# The Returns to On-Farm Storage in NC

## Final Report for the CGANC

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# Research Objectives

What is the cost of investing and operating on-farm storage and annual returns and average years for ROI?

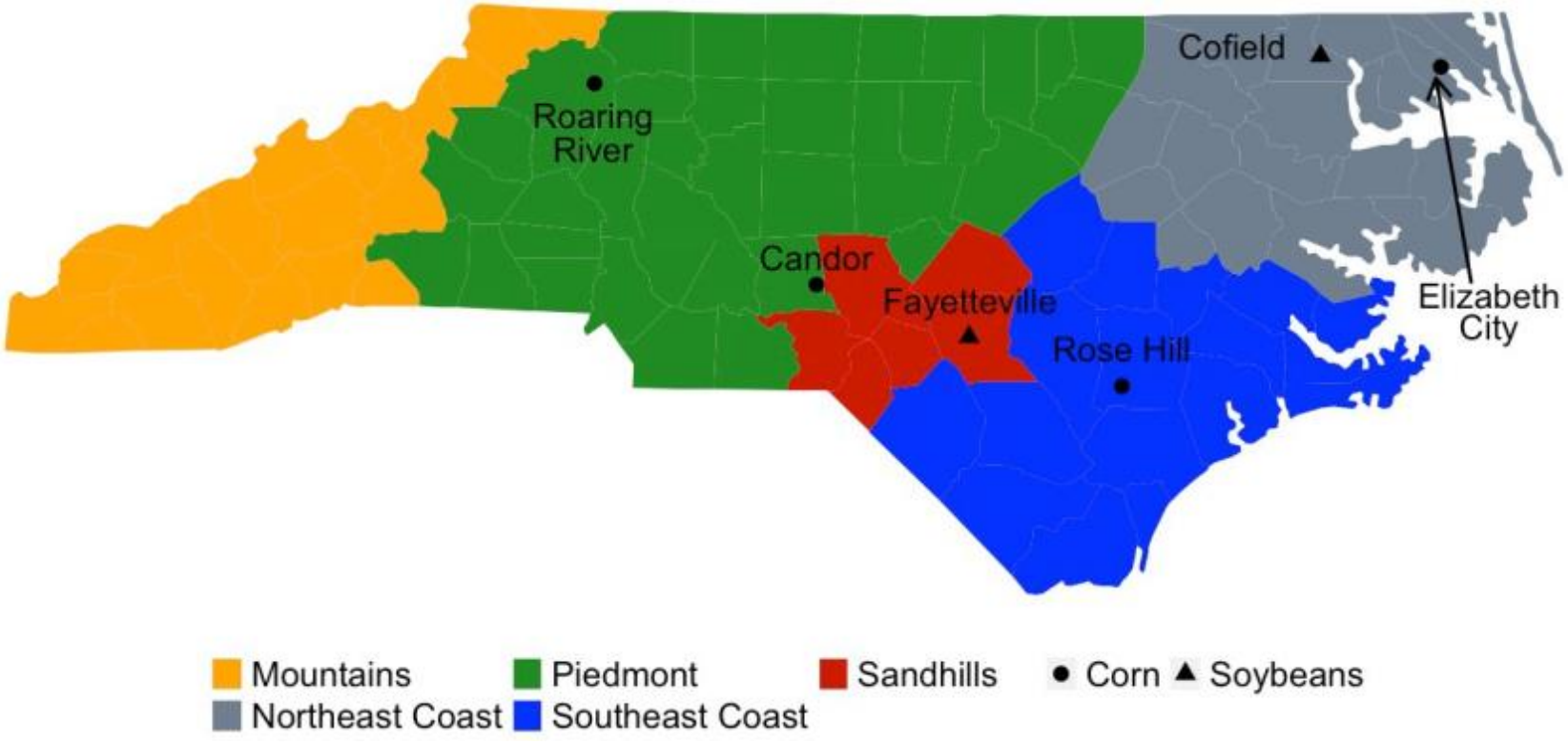
## Objectives:

