30-minute, and daily increments, and to observe the existence of directionally accurate price drift prior to release, as has been noted by prior research. Finally, we seek to identify whether the relationship between polling errors and price movements demonstrates monthly, seasonal, annual, or continuous patterns.

To determine the surprises, we borrow methodology from (Bernile, Hu, and Tang, 2014) and (Kurov et al., 2014), who studied directionally accurate price drift preceding macroeconomic releases. Central to our analysis is the concept of the z-score², which indicates how far a data point is from the average of its group. A z-score of zero tells us that the number is equivalent to the average of its group, while a z-score of 1 indicates that the value is one standard deviation above the average and z-score of -1 indicates that the value is one standard deviation below the average. To examine the relationship between surprises over time, as well as between surprises and price movement, we employed linear regression analysis.

The U.S. corn and soybean ending stock indicators were the primary subject of analysis, due to the availability of ending stock polling data each calendar month. Moreover, we believe that ending stocks, which function as a net of both supply and demand, contain more information than yield or output alone, though it was observed that for months offering yield and output polling, those surprises were on average more strongly correlated with ending stock surprises.

RESULTS

Figure 1 shows that the z-scores of the surprises for the four Reuters polls denoting U.S. corn and soybean ending stocks are approximately normally distributed. Between 2013 and 2024, the polling median was equal to actual WASDE estimate 28 times, constituting zero surprise. We performed a t-test to determine whether the difference between the number of bearish and bullish surprises across years is statistically significant, and with a p-value of 0.208, we cannot observe statistically significant difference between the frequency of bearish vs. bullish surprises. The total number of bearish surprises (actual - polling > 0, experts underestimating) is 187 and of bullish surprises (experts overestimating) is 163.

For the Reuters poll estimating U.S. new crop corn ending stocks, the standard deviation of polling errors is equivalent to 110 million bushels, meaning that roughly 68% of polling medians fall within +/- 110 million bushels of the reported WASDE U.S. new crop corn ending stocks number. Between the four indicators, old crop polling is associated with lower standard deviations of errors than new crop polling, suggesting greater accuracy of old crop polling. The Reuters poll with the greatest standard deviation of surprise was for U.S. new crop soybean ending stocks, with a standard deviation of polling errors of 10% of the total number, or 40 million bushels.

We observed polling accuracy as indicated by the standard deviation of polling surprise. Both U.S. new crop corn and soybean ending stocks show the widest ranges and highest median standard deviations in May and August, while patterns are less observable for old crop indicators. This is intuitive because the May WASDE provides the first annual estimations for the upcoming new crop year, and the August WASDE incorporates novel inputs to the statistical evaluation of the number, likely making polling accuracy more challenging for those two months.

The Effect of WASDE Surprises on Futures Prices

All four of the ending stock indicators show negative and statistically significant correlations when regressing standardized surprise against price movement of the respective assigned futures instruments (see Table 3). While the group of all U.S. new and old crop corn and soybean ending stocks showed a negative and statistically significant correlation when regressed against their designated futures, correlation results are stronger when indicators are examined individually. In both views, there is a pattern of the coefficient of standardized surprise increasing as time from the release passes, while the R2 coefficient, which indicates the percent of variation attributable to the linear correlation model, decreases. U.S. new crop corn ending stock surprises demonstrate a stronger correlation (indicated by a higher R2) with corn futures prices than U.S. new crop soybean ending stock surprises do with their respective futures. Table 4 results compare the last reported futures prices during the 11:00, 11:05, 11:30 AM, and closing minutes compared to the opening 10:50 and 11:00 AM prices.

In each of the tables, the coefficient of standardized surprise, which indicates the slope of the trendline between the dependent (each price move) and independent variables (standardized surprise), has the lowest absolute value at 11:01 and increases in absolute value from 11:05, 11:30, and to the daily settlement. The coefficient of determination R2, however, demonstrates a pattern of lessening value as the dependent variable covers an increasingly wide period. A strengthening coefficient of standardized surprise as time from the release passes suggests that the effect of the WASDE surprise on futures prices is the strongest in absolute price change at the daily close, suggesting that the WASDE contains fundamental information that the market digests throughout the remainder of the trading day. As the trading day progresses and the market digests other more material information, however, the standardized

WASDE surprise accounts for a diminishing percent of price variation, signified by a lessening R2 value. For both U.S. new crop corn and soybean ending stocks, the coefficients of standardized surprise and determination are stronger when examining price action in comparison to 10:50 rather than to 11:00 AM, indicating the presence of directionally correct pre-release price drift. Additional analysis was done to examine the role that prior WASDE reports play in the price movement post-release, finding no independent correlation with polling surprise. Nor was statistical significance determined to be associated with the direction of surprise, suggesting that bullish and bearish surprises are associated with roughly equal and opposite price movement.

INTERPRETATION OF RESULTS

After completing this work, we have a several takeaways.

- *U.S. corn and soybean ending stocks surprises are statistically significantly correlated with futures price movement. The relationship is stronger for corn than for soybeans.*

This observation is intuitive and corroborated by trade press, which commonly cite corn and soybean futures price movement as attributable to WASDE ending stocks indicators. These indicators serve as foundational information about the nation's commodity supply while additionally carrying information about demand. The relative strength of the relationship in corn could be attributable to the greater trade volume, suggesting a more responsive market. Figure 3 shows the average corn and soybean futures Globex trading volume for the instruments detailed in Table 2's WASDE release dates (Globex volume comprises all electronic volume excluding block trades).

- *WASDE ending stock surprises correlate most strongly with futures price movement benchmarked at 10:50 (10 minutes prior to release) compared to the 11:00 AM opening price, demonstrating directionally correct price drift prior to release.*

Price drift aligning in direction with post-release price movement has been observed in the literature across economic releases not limited to the WASDE (Kurov et al., 2014). Kurov, Sancetta, and Strasser discuss information leakage and superior internal research as potential sources of drift.

- *Between the four WASDE U.S. ending stocks indicators, old crop polling is associated with lower standard deviations of errors than new crop polling.*

U.S. old crop ending stocks polling is more accurate than U.S. new crop ending stocks polling. This observation aligns with our intuitive understanding of crop years, as old crop ending stocks should be readily observable because they physically exist at the time of WASDE release. The numbers in the WASDE indicating U.S. new crop ending stocks, conversely, for May through October, refer to predictions of the nation's commodity stocks. After October, U.S. new crop ending stocks should intuitively still be more difficult to estimate than old crop ending stocks because new crop ending stocks are more less established than their old crop counterparts in WASDE months where both are listed.

- *For regressions examining U.S. new crop corn and soybean ending stocks on futures price movement, the absolute value of the coefficient of standardized surprise increases and the R2 coefficient decrease as the dependent variable is associated with price movement over a longer period.*

When examining the relationship between U.S. new crop corn and soybean ending stocks surprise and price movement, the slope of the regression line (indicated by the coefficient of standardized surprise) is flattest when the post-release window is shortest, and the slope of the regression line is steepest when the post-release window extends to the daily settlement period. At the same time, the coefficient of determination R2 weakens over this period, suggesting that the model has less explanatory power as time from the release passes. This relationship is interesting and intuitive, as the WASDE carries fundamental information that is digested through the day. While at the same time, new information is presented throughout the trade date post-release, weakening the explanatory power of the model on price variation.

- *Change from the prior month's WASDE ending stocks estimate demonstrates an even stronger relationship with corn and soybean futures prices than does polling surprise. Change from the prior month and polling surprise are strongly correlated with one another.*

With the exception of May, which represents the first estimates of the new crop year, each WASDE ending stocks estimate is an update of information from the prior month. For example, the U.S. old crop corn ending stocks number released in the July WASDE is an estimation of the nation's resting corn supply and refers to the same physical supply of corn reported by U.S. old crop corn ending stocks in the WASDE from the prior month (June). In July, the U.S. new crop corn ending stocks number is a projection of the nation's supply in the upcoming crop year, updated with new information from the prior month's estimate. The observed relationships between prior reports, report surprise, and price movement suggest that the prior month's estimate is a major input to polling and therefore cannot be observed as a second independent variable paired with polling surprise. The stronger relationship between the surprise and prior report for soybeans indicates that polling might be more based on the prior number than for corn, which is treated with more accurate polling (discussed above).

- *May and August WASDE polling demonstrates statistically significant difference from other months, across corn and soybean new crop ending stock indicators.*

This observation speaks to the novel information presented in the May and August WASDEs, which make these reports more difficult to accurately predict. May is the first estimation of the new crop year and thus has no prior number reporting on the same physical supply. August includes new survey and yield data and thus differs fundamentally from its prior month. As discussed above, the prior release is a major input to polling, and in May and August, novel methodology makes the prior release is less useful as an input.

CONCLUSION

Traders respond to new information (Kyle, 1985), and the WASDE is one of the most meaningful media in agricultural economics. The results of this paper demonstrate a correlation between the extent to which WASDE corn and soybean ending stock numbers defy expectations (expressed as standardized surprise) and futures price movement in relevant instruments in the periods post- (and pre-) release.

This paper discusses the relationship between futures prices and WASDE U.S. old and new crop corn and soybean ending stock indicators only. Correlations

between WASDE corn and soybean yield and output and futures pricing were examined, and in some cases, coefficients of correlation between these indicators and futures prices were stronger than with ending stock surprises. Yield and output indicators, however, are released only seasonally and therefore were not primary subjects of analysis. Yield and output were not considered in multivariate regression to complement ending stocks due to collinearity. Further research could delve into the relationship between ending stocks, yield, and output to best determine market response to the WASDE report.

Only U.S. WASDE indicators were considered in this analysis, however the WASDE releases additional ending stock numbers for Brazil, Argentina, and the world. Further analysis could examine the effect of international indicators on corn and soybean futures pricing.

Finally, a benchmark time of 10:50 AM (10 minutes prior to release) was chosen to capture drift prior to the WASDE release while considering minimal extraneous information, as determined by Anderson et al. (2007). Kurov, Sancetta, and Strasser (2014), however, found a pre-release window of 30 minutes to be optimal. Both Anderson et al. and Kurov et al. utilize pricing data more than 10 years old, and thus new research with a focus on drift prior to release should be a welcome addition to the corpus.

FOOTNOTES

1 Estimates for a particular crop year are covered in 17 consecutive WASDE reports. A crop year becomes new crop in May and is reported as new crop through April of the next year (13 reports), at which point it becomes reported as old crop from May through September (five reports).

2

$$(1) \quad \text{Surprise} = \text{Actual WASDE estimate} - \text{Polling Median}$$

$$(2) \quad \text{Each surprise is standardized: } \text{Standardized Surprise} = \frac{\text{Surprise}}{\text{st dev}(\text{Surprise}_{RIC})}$$

For statistical purposes, z-score of each surprise is also calculated:

$$(3) \quad z\text{-score} = \frac{\text{Surprise} - \text{average}(\text{Surprise}_{RIC})}{\text{st dev}(\text{Surprise}_{RIC})}$$

Following this logic, a one-unit change in standardized surprise is a one standard deviation degree of polling error with respect to the actual WASDE estimate.

Additionally, when examining the relationship between price movement on WASDE releases and the prior report, we created a similar variable to show the relative magnitude that a WASDE report differs from the prior month.²

$$(4) \quad \text{DIFF_ACT_PREV} = \text{Actual WASDE estimate} - \text{prior month's WASDE estimate}$$

$$(5) \quad \text{Or } \text{PREVIOUS}_{RIC,t} = \text{ACTUAL}_{RIC,t-1}$$

$$(6) \quad \text{Each surprise is standardized: } \text{DIFF_ACT_PREV} = \frac{\text{DIFF_ACT_PREV}}{\text{st dev}(\text{DIFF_ACT_PREV}_{RIC})}$$

For statistical purposes, z-score of each surprise is also calculated:

$$(7) \quad \text{ZSCORE_DIFF_ACT_PREV}_{RIC,t} = \frac{(\text{ACTUAL}_{RIC,t} - \text{PREVIOUS}_{RIC,t}) - \text{avg}(\text{ACTUAL}_{RIC} - \text{PREVIOUS}_{RIC})}{\text{st.dev}(\text{ACTUAL}_{RIC} - \text{PREVIOUS}_{RIC})}$$

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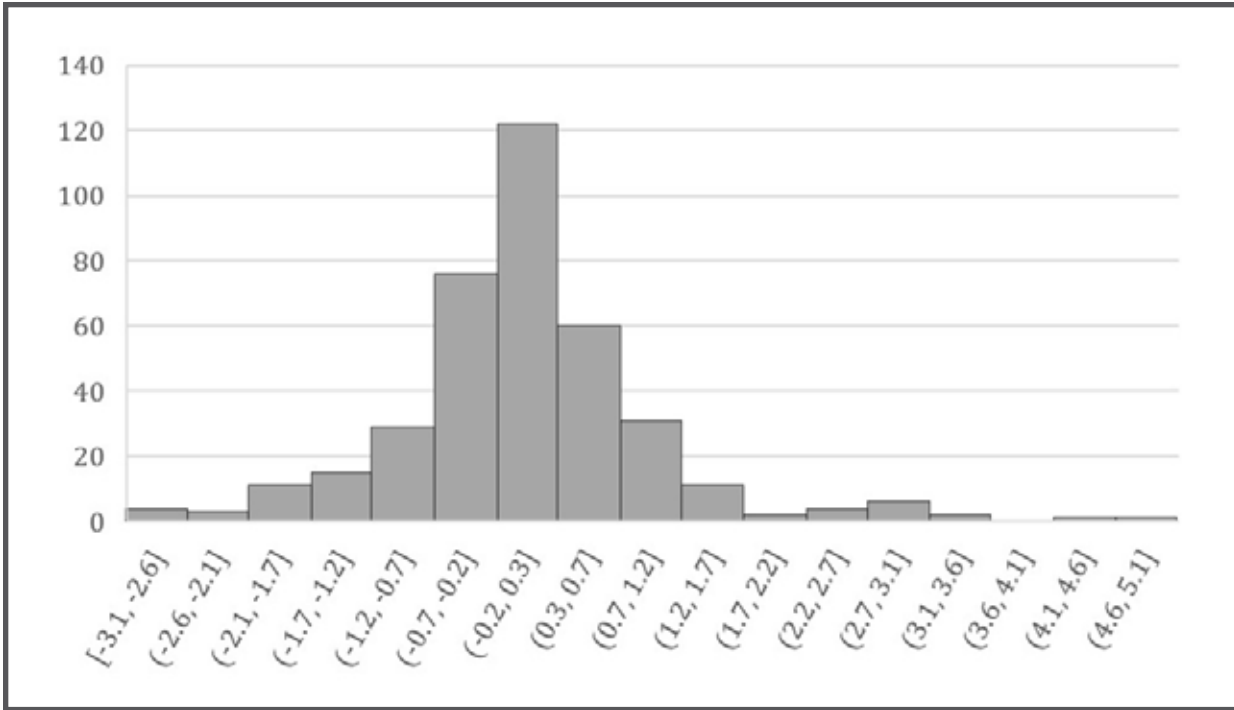


Figure 1. Frequency histogram of surprise z-scores

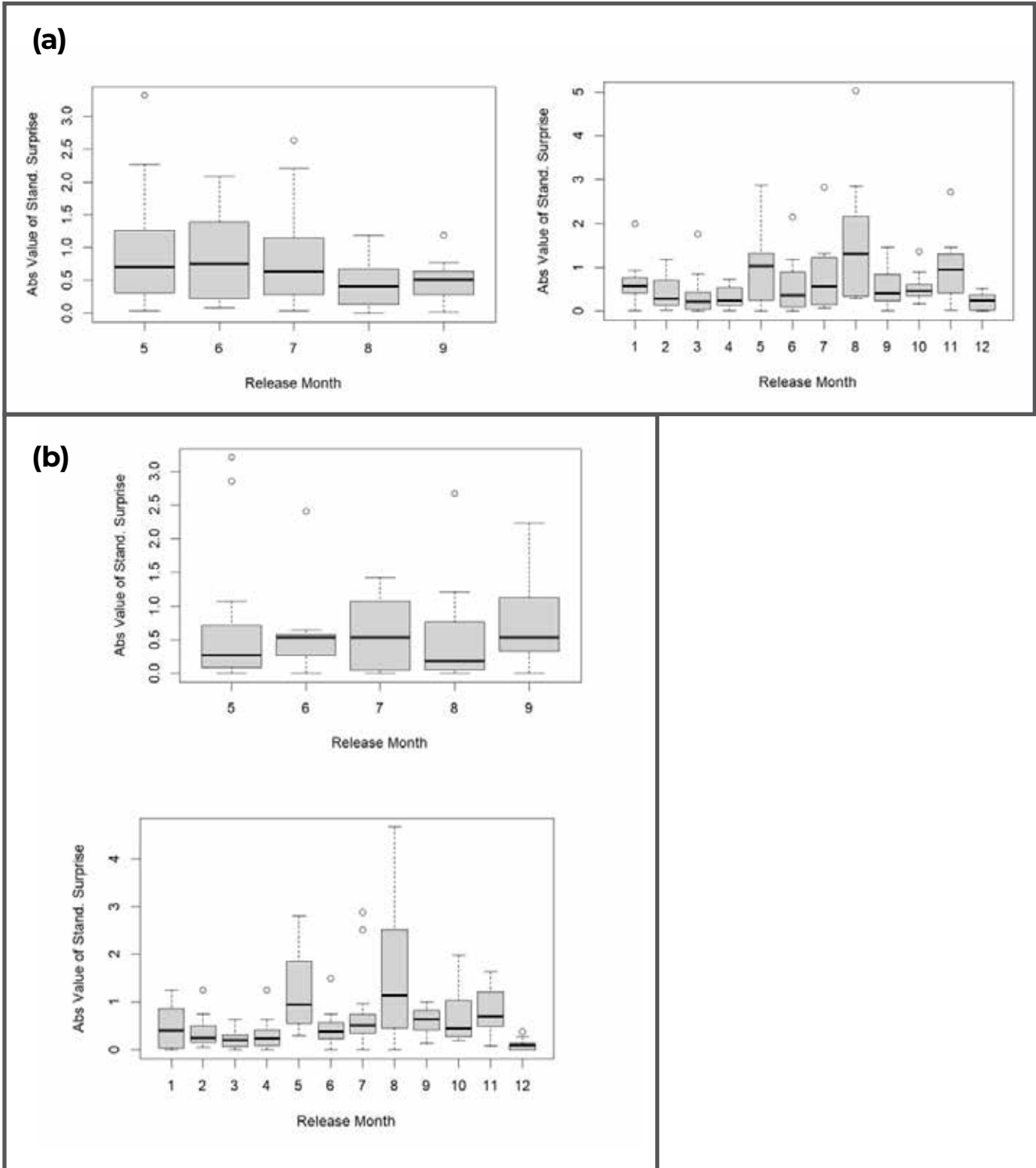


Figure 2. Standardized surprise across WASDE release months: (a) corn ending stocks and (b) soybean ending stocks

