Input Procurement Behavior in United States Agriculture: Evidence and Insights from the National Level Data

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Abstract

The sharp rise in fertilizer and fuel costs during 2021 and 2022 underscored the importance of input procurement strategies of U.S. farms. Empirical evidence on how producers implement these strategies is limited, as procurement behavior is difficult to measure. We use the 2021 Agricultural Resource Management Survey (ARMS) data (the only year) to measure adoption decisions and intensity of fertilizer procurement strategies. These strategies include supplier shopping (shop around), buying-club participation, using advice or services, and forward pricing. We characterize these behaviors across farm and operator characteristics using predicted probabilities and average marginal effect. Results indicate heterogeneity in fertilizer procurement behavior. Specifically, evidence indicates that larger farms are more likely to have higher adoption of supplier shopping, advisory service use, and forward pricing. However, buying-club participation remains limited regardless of farm size. Results also show that commodity specialization is important and affects participation in different strategies. In particular, corn, soybean, and other cash-grain operations have relatively higher adoption of several fertilizer procurement strategies than livestock production specialization farms. The results also suggest that the share of fertilizer forward contracts and its expenditures are also associated with input acquisition strategies and farm characteristics.

Disclaimer: The findings and conclusions in this presentation are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

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Introduction

A sequence of input price shocks in 2021 and 2022 reshaped the input cost environment facing United States agriculture. Fertilizer and fuel prices rose sharply during this period. These increases squeezed farm profitability and heightened the need to better understand how producers procure major inputs. Procurement decisions such as timing of purchase, contract form, and supplier choice became central components of producer margin management. Our study attempts to understand producer strategies using clearly defined ARMS questions from 2021 to operationalize adoption and intensity of input procurement strategies. More explicitly: this paper examines how data from ARMS 2021 questions on shopping across suppliers, buying-club participation, advisory services, negotiated discounts, and forward pricing can be used to quantify the procurement strategies and describe variation across farms.

Evidence from national indices and industry reporting shows sharp increases in fertilizer and fuel prices during this period, with substantial heterogeneity across input classes and purchase windows (ERS, 2022; Schnitkey, Swanson, & Paulson, 2021). Nitrogen fertilizers experienced pronounced runups coincident with increases in natural gas prices—the key cost driver in nitrogen production—intensifying the salience of purchase timing (ERS, 2022; Hendricks & Sumner, 2014). Diesel prices also rose markedly, reasserting fuel procurement and storage decisions as material cost levers (EIA, 2026).

Classic theory models forward purchasing under uncertainty as a choice that trades risk reduction and expected cost savings, with contract terms and discount magnitude shaping adoption. Studies of farm operator's purchasing behavior suggest that price tends to dominate decision criteria for fertilizer while product performance tends to dominate for crop protection and seed. These patterns are consistent with differences in product differentiation and yield risk across input categories and reinforce the idea that measurement should be input specific rather than uniform across all inputs. Reviews of agribusiness supply chain risk emphasize the need for quantitative measurement tools adapted to agriculture, given perishability, seasonality, and bulk logistics that create distinct vulnerabilities. Work on input hedging documents limited adoption in practice, reflecting basis variability and transaction costs, although new instruments have lowered conceptual barriers to input cost hedging. Together, these literatures motivate a focus on measurement of adoption, intensity, and timing of input procurement strategies (Haydu, Myers, and Thompson 1992; Behzadi, O Sullivan, Olsen, and Zhang 2017; Brown 2026; CME Group 2026; Thome e Castro 2023; Keshavarz and Robinson 2025).

While prior studies provide important insights into input procurement decisions, nationally consistent evidence on how producers implement specific procurement strategies remains limited. A central challenge in addressing this gap is measuring input procurement behavior. Inputs differ in quality and performance, contract terms vary across suppliers and regions, and purchase timing interacts with seasonal demand and storage constraints. These features require clear definitions of adoption and intensity that can be applied consistently across farms and inputs. The 2021

Agricultural Resource Management Survey captures input procurement behavior through direct questions on shopping across suppliers, buying groups or alliances, negotiated discounts, advisory services, and forward pricing. This paper translates these survey responses into a structured set of adoption and intensity metrics that can be reported in a nationally consistent way and characterizes the adoption and intensity of procurement strategies across farm structures and commodity specializations.