- Understand how on-farm storage systems operate and how they may vary from farm to farm.
- Determine the factors that influence on-farm storage investment and operating costs.
- Develop a methodology to simulate a range of on-farm storage investment and operating costs.
- Investigate the existence of economies of scale in on-farm storage investment costs.
- Investigate the economic returns and time until ROI is positive

## Contributions:

- Generate a distribution of on-farm storage investment and operating costs that incorporates operator and facility heterogeneity.
- Identify how investment and operating costs vary by location and technical specifications.
- Estimate the economies of scale associated with on-farm storage investments.
- Simulated annual net returns and average years to ROI by location, technology, and commodity

# NC Expert Panel



# Factors Influencing Costs

1. Investment Costs
    - Total Capacity
    - Facility "Type"
    - Facility Design
2. Operating Costs
    - Regional Climates
    - Technical Specifications
    - Commodity
    - Harvest Timing
    - Local Market Factors

Brock Grain. *On-Farm Grain Bins.*

# Storage Facility Technology Levels

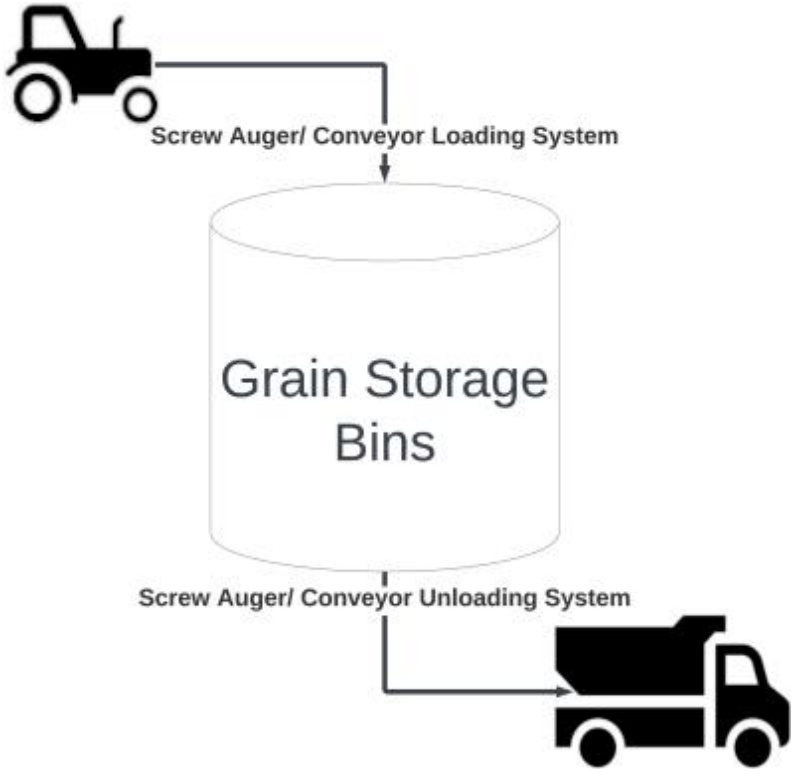



Figure 1.1 (A): Basic Tech.