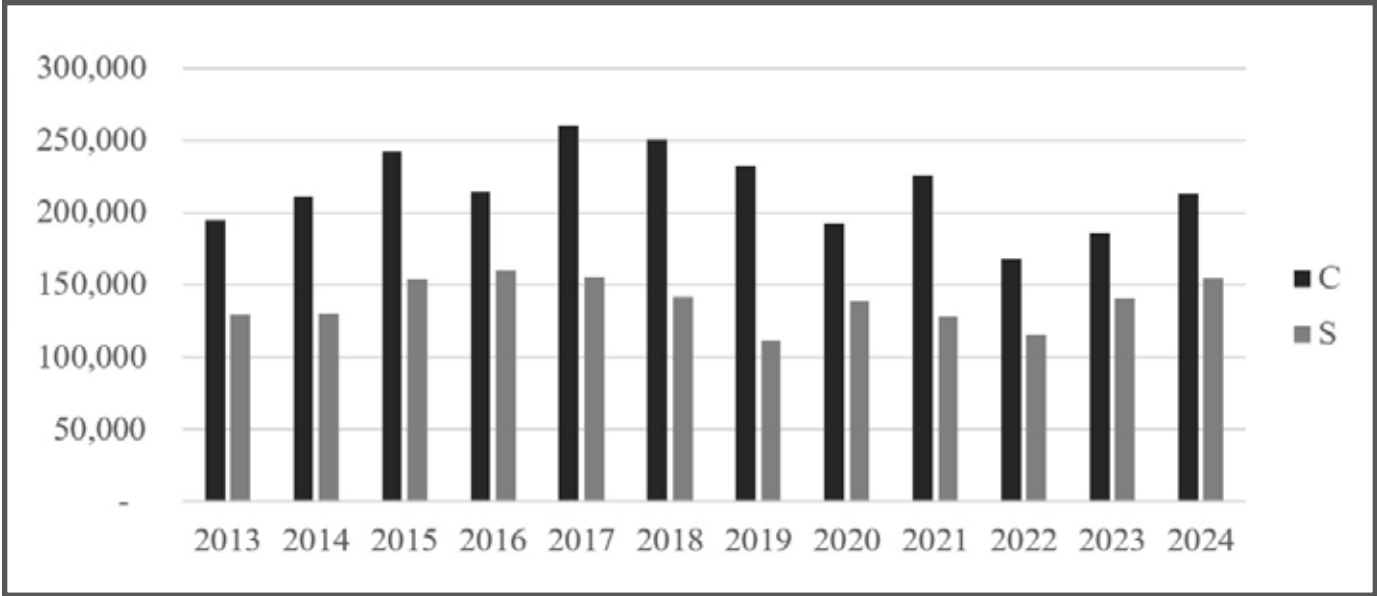


Figure 3. Average corn and soybean futures volume on WASDE days (selected instruments; January 2013 through May 2024)

Table 1. WASDE Months and Corresponding Futures Instruments, 2023

Month of WASDE Release	U.S. Old Crop Corn (Marketing Year 22/23)	U.S. New Crop Corn (Marketing Year 23/24)	U.S. Old Crop Soybeans (Marketing Year 22/23)	U.S. New Crop Soybeans (Marketing Year 23/24)
January 2023		March 2023 corn futures		March 2023 soybean futures
February 2023		March 2023 corn futures		March 2023 soybean futures
March 2023		May 2023 corn futures		May 2023 soybean futures
April 2023		May 2023 corn futures		May 2023 soybean futures
May 2023	July 2023 corn futures	December 2023 corn futures	July 2023 soybean futures	November 2023 soybean futures
June 2023	July 2023 corn futures	December 2023 corn futures	July 2023 soybean futures	November 2023 soybean futures
July 2023	September 2023 corn futures	December 2023 corn futures	August 2023 soybean futures	November 2023 soybean futures
August 2023	September 2023 corn futures	December 2023 corn futures	September 2023 soybean futures	November 2023 soybean futures
September 2023	December 2023 corn futures	December 2023 corn futures	November 2023 soybean futures	November 2023 soybean futures
October 2023		December 2023 corn futures		November 2023 soybean futures
November 2023		December 2023 corn futures		January 2024 soybean futures
December 2023		March 2025 corn futures		January 2024 soybean futures

Table 2. Summary Statistics of U.S. Ending Stock Polls

Description	ST DEV (Bushels)	ST DEV (PCT)	ABS(AVG Stand. Surprise) (Std devs)	ABS(AVG Stand. Surprise) (Bushels)	Observations
U.S. old crop corn ending stocks	50 M	3%	0.73	36.5 M	56
U.S. new crop corn ending stocks	110 M	6%	0.66	72.6 M	134
U.S. old crop soybean ending stocks	28 M	7%	0.64	17.92 M	56
U.S. new crop soybean ending stocks	40 M	10%	0.65	26 M	132

Table 3. Regression Results

(a) U.S. New and Old Crop Corn and Soybean Ending Stocks vs. Futures Pricing

	Last price at time compared to first price at 10:50 <i>Dependent variable:</i>				Last price at time compared to first price at 11:00 <i>Dependent variable:</i>			
	11:00	11:05	11:30	Daily close	11:00	11:05	11:30	Daily close
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Standard surprise	-0.034*** -0.004	-0.037*** -0.005	-0.039*** -0.006	-0.041*** -0.007	-0.031*** -0.004	-0.034*** -0.005	-0.036*** -0.006	-0.038*** -0.007
Constant	-0.007* -0.004	-0.0001 -0.005	-0.003 -0.006	0.002 -0.007	-0.010** -0.004	-0.003 -0.005	-0.006 -0.006	-0.0002 -0.007
Observations	378	378	378	378	378	378	378	378
R2	0.147	0.128	0.102	0.087	0.117	0.109	0.086	0.075
Adjusted R2	0.144	0.126	0.1	0.084	0.115	0.107	0.083	0.073
Residual Std. Error (df = 376)	0.082	0.096	0.116	0.134	0.085	0.097	0.118	0.135
F Statistic (df = 1; 376)	64.603***	55.379***	42.840***	35.627***	49.957***	46.163***	35.250***	30.534***
Note: *p**p***p<0.01					*p**p***p<0.01			

(b) U.S. New Crop Corn Ending Stocks vs. Futures Pricing

	Last price at time compared to first price at 10:50 <i>Dependent variable:</i>				Last price at time compared to first price at 11:00 <i>Dependent variable:</i>			
	11:00	11:05	11:30	Daily close	11:00	11:05	11:30	Daily close
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Standard Surprise	-0.037*** -0.004	-0.039*** -0.005	-0.040*** -0.006	-0.041*** -0.006	-0.036*** -0.004	-0.039*** -0.005	-0.039*** -0.006	-0.041*** -0.007
Constant	0.003 -0.004	0.009* -0.005	0.007 -0.006	0.009 -0.006	0.003 -0.004	0.009* -0.005	0.007 -0.006	0.009 -0.007
Observations	134	134	134	134	134	134	134	134
R2	0.407	0.333	0.271	0.24	0.38	0.317	0.256	0.223
Adjusted R2	0.403	0.328	0.266	0.234	0.375	0.312	0.25	0.217
Residual Std. Error (df = 132)	0.044	0.056	0.066	0.074	0.046	0.057	0.067	0.077
F Statistic (df = 1; 132)	90.696***	65.988***	49.127***	41.732***	80.908***	61.178***	45.407***	37.903***
Note: *p**p***p<0.01					*p**p***p<0.01			

(c) U.S. New Crop Soybean Ending Stocks vs. Futures Pricing

	Last price at time compared to first price at 10:50 <i>Dependent variable:</i>				Last price at time compared to first price at 11:00 <i>Dependent variable:</i>			
	11:00	11:05	11:30	Daily close	11:00	11:05	11:30	Daily close
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Standard Surprise	-0.060*** -0.008	-0.065*** -0.009	-0.077*** -0.011	-0.078*** -0.013	-0.058*** -0.008	-0.063*** -0.009	-0.075*** -0.011	-0.076*** -0.013
Constant	-0.002 -0.008	0.004 -0.009	0.005 -0.011	0.013 -0.013	-0.006 -0.008	0.001 -0.009	0.002 -0.011	0.009 -0.013
Observations	132	132	132	132	132	132	132	132
R2	0.329	0.302	0.284	0.217	0.284	0.279	0.258	0.203
Adjusted R2	0.324	0.296	0.279	0.211	0.279	0.274	0.252	0.197
Residual Std. Error (df = 130)	0.087	0.1	0.123	0.149	0.092	0.102	0.128	0.15
F Statistic (df = 1; 130)	63.657***	56.140***	51.659***	35.961***	51.630***	50.366***	45.167***	33.208***
Note: *p**p***p<0.01					*p**p***p<0.01			

The Impacts of Non-local Buyers on Farmland Market in Alabama



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Abstract

Previous studies show that non-local buyers typically pay a price premium for farmland but most adopt a simple dummy variable to measure buyers' non-locality, which neglects the heterogeneity among non-local buyers. Utilizing a parcel-level farmland transaction dataset, we construct a distance-based variable to measure buyers' non-locality, using multiple regression to investigate their impacts on farmland market. Our results indicate that an additional 1% buyer-to-parcel distance can lead to farmland price increase by 4.3%, suggesting that buyers located farther away typically pay more for land. It is probably because they face greater

asymmetric information and possess more limited local market knowledge.

INTRODUCTION

As the most important asset of the farm family, farmland plays a critical role in food production and supply (Wang et al., 2024). Farmland value also has a strong influence on the agricultural economy (Thomas et al., 2024), with fluctuations in farmland market values closely related to the interest of agricultural producers, lenders, and other investors (Taylor et al., 2020). While a large body of literature reveals that farmland values are mainly determined by their attributes, such as productivity, transportation conditions, and urbanization pressures (Kueth et al., 2011; Sheng et al., 2018; Huang et al., 2006), increasing attention has been directed to the role of non-local investors in farmland markets.

Some previous literature suggests that non-local or non-farmer investors must pay higher prices for farmland because of a higher degree of asymmetric information. Compared with local buyers, they are typically less familiar with local market conditions, the land's quality, and potential profitability. For example, Seifert et al. (2021) investigated the price dispersion of farmland in eastern Germany, indicating that tenant farmers pay less for farmland because of a lower degree of asymmetric information. In contrast, professional and public sellers achieve higher prices because of lower search and information costs. Similarly, Kahle et al. (2019) found that tenant farmers can achieve lower transaction prices because of their informational strength. Taylor et al. (2023) also drew similar conclusions when investigating farmland price differences between foreign and domestic buyers in 11 Midwestern states. They found that foreign buyers pay a 13.7% premium for agricultural land over domestic buyers.

However, asymmetric information is not always the only explanation regarding the price difference among different types of farmland buyers, for example, the bid-rent theory is another common mechanism—

Vyn and Shang (2021) found that non-farmer buyers typically pay a price premium for farmland, but such a price discrepancy only occurs in near-urban areas. They suggested that non-farmer buyers put more value on farmland's development potential and are thus willing to pay higher prices, while farmers only focus on agricultural-related characteristics, leading to a lower willingness to pay "extra."

That said, some studies do not support the argument that non-local buyers pay more than locals, for example, Shultz (2007) reached different conclusions, suggesting that non-local buyers do not pay a price premium for hunting land in areas dominated by waterfowl hunting, but they do pay a significant premium for farmland in regions dominated by pheasant hunting. The apparent price premium exists solely because of outlier observations, indicating that the impacts of non-local buyers on farmland prices are heterogeneous across regions.

Some studies indicate that the influx of non-local investors will ultimately lead to local farmland prices increasing, e.g., Curtiss et al. (2021) used a stochastic metafrontier approach to evaluate the impacts of investors on the farmland market in the Czech Republic, indicated that the entry of non-agricultural investors raised prices, forcing local agricultural buyers to adjust their bidding strategies before the market ultimately converged toward the prices set by investors.

Most of the existing research utilizes a binary variable to measure non-local buyer effects that fail to capture the diversity of the distance from which non-local buyers are located vs. parcels. For example, it is possible that out-of-state buyers bear a higher degree of asymmetric information than buyers from nearby counties. Furthermore, prior studies treat farmland as a homogeneous asset and neglect the fact that its characteristics and price determinants are very different across different land use patterns, e.g., the investment cost and profitability of pastureland is typically lower than cropland.

To address this knowledge gap, we therefore construct a distance-based variable, measured by the actual distance between the property and buyers' mailing addresses, to evaluate the impacts of non-local buyers on farmland prices. We also separate our sample into cropland and pastureland to observe the potential heterogeneity across land classifications.

The goal of this study is to investigate the following research questions: Do non-local buyers pay higher prices for farmland in Alabama? And, if so, do such

effects differ between cropland and pastureland? To achieve our objectives, we use a unique parcel-level transaction dataset provided by CoreLogic, incorporated with county-level population variables provided by the Bureau of Economic Analysis (BEA). Using a hedonic price method, we employ multiple regression models to assess the presence and magnitude of a non-local price premium.

DATA AND VARIABLES

Our primary source of data comes from CoreLogic, a real estate data provider that is widely used in agricultural and urban economics literature (e.g., Won et al., 2025). The dataset contains parcel-level farmland transaction records across 33 counties in Alabama during the period of 2001-2023. Even though a great portion of land in Alabama is categorized as timberland, we limit the analysis to cropland and pastureland because the price determinants of timberland are highly different from other types of agricultural land. Moreover, timberland parcels with hunting and recreational potential are often purchased by non-local, especially urban, investors, leading to higher transaction prices. After excluding records with obvious errors and missing values, we retain 15,335 observations, including 9,441 cropland transactions and 5,894 pastureland transactions.

Our dependent variable is the natural logarithm of the per-acre transaction price. As for our core explanatory variables, we first construct distance-based variables to measure farmland buyers' locality. Because CoreLogic provides the information for buyers' mailing addresses, where buyers include both individual and corporate purchasers, we use ArcGIS to convert addresses to longitudes and latitudes, then calculate the great-circle distance between buyers' addresses and the parcel they purchased.

As for other control variables, parcel size and its squared term are included, which allows us to observe the non-linear relationship between parcel size and farmland price. We expect that this relationship is nonlinear because larger parcels typically sell for a lower unit price due to the smaller pool of potential buyers, but such a discount diminishes as size increases (Thomas et al., 2024). We also control two transaction-specific variables, cash purchase and short sale indicators, as both are expected to negatively influence farmland transaction prices. Cropland is our baseline group because we expect the price of pastureland to be relatively lower than cropland. Although buyer characteristics such as farmer versus non-farmer and absentee versus resident ownership

are often viewed as important determinants of farmland prices, data limitations prevent us from incorporating these variables into our model.

Our dataset provides detailed information about parcel attributes such as land use types, parcel size, and other transaction-specific indicators including whether the sale was a short sale or a cash purchase. Considering the potential impacts of other socioeconomic conditions, we incorporate county-level population data provided by BEA, which can serve as a proxy of farmland's optional value. Even though our dataset provides information regarding the types of buyers, we do not incorporate them to maintain a clear focus on non-local buyers.

Table 1 provides the definitions of variables used in our empirical analysis, and Table 2 introduces the overall summary statistics for these variables. To provide a preliminary understanding of the sample distribution, we further divide the sample into transactions by cropland versus pastureland. The land use categories are based on the classification provided by CoreLogic, and the results clearly show that cropland parcels are typically bigger than pastureland parcels—specifically, the average cropland size is 48.2 acres, while pastureland averages 39.95 acres. Also, buyers of cropland tend to live farther away than buyers of pastureland, with the mean distance between a cropland parcel and the buyer's mailing address being 69.47 miles, compared with only 51.81 miles for pastureland. Furthermore, it is apparent that cropland is located in more urban areas than pastureland.

EMPIRICAL MODEL

Our empirical analysis is based on a hedonic price model developed by Rosen (1974). We first use log-log specifications to evaluate the impacts of non-local buyers on farmland prices as in the following equation:

$$(1) \quad \ln(P_{ict}) = \beta_0 + \beta_1 \ln(\text{Distance}_{ict}) + \beta_2 \text{Acres}_{ict} + \beta_3 \text{Acres}_{ict}^2 + \beta_4 \text{CashPurchase}_{ict} \\ + \beta_5 \text{ShortSale}_{ict} + \beta_6 \text{Population}_{ct} + \beta_7 \text{DistToWaterbody}_{ict} \\ + \beta_8 \text{DistToBigCities}_{ict} + \rho_t + \tau_c + \varepsilon_{ict}$$

where $\ln(P_{ict})$ is our dependent variable, the natural log form of the per-acre transaction price for parcel i in county c and year t . $\ln(\text{Distance}_{ict})$ is our core explanatory variable, the log form of the great-circle distance between the buyer's mailing address and the parcel centroid, allowing to be interpreted as

an elasticity. We also control a series of transaction-specific and farmland characteristics, such as size, the squared term of size, short sale indicator, and cash purchase indicator. Additionally, we control county-level population. We use county fixed effects to control unobservable time-invariant variables such as soil quality and topographic conditions, and we also control year fixed effect pt to capture time-varying unobservable factors that can affect all transacted farmland such as macroeconomic environment; β_0 is the intercept term, and ε_{ict} is the idiosyncratic error term.

Additionally, we use log-linear form to estimate the relationship between buyer-to-parcel distance and farmland prices:

$$(2) \quad \ln(P_{ict}) = \beta_0 + \beta_1 \text{Distance}_{ict} + \beta_2 \text{Acres}_{ict} + \beta_3 \text{Acres}_{ict}^2 + \beta_4 \text{CashPurchase}_{ict} \\ + \beta_5 \text{ShortSale}_{ict} + \beta_6 \text{Population}_{ct} + \beta_7 \text{DistToWaterbody}_{ict} \\ + \beta_8 \text{DistToBigCities}_{ict} + \rho_t + \tau_c + \varepsilon_{ict}$$

where β_1 should be explained as a semi-elastic effect.