The 2021 episode offers an informative case study because ARMS includes these procurement questions only that year. Our key findings indicate that larger farms consistently show higher adoption and intensity of procurement strategies. Furthermore, crop farms, particularly corn, soybean, and other cash-grain operations, show higher adoption than livestock farms. In addition, forward pricing shows economically significant differences across farm size and commodity specialization. Overall, the findings imply systematic differences in input procurement strategies for fertilizer across U.S. farms.

Data

Our analysis uses the 2021 ARMS data. ARMS is the USDA's primary source of national data on farm production practices, financial performance, and household characteristics. The survey is administered jointly by the Economic Research Service (ERS) and the National Agricultural Statistics Service (NASS) and is nationally representative. To ensure national representativeness, all empirical estimates use the survey's jackknife replicate weights, and all additive statistics pass USDA's standard disclosure and dominance tests.

The 2021 ARMS included a block titled *Farm Management Practices*, which collected data on whether farm operations used procurement strategies for inputs such as seeds, fertilizer, chemicals, fuel, and feed. Specifically, respondents reported whether they employed: (1) supplier shopping ("shop around"), (2) buying-club participation, (3) use of advice or services, (4) negotiated price discounts, and (5) forward pricing (USDA NASS 2021; ERS 2022).

Table 1 reports weighted means and proportions for key variables in the estimation sample of 11,049 farms. The results show that shopping around is the most common fertilizer price-management strategy, with an average usage rate of about 0.21. In contrast, buying-club participation (0.01), the use of advice services (0.04), and forward pricing (0.05) occur much less frequently. Across all farms, the average share of fertilizer that is forward priced is roughly 27 percent, meaning that farms typically lock in about one-quarter of their total fertilizer needs.

Farm structure is dominated by small and nonfamily farms: small operations (gross cash farm income [GCFI] < $350,000) account for about 40 percent, midsize farms (GCFI $350k–$999k) roughly 5 percent, and large and very-large farms (GCFI ≥ $1 million) around 3 percent. Commodity specialization is concentrated in cattle (≈ 38 percent) and specialty/miscellaneous crops (≈ 43 percent). Operator age skews older: less than 10 percent are under 45, about

46 percent are aged 65 or above. Nearly 88 percent of farms are family or individual operations, and about 74 percent of operators are married.

A farm is considered “specialized” in a specific commodity if over 50 percent of its gross cash receipts derive from that commodity. In our Table 1, “specialty” includes farms where more than half of production receipts come from horticulture, fruits, vegetables, tree nuts, or nursery crops. Table 1 reports survey-weighted farm-level ratios without trimming or winsorization. We retain all farms in the sample regardless of whether they hold debt or earn profits. Because only about one quarter of U.S. farms report any debt, the distribution of the debt-to-asset ratio becomes highly skewed (Subedi and Giri 2024). Many farms have a debt-to-asset ratio of zero simply because they carry no debt at all, while farms that do borrow can have very high ratios, particularly when their asset values are small. In a similar way, operating profit margins can be strongly negative for farms that experience losses. These characteristics mean that the survey-weighted averages may look unusual at first glance, but they should be understood as describing the entire distribution of farms rather than representing typical or central values.

Table 1. Summary Statistics (Weighted Means and Standard Errors)

Variable	Estimate	Std. Err.
Behaviors		
Shop around	0.2095	0.0089
Participate in buying club	0.0098	0.0019
Use advice/services	0.0375	0.0029
Forward pricing	0.0460	0.0022
Share forward-priced	0.2725	0.0182
Financial Indicators		
Operating Profit Margin (%)	–111,369.2	30,476.6
Debt-to-Asset Ratio (%)	682.24	41.71
Farm		
Small	0.4029	0.0103
Midsize	0.0492	0.0015
Large+Very large	0.0256	0.0008
Nonfamily/Other	0.5222	0.0101
Commodity Groups		
Poultry/eggs	0.0241	0.0040
Corn	0.0632	0.0030
Soybeans	0.0460	0.0045
Hogs	0.0082	0.0020
Cattle	0.3832	0.0085
Other cash grains	0.0324	0.0018
Cotton	0.0030	0.0006
Dairy	0.0053	0.0005
Specialty/misc	0.4346	0.0099
Operator Age		
<45	0.0923	0.0059
45–54	0.1142	0.0066
55–64	0.3313	0.0103
65+	0.4622	0.0106
Legal Type		
Family/Individual	0.8799	0.0053
Partnership	0.0605	0.0036
C-corp	0.0136	0.0015
S-corp	0.0263	0.0035
Other	0.0196	0.0032
Married	0.7442	0.0137