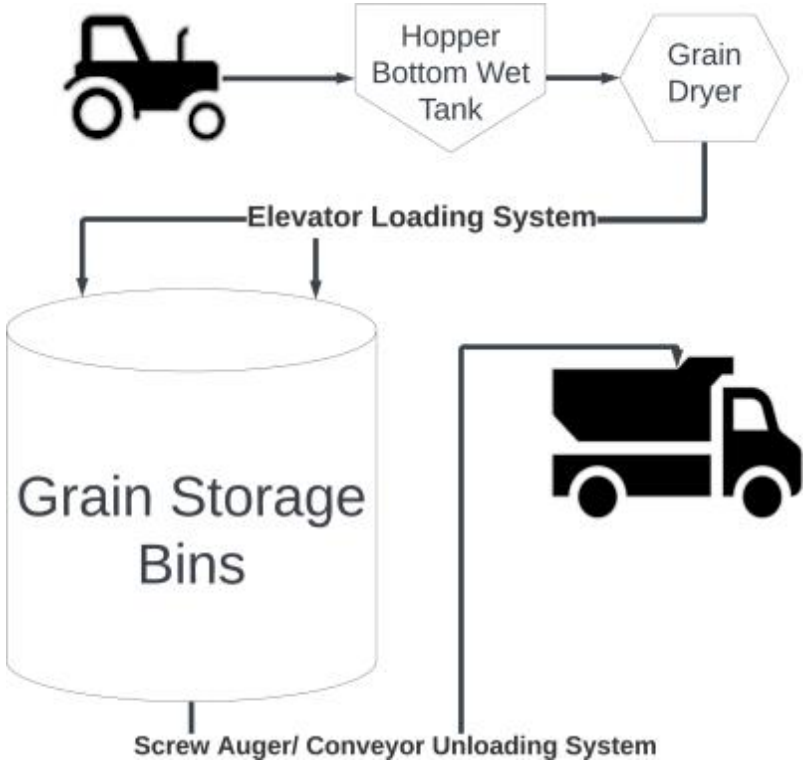



Figure 1.1 (B): Intermediate Tech.

# Storage Facility Technology Levels (cont.)

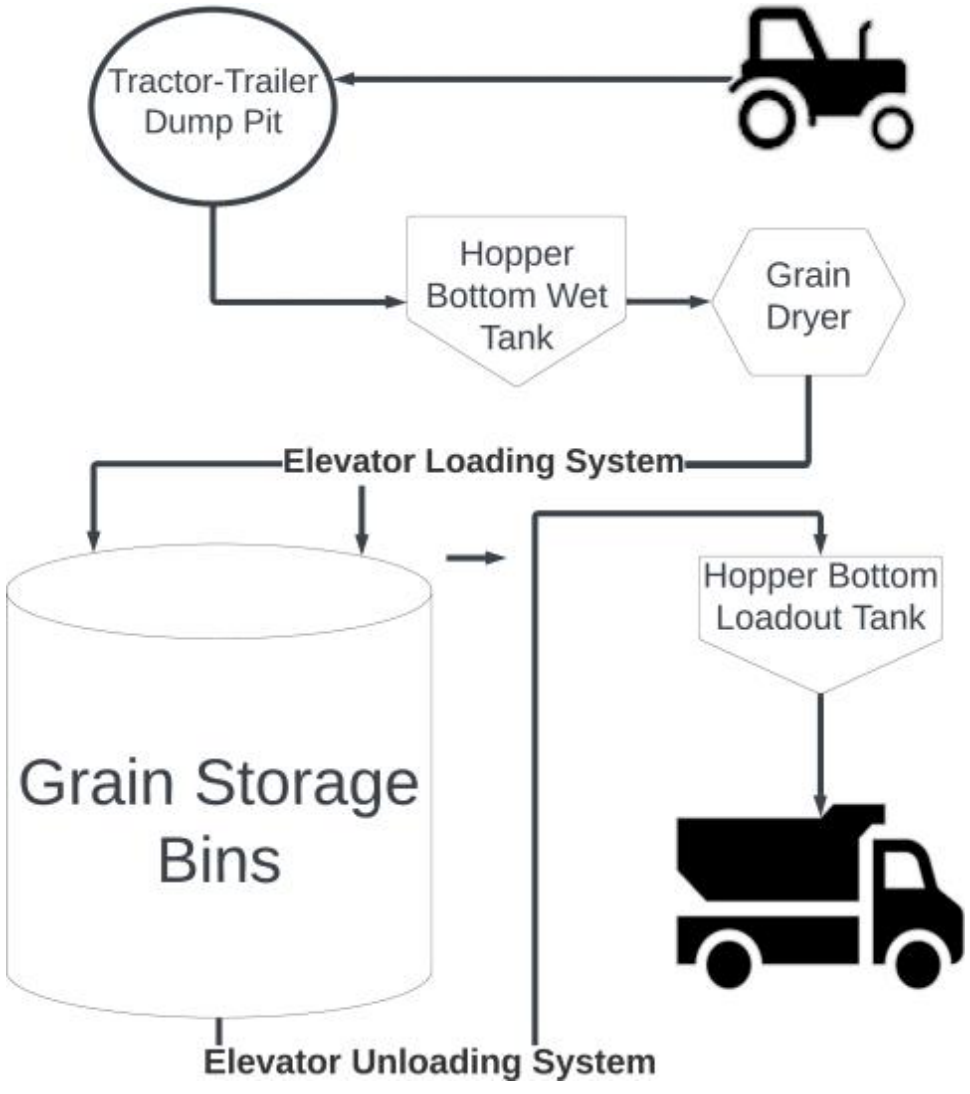



Figure 1.1 (C): Advanced Tech.

