1. In 3-5 sentences, describe what groups (besides Farmer Jones herself) might be at risk of loss in regards to farming corn? Identifying the scope (boundaries on size) and scale (potential severity or impact) that the risks have is important for understanding what needs to be characterized. Identify 2-3 other groups at different levels (e.g., local, state, national, and international levels) within your response who may have a loss related to corn crops.

Groups aside from Farmer Jones who are at risk of loss from corn farming include insurance agencies, corn vendors, and industries such as ethanol that rely on corn. At the state level, Iowa's government risks losing taxpayer money when corn production and industry slow, affecting the national economy. Additionally, local citizens are at risk of getting lower-quality corn if corn needs to be imported from elsewhere due to local farms not producing the desired quantities/quality.

2. In 3-5 sentences, describe the risk to Farmer Jones and her farm itself. What kind of quantified values can you identify that could be valuable numerical ways of characterizing the risks of crop loss? You may refer to the available datasets and prompts for ideas, but also consider what kind of data or numbers you would think would be the most helpful (even if that data does not exist in the provided datasets–sometimes you have to dream about what data you would like to find to drive you to fruitful data searches in your own project).

The risk to Farmer Jones and the farm itself is crop loss. Some potential quantified values that could be used to characterize the risks of corn loss are the amount of money lost due to decreased corn production and malnutrition. Some numerical ways of categorizing the risks of crop loss would be the annual crop production, corn market price, crop weight, and crop quality.

3. In 3-5 sentences, identify a risk mitigation strategy that Farmer Jones may choose to mitigate risk for her farm in each of the three categories and describe how you think each of these three strategies might be able to help mitigate those losses. Is there a strategy category that seems to be more or less feasible than another category to pursue? No calculations needed.

Farmer Jones may choose to decrease the likelihood of an undesirable event occurring by increasing the quality of fertilizers used, and/or by using chemicals/sprays that ward off pests (1). If an undesirable event cannot be prevented by the farmer, she will need to have protective measures installed to reduce impact severity of the event; for example, she can install a large enclosure around the corn to mitigate the effects of extreme weather, or by maintaining her farming items so as not to spend more than she need in the case of market inflation (2). An easy way to acquire more insurance for Farmer Jones would be to apply to the Federal Crop Insurance Program (FCIP) to prevent a severe loss to her farm in the case of disaster. The most feasible strategy seems to be insurance because it consistently results in the highest amount of money received per loss (3).

#4: In 2-3 sentences each, identify which of the three categories of data are identified in the Actuarial Process. Guides are provided in each of the tabs of the scenario's attached dataset. Be specific in identifying the column (or description) from the dataset or the scenario description in your response. Explain (at a high level) what information and insights these datasets can provide.

- Cause of Loss Smith Co tab: This dataset can be used to characterize and refine the categories of loss, define severity or range of loss of potential outcomes, and define frequency or likelihood of potential outcomes. The dataset includes descriptive fields to categorize outcomes, financial severity data such as payouts and losses, and the frequencies of outcomes (counts).
- Corn Planting Costs tab: This tab can be used to characterize and refine the categories of loss and define the severity or range of loss of potential outcomes. The dataset includes years to characterize outcomes and costs to characterize severity and ranges of loss.
- Corn Harvest Costs tab: This section can be used to characterize and refine the categories of loss and define the severity or range of loss of potential outcomes. The dataset includes years, months, and average calendar/market prices to characterize outcomes and prices to characterize severity and ranges of loss.

#5: What is the average total cost per acre for corn production (2016-2025) and average total cost per bushel (2016-2025)?

$548.11 per acre, and the average total cost per bushel is $4.45

#6: What is the average assumed yield (bushels per acre) for 2016–2025?

178.50 bushels per acre

#7: For Farmer Jones, if all 345 of her farm's acres are planted, using the average cost per acre found above in #5, what is the anticipated total cost for planting in the next season?