Notes: Summary statistics are based on 11,049 survey-weighted observations. Estimates and standard errors are reported as survey-weighted means.

Empirical Identification Strategy

Procurement of fertilizer and fuel exposes farms to price variation that is linked to seasonality, inventory cycles, and global shocks. Under uncertainty, producers adopt strategies that reduce risk

or expected costs when benefits exceed information and transaction costs. Larger operations generally face lower per-unit search and contracting costs and often possess greater managerial capacity. Organizations with more formal governance, such as partnerships and corporations, may rely more on structured purchasing processes and external information sources. Commodity specialization influences procurement behavior. Crop systems with seasonal nutrient demand have strong incentives to manage price risk, while livestock systems tend to show more stable nutrient demand. These considerations motivate a measurement approach that defines adoption, intensity, and timing in a way that can be consistently applied across farm structures and commodity types (Anderson and Dillon 1992; Williamson 1985; Grossman and Hart 1986; Hendricks and Sumner 2014).

The paper presents modeling templates that treat shopping, buying groups, advisory services, and forward pricing as jointly determined choices influenced by observed farm characteristics and an unobserved managerial factor. The templates are designed for use with appropriately constructed national measurement data. Farm structure plays an important role in the adoption of such behaviors. Larger farms tend to have lower per-unit search and contracting costs and greater managerial capacity, making them more likely to adopt procurement strategies (Williamson, 1985). Governance models also suggest that organizational forms with multiple decision-makers—such as partnerships or corporations—may rely more heavily on formal information sources and structured purchasing processes (Grossman & Hart, 1986). Commodity specialization may influence adoption as well, since fertilizer demand is more seasonal and price-sensitive in crop systems than in livestock systems (Hendricks & Sumner, 2014).

These strategies may result in correlated decisions driven by common unobserved factors such as managerial sophistication, information access, risk preferences, or supply-chain relationships. To account for this, we estimate a multivariate probit model that allows the binary adoption decisions to be jointly determined. Correlation across the adoption equations is captured using a shared latent factor, following econometric work on jointly determined binary outcomes (Li & Ullah, 1998). In addition, the intensity of forward pricing—the proportion of fertilizer purchased under a forward price—is modeled using a fractional response framework designed specifically for variables constrained to the unit interval (Papke & Wooldridge, 1996). Finally, to examine the economic effect of forward pricing on fertilizer expenditures, we estimate an instrumental variables model, with upstream adoption behaviors serving as theoretically grounded instruments (Wooldridge, 2010).

Econometric Specification

This study employs three econometric models to distinguish: the adoption, intensity, and expenditure dimensions of fertilizer procurement. The first model addresses the adoption of four procurement strategies, the second model examines forward pricing intensity, and the third model assesses the relationship between forward pricing intensity and fertilizer expenditures.

Let Y_{ik} denote adoption of procurement strategy (k) by farm (i), where each farmer i makes

four adoption decisions:

$$Y_{i1} = \text{shop around}, Y_{i2} = \text{buying club}, Y_{i3} = \text{advice/services}, Y_{i4} = \text{forward pricing}.$$

The corresponding latent variable specification becomes:

$$Y_{ik} = 1\{\eta_{ik} > 0\}, k = 1, \dots, 4 \quad (1)$$

and

$$\eta_{ik} = \alpha_k + X_i'\beta_k + \lambda_k U_i + \varepsilon_{ik} \quad (2)$$

where α_k is an equation-specific intercept, while β_k is a vector of coefficients on observed covariates for equation k. Other parameters in the model include a shared latent factor (U_i) capturing unobserved managerial ability, information capacity, and risk-management propensity, loading of the latent factor onto adoption behavior k (λ_k), and the disturbance term (ε_{ik}).

