

Climate Related Financial Disclosure for Growmark Inc.

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Introduction

The question: How is climate change affecting agriculture in the Midwest

This presentation dives into how climate change is affecting the Growmark's bottom line. We used a TCFD format for the project to identify the financial implications that climate change poses. Task Force on Climate-related Financial Disclosures report, is a voluntary, consistent framework for companies to disclose their climate-related financial risks and opportunities. We used open-source data to identify shifts in temperature, precipitation, and CO₂ levels in the next few years. Other proposals of this project include how Growmark can mitigate its risk in these areas and potential costs.

Background

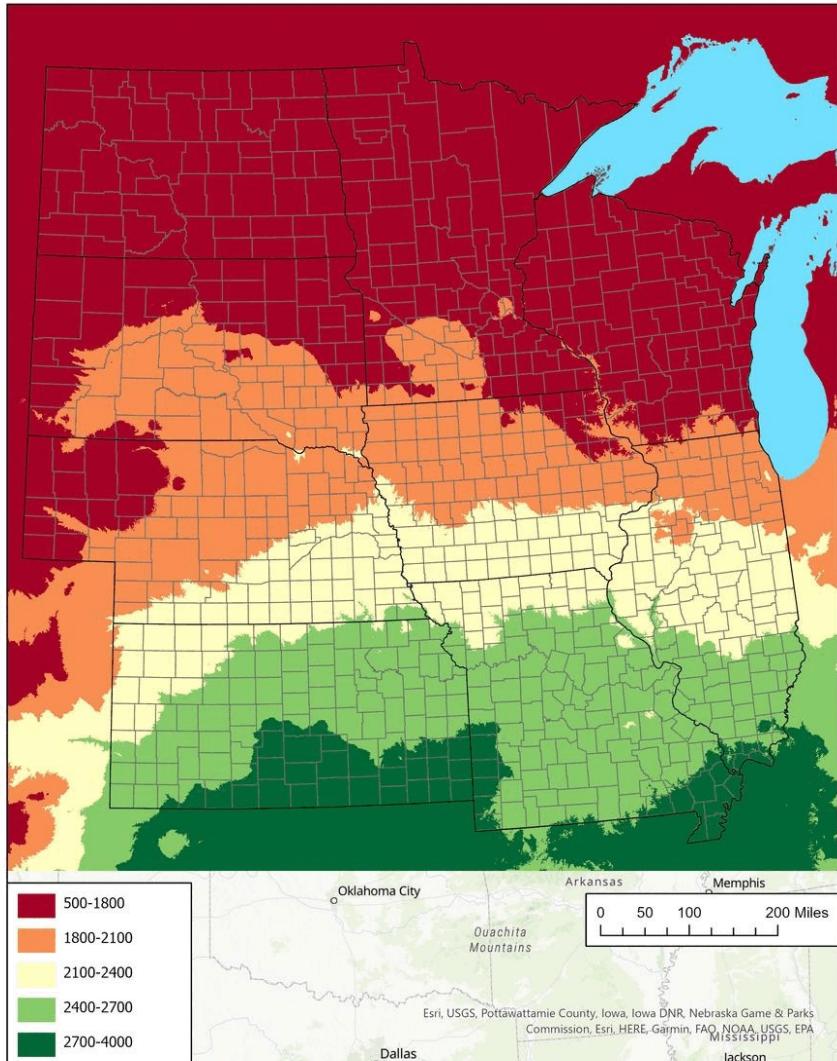
Increased Temperature	Increased Atmospheric Moisture
<p>Midwest warm season temperatures are estimated to see largest increase in U.S.</p> <p>Late-century estimates predict average temperature increase of five degrees Fahrenheit for RCP 4.5 and as much as eight degrees Fahrenheit in the Midwest (Vose et al. 2017).</p>	<p>Increased warm season precipitation intensity</p> <p>Mesoscale Convective Systems (large storms) frequency and intensity perpetuated by warmer Springtime temperatures and are expected to increase with current Midwestern climate predictions (Feng et al. 2016).</p>
<p>Extreme temperatures expected to increase (daily minimum and maximum)</p> <p>Late-century daily minimum and maximum temperatures may rise as much as ten degrees Fahrenheit under human contributed climate change (Sillman et al. 2013).</p>	<p>Precipitation Variability</p> <p>Although generally the Midwest has seen an increase in precipitation, the SPI (Standardized Precipitation Index) magnitude and range has also increased in parts of the Southern Midwest (Ford et al. 2020). This can also be quantified during drought.</p>
<p>Increased evaporation (Drought)</p> <p>The rate of evaporation increases as temperature increases, which can affect both agricultural drought and hydrological drought. Of larger concern to the Midwest would be agricultural drought, where higher temperatures will decrease the amount of moisture in soil (Wehner et al. 2017).</p>	<p>Increased Spring Precipitation (frequency)</p> <p>Projected intensity of the Great Plains Low Level Jet increased, which correlates to an increase in Springtime (April, May, June) rainfall (Cook et al. 2008).</p>