Cost per acre * acres = $189,098.64 for planting in the next season

#8: Realistically, is this value found in #7 higher, lower, or "about right" for the actual anticipated costs? What might be a realistic range (i.e., reasonable minimum and maximum values for the planting costs)? Why? Explain in 1–2 sentences (additional computations are optional).

A reasonable range for planting costs per acre would be $171644.4 to $252671.10; this range is calculated by taking the lowest total cost per acre in a given year times the number of acres and the highest total cost per acre in a given year times the number of acres to acquire own extremes. The number found in question 7 is reasonable as it falls in the range in about the middle.

#9: For Farmer Jones, if all 345 acres of her farm are harvested with the average yield found above in #6, what is the projected total yield (in bushels)?

Total bushel yield = 178.50 bushels/acre * # of acres = 178.5 * 345 = 61582.50 → This would be 61,582 bushels because Farmer Jones cannot harvest half of a bushel.

#10: Find the average cash corn prices for each individual month (Jan–Dec) for 2016–2025 and note them in a table.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$4.35	$4.43	$4.47	$4.55	$4.65	$4.73	$4.66	$4.46	$4.34	$4.21	$4.20	$4.35

#11: Identify 2–3 trends that you notice regarding cash corn prices (i.e., over the years, within a calendar year, or within a marketing year) in the Corn Harvest Prices tab that may impact when a farmer wishes to sell their crop. Explain why you believe the trend is noteworthy or why it occurs in 1–2 sentences each.

The first trend we noticed is that the gap between the yearly average and marketing year average often reflects the jump in the yearly average to the subsequent year; for example, in 2023, the yearly average was $6.01, and the marketing average was $4.61, and in 2024, the yearly average ended up being $4.35. This is important because farmers who observe a large increase or decrease between the yearly average and marketing average might decide to sell or not sell, respectively.

Another trend we noticed is that a general increase in the averages until 2023, where there is a crash in the price average. It is likely that an event, perhaps related to weather or bugs, is what prompted this crash, so farmers are likely to be wary of such events, as they could either lose or gain a lot of profit.

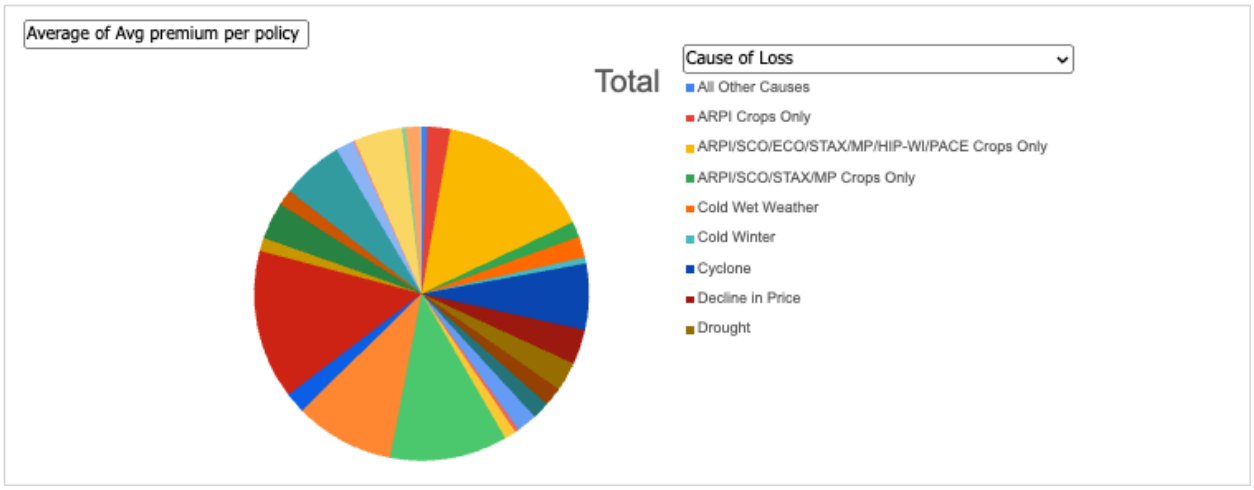
#12: If Farmer Jones harvests and sells her entire harvest (found in #9) using the 2016–2025 average corn sale price for October (as found above in #10), what would her revenue be? What would her profit be (using planting costs found in #7)?