The vector (X_i) includes farm size, commodity specialization, operator characteristics, legal structure, and financial characteristics. Farm size follows the USDA's Economic Research Service (ERS) typology and distinguishes Small, Midsize, Large + Very Large, and Nonfamily operations (defined above), with small farms serving as the reference group. Commodity specialization is defined according to the farm's primary commodity enterprise and includes poultry/eggs, corn, soybeans, hogs, cattle, other cash grains, cotton, dairy, and specialty/miscellaneous production, with poultry/eggs as the reference category. For the buying-club equation, hogs and cotton are combined with other cash grains because of limited observations. Operator characteristics include age group and marital status. Similarly, the operations' legal structure includes family or individual operations, partnerships, C-corporations, S-corporations, and other organizational forms. Operating profit margin and the debt-to-asset ratio control for farm financial conditions. Note that survey-weighted jackknife replicate estimation is used to ensure results represent the full U.S. farm population.

Among farms reporting fertilizer purchases, ARMS also identifies the percentage of fertilizer purchases for which the price was locked in. Using this information, we construct forward-pricing intensity, (θ_i), defined as the share of fertilizer purchases made under a locked-in price (percent locked), where:

$$\theta_i \in [0,1] \quad (3)$$

Because $\theta_i$is a proportion bounded in the unit interval, we estimate a fractional logit model:

$$E[\theta_i \mid X_i] = \Lambda(X_i'\gamma), \quad (4)$$

where, $\Lambda(\cdot)$ is a logistic function and γ represents the coefficient vector governing how observable farm characteristics affect intensity of forward pricing. The parameter $X_i'\gamma$ measures marginal effects of covariates on the log-odds of forward-pricing intensity, and θ_i measures the expected share of fertilizer forward priced for farmer i. The above equation uses the same covariates as the probit equations, allowing consistent comparison across adoption and intensity.

To study whether forward pricing affects fertilizer expenditure, we link fertilizer expenditures to forward-pricing adoption and observed farm characteristics:

$$\text{FertExp}_i = \delta_0 + \delta_1 \widehat{Y_{i4}} + X_i'\delta_2 + \nu_i, \qquad (5)$$

where:

- Y_{i4}= forward-pricing adoption indicator,
- $\widehat{Y_{i4}}$= fitted values from the first-stage instrumented equation,
- X_i= covariate vector defined above,
- δ_1= causal effect of forward pricing on expenditure.

Forward-pricing adoption may be endogenous because farms that choose to lock in fertilizer prices may differ systematically from nonadopters in unobserved characteristics that also affect fertilizer expenditures. To address this concern, forward-pricing adoption is instrumented using upstream procurement behaviors, i.e.

Z_i = (shop around, buying club, advice/services),

First-Stage Equation (Forward-Pricing Adoption)

To recover the fitted value $\hat{Y}_{i4}$used in the second stage, the first stage relates forward-pricing adoption to the excluded instruments and all included covariates:

$$Y_{i4} = \pi_0 + \pi_1 Z_{i1} + \pi_2 Z_{i2} + \pi_3 Z_{i3} + X_i'\pi_4 + \omega_i, \qquad (6)$$

where

• Y_{i4}= forward-pricing adoption indicator (binary)
• Z_{i1}, Z_{i2}, Z_{i3}= "shop around," "buying club," and "advice/services"
• X_i= full covariate vector (farm size, commodity specialization, operator age, legal structure, OPM, DAR, marital status)
•ω_i= first-stage disturbance term
• π= first-stage parameters

The fitted values from this equation are: $\hat{Y}_{i4} = E[Y_{i4} \mid Z_i, X_i]$. These fitted values are obtained using the instrumented probit first stage under the survey jackknife replicate design.

Second-Stage Equation (Fertilizer Expenditure)

The structural IV equation evaluates whether forward pricing causally affects fertilizer spending:

$$\text{FertExp}_i = \delta_0 + \delta_1 \hat{Y}_{i4} + X_i' \delta_2 + \nu_i, \quad (7)$$

where

• FertExp_i= fertilizer expenditure for farm i
• $\hat{Y}_{i4}$= instrumented forward-pricing adoption (from the first stage)
• X_i= same covariates as in the multivariate probit and fractional logit
• δ_1= causal impact of forward pricing on expenditure
• ν_i= second-stage disturbance term

which affects the likelihood of adopting forward pricing through managerial processes (search, coordination, information acquisition) but do not directly determine fertilizer spending except through adoption.