Apart from that, we utilize dummy variables to estimate whether in-state/out-of-county and out-of-state buyers pay more than local buyers:

$$(3) \quad \ln(P_{ict}) = \beta_0 + \beta_1 \ln(\text{Distance}_{ict}) + \beta_2 \text{InStateOutOfCounty}_{ict} \\ + \beta_3 \text{OutOfState}_{ict} + \beta_4 \text{Acres}_{ict} + \beta_5 \text{Acres}_{ict}^2 \\ + \beta_6 \text{CashPurchase}_{ict} + \beta_7 \text{ShortSale}_{ict} + \beta_8 \text{Population}_{ct} \\ + \beta_9 \text{DistToWaterbody}_{ict} + \beta_{10} \text{DistToBigCities}_{ict} + \rho_t + \tau_c \\ + \varepsilon_{ict}$$

where $\text{InStateOutOfCounty}_{ict}$ is a dummy variable equal to 1 if the buyer resides in-state/outside the county in which parcel i is located, 0 otherwise. OutOfState_{ict} is a dummy variable equal to 1 if the buyer resides outside the state of Alabama, 0 otherwise.

RESULTS AND DISCUSSION

We first present the distribution of farmland transactions by local and non-local buyers in each county in Alabama, then we analyze the distributions of farmland buyers by their regions. From there, we report the results of regression analysis and heterogeneity analysis that compares cropland and pastureland.

Geographical Distribution of Non-Local Buyers

We present the ratio of non-local buyers in each county in Figure 1. Although data limitations prevent us from covering the entire state, the available evidence clearly indicates that Alabama's farmland market exhibits substantial variation in the share of out-of-county buyers. In particular, Figure 1 shows that in urbanized counties such as Mobile County, Montgomery County, and Houston County, the proportion of out-of-county buyers remains relatively low. By contrast, in several remote, less-populated rural counties such as Fayette County, Monroe County, and Clay County, the share of out-of-county buyers often exceeds 40%. In these counties, local land demand is relatively limited, amplifying the relative presence of outside buyers, but these relatively low land prices are also attractive to non-local buyers. Taken together, our results suggest that the influences of non-local buyers are very pronounced in remote rural areas.

The Distribution of Farmland Non-Local Buyers by Origins

We present the distribution of farmland buyers by their origins in Alabama in Figure 2. Panel A shows that local farmland buyers account for 67% of all transactions, in-state/out-of-county buyers represent 21%, while out-of-state buyers make up 12%. This indicates that although the farmland market remains dominated by local buyers, non-local buyers still play a significant role, together representing nearly one-third of all observed transactions.

Panel B shows the distribution of in-state/out-of-county buyers, with four counties standing out as the primary origins of these buyers: Jefferson County (8%), Madison County (8%), Mobile County (8%), and Shelby County (6%). These counties are also the most densely populated urban areas and home to metro areas such as Birmingham, Huntsville, and Mobile, a pattern implying that a large share of in-state/out-of-county buyers comes from urban areas, further suggesting that urban investors are targeting farmland in rural areas for investment.

Panel C depicts the composition of 1,795 out-of-state buyers, a considerable portion of which come from neighboring states: Florida (34%), Georgia (15%), Mississippi (5%), and Tennessee (7%), with the remaining 39% spread out over the U.S. This pattern suggests that while Alabama farmland attracts investors from across the country, demand is primarily driven by buyers from surrounding regions.

The Results of Regression Analysis

Table 3 reports our baseline estimates, with columns (1), (2), and (3) presenting results from the log-log form, log-linear form, and dummy variables specification, respectively.

Across all models, the distance between properties and buyers' addresses positively influence farmland prices. Specifically, as shown in model 1, each 1% increase in buyer-to-parcel distance can cause an increase of 4.3% in transaction price; similarly, the results of model 2 indicate that each additional 1 mile of buyer-to-parcel distance is associated with a 0.04% increase in farmland transaction price. We also find that, in model 3, relative to local in-county buyers, in-state/out-of-county buyers pay prices that are approximately 9.6% higher, while out-of-state buyers pay prices that are approximately 14.9% higher, holding all other factors constant. Meanwhile, a 1% increase in buyer-to-parcel distance is associated with a 2.9% increase in transaction prices, indicating that greater buyer-parcel distance is linked to higher price premium.

These results are consistent with the explanation provided by previous literature where buyers located in regions farther from the parcels suffer from a higher degree of asymmetric information and pay a higher price for farmland. Consistently, in-state/out-of-county and out-of-state buyers also pay a price premium, probably because local buyers are more familiar with local market dynamics, institutions, and transaction norms as well as agricultural productivity. In addition, even though it is not the key focus of this present study, several transaction-specific and farmland characteristics also play an important role in shaping farmland values. Specifically, parcel size shows a U-shaped relationship with farmland prices, with two transaction indicators, cash purchase and short sale, having significant effects on farmland prices. We also find that distance to big cities significantly and negatively influences farmland values, indicating that farmland located closer to large cities tends to have higher prices. To further explore potential heterogeneity, we separate the sample into two groups based on land use types. Table 4 shows that the price premium paid by non-local buyers is more pronounced for pastureland than cropland, specifically, an additional 1% buyer-to-parcel distance can lead to 4.1% and 5.4% increase in transacted prices, respectively.

These heterogeneous responses on farmland prices across land use patterns might be driven by different degrees of asymmetric information.

Our aforementioned descriptive statistical analysis results show that transacted pastureland is typically located in less-populated areas than cropland, which may suggest that pasturelands are generally located in more remote rural areas. Local market conditions in these areas typically are less transparent and accessible than urban and semi-urban areas, amplifying non-local buyers' information disadvantages and potentially making them pay a higher premium price for forest land.

CONCLUSION

Farmland is not only the most critical input in agricultural production, it's also the most valuable asset of farm households (Lee et al., 2021). Thus, an understanding of how non-local investors influence local farmland markets is important for agricultural and land use policy design. Although a large body of literature shows that non-local farmland buyers significantly influence local markets, to the best of our knowledge, most existing literature uses a simple binary variable to measure buyers' non-locality, neglecting the heterogeneity among non-local buyers. In this study, we construct a continuous distance-based variable to more accurately capture the impacts of non-local buyers on farmland prices,

Our descriptive statistical analysis reveals that the influence of non-local buyers on farmland markets is concentrated primarily in remote rural areas instead of densely-populated urban areas, since local land demand in these more rural counties is limited. We find that most in-state/out-of-county buyers originate from major urban areas such as Birmingham, Huntsville, and Mobile, reflecting the growing inflow of urban investors into rural areas to seek investment opportunities. Most out-of-state buyers, on the other hand, come from nearby states such as Georgia and Florida, which underscores the role of geographic proximity in farmland transactions.

Apart from that, our multiple regression models can help evaluate how buyer-to-parcel distance influences farmland prices in Alabama, with our results indicating that an additional 1% increase in the buyer-to-parcel distance can cause farmland prices to increase by 4.3%; the log-linear and dummy variables model specification provides similar results. These results indicate that buyers living farther from the property typically pay a higher price, probably because of greater asymmetric information.

Interestingly, this premium is heterogeneous between cropland and pastureland: an additional 1% distance

between property and buyers' mailing address can lead to a 4.1% and 5.4% increase in transacted prices, respectively. This may be that since pastureland parcels are generally located in more remote rural areas with less available market information, the non-local buyers' information disadvantages are amplified, leading to a higher price premium for pastureland. In addition, our regression results also reveal that other parcel characteristics, such as acreage, land use patterns, and short sale indicators, also play a significant role in determining farmland prices.

Even though this present study is not the first to discover that non-local buyers pay a significant price premium for farmland, our contribution to the literature is in showing that the buyer-to-parcel distance significantly influences the price of farmland and that this price premium effect is uneven across different land use types. Our empirical evidence also shows that price premiums caused by asymmetric information reflect the limited transparency in Alabama's farmland market. In particular, previous transaction records aren't typically available in rural areas, and automatic valuation models largely focus on urban areas, further exacerbating information asymmetry. Local governments can play a role in providing more information, such as establishing a digital platform to share historical transaction records to reduce search costs for all market participants.

Notwithstanding the fruitful insights into non-local buyers' impacts on farmland prices, it is critical to acknowledge potential limitations and identify avenues for future research. First, this present study only focuses on Alabama rather than a wider geographic scope. Even though the diverse land use patterns in Alabama give us a unique opportunity to observe heterogeneous price responses to different farmland buyers' identities, it would be useful to compare differences between the southeastern U.S. and the Midwest—doing so could provide better external validity of the results. Second, our analysis relies on a multiple regression framework to examine the relationship between non-local buyers and farmland prices, but we do not employ rigorous causal identification strategies. Future research may consider adopting instrumental variables or difference-in-difference to better address causal effects. Third, asymmetric information is only one possible mechanism that can explain observed price differentials between local and non-local farmland buyers, and we do not exclude the possibility of other alternative explanations. Future research can attempt to verify the rationales of different explanations.

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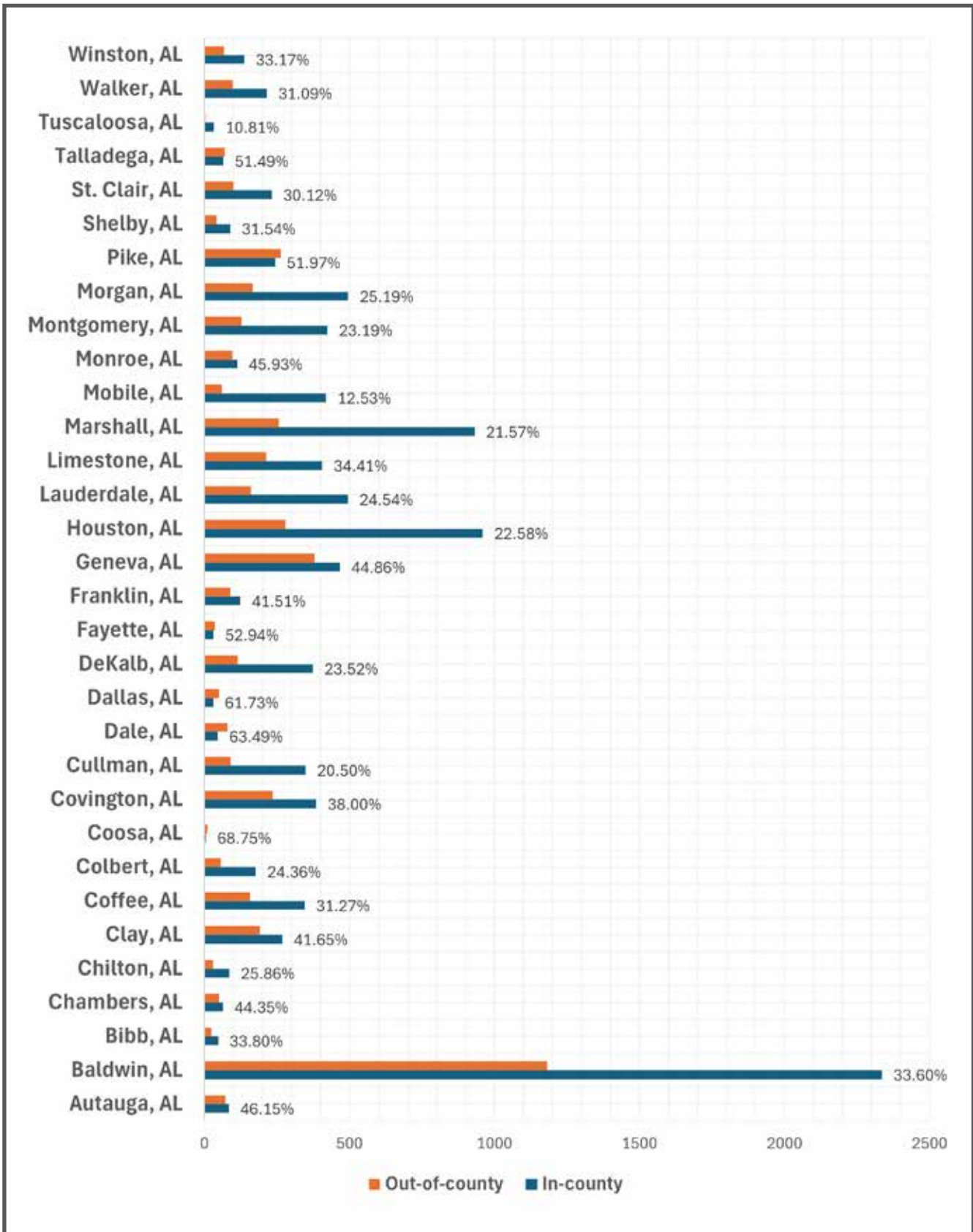


Figure 1. Distribution of farmland transactions by local and non-local buyers in Alabama counties

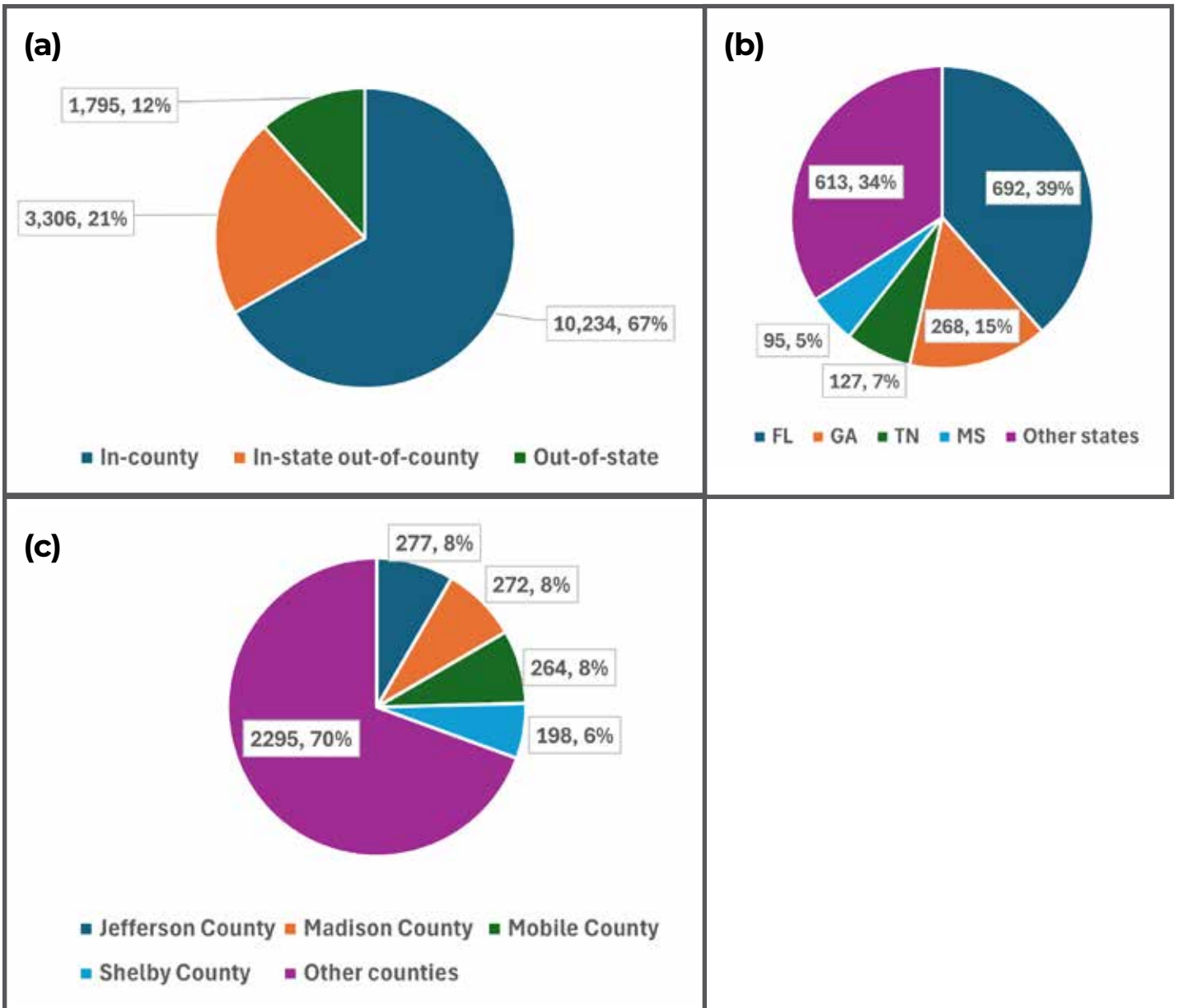


Figure 2. Distribution of farmland buyers in Alabama by origin: (a) distribution of farmland transactions (the numbers in each box indicate the number of farmland transactions in each buyer category; the percentages represent the share of total transactions); (b) county of origin of in-state/out-of-county farmland buyers (the number shown in each box indicates the count of in-state/out-of-county farmland transactions originating from that county, while the percentage represents that county's share of all in-state/out-of-county transactions); and (c) state of origin of out-of-state farmland buyers (the numbers in each box represent the number of farmland transactions originally from that state, and the percentages indicate the share of total out-of-state transactions by buyers' state of origin).