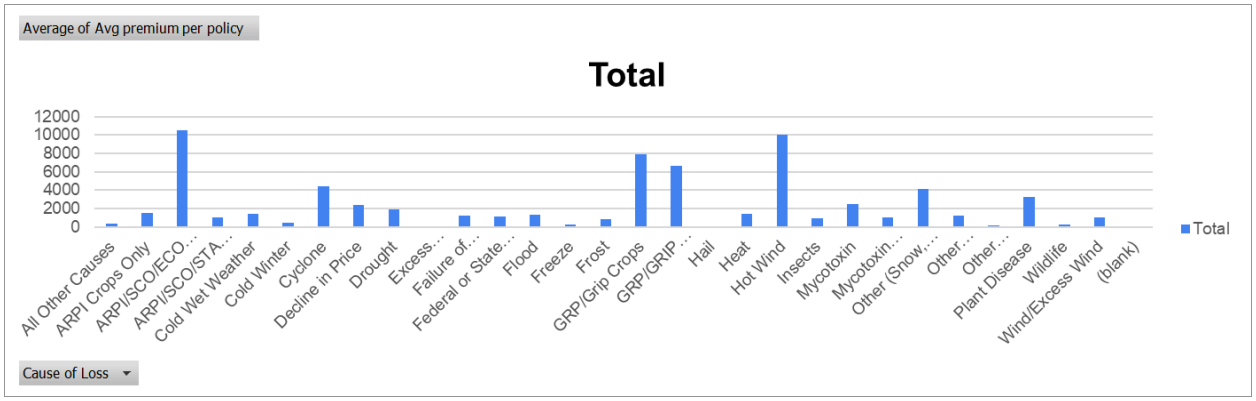
If Farmer Jones harvests and sells her entire harvest of 61582 bushels, according to the 2016-2025 average corn sale price for October, her revenue would be $258,988.63 with a profit of $69889.99.

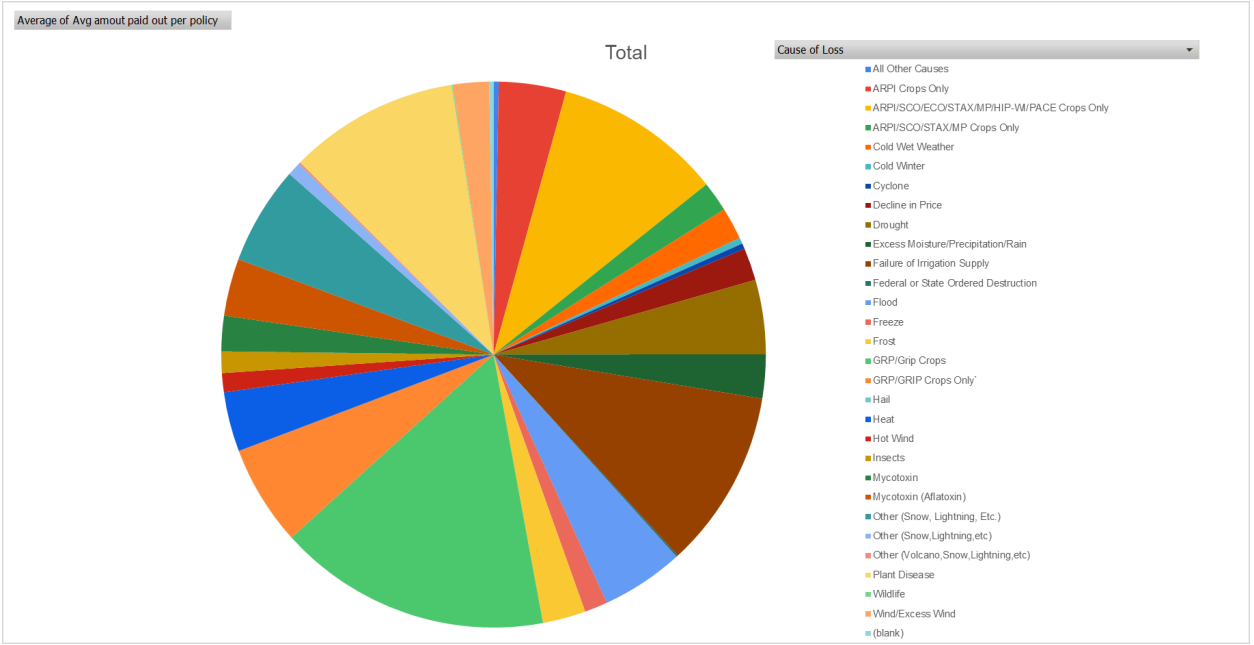
#13: If Farmer Jones is able to store her harvested corn and wait for the optimal sale, using the 2016–2025 averages found in #10, what could she anticipate for maximum revenue? Identify the month and revenue amount.