Strategy C Scenario Analysis

Agricultural Asset	Crop Protection	Crop Nutrients	Crop Harvest
Associated risks under projected climate trends over the next century.	<p>Climate associated risk: Increased annual temperatures (warm and cold season)</p> <p>Potential Outcome: Insects and pests that are traditionally vulnerable in colder months will have increased survivability.</p> <p>Northward expansion of native southern insects and pathogens as Midwest climate conditions become more favorable. (Vigil et al. 2018)</p> <p>Increased growing season window, warmer temperatures in Springtime create optimal planting conditions earlier.</p> <p>Advisory Steps: Investigate thresholds and pesticides against Midwestern pests that will be more durable considering their increased survivability.</p> <p>Explore alternate pesticides that include resilience against native Southern insects and pathogens</p>	<p>Climate associated risk: Increased warm season precipitation frequency and intensity</p> <p>Potential Outcome: Increased soil erosion, possible water-logged soil, which will affect the health of crops and reduce number of available workdays in the field.</p> <p>Will cause nutrient runoff, possibly contaminating nearby bodies of water</p> <p>Climate associated risk: Warm, saturated air can hold more water, causing drought</p> <p>Potential Outcome: Heat stress and insufficient water can lead to significantly reduced crop yield (USDA 2013).</p> <p>Advisory Steps: Precision agriculture, usage of drones to capture drone imagery, using short-wave infrared bands to visualize soil moisture, examining areas impacted by soil erosion or nutrient loss.</p>	<p>Climate associated risk: Increased humidity, high moisture conditions</p> <p>Potential Outcome: Stored grain pests that favor high-humid environments will be more suited to Midwest predicted climate conditions.</p> <p>Mold, toxins more prevalent in late growing season</p> <p>Climate associated risk: Increased nighttime temperatures, average daytime temperatures in late grow season</p> <p>Potential Outcome: If the crop has reached early maturity and soil moisture is highly variable, faster drying times in harvest window may be possible.</p> <p>Advisory Steps: Examine costs of drying, storing , and transporting grain in high moisture scenarios. The larger the moisture the content, the more costly it is to bring it down, which is why early harvest conditions are beneficial to cost savings.</p>

Growing Degree Days

Projected Growing Degree Days (Above 50°F Below 104°F) for 2021-2040 4.5 Scenario



Projected number of grow days throughout the 21st century using the RCP 4.5 Scenario (Emissions peak around 2040 and decline afterwards) in the Midwest region.

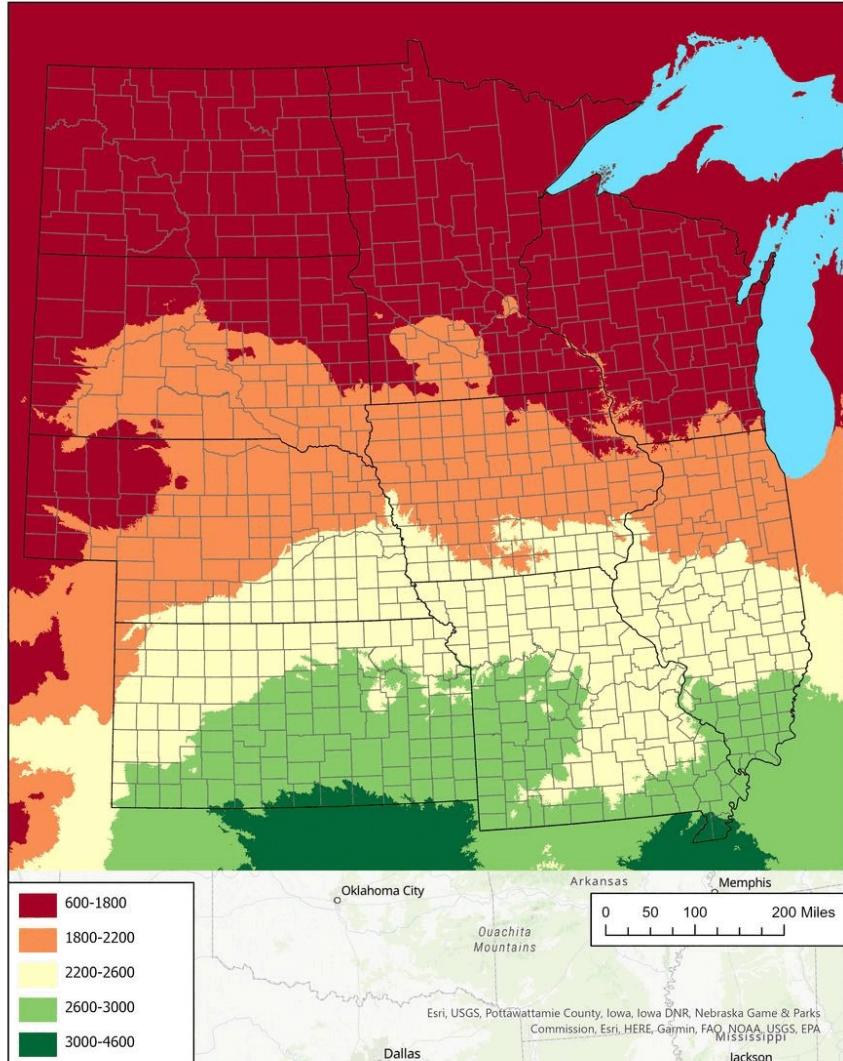
Growing degree days are calculated by subtracting minimum crop threshold temperature from daily air temperature.
[55°F (daily value) - 50°F (minimum threshold) = 5 GDD value]