Table 1. Variables and Descriptions in the Study of the Impacts of Non-Local Buyers on Farmland Market in Alabama

Variable	Description
Dependent variable	
Ln (unit price)	Natural log of price per acre
Independent variable	
Distance (miles)	The distance between the transacted property and buyers' address
Ln (Distance)	The natural log of the distance between the transacted property and buyers' address
Distance to big cities (miles)	The distance between the transacted property and nearest big cities
Distance to waterbody (miles)	The distance between the transacted property and nearest waterbody
Acres	total acres in the parcel
Acres2	total acres in the parcel squared
Cash purchase (0/1)	If the transaction was transacted in cash =1, otherwise =0
Short sale (0/1)	If the transaction was a short sale =1, otherwise =0
Population	County-level population
Cropland (0/1)	If the parcel is classified as cropland =1, otherwise =0
Pastureland (0/1)	If the parcel is classified as pastureland =1, otherwise =0

Table 2. Descriptive Statistics of Variables in the Study of the Impacts of Non-Local Buyers on Farmland Market in Alabama

Variable	Full sample (n=15,335)		Cropland (n=9,441)		Pastureland (n=5,894)	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Ln (unit price)	8.33	1.64	8.38	1.63	8.25	1.66
Distance	62.68	221.64	69.47	230.58	51.81	206.07
acres	45.03	85.56	48.2	99.54	39.95	55.99
Short sale indicator	0	0.05	0	0.05	0	0.06
Cash purchase indicator	0.79	0.41	0.8	0.4	0.77	0.42
Population	119996	87785.1	125657	84067.2	110928	92722.4
Distance to big cities	47.03	27.13	49.33	29.37	43.35	22.63
Distance to waterbodies	0.30	0.28	0.30	0.27	0.30	0.29

Table 3. Regression Analysis Results: The Impacts of Non-local Buyers on the Farmland Market

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3
Ln (distance)	0.043*** (0.005)		0.029*** (0.007)
Distance		0.000*** (0.000)	
In-state out-of-county			0.096*** (0.037)
out-of-state			0.149*** (0.049)
Distance to big cities	-0.011*** (0.002)	-0.010*** (0.002)	-0.011*** (0.002)
Distance to waterbody	-0.056 (0.046)	-0.041 (0.046)	-0.053 (0.046)
Acres	-0.007*** (0.000)	-0.007*** (0.000)	-0.007*** (0.000)
Acres2	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Short sale indicator	-0.527*** (0.162)	-0.542*** (0.162)	-0.523*** (0.162)
Cash purchase indicator	-0.688*** (0.028)	-0.687*** (0.028)	-0.689*** (0.028)
Population	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Pastureland	-0.037 (0.035)	-0.049 (0.035)	-0.038 (0.035)
Constant	8.435*** (0.824)	8.453*** (0.824)	8.416*** (0.834)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	15,335	15,335	15,335
R-squared	0.119	0.119	0.120

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Model 1 is based on log-log specification, model 2 is based on log-linear specification, model 3 is based on dummy variables specification.

Table 4. Heterogeneity Analysis of Buyer-to-Parcel Distance Effects on Farmland Prices by Land Use Types

VARIABLES	(1) Cropland	(2) Pastureland
Ln (distance)	0.041*** (0.007)	0.054*** (0.008)
Acres	-0.007*** (0.000)	-0.018*** (0.001)
Acres2	0.000*** (0.000)	0.000*** (0.000)
Short sale indicator	-0.476** (0.215)	-0.669*** (0.221)
Cash purchase indicator	-0.613*** (0.035)	-0.832*** (0.043)
Population	0.000** (0.000)	0.000 (0.000)
Distance to big cities	-0.015*** (0.002)	0.000 (0.003)
Distance to waterbody	-0.095 (0.058)	0.047 (0.075)
Constant	8.319*** (0.849)	9.397*** (0.679)
County FE	Yes	Yes
Year FE	Yes	Yes
Observations	9,441	5,894
R-squared	0.130	0.168

Note: The analysis is based on Model 1. Column (1) reports the estimates for cropland transactions, and Column (2) reports estimates for pastureland transactions. Robust standard errors in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1.

Population Growth and Farmland Option Value in Alabama



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Abstract

This study investigates how short-run population growth influences the development option value of agricultural land, defined as the per-acre gap between market and current use values. Using parcel-level Alabama data (2016-2020), we quantify how both own and neighboring population density changes affect farmland valuation. Results show that changes in population density—particularly within a 10-mile radius—are positively associated with the development option value, with robust spatial spillovers (i.e., effects from nearby population growth). These effects vary by land use type. The findings highlight how dynamic development pressure, rather than static conditions, drives valuation gaps, informing farmland appraisal, tax policy, and land use planning.

INTRODUCTION

The concept of development option value—the hidden value due to future development potential, which is embedded in land prices due to the potential for future conversion to non-agricultural uses—has become increasingly relevant in agricultural and rural land economics. As urban expansion intensifies and land markets evolve, understanding how development pressure is capitalized into farmland values is critical for appraisers, policymakers, and landowners. This study investigates the relationship between population growth and the development option value of farmland, using parcel-level data from Alabama.

In agricultural appraisal contexts, the development option value is often inferred from the gap between market value and appraised value (or current use value). Market value is the price farmland would likely sell for in an open and competitive market, where both buyer and seller are informed, willing, and acting without forced sale pressure or unusual financing concessions. It reflects typical conditions where all relevant information, including development potential, soil quality, location, and market demand, is known to both parties. In contrast, appraised value under current use valuation is based on the parcel's productivity in agriculture, excluding speculative or alternative use considerations. This gap—intentionally created in many states through differential tax assessment policies—is designed to mitigate tax burdens and slow farmland conversion. However, the size and responsiveness of this gap to development pressure remain underexplored at the parcel level.

Recent studies have shown that farmland values are influenced not only by agricultural returns but also by non-agricultural factors such as urban proximity, natural amenities, and zoning restrictions (Borchers, Ifft, and Kuethe, 2014; Eagle et al., 2015; Plantinga, Lubowski, and Stavins, 2002). In regions experiencing rapid population growth, these factors may significantly inflate market values relative to appraised values, creating a measurable wedge that reflects development expectations. This wedge is particularly salient in states like Alabama, where current use valuation is widely applied but urban expansion continues to exert pressure on agricultural land.

We hypothesize that population growth—both own area and neighboring areas—will be positively associated with the development option value and that this relationship will vary by land use type. To test this, we construct a parcel-level panel dataset for Alabama that combines annual property assessment records from CoreLogic with gridded population data from the Gridded Population of the World (GPW) from 2016 to 2020. The development option value is measured as the per-acre difference between market value and appraised value by county (i.e., current use value), reflecting the premium attributed to future development potential. We link this valuation gap to both the level and change in population density at multiple spatial scales (5-, 10-, and 20-mile buffers), lagged to account for the temporal delay in market response.

Our contribution is threefold. First, we analyze development pressure at the parcel level using high-resolution appraisal and population data. Second, we distinguish between short-run changes in population density and long-run baseline conditions, allowing us to isolate short- and long-term effects. Third, we compare how development pressure plays out across different land uses—such as crop, forest, pasture, and mixed-use parcels—and across surrounding areas.

BACKGROUND

The development option value of farmland refers to the portion of a parcel's market value that reflects its potential for future conversion to non-agricultural uses. This concept is rooted in real options theory, which views land as an asset with embedded flexibility—landowners can delay conversion until market conditions become favorable (Capozza and Helsley, 1990). A real option value treats farmland as something more than its current use, namely, that it's an asset that gives its owner flexibility: the owner can keep farming today while retaining the option to convert the land later. This option becomes more valuable when conditions (i.e., development potential) are changing because the owner can wait and choose the most favorable moment to switch to development. When population growth increases development pressure, the value of having this flexibility rises, creating a larger gap between the land's market value and its current use value. In practice, this value is often latent and difficult to observe directly. However, in appraisal contexts, it can be inferred from the gap between market value and current use value, especially in jurisdictions that apply differential tax assessment policies.

Under current use valuation, farmland is assessed based on its productivity in agriculture, excluding speculative or alternative use considerations. This approach is designed to reduce property tax burdens and discourage premature conversion. However, as Eagle et al. (2015) and Siu, Li, and Caplan (2023) showed, the effectiveness of such policies depends on the credibility of zoning restrictions and the intensity of development pressure. In regions with weak enforcement or high urban demand, the development option value may still be capitalized into market prices, creating a persistent wedge between the market value of land and its value for farming use.

Theoretical models of farmland valuation (Plantinga, Lubowski, and Stavins, 2002; Livanis et al., 2006) decompose land value into agricultural and development components. These models suggest that proximity to urban centers, infrastructure, and population growth can significantly increase the development component, even if the land remains in agricultural use. Empirical studies using hedonic pricing and spatial econometric models have confirmed that farmland near urban areas commands higher prices due to its conversion potential (Delbecq, Kuethe, and Borchers, 2014; Borchers, Ifft, and Kuethe, 2014).

A key mechanism through which development pressure affects land value is population density. As density increases, especially in peri-urban areas, the likelihood of land conversion rises. This pressure is not limited to the parcel itself; spatial spillovers from neighboring development can influence market expectations. For example, infrastructure expansion or residential growth in adjacent areas may signal future conversion potential, even if the parcel's own use remains unchanged. Eagle et al. (2015) found that farmland within protected zones depreciated over time due to the perceived permanence of zoning restrictions, while unimproved parcels retained or gained value, driven by expectations of future development.

To capture these dynamics, our study distinguishes between baseline population density and short-run changes. Baseline density reflects long-standing structural conditions, while short-run changes capture recent shifts in demand. Lagging both measures allows us to account for the temporal delay between demographic change and its capitalization into land values, a delay often driven by regulatory inertia, infrastructure planning, or speculative holding. This approach aligns with the logic of Eagle et al. (2015), who modeled the impact of zoning over a 35-year period using hierarchical linear models.

Land use heterogeneity further complicates the relationship between development pressure and valuation gaps. Forest parcels may be held for conservation or speculation, while crop and pasture lands are more readily converted. Zoning regulations, conservation easements, and market expectations vary across land types, influencing how development pressure is reflected in valuation gaps. Our empirical strategy accounts for these differences by estimating stratified models and testing robustness across spatial buffers.

In summary, the development option value of farmland is a critical but underexplored component of land valuation. By linking parcel-level appraisal data to spatially explicit measures of population growth, this study provides new insights into how development pressure is capitalized into farmland values. It also contributes to the broader literature on land use policy, appraisal accuracy, and the economics of farmland preservation.

DATA AND EMPIRICAL STRATEGY

To examine the relationship between farmland valuation and development pressure, we construct a set of parcel-level variables based on two data sources: farmland valuation data from CoreLogic and population density data from GPW. We construct a parcel-level panel dataset covering Alabama from 2016 to 2020.

Parcel-Level Farmland Valuation Data

Parcel-level property assessment data are sourced from CoreLogic, which provides annual assessments and farmland characteristics (farm acreage and type) in Alabama. Each parcel record contains both the market value—defined as the estimated price at which the property would sell under fair market conditions—and the current use value, which reflects the valuation based on the property's existing use as of October 1 of the taxable year.

In Alabama, current use value is computed under a statutory formula established in §40-7-25.1 of the Code of Alabama (Code of Alabama, 1975)⁶. The Department of Revenue determines annual standard values by capitalizing the 10-year weighted average of net returns to land for the state's three most harvested crops excluding hay—cotton, soybeans, and peanuts—adjusted for soil productivity ratings. Net returns are calculated by subtracting USDA-estimated production costs from gross returns and dividing by the average effective interest rate on Federal Land Bank loans

over the past decade. Soil productivity ratings modify these values by +20% for good, -30% for poor, -75% for nonproductive, and no change for average. While this approach reflects agricultural income potential, it relies on statewide averages and omits certain crops, which may cause current use values to understate parcel-specific productivity. Consequently, the option value—defined as the gap between market value and current use value—may be biased if current use assessments are systematically different from true agricultural returns. Upward bias may occur when the statutory formula is conservative or omits high-value crops, causing parcels with above-average productivity to appear undervalued. Conversely, downward bias can occur in areas with low market value or on parcels with poor soils, where current use assessments may be relatively high compared to market value. This limitation should be considered when interpreting the magnitude of the valuation gap, as it reflects both development pressure and statutory adjustments intended to provide tax relief.

The difference between market value and current use value, normalized by parcel acreage, is defined as the development option value (*Option Value*). This measure serves as a proxy for the hidden value due to future development potential associated with potential land conversion, excluding speculative or alternative use considerations. Figure 1 illustrates the spatial distribution of per-acre farmland value gaps across Alabama in 2020, highlighting regional variation in development option value that aligns with urban proximity and population growth patterns.

To account for scale effects, we include parcel acreage as a control variable. The dataset also contains parcel identifiers, land use classifications (e.g., crop, forest, pasture), and assessment year, allowing for stratified analysis and the inclusion of fixed effects.

Population Density Data

The GPW dataset provides globally harmonized, georeferenced population counts at approximately 1 km² resolution for benchmark years 2000, 2005, 2010, 2015, and 2020. Developed by the Center for International Earth Science Information Network (CIESIN), GPW integrates Census data into a consistent global grid, ensuring comparability across space and time. For intermediate years, population values are interpolated to capture gradual demographic changes.

In this study, the 1-km grid cells are aggregated to the county level to construct population totals and population density measures that match the

geographic units used in the empirical analysis. And aggregated values are converted from square kilometers to square miles to maintain consistency in units. This procedure retains the fine spatial detail of the underlying raster while producing county-level measures that align with socioeconomic and environmental datasets, thereby strengthening the reliability of the population variables included in the statistical models.

For each parcel, we construct two measures of population density: own population density (*Own Density*) and neighboring population density (*Adjacent Density*), calculated within alternative buffer distances (5, 10, and 20 miles). These spatial buffers are designed to capture both localized development pressure and spillover effects from surrounding areas. The primary specification employs a 10-mile radius to define neighboring population density, which balances the need to capture localized development pressure while minimizing noise from distant population centers. The 10-mile buffer used to define neighboring population density serves as a proxy for the urban fringe, an area where agricultural land values are influenced by proximity to urban centers and potential conversion to non-agricultural uses. This operationalization aligns with empirical findings from Delbecq, Kuethe, and Borchers (2014), who estimated the urban fringe to extend approximately 33 miles from major metropolitan areas, and with prior studies suggesting that development pressure dissipates within 40 miles (Guiling, Brorsen, and Doye, 2009). A 10-mile radius thus captures the core of this transition zone while minimizing noise from more distant population centers. Figure 2 shows the spatial distribution of Alabama population density in 2020, which serves as the primary proxy for development pressure in our analysis.

To reflect the temporal dynamics of land markets, we decompose short-run and persistent development pressure by distinguishing between changes in density and baseline density. Baseline density, measured at time $t-1$, reflects longer-run structural conditions such as persistent demographic concentration, urban form, and other slow-moving features of the local economy. In contrast, changes in density, defined as the difference between density at $t-1$ and $t-2$, capture short-run demand pressures generated by recent growth in population, which often reflects sudden shifts such as new residential development. Specifically, we compute these changes as:

$$\Delta \text{Own Density}_{t-1} = \text{Own Density}_{t-1} - \text{Own Density}_{t-2}$$

$$\Delta \text{Adjacent Density}_{t-1} = \text{Adjacent Density}_{t-1} - \text{Adjacent Density}_{t-2}$$

This two-year difference approach captures recent growth dynamics while smoothing annual fluctuations. Both baseline density and change measures are lagged by one year in the regression specification to account for delayed market response.

Lagging both baseline and change measures recognizes the temporal delay between demographic change and its capitalization into land values. Development pressure typically builds gradually (Shih et al., 2022), while responses in land markets may be slowed by regulatory processes, infrastructure planning, or speculative holding. By including both lagged baseline density and lagged changes in density, our specification separates the influence of long-standing population conditions from short-run growth dynamics, thereby identifying distinct channels through which demographic shifts affect development option value.

Summary statistics for the key variables used in the empirical analysis are presented in Table 1, which provides context for the variation in development option value and population density across parcels.

Empirical Model

Our core empirical strategy involves estimating a fixed effects panel regression of the form:

$$\text{Option Value}_{ijt} = \beta_0 + \Delta \text{Density}_{ijt-1} \beta_1 + \text{Density}_{ijt-1} \beta_2 + \beta_3 \text{Acres}_{ijt} + \alpha_j + \gamma_t + \varepsilon_{ijt} \quad (1)$$

where *Option Value*_{ijt} is the per-acre gap between market value and current use value for parcel i in county j and year t ; $\Delta \text{Density}_{ijt-1} = (\Delta \text{Own Density}_{ijt-1} - \Delta \text{Adjacent Density}_{ijt-1})$ captures changes in own and neighboring population density between $t-1$ and $t-2$; $\text{Density}_{ijt-1} = (\text{Own Density}_{ijt-1} + \text{Adjacent Density}_{ijt-1})$ includes own and neighboring population density in year $t-1$; *Acres*_{ijt} is the parcel acreage; the county fixed effect (α_j) and the year fixed effects (γ_t) are incorporated to control for time-invariant regional such as differences in appraisal practices or land market conditions and temporal shocks including macroeconomic fluctuations and policy changes; and ε_{ijt} is the idiosyncratic error term. Standard errors are clustered at the county level to correct for spatial correlation in the error structure.

The parameter of primary interest, β_1 , captures the extent to which growth in own and neighboring population density—interpreted as shifts in development demand—affects parcel-level development option value. By including both density

changes and baseline density, the specification separates short-run demand pressures from longer-run population conditions, while controlling for parcel size and unobserved heterogeneity across counties and over time. The specification allows us to identify whether development demand—proxied by changes in population density—is associated with increases in development option value, while controlling for parcel size, baseline population conditions, and unobservable county-fixed effects and year-fixed effects.

RESULTS

Main Empirical Specification Results

Table 2 presents parameter estimates from the fixed effects panel regression model using a 10-mile buffer to define neighboring population density. The model includes county and year fixed effects and controls for parcel size and baseline population conditions. The “Overall” column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix), while the remaining columns present stratified results by land use type.

Across all specifications, changes in own population density ($\Delta \text{Own Density}_{t-1}$) are positively and significantly associated with the development option value. For the overall model, a one-unit increase in own density change corresponds to a \$280 increase in the development option value per acre. Stratified results show similarly strong effects for crop parcels (\$278) followed by pasture and forest parcels, while mixed-use parcels exhibit a small and statistically insignificant effect. These findings suggest that recent population growth within a parcel's immediate vicinity is a strong predictor of latent development pressure in most land use types. This is consistent with the policy rationale behind current use valuation, which aims to reduce development incentives by lowering property tax burdens on agricultural land.

A one-unit increase in own population density change is associated with an increase in development option value equivalent to about 46% of the sample mean per-acre gap (\$608.16/acre from Table 1), while a one unit increase in adjacent density change corresponds to 117% of the sample mean. Although these elasticities indicate substantial localized development pressure, they are unusually large relative to patterns documented in a prior study. Salois et al. (2011), for example, found that farmland values tend to be more strongly linked to movements in agricultural returns than to shifts in population growth. This broader evidence implies that profitability typically dominates as the primary driver of farmland values,

with demographic forces playing a more limited role. The comparatively large marginal effects in our setting likely capture pronounced spillover dynamics operating at fine spatial scales rather than the regional adjustments emphasized in earlier work.