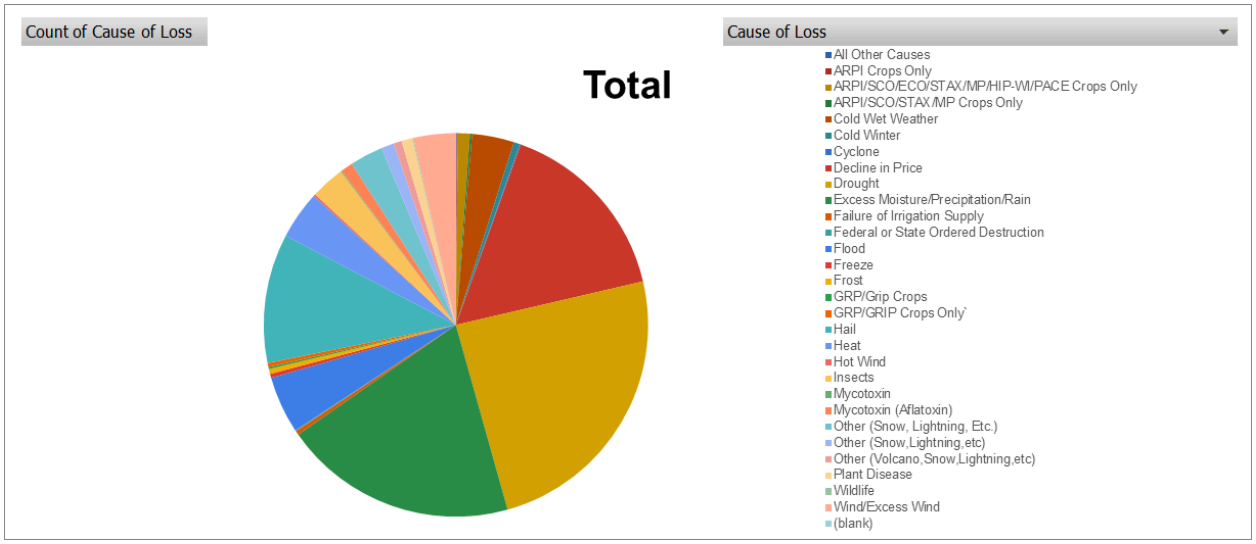
The month with the highest revenue is June, with a corn sale per bushel of $4.73. There are 345 acres total, with the average yield of bushels per acre being 178.5. The maxim yield = 345 acres * 178.5 bushels/acres * $4.73 corn sale per bushel = $291,079.95.

#14: Create a chart (e.g., pie chart, bar chart, etc.) that summarizes, labels, and categorizes the causes of loss for claims for 1994–2024. Include the chart in your response.