We estimate the IV model using ARMS jackknife weights for representativeness and compute supplemental non-survey diagnostics (first-stage F-statistics and overidentification tests) for transparency.

Results

We report average marginal effects (AMEs) and predicted probabilities for each fertilizer procurement strategy across farm and operator characteristics from multivariate probit. We also report AMEs for fractional logit and second-stage estimates for the IV-2SLS model. For interpreting the AMEs, the reference categories are small farms for farm size, poultry/eggs for commodity specialization, operators under age 45 for age, family or individual operations for legal structure, and unmarried operators for marital status.

Effects on Shop Around Behavior

Table 2 shows the AMEs and predicted probabilities from multivariate probit for shop around behavior. Results show that larger farms are more likely to shop around for fertilizer prices than smaller farms, which likely reflects larger farm's stronger managerial capacity and better access to information. Nonfamily operations and relatively older operators are less likely to shop around. Farms with formal legal structures and married operators have higher propensity to shop around. Farms engaged in crop-oriented sectors, especially cotton, dairy, and other cash grains, are more likely to shop around than those engaged in livestock sectors.

On the magnitude of predicted probabilities (table 2), a high magnitude of 0.482 for Large+Very large farms indicate that these operations are nearly twice as likely to shop around for fertilizer prices than small farms (with predicted probability of 0.217). Midsize farms also have notably higher predicted probability, while nonfamily farms have considerably lower probability. These

patterns indicate that managerial structure, household composition, and commodity specialization play significant roles in shaping shop around behaviors, an indication of price search motives. The magnitude of AMEs, which show the partial effects associated with the particular variable, is overall consistent with our discussion presented for predicted probabilities. For example, a high AME of around 0.16 on Large+Very large variable suggests that having a large or very large operation increases the likelihood of shopping around behavior by 16 percentage points over the small farms, the base category. We also found that farm businesses' formal legal structure could significantly affect shopping around behavior—marginal effects of C-corp, S-corp, and partnership business structures, suggest that having these business structure, over the individual or self-proprietorship, are associated with around 15, 7, and 5 percentage higher likelihood of shop around behavior, respectively. Finally, the AMEs on age of the principal operator shows that relatively older principal operators aged 55-64 and those above 65, are around 9 percentage points less likely to shop around as compared to younger principal operators below 45.

Table 2. AMEs and Predicted Probabilities from multivariate probit for Shop Around Behavior

Category	Estimate	Std. Err.
Predicted Probabilities		
Small	0.2174	0.0113
Midsize	0.3922	0.0159
Large+Very large	0.4821	0.0265
Nonfamily/Other	0.1722	0.0143
AMEs		
Midsize	+0.0925 ***	0.0230
Large+Very large	+0.1595 ***	0.0284
Nonfamily/Other	–0.0603 ***	0.0159
Selected		
Married	+0.0551 **	0.0217
Partnership	+0.0562 **	0.0273
C-corp	+0.1559 *	0.0898
S-corp	+0.0713 *	0.0395
Age 55–64	–0.0960 **	0.0403
Age 65+	–0.0947 *	0.0463

Notes: *** = statistically significant at the 1% level ($p < 0.01$); ** = statistically significant at the 5% level ($p < 0.05$); * = statistically significant at the 10% level ($p < 0.10$). ** Predicted probabilities and average marginal effects (AMEs) are reported in probability units.

Effects on Buying Club Participation

Table 3 shows the AMEs and predicted probabilities from multivariate probit for participation in buying clubs. Overall participation is very low across all farm sizes, suggesting that buying clubs are not widely adopted strategies in fertilizer procurement decisions. Differences across farm size

classes are minimal. However, higher magnitude of AMEs of crop-commodity type than those in farm size or scale factors also indicate that crop-oriented commodity conditions drive buying-club participation than scale or size of the operation.