These effects are consistent with empirical findings that farmland value reflects not only agricultural returns but also nonfarm factors, including expected returns from potential development (Borchers et al., 2014; Hardie et al., 2001; Livanis et al., 2006; Ma & Swinton, 2012; Plantinga & Miller, 2001; Plantinga et al., 2002; Vyn & Shang, 2021; Zhang & Nickerson, 2015). For example, Zhang and Nickerson (2015) showed that farmland parcels closer to city centers sell for higher prices, with the urban premium accounting for about 40% of Ohio farmland prices before 2008 and falling to 20% after the housing market crash. Ma and Swinton (2012) found that appraised values in Michigan often understate market prices because appraisal formulas emphasize agricultural factors while ignoring nonfarm influences, a gap that widens in areas where cities are expanding. Livanis et al. (2006) demonstrated that urban proximity raises farmland values by enabling farmers on the urban fringe to produce higher-value crops such as fruits and vegetables. Plantinga et al. (2002) reported stark regional differences: development potential explains more than 80% of farmland value in New Jersey and Connecticut but less than 5% in rural Midwestern states. This contrast reflects variation in urban pressure—densely populated states face strong demand for housing and commercial development, which capitalizes into land prices, while rural Midwestern states have limited development prospects, so farmland values remain tied primarily to agricultural returns. Hardie et al. (2001) showed that in the mid-Atlantic region, nonfarm factors—such as housing prices—have a greater impact on farmland values than farm revenue. Plantinga and Miller (2001) argued that development potential is better captured by expected population growth than current population levels, as urban expansion reflects future demand. Borchers et al. (2014) noted that non-agricultural determinants extend beyond development potential to include amenities such as golf courses and college campuses. Similar patterns emerge in Canada (Turvey, 2003; Vyn and Shang, 2021).

Changes in neighboring population density ($\Delta \text{Adjacent Density}_{t-1}$) also show strong positive effects, indicating spatial spillovers. In the overall model, a one-unit increase in adjacent density change within a 10-mile radius is associated with a \$713 increase in the valuation gap. Crop parcels show the largest effect (\$1,154), followed by forest and pasture parcels. This

suggests that development pressure in nearby areas contributes to the perceived conversion potential of a parcel, even if its own grid has not yet experienced population growth.

Taken together, these results provide strong empirical evidence that both direct and spillover effects of population growth are capitalized into farmland valuation gaps. The magnitude of these effects is economically meaningful and consistent with theoretical expectations from land economics and urban development literature. The findings also highlight the importance of distinguishing between short-run changes in population density and long-run baseline conditions, as the former appears to be a more powerful predictor of development option value.

The coefficients on lagged population density levels, particularly adjacent population density, are generally negative and modestly significant. It can suggest that areas with already high nearby population density may face zoning constraints or infrastructure saturation that limit further development potential. These results underscore the importance of capturing dynamic changes in population rather than relying solely on static density measures. Parcel acreage is negatively associated with development option value in most specifications, with statistically significant effects for overall parcels and pasture parcels. This may reflect higher transaction costs or reduced feasibility of converting larger parcels, particularly in fragmented or peri-urban landscapes.

DISCUSSION

The empirical results provide strong evidence that both direct and spillover effects of population growth are capitalized into farmland valuation as a development option value. The magnitude of the estimated coefficients is economically meaningful. For example, a one-unit increase in adjacent population density change within a 10-mile radius corresponds to a \$1,154 increase in the development option value for crop parcels. This substantial effect highlights how even modest demographic shifts can significantly alter market expectations about land conversion potential.

These valuation gaps serve as early signals of development pressure in land markets. The responsiveness of market value to recent population growth suggests that appraisers and policymakers can use these gaps as indicators of emerging urban expansion. This is particularly relevant for regions undergoing rapid demographic change, where

traditional appraisal methods may lag behind market dynamics.

From a policy standpoint, the findings underscore the importance of revisiting property tax assessment systems that rely on current use valuation. While these systems aim to preserve agricultural land by reducing the financial incentive to sell, the strong capitalization of population growth into market value suggests that they may be insufficient in high-growth areas. Zoning regulations and infrastructure planning should also account for the spatial spillover effects identified in this study, as development pressure is not confined to individual parcels but radiates across neighboring areas.

Our findings have direct relevance for appraisal professionals and valuation standards. A large body of literature shows that non-agricultural determinants such as urban proximity and demographic trends significantly influence farmland prices (Ma and Swinton, 2012; Zhang and Nickerson, 2015; Deaton and Lawley, 2022; Vyn and Shang, 2021). Appraisers should move beyond traditional approaches that rely primarily on historical sales or static productivity measures, as these often understate development pressure in rapidly urbanizing regions. For example, Ma and Swinton (2012) found that appraised values based on tax assessment formulas tend to emphasize physical and agricultural attributes while underrepresenting non-agricultural components (i.e., option value), which leads to biased interpretations of land value determinants when land use is changing. Similarly, Zhang and Nickerson (2015) demonstrated that the urban premium, the portion of farmland value attributable to proximity to urban areas, can fluctuate with housing market cycles. In Ohio, they found the urban premium accounted for 40% of per-acre farmland prices before 2008. These findings underscore the importance of incorporating spatial metrics and demographic indicators into appraisal models to improve accuracy and maintain consistency with market realities. Doing so can help appraisers anticipate emerging development pressure, support fair taxation, and guide landowners in making informed decisions about conversion timing. Ignoring these factors risks misestimating the contribution of development potential to market value, particularly in peri-urban areas where land conversion expectations are strong.

While the results are robust and consistent across specifications, several limitations should be acknowledged. First, the analysis does not directly observe land conversion events; instead, the development option value is inferred from the gap

between market and current use values. Ideally, access to actual sales prices would allow for a more precise estimation of development option value. However, the lack of comparable sales records is a common challenge in farmland appraisal, making it unlikely that such data could be reliably obtained for a large sample.

Second, potential endogeneity may arise if population growth is influenced by land market dynamics. For example, rising land values may attract residential development, which in turn increases population density—creating a feedback loop between valuation and demographic change. Additionally, unobserved factors such as infrastructure investment, zoning changes, or local economic shocks could simultaneously affect both population growth and land values. Although county and year fixed effects help mitigate these concerns by controlling for time-invariant and region-specific characteristics, future research could explore instrumental variable approaches or spatial econometric models to address endogeneity more directly.

Third, the study focuses on short-term development pressure by using one-year lagged changes in population density. This approach is reasonable for capturing recent shifts in demand, especially in fast-growing regions where land markets respond quickly to demographic changes. However, mid- to long-term population trends (e.g., three- to five-year changes) may also influence development option value, particularly in areas with slower planning cycles or long-term infrastructure investments. Incorporating longer-term measures could provide a more comprehensive view of development dynamics.

Fourth, the generalizability of the findings may be limited to regions with similar land use policies, demographic trends, and appraisal systems. While all U.S. states have laws that tax agricultural land differently from other land uses to reduce property tax burdens for producers, the specifics of these “differential tax assessment” laws vary widely across states (National Agricultural Law Center, 2019). States differ in how they define qualifying land, calculate agricultural value, and impose penalties for conversion. Therefore, extending the analysis to other states or incorporating zoning and infrastructure data could improve external validity and enhance the policy relevance of the findings.

While our analysis focuses on development pressure as the primary driver of option value, we recognize that coastal areas, particularly around Mobile Bay, may reflect heterogeneous influences. In these regions,

high market value premiums likely incorporate amenity-based factors such as waterfront access, scenic views, and recreational opportunities, alongside urban expansion effects. Because our model does not explicitly separate amenity value from development potential, the estimated option value in coastal parcels may overstate the role of population-driven development pressure. Future research could address this by introducing a coastal dummy or interaction terms to isolate amenity effects and better distinguish between urban growth and natural amenity contributions to farmland valuation.

Despite these limitations, the study provides a strong empirical foundation for understanding how demographic change influences farmland valuation. It also offers practical insights for appraisers, planners, and policymakers seeking to manage development pressure and preserve agricultural land.

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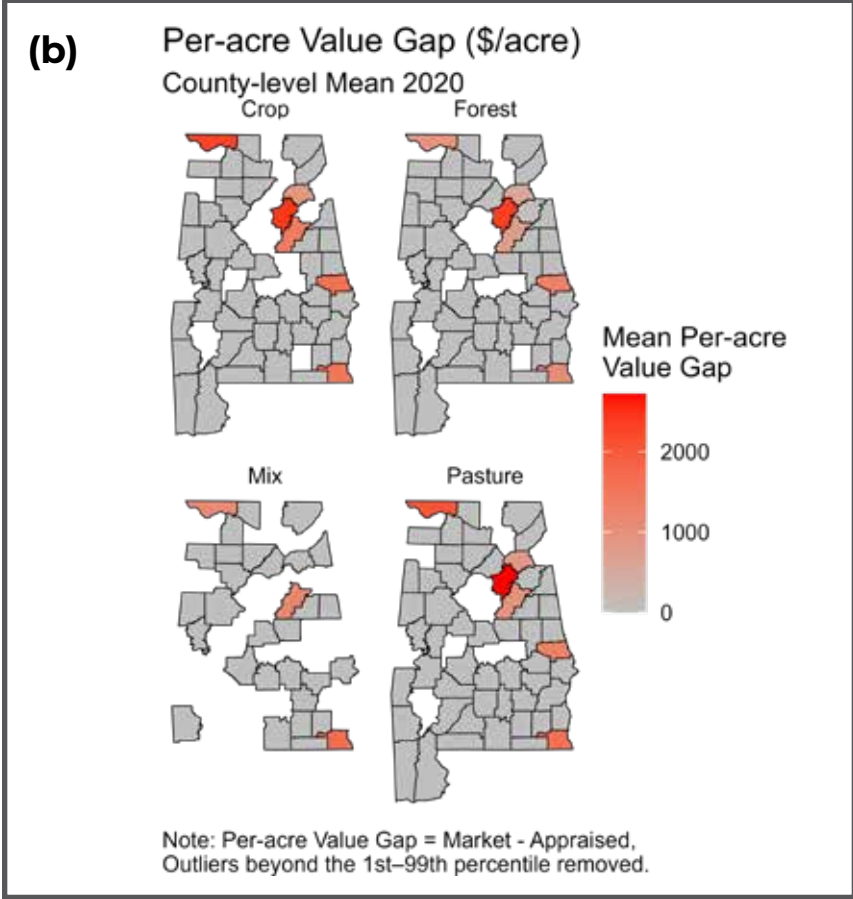
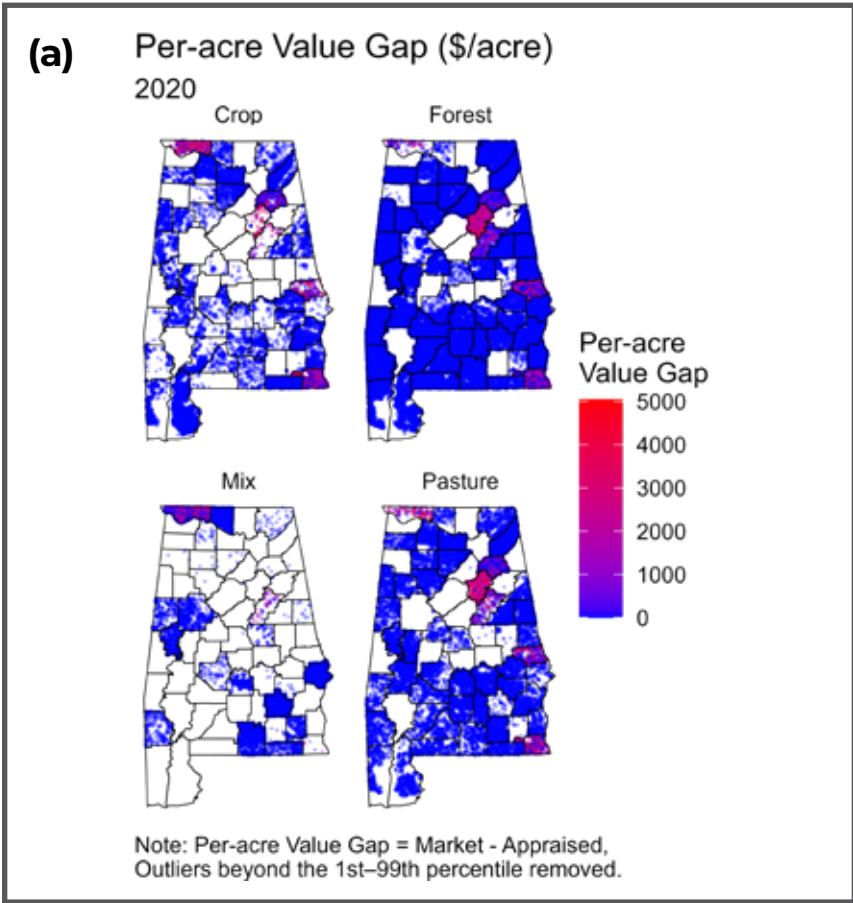
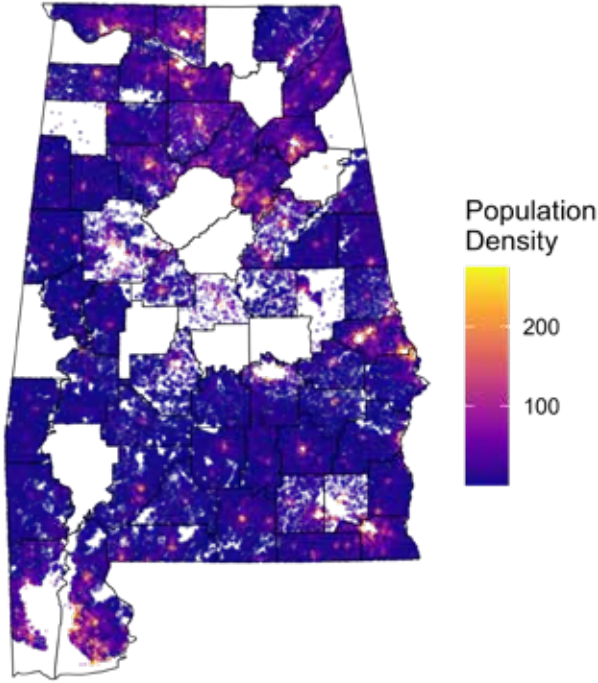


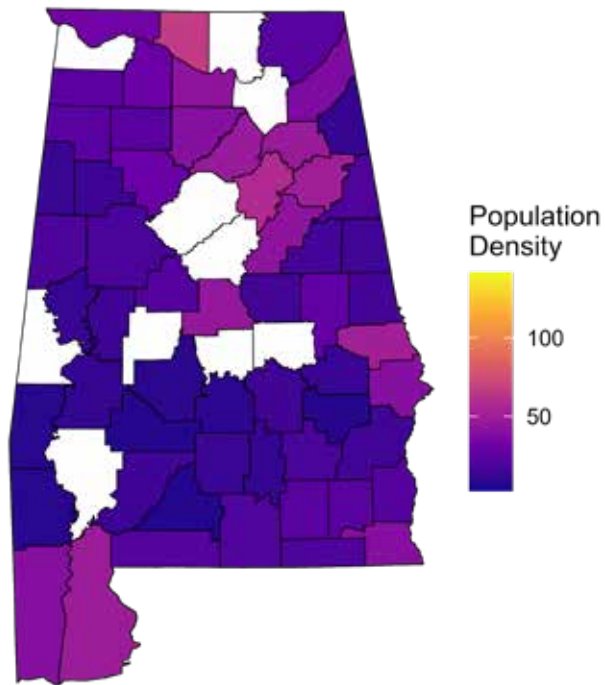
Figure 1. Spatial distribution of per-acre farmland value gaps by land type in Alabama, 2020 (\$/acre): (a) parcel level and (b) county level, mean

(a) Population Density (Persons/mi²)
2020



Note: Outliers beyond the 1st–99th percentile removed.

(b) Population Density (Persons/mi²)
2020 County-level Mean



Note: Outliers beyond the 1st–99th percentile removed.

Figure 2. Spatial distribution of population density in Alabama, 2020 (Persons/mi²): (a) parcel level and (b) county level, mean

Table 1. Summary Statistics of Variables Used in the Baseline Empirical Models, 2016-2020

Variable	Unit	Mean	Std. Dev.	Min	Max
<i>Option Value</i>	\$ / acre	608.16	4336.86	-255337.42	796488.24
Δ Own Density, <i>t-1</i>	Persons per square mile	0.54	2.50	-19.61	76.24
Δ Adjacent Density (5-mile), <i>t-1</i>	Persons per square mile	0.65	1.95	-3.55	25.29
Δ Adjacent Density (10-mile), <i>t-1</i>	Persons per square mile	0.70	1.66	-0.93	13.73
Δ Adjacent Density (20-mile), <i>t-1</i>	Persons per square mile	0.76	1.40	-0.31	9.42
Own Density, <i>t-1</i>	Persons per square mile	67.88	156.46	0	5103.68
Adjacent Density (5-mile), <i>t-1</i>	Persons per square mile	74.78	114.75	1.15	1625.89
Adjacent Density (10-mile), <i>t-1</i>	Persons per square mile	78.46	91.91	3.28	979.8
Adjacent Density (20-mile), <i>t-1</i>	Persons per square mile	86.61	84.01	7.05	646.03
Acres	Acre	57.47	91.25	0.01	7300

Note: The number of observations used in the baseline empirical models is 907,488.