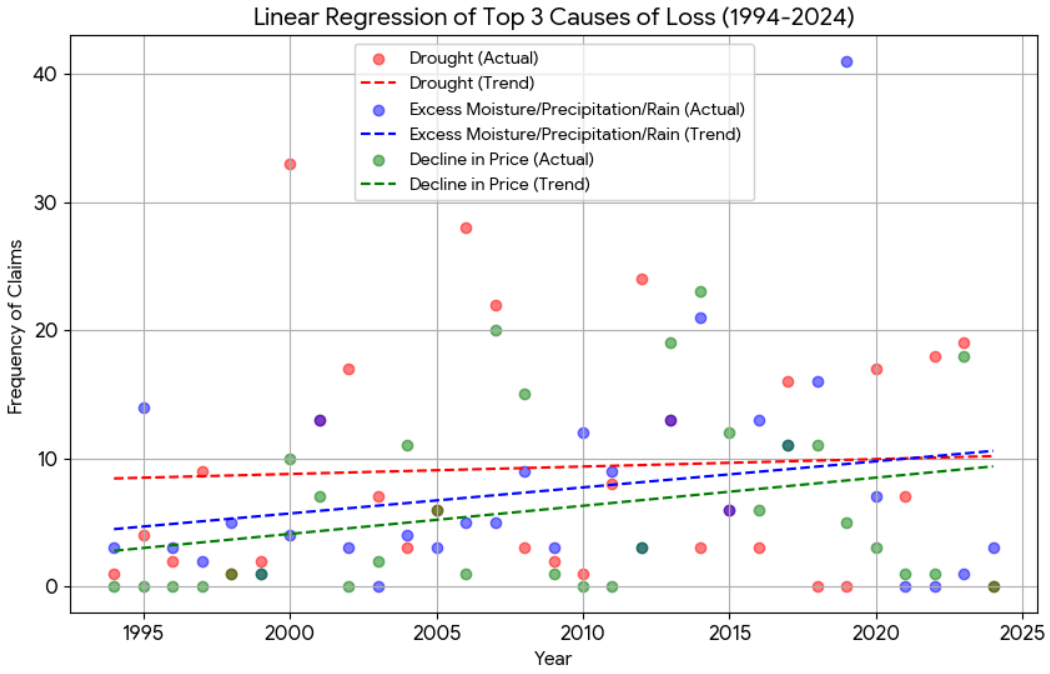


#15: Based on the data visual you created, what appear to be the top 3 leading causes for a loss claim? Why? Explain in 1–2 sentences (include the frequency of these claims in your response). How does this information on the top 3 causes of loss inform Farmer Jones as she plans for future risks to her farm in Smith County? Explain in 2–3 sentences.

Based on the dataset, the top three leading causes of loss claims are Drought (288 claims), Excess Moisture/Precipitation/Rain (233 claims), and Decline in Price (188 claims). These rank as the top three because they have the highest frequency of occurrence over the 30 years, significantly outpacing other causes like Hail (129 claims).

This information informs Farmer Jones that she faces a "dual threat" of physical weather extremes and financial market volatility. To plan for the future, she should prioritize physical mitigation strategies for weather (such as installing irrigation for drought and tile drainage for excess moisture) while simultaneously maintaining Revenue Protection insurance to hedge against the significant risk of price declines.

#16: LINEAR REGRESSION
Conduct a linear regression on the frequency of loss claims for the top 3 causes of loss identified in prompt #15 for 1994–2024. Provide the plot (plot all 3 on the same chart), regression equations, and correlation coefficients in your response.



Drought Equation

- Equation: y = 0.058x - 107.36
- Correlation Coefficient (r^2): 0.003
- Interpretation: There is a very slight positive trend (increasing frequency), but the very low r^2 indicates high variability (volatility) year-to-year rather than a consistent linear pattern.

Excess Moisture/Precipitation/Rain Equation

- Equation: y = 0.204x - 401.58
- Correlation Coefficient (r^2): 0.051
- Interpretation: There is a clearer positive trend (slope of 0.204) compared to drought, suggesting that wet-weather claims are becoming more frequent over time, though the trend is still noisy.