The predicted probability for Large+Very large farms is 1.6% (shown by 0.016 magnitude), which is the highest among farm-size types, but still at a critically low rate, while small farms have the lowest probability of participation. On the other hand, the marginal effects of crop or commodity type (corn, soyabean, cash and specialty crops type farms) are notable to derive that the crop specialization likely plays a more important role than scale of operation in club participation decisions.

Table 3. AMEs and Predicted Probabilities from multivariate probit for Participation in Buying Club

Category	Estimate	Std. Err.
Predicted		
Small	0.0077	0.0027
Midsize	0.0120	0.0037
Large+Very large	0.0163	0.0050
Nonfamily/Other	0.0110	0.0044
Commodity		
Corn	+0.0158 ***	0.0051
Soybeans	+0.0186 *	0.0105
Specialty/misc	+0.0117 **	0.0050
Other cash grains	+0.0065 ***	0.0023

Notes: *** = statistically significant at the 1% level ($p < 0.01$); ** = statistically significant at the 5% level ($p < 0.05$); * = statistically significant at the 10% level ($p < 0.10$). ** Predicted probabilities and average marginal effects (AMEs) are reported in probability units. Cotton and hogs are included in other cash grains.

Effects on advice/services

Table 4 shows the AMEs and predicted probabilities from multivariate probit for use of advice/services. Larger farms and farms with more formal organizational structures exhibit greater use of advisory services, suggesting that these farms rely more heavily on external expertise. Married operators also have higher adoption. Crop systems, especially dairy and cash grains, show higher predicted probabilities than livestock systems.

The predicted probability for Large+Very large farms is 0.162, meaning these farms use advisory services at much higher rates than small farms, which have a predicted probability of 0.033. Midsize farms also adopt them at substantially higher rates. C-corps and S-corps show additional positive associations, underscoring the role of business's legal structure on the use of advisory services.

Table 4. AMEs and Predicted Probabilities from multivariate probit for Use of Advisory Services

Category	Estimate	Std. Err.
Predicted Probabilities (Farm Size)		
Small	0.0329	0.0069
Midsize	0.1369	0.0195
Large+Very large	0.1618	0.0162
Nonfamily/Other	0.0253	0.0037
AMEs vs Small		
Midsize	+0.0363 *	0.0184
Large+Very large	+0.0354 **	0.0145
Partnership	+0.0429 *	0.0234
C-corp	+0.0397 ***	0.0121
S-corp	+0.0712 *	0.0453
Married	+0.0151 ***	0.0052

Notes: *** = statistically significant at the 1% level ($p < 0.01$); ** = statistically significant at the 5% level ($p < 0.05$); * = statistically significant at the 10% level ($p < 0.10$). ** Predicted probabilities and average marginal effects (AMEs) are reported in probability units.

Effects on Forward Pricing

Table 5 shows the predicted probabilities and AMEs from multivariate probit for forward pricing. Larger farms and crop-specialized farms are more likely to use forward pricing in fertilizer procurement. Table 5 also suggests that forward pricing is rare among livestock producers and small farms. Among the farm size types, midsize farms have the highest use of forward pricing, reflecting that these farms are more likely to undertake strategic procurement practices in the face of greater exposure to price risk. The significantly positive coefficients of shopping and advice/ services on this forward pricing equation suggest that the adoption of these strategies increase the use of forward pricing. This may indicate the use of upstream activities or behavior like shopping around and advice seeking work complimentarily and could enhance the use of forward pricing strategies.

The predicted probability for midsize farms is 0.276, which indicates that these farms adopt forward pricing roughly eight times more frequently than small farms (which have a predicted probability of 0.032). Among the farm types, forward pricing seems more common among corn and other cash-grain farms, with predicted probabilities of 0.29 and 0.26. This suggests that corn and cash grain farmers have higher use of forward pricing strategies and have strong incentives to do so from seasonal fertilizer markets for price management.