Table 2. Fixed-Effects Panel Regression Results: Impacts of Population Density on Option Value (Dependent Variable: Option Value (\$/acre), 10-Mile Radius Population Buffer)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, <i>t-1</i>	280.40*** (38.09)	278.47*** (26.20)	232.77*** (42.69)	260.36*** (58.32)	12.74 (9.13)
Δ Adjacent Density (10-mile), <i>t-1</i>	712.58*** (252.95)	1153.99*** (228.18)	479.85*** (130.73)	404.07** (172.13)	-166.91** (67.60)
Own Density, <i>t-1</i>	-0.58 (0.67)	-0.33 (0.68)	0.49 (0.34)	0.27 (0.57)	-0.20 (0.13)
Adjacent Density (10-mile), <i>t-1</i>	-3.98* (2.23)	-7.96* (4.28)	-1.96** (0.87)	-1.71* (0.95)	2.73** (1.13)
Acres	-1.03* (0.61)	-5.26 (3.59)	-0.39 (0.24)	-0.84** (0.36)	-0.29 (0.30)
No. of observations	907488	121057	538387	164458	83586
Adjusted R ²	0.16	0.14	0.19	0.32	0.26

Note: The “Overall” column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

APPENDIX

Robustness Checks: Sensitivity to Spatial Definitions

To assess the sensitivity of our findings to spatial definitions and model specifications, we re-estimate the model using alternative spatial buffers of 5 miles and 20 miles. The 5-mile radius captures more immediate neighborhood effects, potentially reflecting short-run development spillovers, while the 20-mile radius tests whether broader regional population dynamics exert influence on parcel-level valuation gaps. Across these specifications, the direction and significance of key coefficients remain consistent, suggesting that the observed relationship between population change and development option value is not overly sensitive to the choice of spatial radius.

Tables A1 and A2 present parameter estimates from alternative specifications using 5-mile and 20-mile buffers to define neighboring population density. These robustness checks test the sensitivity of the main findings to the spatial definition of “adjacent” development pressure. All models include county and year fixed effects, and the “Overall” column includes land use controls. Across both alternative specifications, alternative spatial buffers (5-mile and 20-mile) confirm the stability of the main findings. In Table A1 (5-mile buffer), the coefficients of $\Delta Own\ Density_{t-1}$ remains positive and significant for all land use types. Their magnitudes are slightly lower than those in the 10-mile buffer model, which is expected given the narrower spatial scope of development pressure. The effect of $\Delta Adjacent\ Density_{t-1}$ in the 5-mile buffer is also positive and significant. These results suggest that even short-range population growth in neighboring areas is capitalized into farmland valuation.

As shown in Table A2 (20-mile buffer), the direction and magnitude of coefficients remain consistent across specifications, although the 20-mile buffer introduces more noise, particularly for forest and pasture parcels, where the changes in neighboring population density ($\Delta Adjacent\ Density_{t-1}$) becomes insignificant while positive. This suggests that broader regional population dynamics may be less relevant for certain land types, or that the signal becomes noisier at larger spatial scales.

Across all robustness checks, the direction and significance of the key coefficients remain consistent, reinforcing the interpretation that parcel-level

valuation gaps are responsive to recent and localized changes in population density. These findings support the robustness of the main empirical results and highlight the importance of spatial scale in modeling development pressure.

Robustness Checks: Urban Influence Measures

The development option value likely reflects accessibility and proximity to both in-state and nearby out-of-state metropolitan areas (e.g., Atlanta) as well as major transportation corridors (e.g., interstate highways). To test the association, we re-estimated the baseline model (Table 2) by adding two accessibility variables employed as urban influence measures in Zhang and Nickerson (2015): distance to the nearest city center with population greater than 40,000 (Alabama and adjacent states), distance to the nearest highway on-ramp (Alabama and adjacent states). City population data were obtained from U.S. Census population estimates, and all interstate on-ramp locations were extracted from OpenStreetMap (2025)⁷. Table A3 provides the summary statistics of those two variables while Figure A1 illustrates the spatial distribution of development-relevant accessibility across Alabama.

As shown in Table A4, the inclusion of the variables that potentially explain the development option value confirms the stability of the main findings. Including accessibility variables does not materially change the coefficients on population density changes; they remain positive and significant, with only marginal shifts in magnitude. This confirms that development pressure—captured by short-run changes in population density—is the dominant driver of option value. Unlike static measures such as distance to cities or highways, which reflect long-term locational advantages, population change signals recent inflows of residents and emerging development demand, making it a more precise indicator of conversion pressure. While accessibility measures show expected signs in some cases, their inclusion does not alter the interpretation of development pressure effects, likely because fixed effects already absorb much of their influence. Overall, these results indicate that our main findings are robust to controls for metropolitan accessibility and transportation infrastructure.

Robustness Checks: Placebo Test Using Slope

Our baseline model controls for county-level heterogeneity but does not explicitly include parcel-level characteristics such as slope, soil quality, or floodplain status. These factors can affect both agricultural returns and conversion feasibility, potentially influencing development option value. Incorporating them could refine estimates and strengthen causal interpretation because these attributes can affect both agricultural returns and conversion feasibility, potentially influencing the magnitude of development option value.

We implemented a placebo test comparing parcels with steep slopes (high development constraints) to those with favorable physical conditions. Slope was calculated from NASA Digital Elevation Model (DEM) data at parcel centroids. Consistent with planning guidelines and prior literature (Saiz, 2010), slopes above 15% significantly limit residential development potential. In reality, many zoning ordinances restrict development on slopes greater than 10%, and some allow up to 15% (Southern Tier Central Regional Planning and Development Board, 2012).

Based on these norms, we created slope categories ($\geq 10\%$, $\geq 15\%$, $\geq 20\%$, $\geq 25\%$) and defined binary less-developable (LD) indicators using parcel centroid slope. While centroid-based slope may not capture internal variation within parcels, we assume slope heterogeneity is minimal for most parcels. For example, $= 1$ if a parcel's centroid slope is larger than 10%. We re-estimated the model stratified by LD status and test sensitivity across thresholds.

Results indicate that population-driven effects diminish in less developable parcels across all slope thresholds: the influence of recent population growth within a parcel's immediate area weakens substantially on steep-slope parcels, and the effect of growth in surrounding areas disappears. This supports the interpretation that development pressure operates primarily where conversion is feasible. These findings provide additional evidence that observed valuation gaps reflect development pressure rather than unobserved physical limitations. Figure A2 shows the distribution of slopes in Alabama, and Table A5 presents regression results.

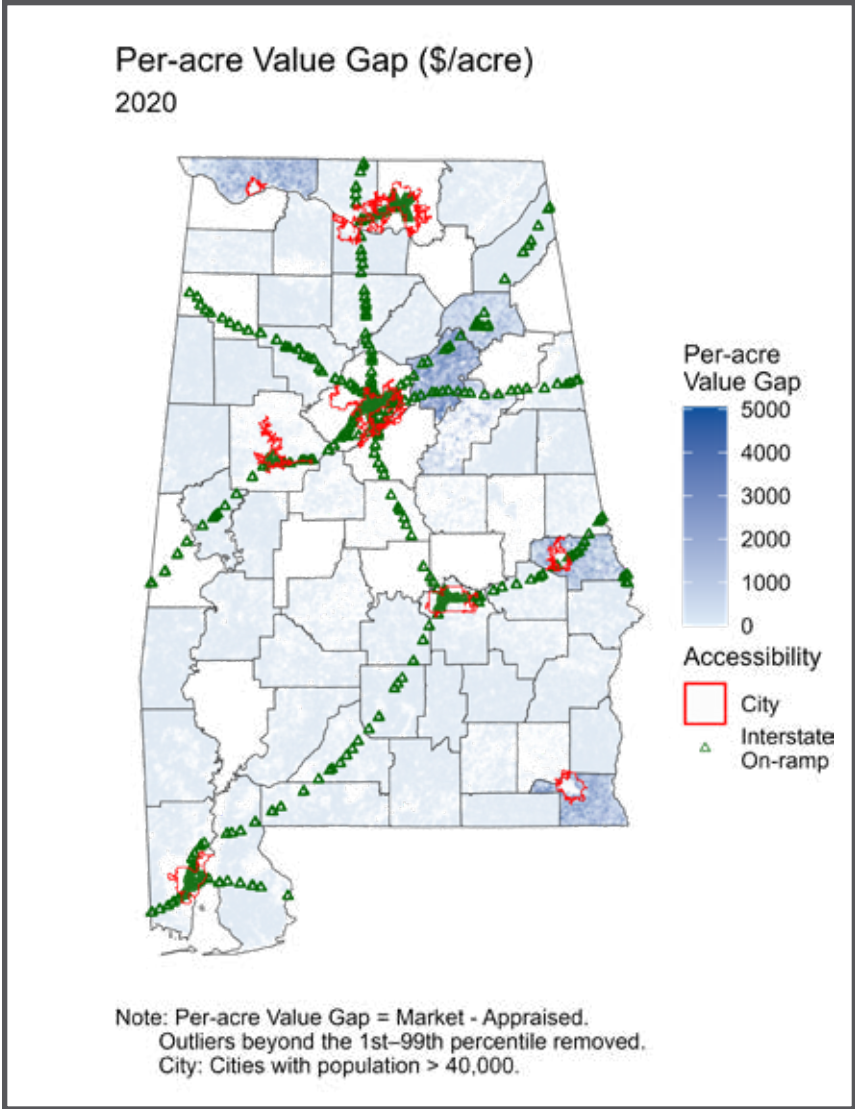


Figure A1. Spatial distribution of per-acre farmland value gaps (all land types) and development-relevant accessibility (proximity to cities and highway on-ramps) in Alabama, 2020 (\$/acre)

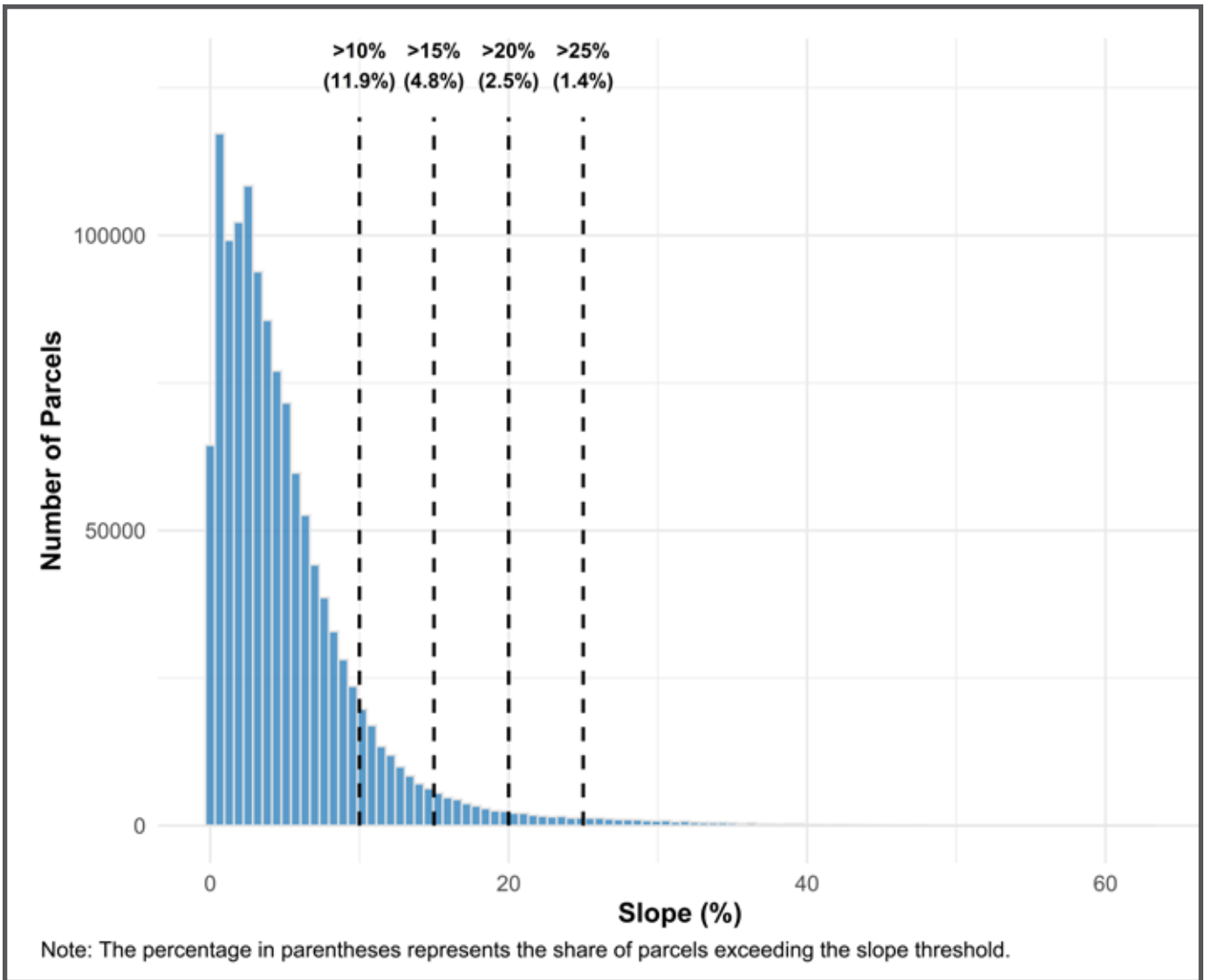


Figure A2. Distribution of parcel slopes in Alabama

Summary statistics, 2016-2020					
Variable	Unit	Mean	Std. Dev.	Min	Max
Slope	%	5.32	5.34	0.00	62.98

Table A1. Robustness Check: Fixed-Effects Panel Regression Results Using 5-Mile Radius Population Buffer (Dependent Variable: Option Value, \$/Acre)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, <i>t-1</i>	191.72*** (33.28)	200.39*** (26.88)	135.88*** (17.20)	178.86** (77.27)	10.73 (9.64)
Δ Adjacent Density (5-mile), <i>t-1</i>	623.10*** (171.93)	862.77*** (104.51)	493.75*** (102.12)	457.86** (185.90)	-70.97* (35.36)
Own Density, <i>t-1</i>	-0.51 (0.54)	-0.31 (0.65)	0.31 (0.25)	0.24 (0.44)	-0.28 (0.22)
Adjacent Density (5-mile), <i>t-1</i>	-2.80* (1.53)	-4.32** (2.11)	-0.96 (0.70)	-1.31 (0.86)	1.26 (0.79)
Acres	-1.09 (0.65)	-5.50 (3.79)	-0.43* (0.25)	-0.86** (0.34)	-0.29 (0.32)
No. of observations	907488	121057	538387	164458	83586
Adjusted R ²	0.16	0.14	0.21	0.33	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

Table A2. Robustness Check: Fixed-Effects Panel Regression Results Using 20-Mile Radius Population Buffer (Dependent Variable: Option Value, \$/Acre)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, <i>t-1</i>	348.07*** (58.38)	394.79*** (37.32)	275.82*** (54.50)	292.32*** (54.96)	-1.74 (2.34)
Δ Adjacent Density (20-mile), <i>t-1</i>	562.36* (298.76)	1037.97*** (172.36)	219.70 (157.38)	86.60 (122.84)	-123.05*** (31.66)
Own Density, <i>t-1</i>	-0.67 (0.70)	-0.91 (1.01)	0.47 (0.36)	0.18 (0.60)	0.01 (0.04)
Adjacent Density (20-mile), <i>t-1</i>	-2.81** (1.09)	-1.89 (1.30)	-1.71* (0.88)	-0.38 (0.76)	2.64*** (0.93)
Acres	-1.08* (0.64)	-5.54 (3.58)	-0.45* (0.26)	-0.86** (0.36)	-0.28 (0.29)
No. of observations	907488	121057	538387	164458	83586
Adjusted R ²	0.15	0.13	0.18	0.31	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

Table A3. Summary Statistics of Distance Variables Used in the Empirical Models, 2016-2020

Variable	Unit	Mean	Std. Dev.	Min	Max
Distance to nearest city center	miles	38.31	18.79	0.26	90.35
Distance to nearest highway on-ramp	miles	41.53	19.76	0.25	100.82

Note: The number of observations used in the baseline empirical models is 907,488.

Table A4. Robustness Check: Fixed-Effects Panel Regression Results with the Inclusion of Accessibility-Relevant Variables (Dependent Variable: Option Value (\$/acre), 10-Mile Radius Population Buffer)

Independent variable	Overall	Crop	Forest	Pasture	Mix
Δ Own Density, $t-1$	279.51*** (37.61)	277.87*** (25.88)	232.53*** (42.32)	259.63*** (58.21)	12.30 (9.04)
Δ Adjacent Density (10-mile), $t-1$	720.34*** (253.69)	1141.90*** (210.62)	486.29*** (129.61)	402.45** (170.19)	-159.66** (69.99)
Own Density, $t-1$	-0.57 (0.66)	-0.32 (0.66)	0.49 (0.34)	0.29 (0.57)	-0.19 (0.14)
Adjacent Density (10-mile), $t-1$	-3.70* (2.10)	-6.68* (3.70)	-1.84** (0.82)	-1.50 (0.91)	2.58** (1.14)
Acres	-1.03* (0.60)	-5.29 (3.58)	-0.39 (0.23)	-0.84** (0.36)	-0.29 (0.30)
Distance to nearest city center	9.05 (6.00)	29.84** (14.76)	3.85 (2.31)	3.09 (3.76)	-1.67* (0.84)
Distance to nearest highway on-ramp	3.31 (3.18)	-5.40 (6.76)	2.25 (2.57)	6.92* (4.02)	1.48 (3.31)
No. of observations	907488	121057	538387	164458	83586
Adjusted R ²	0.16	0.14	0.19	0.32	0.26

Note: The "Overall" column includes land use controls via categorical indicators for parcel type (Crop, Forest, Pasture, Mix); all columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

Table A5. Placebo Test: Fixed-Effects Panel Regression Results by Slope Threshold (Dependent Variable: Option Value (\$/acre), 10-Mile Radius Population Buffer)

(a) Threshold: 10% Slope			(b) Threshold: 15% Slope		
Independent variable	Slope>10%	Slope≤10%	Independent variable	Slope>15%	Slope≤15%
<i>Δ Own Density, t-1</i>	386.52*** (109.97)	733.12*** (96.06)	<i>Δ Own Density, t-1</i>	295.87** (130.02)	733.21*** (99.05)
<i>Δ Adjacent Density (10-mile), t-1</i>	166.88 (164.39)	1945.25*** (635.32)	<i>Δ Adjacent Density (10-mile), t-1</i>	127.22 (212.15)	1881.86*** (651.35)
<i>Own Density, t-1</i>	-1.50* (0.89)	-1.41 (1.75)	<i>Own Density, t-1</i>	-0.84 (1.10)	-1.57 (1.75)
<i>Adjacent Density (10-mile), t-1</i>	1.25 (1.76)	-10.43** (4.96)	<i>Adjacent Density (10-mile), t-1</i>	1.58 (1.25)	-10.04* (5.04)
<i>Acres</i>	-0.53** (0.26)	-1.10 (0.69)	<i>Acres</i>	-0.46* (0.27)	-1.08 (0.66)
No. of observations	113793	809230	No. of observations	45851	877172
Adjusted R ²	0.25	0.16	Adjusted R ²	0.14	0.16
(c) Threshold: 20% Slope			(d) Threshold: 25% Slope		
Independent variable	Slope>20%	Slope≤20%	Independent variable	Slope>25%	Slope≤25%
<i>Δ Own Density, t-1</i>	179.55*** (55.09)	732.03*** (99.39)	<i>Δ Own Density, t-1</i>	182.84*** (50.58)	730.99*** (99.45)
<i>Δ Adjacent Density (10-mile), t-1</i>	38.62 (81.69)	1858.82*** (655.11)	<i>Δ Adjacent Density (10-mile), t-1</i>	41.95 (108.89)	1847.21*** (656.83)
<i>Own Density, t-1</i>	-1.20** (0.59)	-1.56 (1.75)	<i>Own Density, t-1</i>	-1.58*** (0.57)	-1.55 (1.74)
<i>Adjacent Density (10-mile), t-1</i>	2.62* (1.53)	-9.88* (5.03)	<i>Adjacent Density (10-mile), t-1</i>	3.26** (1.27)	-9.77* (5.01)
<i>Acres</i>	-0.29 (0.24)	-1.07* (0.64)	<i>Acres</i>	-0.25 (0.22)	-1.07* (0.63)
No. of observations	23545	899478	No. of observations	13311	909712
Adjusted R ²	0.44	0.16	Adjusted R ²	0.48	0.16

Note: All columns include county and year fixed effects; errors are clustered by county; standard errors are shown in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01

Teaching Farm and Rural Property Appraisal at America's Colleges: Synthesis and Reflections



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Abstract

The 2025 ASFMRA FutureEd Forum brought together university instructors, ASFMRA chapter leaders, and practitioners to examine how farm and rural property appraisal is taught across U.S. colleges. Using instructor surveys, forum discussions, and case studies from three land-grant universities, this article documents the objectives, structure, and challenges of university-based appraisal instruction. These courses emphasize

foundational appraisal concepts, including scope of work, ethics, highest and best use, and the income, cost, and sales comparison approaches, reinforced through project-based learning and strong support from local ASFMRA chapters. We highlight effective teaching practices and opportunities to strengthen collaboration between academia and the profession.