Decline in Price Equation

- Equation: y = 0.220x - 435.43
- Correlation Coefficient (r^2): 0.081
- Interpretation: This shows the steepest positive trend among the top three, indicating that claims related to revenue loss (price drops) have occurred more frequently in recent years compared to the 1990s.

#17: CAUSE OF LOSS TRENDS OR PATTERNS

Referring to your regression conducted above in #16, describe 2–3 trends or patterns you observe in causes of loss over the historical timeframe (e.g., maximums, minimums, patterns, co-occurrence of causes of loss, etc.). Offer a short, plausible explanation for why you believe the trend occurs (1–2 sentences each).

One observable trend is the increase in excess moisture/precipitation/rain, and the trend of claims of price declines increasing as time goes on. We believe that this is because of recent global warming, causing the excess moisture and a move to big farming companies for price declines, as companies move away from smaller farms.

A second trend we see throughout the graph is that the claims due to drought remain stagnant. We believe this has remained relatively stagnant because there has been no cause to change the number of claims caused by droughts, such as the other two.

#18: ASSUMPTION EVALUATION

In 1–2 sentences, evaluate and assess the reasonableness and rational basis for the assumption below. Note why the assumption is necessary or reasonable to simplify the topic to model, or if the assumption goes beyond what is reasonable.

> Assumption: “Nationally, approximately 91% of farm producers have farm insurance. We assume that the rate of farm producers who have farm insurance is the same for Smith County, Iowa.”

The assumption is necessary for our model as it provides a basis for the proportion of farming insurance in our model. However, the assumption here is not very reasonable because insurance proportions change significantly between states, making the assumption very unrealistic.

#19: ASSUMPTION DEVELOPMENT

Write your own 1–2 sentence assumption that would pertain to this real-world scenario for math model creation (it may be an assumption about the scenario’s data, problem statement, possible outcomes, math model structure, or other pertinent factor). Provide a 1–2 sentence justification explanation as to why the assumption is needed and reasonable.

Assumption: The average yield and production costs for Farmer Jones’ farm are representative of the average values for all Smith County corn farms.

Justification: This assumption is needed to use county data to model Farmer Jones’s potential income and risk, and it is reasonable because her farm size and other factors align with the county averages described in the scenario.

#20: FREQUENCY OF CLAIMS DUE TO DROUGHT

From the Cause of Loss tab (1994–2024), what is the annual average frequency of claims made for drought for farmers in Smith County, Iowa?

The annual average frequency of claims made for drought for farmers in Smith County, Iowa, is 9.29 claims.

#21: EXPECTED VALUE OF LOSS DUE TO DROUGHT

For Farmer Jones, what is the expected value of crop loss due to drought in a given year (based only on the actual cost for Farmer Jones to plant)? Refer to the planting costs found in #7 for Farmer Jones' severity of loss.

The expected value of crop loss due to drought is the probability of drought occurring multiplied by the average loss. Since there are 2672 insured farms (91% of the 2936 farms in Iowa that have insurance) and the average frequency of drought claims is 9.29 claims/year, the probability that Farmer Jones experiences a drought is 9.29/2672, which is 0.35%. The expected value, therefore, is 0.0035 * 189098.64 (planting cost found in #7), which is also $657.57.

#22: AVERAGE ANNUAL INSURANCE PAYOUT DUE TO DROUGHT

What is the average annual insurance payout per policy for farmers in Smith County due to drought (use the Cause of Loss tab)? What could this mean for Farmer Jones as she considers her risks due to drought? Explain in 2–3 sentences.

The average annual insurance payout per policy for farmers $12,774 for loss. This could mean that during a drought, Farmer Jones could lose $12,774 in a given year that they encounter a drought, signifying increased financial risk. Additionally, this means that Farmer Jones should consider some mitigation strategies, like maintaining or increasing drought insurance or coverage, and invest in drought-resilient crops.