Table 5. AMEs and Predicted Probabilities from Multivariate Probit for Adoption of Using Forward Pricing

Category	Estimate	Std. Err.
Predicted Probabilities (Farm Size)		
Small	0.0319	0.0026
Midsize	0.2758	0.0200
Large+Very large	0.2476	0.0232
Nonfamily/Other	0.0251	0.0040
Predicted Probabilities (Commodity)		
Corn	0.2866	0.0145
Soybeans	0.1309	0.0166
Hogs	0.0563	0.0175
Cattle	0.0184	0.0055
Other cash grains	0.2616	0.0260
Cotton	0.0664	0.0307
Dairy	0.1318	0.0332
Poultry/eggs	0.0081	0.0063
Specialty/misc	0.0107	0.0019
AMEs vs base		
Size: Midsize	+0.0571 ***	0.0136
Size: Large+Very large	+0.0363 **	0.0153
Size: Nonfamily/Other	–0.0038	0.0055
Corn	+0.1641 ***	0.0167
Soybeans	+0.0821 ***	0.0157
Hogs	+0.0387 **	0.0180
Cattle	+0.0149	0.0107
Other cash grains	+0.1231 ***	0.0193
Cotton	+0.0090	0.0143
Dairy	+0.0402 **	0.0190
Specialty/misc	+0.0021	0.0080
Married	+0.0133 ***	0.0045
Operating profit margin	+3.85e-07 ***	1.31e-07
Shop around	+0.0346 ***	0.0044
Use advice/services	+0.0453 ***	0.0081
Participate in buying club	+0.0185	0.0140
Debt-to- asset ratio	–8.56e-07	5.97e-07

Notes: *** = statistically significant at the 1% level ($p < 0.01$); ** = statistically significant at the 5% level ($p < 0.05$); * = statistically significant at the 10% level ($p < 0.10$). Predicted probabilities and average marginal effects (AMEs) are reported in probability units.

Effects on Forward-Pricing Intensity

Table 6 reports the average marginal effects (AMEs) from the fractional logit model of forward-pricing intensity. Most farm characteristics are not statistically significant. Evidence suggests that farms adopting a forward-pricing input acquisition strategy have a higher share of fertilizer purchases made under contract. In contrast, farms with greater financial leverage are less likely to purchase fertilizer through forward pricing.

Table 6. Average Marginal Effects from the Fractional Logit Model of Fertilizer Intensity

Category	Estimate	Std. Err.
Farm size		
Midsize	-0.0021	0.0014
Large+Very large	0.0010	0.0012
Nonfamily/Other	0.0013	0.0016
Commodity specialization		
Corn	0.0010	0.0079
Soybeans	0.0003	0.0080
Hogs	0.0014	0.0095
Cattle	-0.0009	0.0085
Other cash grains	-0.0017	0.0086
Cotton	-0.0125	0.0091
Dairy	0.0002	0.0081
Specialty/misc	0.0002	0.0082
Operator age		
45–54	-0.0020	0.0020
55–64	-0.0002	0.0013
65+	0.0005	0.0014
Legal structure		
Partnership	0.0002	0.0013
C-corp	-0.0019	0.0016
S-corp	0.0003	0.0017
Other	-0.0063*	0.0036
Other Controls		
Married	-0.0005	0.0008
Operating profit margin	-1.67e-08	1.09e-08
Debt-to-asset ratio	-3.29e-07*	1.82e-07
Shop around	-0.0005	0.0009
Buying club	0.0020	0.0025
Advice/services	-0.0003	0.0012
Forward-pricing adoption	3.0573***	0.2077

Notes: *** = statistically significant at the 1% level ($p < 0.01$); ** = statistically significant at the 5% level ($p < 0.05$); * = statistically significant at the 10% level ($p < 0.10$).

Effects on Fertilizer Expenditures

Table 7 reports the second-stage estimates of the instrumental variable model examining fertilizer expenditures. The key results suggest that farms adopting forward pricing tend to have higher fertilizer expenditures. Farms with greater fertilizer needs may be more inclined to lock in prices to manage price and supply uncertainty. Farm size is also positively associated with expenditures, with larger farms spending more on fertilizer than smaller farms. Compared with small farms, midsize farms spend about $15,507 more on fertilizer, while large and very large farms spend about $157,970 more. Fertilizer expenditures vary across commodity groups, farm legal structures, and operators' marital status and age. In addition, farms with higher operating profit margins and greater financial leverage tend to have higher fertilizer expenditures. Operators' marital status and age are also found to be key determinants of fertilizer expenditures.