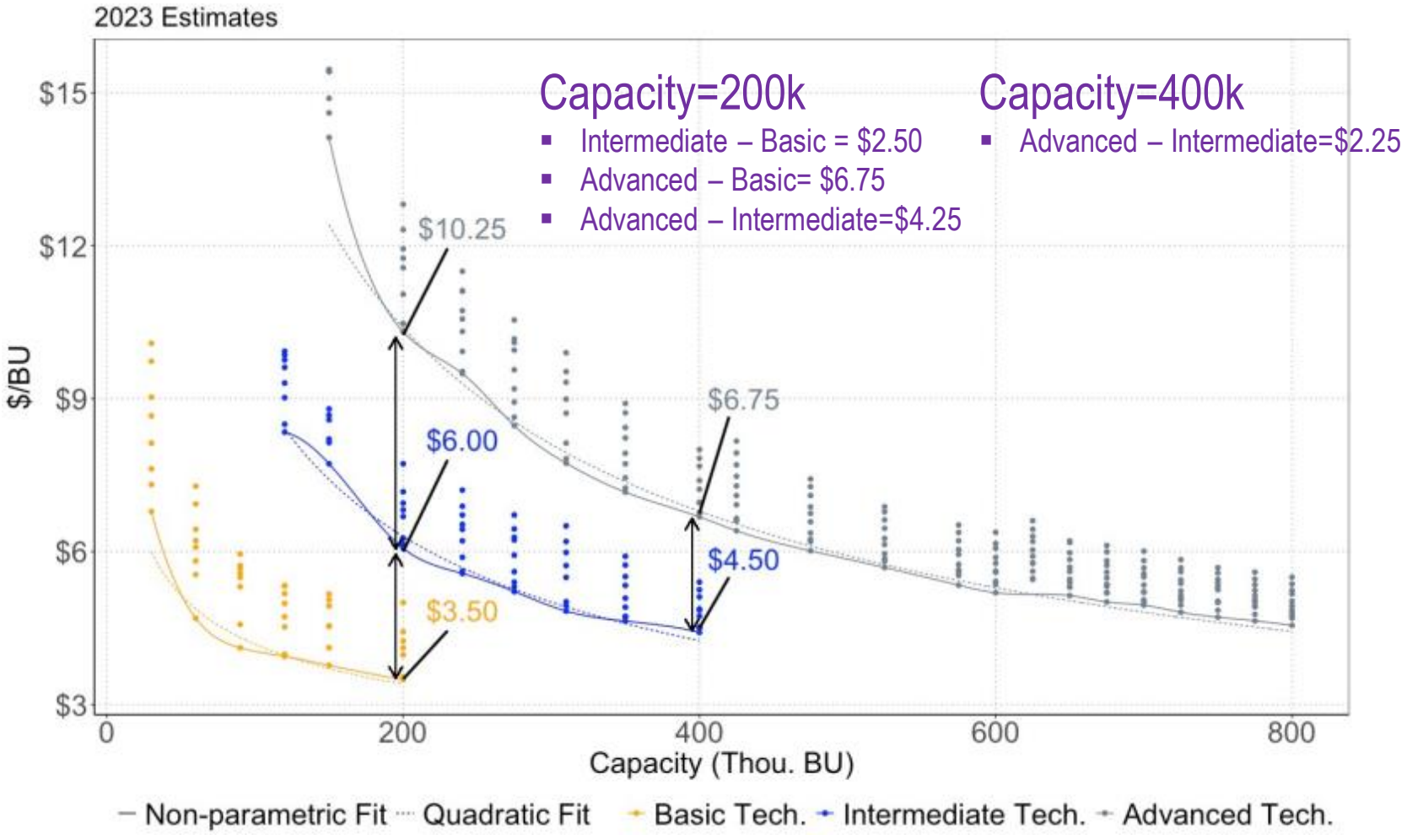
# Simulating Investment and Operating Costs

- Use data from the range of sources and responses from the expert panel to calibrate the simulated costs of 308 distinct storage facility "scenarios".
- "Scenarios" are constructed to vary by design, technology level, and total capacity.