#23: RISK MITIGATION STRATEGY: GRAIN SILO

- What risk(s) might Farmer Jones mitigate by installing a grain silo? What kind of risk mitigation strategy is this (behavior change, modifying the outcomes, insurance)? Explain in 1–2 sentences.

A grain silo helps protect corn from spoilage, moisture, pests, and weather after harvest, and it lets Farmer Jones wait to sell when prices are better. This is a risk-reduction / outcome-modifying strategy.

- Identify 2–3 advantages or "pros" of installing a grain silo as a risk mitigation strategy. Explain and justify your response in 2–3 sentences (no new computations necessary).

A silo reduces spoilage and keeps the corn in good condition, which helps protect the farmer's revenue. It also allows her to store grain and sell it later in months with higher prices. This gives her more flexibility and better control over when and how she sells her crop.

- Identify 2–3 disadvantages or “cons” to installing a grain silo as a risk mitigation strategy. Explain and justify your response in 2–3 sentences (no new computations necessary).

The biggest cons for Farmer Jones to install a grain silo are the initial cost, the manual labor to install the silo, and the space it would take. Due to all of these cons, the initial installation process would be very costly, but following the installation, the silo would be beneficial.

#24: RISK MITIGATION STRATEGY: IRRIGATION SYSTEM

- Identify the installation costs and annual operating costs of the irrigation system for Farmer Jones’ farm.

A full irrigation system for 345 acres is expected to cost about $517,500 to install, with yearly operating and maintenance costs of about $30,360.

- What is the anticipated annual corn harvest yield (in bushels) with the irrigation system?

Irrigation often raises yields, so Farmer Jones’ neighbors expect Jones’ farm to increase from 178.5 bu/acre to about 270 bu/acre. This gives roughly 93,150 bushels total.

- If Farmer Jones were to sell her entire crop upon harvesting in October, what is the anticipated revenue for this anticipated harvest with the irrigation system (use the 2016–2025 average corn sale price for October as found above in #10)?

Selling the irrigated harvest in October would give about $392,161.50 in revenue.

25: CHARACTERIZING THE CROP INSURANCE SCENARIO

Using the equations and conditions outlined above: Find the revenue “guarantee per acre” with 85% coverage. Find the “actual revenue per acre.” Use the values found above. If the insurance payout is triggered, compute the insurance payout per acre and total insurance payout. If the insurance payment is not triggered, explain why not (in 1-2 sentences).

Guarantee per acre = projected yield * percent_coverage * higher_price

Higher price = $5.20

Percent_coverage = 0.85 or 85%

178.5 × 0.85 = 151.725 bushels

151.725 * $5.20

= $788.97 per acre

Actual revenue per acre = 178.50 * 4.39 = $783.62

The payout is **triggered** since the guaranteed price per acre is greater than the actual revenue per acre.

Payout is triggered → Insurance payout per acre = Payout per acre = 788.97 − 783.62 = **$5.35 per acre**

Total payout = (price_per_acreage) * num_acres = 5.35 * 345 = **$1,845.75**

#26: VALUE OF THE INSURANCE POLICY

While Revenue Protection can address the risk of lower yields than anticipated, Farmer Jones is specifically interested in exploring how Revenue Protection can be used to mitigate the risk of a drop in price (if she was only interested in mitigating risk of lower yields, she could purchase the cheaper Yield Protection insurance). Identify the total cost of the annual premium for Farmer Jones' farm for the Revenue Protection plan outlined above. Based on the analysis conducted here on Revenue Protection, would you recommend that Farmer Jones purchase revenue protection crop insurance to protect against a drop in price or potentially rely on Yield Protection insurance only? Why or why not? Explain in 2-3 sentences (additional computations optional).