Table 7. Instrumental Variable-2SLS Estimates of Fertilizer Expenditures

Category	Estimate	Std. Err.
Forward-pricing adoption (fwd_fert)	126,303.00***	36,036.76
Farm size		
Midsize	15,507.26***	5,444.48
Large+Very large	157,969.70***	10,816.81
Nonfamily/Other	875.95	532.88
Commodity specialization		
Corn	10,224.82	9,121.75
Soybeans	5,225.31	5,160.80
Hogs	-9,828.83	5,809.70
Cattle	5,667.82**	2,170.01
Other cash grains	20,282.28*	10,446.24
Cotton	31,481.93**	15,229.30
Dairy	-15,885.09**	6,547.85
Specialty/misc	8,238.65***	2,044.65
Operator age		
45–54	5,971.51**	2,256.64
55–64	2,606.01	2,059.71
65+	978.02	2,045.58
Legal structure		
Partnership	16,355.00***	3,318.07
C-corp	23,045.90**	8,376.52
S-corp	197.44	4,007.29
Other	1,637.61	4,422.64
Other Controls		

Married	-2,042.82**	778.01
Operating profit margin	9.25e-05**	3.93e-05
Debt-to-asset ratio	0.8115**	0.3168
Constant	-7,964.29**	3,347.24

Notes: *** = statistically significant at the 1% level ($p < 0.01$); ** = statistically significant at the 5% level ($p < 0.05$); * = statistically significant at the 10% level ($p < 0.10$).

Conclusion

In this study, we use the 2021 ARMS to measure the adoption and intensity of fertilizer procurement strategies. These strategies include supplier shopping, buying-club participation, use of advisory services, and forward pricing. Factors shaping the farmer's strategic decisions and underlying behavior are particularly important to understand as the agricultural sector has been experiencing a sequence of input price shock events and episodes, particularly on fertilizer and fuel inputs. Across all four-fertilizer price-management strategies we studied, larger farms consistently adopt more intensive price-management behaviors. The difference between small farms and midsize or large+very large farms is substantial for shopping, advice use, and forward pricing. These gaps highlight the importance of managerial specialization and the ability to integrate information and contracting tools.

In addition to size or scale of operation, farm business's formal legal structure could also seem to affect the decision on strategies like shopping around for price motives and using advisory services in fertilizer procurement. As the legal business structure may have different levels of resilience capacity as well as different levels of complexity within structure, it is plausible to have its effect on price management strategic decisions. We found that farm businesses on relatively formal legal structure (partnerships, C-corp and S-corp), as compared to single or sole proprietorship, are likely to use shop around and advisory services.

Demographic factors and farm household composition also seem to influence price management strategic decisions. We found inverse relation of age to the use of shop around strategy. As compared to young principal operators, relatively older principal operators tend to refrain from shopping around. However, the married operators seem to use price-management practices more often, suggesting that the presence of additional household labor or collaborative decision-making may support these activities.

Commodity specialization is particularly important and influential on strategies like participation in buying clubs and forward pricing. Our findings indicate that buying club participation could be heavily influenced by commodity crop specialization, more in magnitude than the scale or size of farm operation. Crop sectors (especially corn, soybeans, and other cash grains) exhibit elevated use of price management by participating in buying clubs. Seasonal fertilizer markets and exposure to price volatility are likely to create stronger incentives for these farms to engage in price-management practices. Livestock production, with more stable nutrient demands and less exposure to seasonal shocks, consistently have lower use of these price management strategies.

Finally, the forward pricing strategy seems to have stratification by size and commodity type. The use of forward pricing strategy is concentrated among crop farms and mid-to-large operations, driven by market characteristics that make fertilizer price-risk management particularly valuable. In particular, the fertilizer expenditure findings suggest that farms with greater input-purchasing needs are likely to use forward pricing more extensively, potentially contributing to higher fertilizer expenditures. Our findings also indicate that upstream behaviors—shopping and advice use—reinforce forward-pricing adoption, which highlight the complementarities among price-management strategies. Overall, the results show that the adoption of fertilizer price-management strategies and the underlying behavior align with the differences and importance of farm and economic factors such as farm size, specialization, organizational complexity, and farm household composition and is particularly important to understand as the sector experiences a series and episodes of input price shocks.

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