Kentucky Farm Bureau. *Grain Bins - A Game Changer for Many Producers.*

# Facility Investment Costs

## Figure 1.2: Per-Bushel Investment Costs by Capacity and Type




Each dot represents a simulated storage facility of that specific type and capacity combination. There are 308 distinct constructed hypothetical storage facilities. The non-parametric fit (solid line) calculates the minimum cost for each facility type's different capacity levels. The quadratic fit (dashed line) represents the "best fit" line corresponding to the minimum cost for each capacity level across facility types.

# Investment Cost Elasticity

$$\text{Cost Elasticity } (v) = \frac{\%\ \Delta\ \text{Average Cost}}{\%\ \Delta\ \text{Capacity}} \qquad (1)$$

Table 1.1: Cost Elasticity by Facility Type with respect to Capacity

| Facility Type | $\hat{v}$ | 95% Confidence Interval |
|---|---|---|
| Basic | -0.30 | ( -0.3198 , -0.2721 ) |
| | (0.01254) | - |
| Intermediate | -0.56 | ( -0.5797 , -0.5483 ) |
| | (0.00831) | - |
| Advanced | -0.615 | ( -0.6305 , -0.5967 ) |
| | (0.00872) | - |

More elastic by facility type wrt capacity. Adv. is more than double Basic.

Cost elasticities are estimated using OLS of the double-log specification:

$$\ln(y_f) = \beta_{0,f} + \beta_{1,f} \ln(\text{Capacity}) + \epsilon_f, \qquad (2)$$

where $f$ = Basic, Intermediate, and Advanced and Capacity is in thousands of bushels. The $\hat{v}$ column corresponds to the estimated $\beta_{1,f}$ coefficients. Standard errors and confidence intervals were obtained via bootstrapping using 1,000 simulated samples with replacement. Bootstrap standard errors are shown in parentheses beneath estimated coefficients.

# Investment Cost Elasticity (cont.)

## Key Results:

1. Estimated cost elasticities negative for all facility types and are statistically different from zero.
    - ⇒ Confirms economies of scale with respect to capacity.
    - ⇒ Increasing capacity reduces per bushel storage facility investment costs.
2. Cost elasticities vary across facility type.
    - ⇒ Elasticities are statistically different across facility types.
    - ⇒ Cost elasticity increases (in magnitude) progressively from basic, to intermediate, and advanced facility types.
    - ⇒ Confirms that economies of scale increase as storage facility adopts more advanced technology.
    - ⇒ Difference in elasticities across facility types occur since advanced technologies are expensive and tailored to facilitating storage and harvest efficiencies but do not affect capacity directly.

# Estimating the Returns to Storage Investments

1. Simulate the viability of on-farm storage investments assuming a 45-year anticipated useful life of on-farm storage assets
    - ⇒ 45-year useful life applies to grain bins and elevators systems.
    - ⇒ Assume annual maintenance of necessary equipment
2. Apply a basic grain storage decision rule to determine when deferred sales from storage are made over the marketing year
    - ⇒ At harvest, the grower forms expectations on future net returns to storage by computing the monthly average profits from the previous three years.
    - ⇒ The month with the highest peak net return is identified
    - ⇒ If the expected annual profits exceed the returns at harvest (net of congestion costs), the grower will store and engage in deferred sales in the spot market in the expected peak month.