INTRODUCTION

For nearly a century, the American Society of Farm Managers and Rural Appraisers (ASFMRA) has provided the intellectual and professional backbone for rural property valuation in the United States. Since its founding in 1929, ASFMRA has linked universities, private practitioners, and policymakers to strengthen the professionalism of land management and appraisal. Its journal, educational programs, and ethical standards established a bridge between research and applied expertise.

Over the years, agricultural and rural property markets have become more dynamic and data-intensive. Appraisers must interpret spatial data, renewable energy leases, and environmental easements alongside traditional farmland sales. At the same time, the profession faces a generational transition as many experienced appraisers approach retirement. A strong pipeline of university-trained graduates—skilled in valuation methods, market interpretation, and communication—is essential to sustain the field (The Appraisal Foundation, 2024). Yet university teaching capacity in appraisal is uneven. Some land-grant and regional universities have maintained dedicated courses in *Farm and Rural Property Appraisal*, while others integrate valuation only briefly into farm management or real estate finance. Many programs

rely on one faculty member, creating a “single-instructor problem”—when that person retires or shifts roles, the course often disappears.

Recognizing these challenges, ASFMRA convened the FutureEd Forum in 2025 to reconnect academic and professional educators. The goal was to document where and how appraisal is being taught, share innovative course designs, and discuss how local chapters can strengthen classroom instruction.

University-based appraisal courses are not designed to replicate ASFMRA’s accreditation, qualification, or continuing education programs. Rather, they serve four complementary purposes: (i) introducing students to appraisal as a potential career pathway; (ii) building valuation literacy for future agricultural lenders, farm managers, real estate professionals, and policymakers; (iii) providing analytical foundations for understanding land markets and valuation logic; and (iv) creating early entry points into professional mentoring, training, and certification through ASFMRA chapters. In this sense, university instruction complements, rather than competes with, ASFMRA’s professional education system.

In this article, we document the current landscape of farm and rural property appraisal education across U.S. colleges and universities, drawing on survey data, forum discussions, and case studies from three land-grant institutions. We highlight how instructors structure appraisal courses, integrate professional standards, and collaborate with ASFMRA chapters to enhance student learning. The article also identifies common challenges, such as diverse student backgrounds, limited instructional capacity, and the broad scope of land markets, while also highlighting effective teaching practices and technologies that bridge the gap between the classroom and professional context. Finally, we outline opportunities for deeper partnership between academia and ASFMRA, emphasizing how coordinated efforts in mentoring, shared materials, and professional engagement can strengthen the next generation of rural appraisal education.

OVERVIEW OF THE 2025 FUTUREED FORUM AND INSTRUCTOR SURVEY

The 2025 FutureEd Forum, held in Denver, brought together faculty from universities offering appraisal or farm management courses, ASFMRA chapter leaders, and industry partners. Its agenda featured presentations on teaching innovations, survey results,

and two interactive sessions on curriculum design and outreach. The ASFMRA leadership emphasized how teaching appraisal is “a shared opportunity between universities and ASFMRA chapters” and encouraged participants to become academic members and to “use guest lectures and student networks as two-way bridges.”

A pre-event instructor-based survey collected 33 responses nationwide. About 12% (four respondents) explicitly mentioned teaching farm or rural appraisal (see Tables 1 and 2). This limited, but geographically distributed, presence underscores both the importance and fragility of university-based appraisal education nationally. These instructors commonly emphasized project-based learning anchored in the income, cost, and sales comparison approaches, supplemented with highest and best use analysis and written capstone reports. Across institutions, students are explicitly required to define an appropriate scope of work for their appraisal projects, including the intended use and users, property rights appraised, definition of value, and assignment conditions. This step is used pedagogically to emphasize professional independence, ethical responsibility, and analytical discipline, reinforcing that appraisal quality depends on clearly defining the appraisal problem before applying valuation methods. Ethics and non-advocacy principles are reinforced through project design, instructor feedback, and practitioner guest lectures, particularly those provided by local ASFMRA chapters.

One respondent wrote, “*My students complete a full appraisal report—from market analysis to reconciliation—with weekly progress checks.*” Another emphasized guest engagement: “*We invite seven to eight appraisers and auctioneers over the semester to talk about real cases and ethics.*”

The pre-forum survey showed how these courses differ in format. Roughly half are taught annually; others alternate by year depending on faculty availability. Class sizes range from small seminars of 15-20 students to large sections exceeding 100 in introductory agribusiness programs.

Most courses rely on real appraisal reports, Multiple Listing Service (MLS) or public sales data, and geospatial mapping exercises. A few respondents referenced using the ASFMRA (2019) textbook *Valuing Rural America*, or the Appraisal Foundation’s *USPAP Manual*, but many developed in-house materials, such as William Murray’s *Farm Appraisal and Valuation* (Murray et al., 1983) at Iowa State University. The pre-survey also revealed regional clusters of teaching institutions, summarized in Table 2. Together, these institutions represent a modest

but nationally dispersed footprint of formal appraisal instruction. The relatively limited number of standalone courses highlights the reliance on individual faculty champions and strong local chapter partnerships to sustain offerings.

CASE STUDIES FROM THREE LAND-GRANT UNIVERSITIES

We consider three university case studies of how appraisal is taught to explore and understand what topics are covered, which materials are chosen, what teaching methods are used, and what lessons can be learned from their structures. This allows us to gain insight into the current priorities, trends, or shifting areas of focus. Comparing courses across universities exposes differences in teaching emphasis and curriculum design (see Table 3). The appraisal courses of interest for Iowa State University, Texas A&M University, and Auburn University are taught by Drs. Rabail Chandio, Chrystol Thomas, and Mykel Taylor, respectively.

Texas A&M University

The Agricultural Economics Department at Texas A&M University has incorporated appraisal instruction since its founding in 1922 through a *Land Economics* course that includes appraisal components. Over time, *AGEC 432: Rural Real Estate and Financial Analysis* was added for students in the finance and real estate (FRE) track, enrolling more than 130 juniors and seniors each spring and covering investment analysis, agricultural finance, market analysis, and valuation. Both courses are required within the FRE track, and since 2009, students have received Appraiser Qualifications Board (AQB) credit toward licensure through the Texas Appraiser Licensing and Certification Board.

In the early 1970s, under Dr. Ivan Schmedemann's leadership, the department launched the Master of Land Economics & Real Estate (LERE), which later transitioned to Mays Business School as the Master of Real Estate (MRE). Many practicing general appraisers in Texas were trained through these programs, reinforcing strong ties between agricultural economics and professional appraisal and motivating the development of a new course focused exclusively on rural resource appraisal.

The *Principles and Concepts of Resources Appraisal* course, first offered as a mini-mester in summer 2023, has evolved over the years. This transition would not have been possible without the committed support from the Texas Chapter of the ASFMRA, as well as other

real estate and financial institutions across the state. As a result, the course is heavily industry-focused, making it one of a kind in the AGECE department. The three-week hybrid course offers theoretical information online and asynchronously, followed by a week of daily eight-hour in-person application sessions. Appraisal topics are taught in person by Mr. Justin Bierschwale (ARA, MAI), a general appraiser, ASFMRA-certified educator, and member of the ASFMRA, Texas Chapter. The course uses the ASFMRA's *Valuing Rural America: Foundations of Data Analysis* textbook.

The course grading policy includes various assignment types: topic quizzes account for 20%, in-class assignments 20%, the mid-term exam 15%, attendance and participation 15%, and a group project 30%. The project involves a real-world example using an operating farm that students visit. Students are not allowed to choose the property themselves to ensure fairness in grading and to allow the instructor to be familiar with the property. Each student is provided with comparable sales and given the freedom to select at least two comparable properties to help determine the value of the assigned property. Student feedback has been positive; they appreciate having industry leaders in the classroom and the opportunity to apply theory in real-world settings. The hands-on and laid-back nature of the course was noted to create a stress-free classroom environment. One student's feedback on Mr. Bierschwale was, "Holy cow, where to begin? His real-world experience, perspective, and anecdotes were the glue of the class. I could not imagine a better teacher, encouraging, approachable, and who stands out in his profession for his excellence. A role model. Inspiring."

Guest speakers from across the real estate industry provide additional insights to students on the use of appraisal not just as an appraiser but as a real estate agent, financial professional, and individual. Guest speakers from Capital Farm Credit, Capital Ranch Sales, Mays Business School, Kokel-Oberrender-Wood Appraisal, Lewis & Seely Appraisals, Inc., and Above & Beyond Real Estate Services, Inc., have presented to the students over the years. Besides guest-speaking in the classroom, the AGECE department has received donations from Bierschwale Land Company, LLC, and Capital Farm Credit to support course-related expenses. Many real estate and appraisal companies, as well as ag lenders, also offer internship opportunities to students.

Students who complete the course have mostly entered the real estate profession as appraisers, real estate agents, or agricultural lenders, while some have pursued further education in real estate.

The appraisal course is scheduled to transition to a full 16-week format during the fall and/or spring semesters, which will allow the university to reach a broader student audience across the FRE option and other related fields, as well as host at least 10 invited industry guest speakers per semester, further expanding the professional exposure and applied learning aspects of the course.

Iowa State University

At Iowa State University, undergraduate instruction in appraisal is offered annually through a semester-long course titled *Rural Property Appraisal*. This course was taught in the 1970s-1980s by legendary professor Dr. William Murray, who wrote the classic textbook *Farm Appraisal and Valuation*, but it was discontinued for many years. In 2013, it was restarted with initiatives and monetary contributions from the ASFMRA, Iowa Chapter. This is an elective course, primarily taken by junior and senior students majoring in agricultural business or agricultural studies, with a minority of students from other majors, such as agronomy or engineering. Enrollment typically draws students planning a career as farm managers, agricultural lenders, or agricultural sales professionals, with only a small number of students planning to pursue appraisal as a career. Class size ranges from 25-50 students. The curriculum emphasizes the scope of work, highest and best use, and all three approaches to appraisal— income, cost, and sales comparison—while connecting these methods in broader economic theories of land valuation.

A key aspect of the course is the semester-long appraisal project, which accounts for 40% of the grade. Each student selects a parcel of their choice, often a farm to which they are personally connected, and receives approval for the property within the first few weeks of the semester. Then, in the form of four subsequent deliverables, students gradually complete a comprehensive narrative appraisal report, as though presenting to a potential buyer. Students begin by learning about and documenting the parcel's location, ownership history, and characteristics, utilizing software and platforms recommended by professionals. This is followed by collecting comparable sales information, again supported by licensed software, and applying the three appraisal approaches to their chosen parcels, synthesizing everything into a professional final report.

This stepwise structure not only mirrors the appraisal process but also allows students to spend ample time on each step and benefit from the opportunity

to discuss it with an appraiser in the form of a guest speaker. As a student highlighted, "*I think the biggest help was either the in-class assignments or the appraisal project reports that were due throughout the semester. They both related well to the class and helped me piece together what we were learning with how it works in an actual appraisal.*"

The course relies heavily on industry partnerships. ASFMRA guest speakers participate throughout the semester, engaging with students at key stages of their appraisal projects to discuss professional approaches, scope of work, and ethics. Members of the ASFMRA Young Professionals Network (YPN) also highlight career pathways and networking opportunities. Additional speakers, including county assessors, institutional investors, lenders, and real estate brokers, demonstrate how appraisals are used across the broader agricultural industry, strengthening the connection between classroom instruction and professional practice.

Technology integration is another distinctive feature of this course. Students are trained to work with digital resources, including CamoAg, Acres, AgriData's Surety Pro, AcreValue, county assessor databases, and landowners' records at Iowa Land Records. While the county assessor databases and landowner records through Iowa Land Records are publicly available, the other platforms are licensed and require a formal request for use in classroom instruction. Using industry-standard software exposes students to professional standards and best practices.

Overall, Iowa State's *Rural Property Appraisal* course adopts a comprehensive and experiential approach to teaching farmland valuation that is useful for students going to a wide array of careers in agricultural markets, including as farm managers, agricultural sales professionals, agricultural lenders, and every now and then as appraisers, too.

Auburn University

Auburn University has been offering *Farm Appraisal* as a class for many years, giving students an elective that rounds out their agricultural business and economics degree. The class has evolved in recent years by expanding the material covered in class from appraisal methods to include understanding farmland market drivers and the use of statistics to describe land values and the impact of various land characteristics on overall value.

Farm Appraisal is a two-credit course that is referred to as a professional elective at Auburn University. The

idea of the professional elective is to give students exposure to concepts they will encounter in their professional careers, although appraisal is often something that many students will see in their personal lives as well. The class has no prerequisites and, therefore, will have students from freshmen to seniors. This means that the material covered in the class is also relatively basic and is more of a survey class than a deep dive into more complex concepts.

The course begins with an overview of farmland markets and key value drivers, including soil characteristics, production systems, and urban proximity, ensuring students from non-agricultural backgrounds develop a foundational market understanding about Alabama and the nation. The second part of the class teaches the students about sales, income, and cost methods of appraisal. Students survey these methods, with a learning goal of having a basic understanding of the difference between the methods and the data needed to conduct an appraisal.

The final portion of the class focuses on statistics of farmland data, including the ability to perform basic summary statistics and understand the impacts of outliers, leading to basic concepts in data collection and cleaning. The final step introduces students to a simple statistical hedonic land price model used for market analysis and price decomposition, not as a valuation method. This exercise is explicitly framed as an analytical tool for understanding how land characteristics correlate with observed market prices rather than as an appraisal technique. In addition to the prescribed material, students are exposed to professionals in the appraisal field with guest lectures from ASFMRA appraisers located in Alabama. These guest lectures allow students to see how the material they are learning in the classroom translates into professional careers. They are also given assignments to listen to webinars by land professionals in other states and make comparisons to what they know about land markets in Alabama.

Students who have recently taken this class have gone on to work in the fields of agricultural lending and as appraisers for lending institutions, as well as county appraisers.

PEDAGOGICAL DESIGN AND ASSESSMENT

Although instructional approaches vary across institutions, most appraisal courses follow a three-pillar structure encompassing the income, cost, and sales comparison approaches to appraisal. The capstone

appraisal report remains the focal point of learning and assessment, integrating analytical methods with communication and reasoning skills.

Several instructors employ iterative feedback structures to reinforce learning. One instructor noted, *“Students submit sections weekly—market analysis, income, cost—and we reconcile at the end.”* Another model introduced short oral defenses, teaching students to justify adjustments and explain their valuation logic. Forum participants emphasized that communication is as critical as computation in developing appraisal competence, with one remarking, *“We can teach formulas all day, but appraisal is communication.”* Peer review assignments, modeled after journal referee reports, were also cited as effective tools in teaching critical reasoning and concise written justification.

With the world becoming increasingly digital, and numerous new tools and platforms emerging in the land markets industry, incorporating them into the classroom ensures that students are exposed to and can critically engage with the fast-paced changes in technology. In an individual capacity, platforms like AgriData’s Surety Pro Maps (<https://www.agridatainc.com/>), CamoAg (<https://camo.ag/>), Acres (<https://www.acres.com/>), AcreValue (<https://www.acrevalue.com/>), and Growers Edge (formerly Farmland Finder, now rebranded as the RangeAg (<https://insights.farmlandintel.com/>)) have been supportive in providing student access to their licensed software, which allows students to see the amount of real-world data that is available to professional appraisers and the difficulties associated with seemingly subjective decisions. Leveraging them in the classroom through guided assignments and tasks helps students learn the theoretical processes involved in key choices, such as selecting the right comparable sales, while also appreciating the complexity of the decision.

CHALLENGES IN TEACHING APPRAISAL

Several challenges remain when it comes to teaching appraisal.

Serving Students with Different Backgrounds

Many agricultural economics programs now draw students from urban or non-farm backgrounds, and instructors across institutions have reported that students often lack early familiarity with rural land uses and valuation contexts. To bridge this

gap, faculty shared strategies for experiential and contextual learning by showing aerial imagery, sharing assessor records, and doing short site visits. Instructors recommended building storytelling into assignments, asking students to narrate property histories or community significance. These techniques help non-traditional students connect emotionally and intellectually to rural assets. As one instructor summarized at the FutureEd Forum, *“We start with what land means to people before we teach valuation.”*

At Texas A&M, the hybrid format and structured prerequisites allow students with different backgrounds to build the foundational knowledge essential for understanding the rural component of the course. The course textbook reinforces this by introducing what constitutes “rural,” along with clarifying key definitions and concepts essential to understanding appraisal. Additionally, students participate in a site visit, where they gain hands-on experience with rural land and learn what is expected when conducting an appraisal report.