Premium = 25$

Num_acres = 345

Total annual premium = 25 * 345 = $8,625

Based on the scenario, the revenue protection only produces a $5.35 per acre payout when prices fall, which is below the premium of $25. This means Farmer Jones would pay significantly more in premiums than she would expect to gain from price-drop protection alone. Unless she is concerned about major yield losses in addition to price risk, relying on cheaper yield protection insurance is more cost-effective.

#27: IRRIGATION SYSTEM IMPACT

Based on the data available to Farmer Jones, other corn farmers in Smith County who have installed an irrigation system like the one she is considering have found that their chance of loss due to drought has dropped to 0.2% in any given year.

If Farmer Jones installs the irrigation system as outlined in Prompt #24 above, what is her expected value of loss due to drought (with severity of loss being the cost of planting found in #7)?

Chance of loss: 0.35% -> 0.2%

Severity of loss = $189,098.64

Expected value = chance * severity = 0.002 * 189098.64 = $378.19

#28: COMPARISON OF EXPECTED VALUE OF LOSS
Compare the expected value of loss with the irrigation mitigation strategy (what you just found in #27 above) to the expected value of loss without mitigation measures that you computed in #21. Is this expected value of loss a noteworthy improvement or not? Explain in 1-2 sentences and justify your answer with relevant supporting computations.

Expected value from 21 (without irrigation): $657.57

Expected value from 27 (with irrigation): $378.19

This expected value is a noteworthy improvement, as it was an almost 42.5% decrease from the original strategy, which lacks mitigation. This means that the irrigation system resulted in a massive improvement from the original.

#29: PROFIT TRAJECTORY WITH IRRIGATION
What is the anticipated profit for the first year after utilizing the described irrigation system (assuming the planting costs as found in #7)? What implication does this have for a timeframe projection of profitability with an irrigation system? Explain and justify your response in 3-5 sentences with any supporting computations necessary.

Revenue with irrigation: $392,161.50

Planting cost: $189,097.95

Installation costs: $517,500.00

Annual operating costs (from #24):
- Energy usage: $58/acre * 345 acres = $20,010
- Maintenance/repairs: $30/acre * 345 acres = $10,350
- Total annual operating: $30,360

Total first-year costs: $736,958.64

Profit = Revenue - Total costs
Profit = $392,161.50 - $736,958.64 = -$344,797.14

The first year shows a net loss of $344,797.14

With irrigation, Farmer Jones would earn about $392,161.50 in revenue, but her total first-year costs, Including installation and operating expenses, it would be $736,958.64, resulting in a net loss of about $344,797. Although the first year is unprofitable due to the large upfront installation cost, the increased yields from irrigation suggest much higher annual revenue in future years. This implies that while the investment may hurt short-term profitability, the irrigation system could become profitable over a longer timeframe as the installation cost is recovered.

#30: SHOULD THE IRRIGATION SYSTEM BE RECOMMENDED?

Identify 1-2 advantages or compelling reasons to install the irrigation system and 1-2 drawbacks or possible consequences of installing the irrigation system.

Based on your analysis, would you recommend that Farmer Jones invest in the irrigation system for her farm? Why or why not? Explain in 3-5 sentences and justify with any relevant computations and values.

Advantages:

An irrigation system sharply reduces drought risk from 0.35% to 0.2%, cutting expected drought losses from $657.57 per year to $378.20 (a savings of $279.37 annually). More importantly, it raises yields from 178.5 to 270 bushels per acre (a 51% increase), which dramatically increases annual revenue and profit stability.

Drawbacks:

The system has a very high installation cost of $517,500. Annual operating expenses add $30,360 in ongoing costs. The upfront capital requirement may strain cash flow or require financing with interest costs.

Recommendation:

Based on the analysis, we would recommend that Farmer Jones install the irrigation system, but only if she has access to adequate financing or capital reserves. The system increases annual profit by approximately $102,813 after the installation year, allowing it to pay for itself in about 5 years. The 51% yield increase provides far more value than the drought risk reduction alone. However, the significant upfront investment and negative first-year cash flow mean this is only viable for farmers with strong financial positioning or favorable loan terms.