# Simulated Annual Net Returns

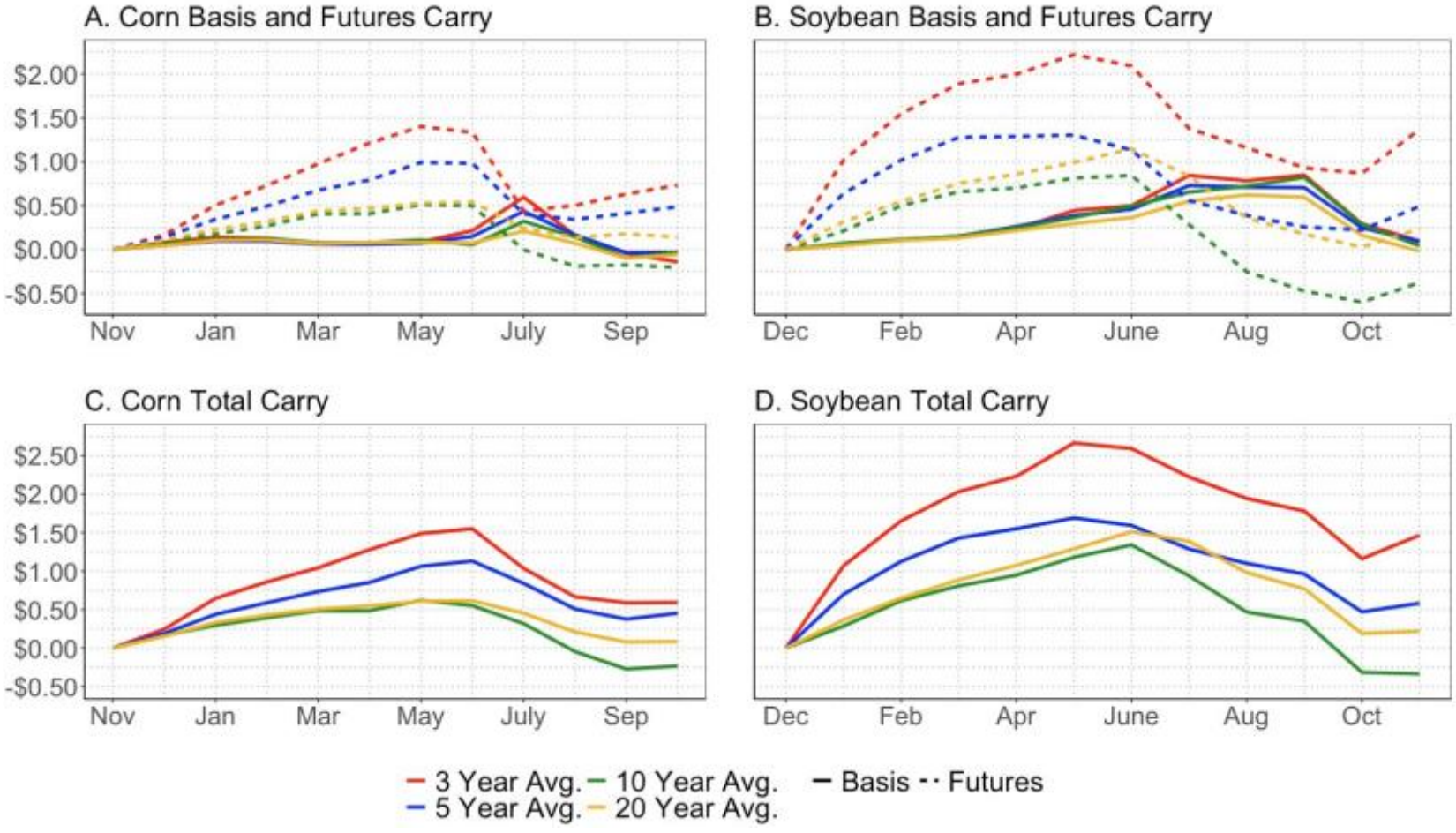
## Table 2: Simulated Annual Net Returns