At Iowa State University, a different challenge has emerged in recent years: accommodating out-of-state students whose agricultural experience may differ markedly from Iowa’s row-crop farming context. While local students engage readily with examples specific to Midwestern production systems, students more familiar with specialty crops or new types of agriculture often need additional context. Because the course allows students to select their own subject parcels, those from non-local regions invest extra effort in locating suitable information sources and consulting the instructor to adapt local examples and appraisal frameworks to their chosen properties.

Students at Auburn from a non-agriculture background have not necessarily thought about farmland, its various uses, and the drivers of farmland markets. As such, the course must begin at a foundational level to bring students up to speed before progressing to more advanced concepts.

Finding the Right Structure for Capstone Appraisal Projects

Another challenge lies in student projects. Choosing a parcel of their choice allows students to pick something they are interested in and emotionally connected to, supporting motivation to engage and learn beyond completing a course project. According to one Iowa State University student, this was the most liked aspect of the course: *“[I liked] learning the proper material to give my family feedback on a potential*

piece of farm land we were looking at buying.” However, it creates challenges to finish grading within a fixed timeline, especially when student numbers rise. In addition to grading several individual and unique project assignments, it’s also challenging for the instructors to be familiar with the property and evaluate student decisions in detail. This is likely why institutions have gone different ways for student projects with the course at Texas A&M, i.e., assigning a specific parcel to be appraised, while Iowa State’s course allows students to choose their own subject properties. We also emphasize that regardless of whether students choose their own subject property, the projects were intentionally made simpler, often with a more straightforward, fee simple, market value intent, and a narrower scope of work than reality.

Student Reflections on Learning and Barriers

Across institutions, students consistently valued appraisal courses that connected theory to practice. Auburn students appreciated learning how soil type, parcel size, and other characteristics affect value and hearing from “real appraisers who explain what happens beyond the textbook.” At Texas A&M, feedback emphasized the hands-on, industry-led format, while Iowa State students highlighted the semester-long appraisal project, structured checkpoints, and individualized feedback as central to their learning. As one student noted, completing a full report “made everything come together.” Guest lectures were widely praised for demonstrating how the income and cost approaches operate in professional settings. Overall, students learned most when rigorous valuation methods were reinforced through applied projects and practitioner engagement.

Students also identified recurring challenges, particularly locating reliable comparable sales data and managing report logistics. Some noted inconsistencies across county data systems, uncertainty about formatting expectations, and timing mismatches between guest lectures and project milestones. Across campuses, many students expressed interest in appraisal careers, yet internship opportunities remain limited due to required supervised training hours and the small scale of many appraisal firms. These reflections suggest that clearer scaffolding, shared data guidance, and closer alignment between coursework and practitioner contributions could further strengthen an already highly valued educational experience.

Evolving Influences on the Land Markets

Technological and structural shifts are reshaping how land markets are analyzed and valued. The emergence of automated valuation models (AVMs) and artificial intelligence (AI) represents such a change and warrants classroom attention, but it can be hard to figure out to what extent to teach that material when the impacts on the profession are rapidly changing and remain uncertain. Some mapping and data platforms used in coursework now include embedded AVM features, giving students a glimpse of how algorithmic valuation tools operate. However, their integration in the class or teaching remains introductory and is limited to a conceptual overview of how such models estimate value and the professional judgment still required to interpret their results.

Beyond technology, broader market forces such as foreign investment, renewable energy development, and evolving government policies may also influence land markets. At Auburn University, a dedicated lecture on foreign agricultural investment provides students with an alternative perspective on how state and federal policies can influence land markets, in addition to serving as a break from the appraisal methods. Similarly, the Iowa State University course introduces students to the valuation implications of wind and solar leases, as well as conservation and government payment programs to highlight how non-traditional income streams (whether from renewable energy or policy incentives) can also be considered through the income approach. The course also includes a dedicated lecture to discuss how bankers and agricultural lenders use appraisals. At Texas A&M, students learn about the role of appraisal in agricultural financing, as well as specialty appraisal topics presented by invited guest speakers. The specialty topics discussed by the general appraisers include vineyards, production agriculture, recreational properties, agricultural facilities, and conservation.

OPPORTUNITIES AND BEST PRACTICES FOR STRENGTHENING APPRAISAL EDUCATION

Several local chapters of the ASFMRA currently have informal partnerships with educational institutions and participate in the classrooms as guest speakers and lecturers, contributing to the success of the university-based appraisal courses. Including professionals like appraisers in the classroom enriches discussion by

connecting academic concepts to real-world practice and problem-solving. Their firsthand experience helps students see how learning applies beyond school, making lessons more relevant, engaging, and practical.

Professional Standards, Ethics, and Mentoring

Professional standards, including USPAP, ethical obligations, scope of work development, and highest and best use analysis, are integral components of university appraisal instruction. These topics are frequently reinforced through guest lectures and applied examples provided by ASFMRA chapter members, helping students connect classroom learning with professional expectations and practice. Courses that incorporate the Uniform Standards of Professional Appraisal Practice (USPAP) and ASFMRA's Rural Valuation Topics (ASFMRA 2025) provide students with a tangible link to the profession's ethical and procedural foundations. As Dr. Chrystal Thomas from Texas A&M remarked at the Forum, "*The more students see the actual forms and standards, the more they appreciate the rigor of the field.*" Including the ASFMRA textbook can prove highly useful, especially given the increase in students from non-farming and non-traditional backgrounds.

The Forum's discussion on mentoring highlighted gender and generational inclusion as well. "*Visibility matters,*" Dr. Mykel Taylor said. "*When students see women and early-career appraisers, they imagine themselves there.*" Several ASFMRA chapters expressed commitment to establishing student-mentor partnerships tied to university appraisal projects, combining faculty supervision with a local professional reviewer.

Utilizing the Young Professionals Network

An opportunity lies in increasing the role of the YPN by directly interacting with and inviting aspiring appraisers and farm managers to join the organization. Greater YPN participation in classrooms would not only introduce students to the professional community at an earlier stage but also facilitate natural mentorship linkages and deeper exposure to professional standards such as USPAP. Such engagement helps students better understand the expectations of the profession and fosters long-term connections that can extend into internships and early-career guidance. Meaningful collaboration with YPN members also provides a practical pathway for chapters to identify and coordinate guest speakers, further strengthening

the connection between local ASFMRA chapters and academic institutions.

Sustaining and Scaling Courses

One recurring theme at the forum was the fragility of appraisal course offerings within universities. Perhaps the most candid exchange came near the session's close: "We're one retirement away from losing our appraisal class," a faculty member admitted. This sentiment, echoed across institutions, sparked a broader conversation about course continuity.

Participants suggested an ASFMRA "teaching commons," where instructors can share syllabi, datasets, and recorded guest lectures. This would reduce duplication, ease onboarding for new faculty, and ensure consistent professional framing.

Build the Teaching Commons and Guest Speaker Network

To strengthen the connection between academia and the profession, an opportunity lies in ASFMRA curating a central resource hub, a shared repository of instructional materials such as sample case studies, grading rubrics, and recorded guest lectures. Making these resources accessible to all academic members and organized by topic and level of complexity would help new and existing instructors more easily integrate appraisal content into their courses.

At the regional level, local chapters could coordinate a guest speaker network, maintaining a shared spreadsheet of professionals by state and area of specialization. This structure would allow chapters to offer consistent classroom engagement and ensure that every program, regardless of size, has access to practicing appraisers and industry perspectives. As one forum participant observed, "If every chapter gives one guest lecture a semester, no program goes unsupported."

Ultimately, the discussions at the FutureEd Forum showed that revitalizing appraisal education is not a one-time effort but an ongoing collaboration between universities and ASFMRA. As one panelist concluded, "If we share what works, the students—and the profession—will follow."

CONCLUSION

The 2025 FutureEd Forum confirmed that while appraisal instruction remains strong in several flagship programs, its national presence is uneven

and vulnerable. Courses at Iowa State, Texas A&M, and Auburn demonstrate that effective appraisal education integrates valuation theory, applied analysis, and professional engagement. Yet most programs depend on a small number of faculty champions—often a single instructor—making them susceptible to turnover and resource constraints. Building a stronger, more connected network of instructors through shared materials, guest speaker networks, and ASFMRA-supported training will be essential to sustain appraisal education nationwide.

Forum discussions and student feedback alike emphasize that students learn best when rigorous valuation methods are paired with hands-on, data-driven, and mentored experiences. They value project-based assignments, timely feedback, and direct interaction with practicing appraisers. Incorporating modern data tools such as Acres, CamoAg, and SuretyPro, along with consistent use of USPAP and ASFMRA teaching resources, strengthens alignment between classroom learning and professional expectations. Expanding ASFMRA's YPN participation, supporting internship pipelines, and sharing teaching modules across universities could bridge educational and workforce gaps while helping attract new and motivated entrants to the field.

Sustaining the next generation of rural appraisers will require ongoing collaboration between academia and the profession. The FutureEd Forum demonstrated that revitalizing appraisal education is not a one-time initiative but an evolving partnership—one that thrives when universities and ASFMRA chapters share innovations, respond to market and technology shifts, and mentor new educators. By linking classroom instruction with the profession's evolving needs, ASFMRA and its academic partners can ensure that appraisal education remains relevant, inclusive, and essential to the stewardship of America's agricultural and rural assets.

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Table 1. Instructor Survey and FutureEd Forum Appraisal-Highlights

Metric	Value
Respondents mentioning teaching farm management	13
Respondents mentioning teaching appraisal	6
# academic members at FutureEd Forum	31 (in-person and online)
Most common appraisal topics (top 5)	Sales comparison approach, farm appraisal project, income approach, cost approach, highest and best use

Table 2. Geographic Distribution and Teaching Frequency of Appraisal Courses

Institution	Avg. Class Size	Course Structure	Teaching Frequency
Texas A&M University	20-25	Standalone, industry-led <i>Rural Appraisal</i> hybrid course	Annually
South Dakota State University	34-62	Sequence of two courses: <i>Farm and Rural Appraisal</i> and <i>Advanced Farm and Rural Appraisal</i>	Annually
Auburn University	40	Standalone <i>Farm Appraisal</i> course	Annually
Iowa State University	40	Standalone <i>Rural Property Appraisal</i> course	Annually
University of Nebraska*	NA	Standalone <i>Agricultural and Rural Property Appraisal</i> course	Annually

* Did not participate in the survey.

Table 3. Detailed Comparison of Appraisal Class at Iowa State, Texas A&M, and Auburn

Topics	ISU	Texas A&M	Auburn
Course Title	<i>Rural Property Appraisal</i>	<i>Principles and Concepts of Resources Appraisal</i>	<i>Farm Appraisal</i>
Year Class Started	Taught in 1970-'80s, restarted in 2013	2023	It's been offered for decades
Class Time & Frequency	Twice a week, 75 min, offered once a year	Mainly offered as a mini-mester (3 weeks hybrid course); theoretical information is provided online and asynchronously followed by in-person for application (8 hours)	Twice a week for 50 minutes, offered once a year
Class size	25-50	20-25	35-45
Student Majors	Primarily ag business, ag studies, agronomy	Primarily agricultural economics, ag business, & animal science	Agricultural business and other ag majors
Student Years	Sophomores through seniors	Sophomores through seniors	Freshmen through seniors
Required vs Elective Class?	Elective	Elective	Elective
ASFMRA Involvement	Guest speakers for content, Young Professional Network (YPN) for career	Industry-led course with ASFMRA, Texas Chapter	Guest speakers, some slides/material from the Valuing Rural America textbook
Appraisal Project Details			
Project Subject Property Chosen by Students?	Yes	No	No
Appraisal Approaches Covered	All three	All three	All three
Appraisal Approaches & Key Concepts Covered	Land valuation economic theory, understanding land markets and drivers of land value, highest and best use, reconciliation	Topics covered from the <i>Valuing Rural America: Foundations of Data Analysis</i> textbook include the appraisal process, property rights and interests, land valuation, reconciliation, highest & best use, depreciation	Understanding land markets and their drivers, use of statistical methods to understand land price data
Other non-ASFMRA Guest Lecturer	County assessors, institutional investors, and sometimes ag lenders	Real estate agents, financial professionals, and real estate educators	Real estate agents
Student Career Goals (if Known)	Farm managers, ag lenders, ag sales, farming, potential appraisers	Trainee appraisers, real estate agents, ag lenders, graduate degree in real estate	Agricultural lenders, farming, sales, agricultural policy
Computer Technology	TopHat, CamoAg, Acres, Agridata SuretyPro, assessor databases	Google Earth; assessor databases	Limited, but have plans for Acres platform

Submission Guidelines

JOURNAL OF THE ASFMRA

The *Journal of the ASFMRA* is an open-access online journal published each year by the American Society of Farm Managers and Rural Appraisers. The *Journal's* editorial board consists of the editor and members of the ASFMRA Editorial Task Force, which includes academic and professional members of the ASFMRA. It is a refereed journal, with the Editorial Task Force serving as peer reviewers.

The *Journal of the ASFMRA* seeks to publish manuscripts that discuss cutting-edge farm management, rural appraisal, and/or agricultural consulting practices, as well as recent research projects whose findings are relevant to professional farm managers, rural appraisers, and agricultural consultants. Academics and industry professionals are encouraged to contribute their expertise by submitting manuscripts for publication. The *Journal* seeks to be the first resource that academic and industry practitioners turn to for state-of-the-art information on the rural property professions.

OBJECTIVES

The objectives of the *Journal* are to:

1. Present papers relevant to farm managers, rural appraisers, agricultural consultants, academics, students, and others interested in the rural property professions.
2. Encourage practical problem-solving contributions highlighting established and cutting-edge farm management, rural appraisal, and agricultural consulting principles and practices.
3. Provide academic authors an opportunity to publish their practical research, and industry professionals an outlet to share their "from the field" experience, in order to reach a broad audience.

AUTHOR GUIDELINES FOR SUBMITTING MANUSCRIPTS

To submit a manuscript for publication consideration in the *Journal of the ASFMRA*, please send all required materials as email attachments to Publications@asfmra.org, using the following guidelines to prepare the submission:

1. **Cover Letter.** In a cover letter accompanying the manuscript, (a) indicate why the manuscript would interest *JASFMRA* readers; (b) certify that the material in the submitted manuscript (or modification thereof) has not been published, is not being published, and is not being considered for publication elsewhere; and (c) stipulate that the material in the manuscript, to the best of the author's knowledge, does not infringe upon other published material protected by copyright.
2. **Title Page.** On a separate page, provide the title of the manuscript and author(s)' name(s) centered and in boldface type. At the bottom of the same page, provide authors' title(s); institutional affiliation(s); and acknowledgments of colleague reviews and assistance, and institutional support, as appropriate. Please provide the corresponding author's address, phone number, and e-mail address. Do not place the name(s) of the author(s) on the first page of the text.
3. **Abstract.** Include an abstract of 100 words or fewer.
4. **Manuscript Title.** Manuscript titles should not exceed ten words, should encompass the topic of the paper, and should be designed to attract potential readers.
5. **Style, Grammar, and Punctuation.** The *JASFMRA* uses *The Chicago Manual of Style* by the University of Chicago Press, and *Webster's Third New International Dictionary* for style, format, and spelling.
6. **Manuscript Format Guidelines.** Manuscripts should be approximately 5,000 words in length or fewer, not counting the references or footnotes. Manuscripts must be submitted as Microsoft Word documents, double-spaced using 12-point Times New Roman font. Please use left justification and allow 1" margins on all sides. All pages and lines must be numbered, with line numbers running consecutively throughout the manuscript.

7. Footnotes. Number footnotes consecutively throughout the manuscript. Combine all footnotes on a separate page immediately following the manuscript text, rather than at the bottom of manuscript pages.

8. References/Text Citations. In a reference section immediately following the footnotes page, list all works cited in the text, alphabetized by author last name. Refer to *The Chicago Manual of Style* for formatting. For within-text citations (either parenthetical or as part of narrative), spell out up to three author last names; use first author's name followed by "et al." for works with four or more authors. When citing a direct quotation, include page number(s) from the author's work. List complete URLs for online sources.

9. Figures and Tables. Place each table, chart, figure, and/or photo on a separate page within the manuscript at its first mention. Include a short, self-contained title/caption for each. Please also include a separate Microsoft Excel version of each table and chart, and a separate high-resolution image for each figure or photo (.pdf, or .jpg format).

10. Math/Equations. Use only essential mathematical notation with equations consecutively numbered throughout the text. When displaying equations, place equation number within parentheses at flush-left margin and center the equation. Use italic type for all variables, both within equations and within the narrative.

11. Submission Deadline. In general, September 15th of each year is the deadline to submit a manuscript for publication in the following year's Journal.

12. The Editorial Review Process.

- a. The Chair of the ASFMRA Editorial Task Force, serving as Editor, assesses the initial suitability of articles submitted.
- b. Authors of submissions considered to be potentially suitable for the *JASFMRA* will be notified and their paper sent to three members of the ASFMRA Editorial Task Force, who will review the article for the Editor.
- c. Unsuitable articles are returned to the authors with a short note of explanation from the Editor. Failure to adhere to the Manuscript Format Guidelines will be cause for the manuscript to be returned to the authors.

- d. The review process is double-blind: The identity of the author(s) remains anonymous to the reviewer and vice versa.
- e. Following review, authors may be asked to resubmit their article in revised form for additional review.
- f. Upon completion of the review and editorial processes, authors will be notified of the Editor's decision regarding publication along with explanatory feedback, including reviewers' reports.
- g. Decisions on submitted manuscripts will be made following the Editorial Task Force's meeting at the ASFMRA Annual Conference each November, with notifications generally sent to corresponding authors by early December. The decision of the Editor is final.

13. Publication Costs. Authors submitting manuscripts are expected to assume obligation for payment of page charges at the time their manuscripts are published. Current page charges are \$95/printed page for non-members and \$80/page for ASFMRA members.

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