| Location | Tech. | Month of Sale | Length of Storage | Storage Carry | | | Storm Risk Value | Avg. Net Storage Returns |
|---|---|---|---|---|---|---|---|---|
| | | | | Price | Futures | Basis | | |
| | | | | Corn | | | | |
| Rose Hill | Basic | June | 7 | 0.57 | 0.51 | 0.06 | 0.002 | 0.36 |
| | Inter. | May | 8 | 0.74 | 0.61 | 0.13 | 0.005 | 0.33 |
| | Adv. | | 9 | 0.67 | 0.48 | 0.19 | 0.03 | 0.33 |
| Elizabeth City | Basic | May | 7 | 0.63 | 0.53 | 0.09 | 0.005 | 0.42 |
| | Inter. | | 8 | 0.88 | 0.60 | 0.28 | 0.02 | 0.41 |
| | Adv. | | 10 | 0.71 | 0.62 | 0.09 | 0.07 | 0.32 |
| Candor | Basic | June | 7 | 0.58 | 0.52 | 0.06 | - | 0.36 |
| | Inter. | | 7 | 0.68 | 0.62 | 0.07 | - | 0.32 |
| | Adv. | | 9 | 0.66 | 0.50 | 0.16 | 0.01 | 0.30 |
| Roaring River | Basic | June | 7 | 0.57 | 0.52 | 0.05 | - | 0.34 |
| | Inter. | | 7 | 0.68 | 0.62 | 0.06 | - | 0.31 |
| | Adv. | | 9 | 0.62 | 0.50 | 0.12 | - | 0.25 |
| | | | | Soybeans | | | | |
| Fayetteville | Basic | June | 7 | 1.14 | 0.83 | 0.31 | - | 0.89 |
| | Inter. | July | 8 | 1.09 | 0.78 | 0.31 | - | 0.89 |
| | Adv. | June | 8 | 1.32 | 0.91 | 0.41 | 0.002 | 1.10 |
| Cofield | Basic | June | 7 | 1.15 | 0.84 | 0.31 | - | 0.90 |
| | Inter. | | 8 | 1.33 | 0.99 | 0.34 | - | 1.00 |
| | Adv. | | 9 | 1.42 | 1.15 | 0.26 | 0.002 | 1.14 |

Note: carry, storm risk value, and average net storage returns are in monetary (dollars per bu) terms.

# Simulated Annual Net Returns (cont.)

## Figure 1: NC Corn and Soybeans Carry




Source: *USDA-AMS, Daily Cash Grain Bids.*. Three year average lines include the 2020-2021, 2019-2020, and 2018-2019 market years. Select locations for corn and soybeans include Rose Hill (NC) and Fayetteville (NC), respectively. Carry computed relative to Nov. and Dec. harvest prices for corn and soybeans, respectively.

# Net Present Value Analysis

## Table 2: Return on Investment

| Location | Technology | % Sims w/ NPV >0 | Avg. Years to ROI (2023 Base) | Avg. Years to ROI (2001 Base) |
|---|---|---|---|---|
| | | Corn | | |
| Rose Hill | Basic | 99.33 | 15 | 6 |
| | Inter. | 93.75 | 27 | 10 |
| | Adv. | 86.9 | 30 | 13 |
| Elizabeth City | Basic | 99.67 | 12 | 5 |
| | Inter. | 94.75 | 22 | 9 |
| | Adv. | 74.25 | 33 | 19 |
| Candor | Basic | 99.33 | 14 | 6 |
| | Inter. | 98.12 | 27 | 8 |
| | Adv. | 80.7 | 32 | 16 |
| Roaring River | Basic | 98.83 | 15 | 6 |
| | Inter. | 96.75 | 28 | 9 |
| | Adv. | 73.85 | 34 | 19 |
| | | Soybeans | | |
| Fayetteville | Basic | 100 | 4 | 3 |
| | Inter. | 100 | 5 | 3 |
| | Adv. | 100 | 4 | 2 |
| Cofield | Basic | 100 | 4 | 3 |
| | Inter. | 100 | 4 | 3 |
| | Adv. | 100 | 4 | 2 |

Net present value computed net of maintenance and depreciation under the assumption of time-varying discount rates. Return on investment (ROI) refers to when the net present value is positive. The percent of simulations with positive NPV refers to the percentage of simulated returns with at least one market year having a positive net present value.

# Important Considerations

1. The specific carry and therefore the return to storage depends on when harvest occurs - this may vary year to year due to climate and crop conditions.
2. The values in this estimation only consider the pure operating net present value under a range of simplifying assumptions.
    - ⇒ *Preference* for labor saving technology OR consider how these may differ across location and farm size.
3. The results in this analysis are interpreted as the average net returns from operating on-farm storage without taking into account heterogeneous preferences for labor saving technology and risk reduction.

# Thank you for your time.

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## Questions?

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