Note that 2700 growing degree days are most optimum for Corn Harvest.

Takeaway: Growing degree days are beyond optimal in Southern Midwest, notice expansion of nearly optimal GDDs to Northwest states.

Growing Degree Days

Projected Growing Degree Days (Above 50°F Below 104°F) for 2021-2040 8.5 Scenario



Projected number of grow days throughout the 21st century using the RCP 8.5 Scenario (Emissions continue to rise throughout the 21st century, most notable difference occurring after 2050) in the Midwest region.

Growing degree days are calculated by subtracting minimum crop threshold temperature from daily air temperature.
[55°F (daily value) - 50°F (minimum threshold) = 5 GDD value]

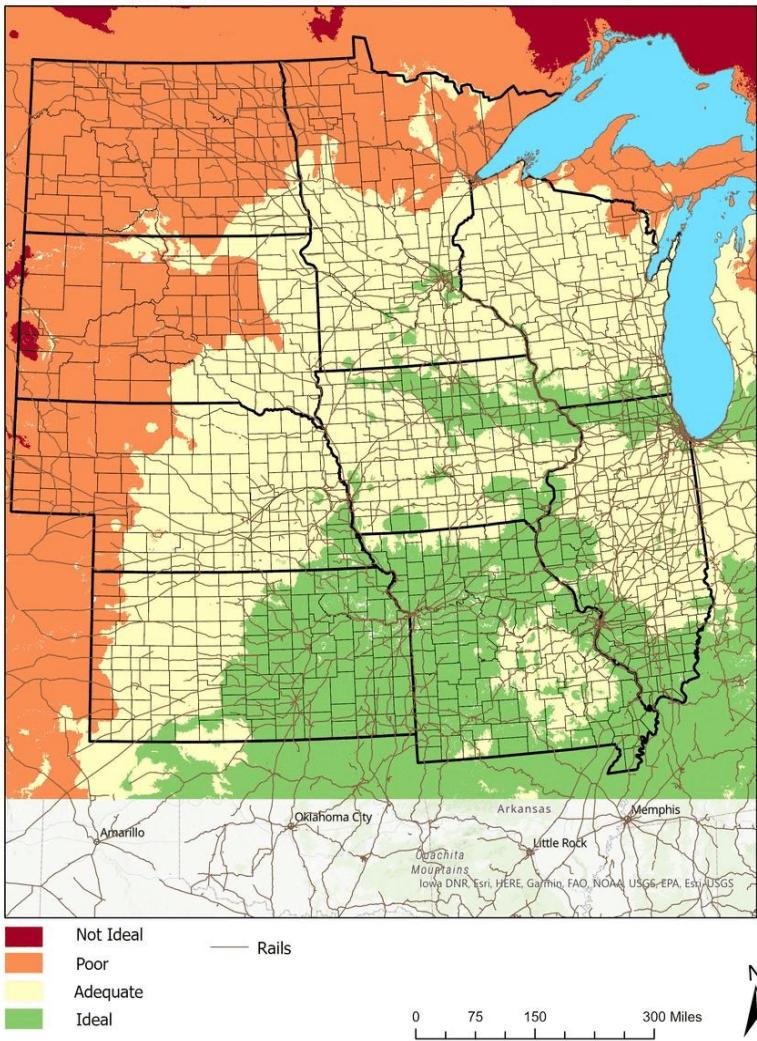
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Site Suitability Model

Ryan Krakowiak

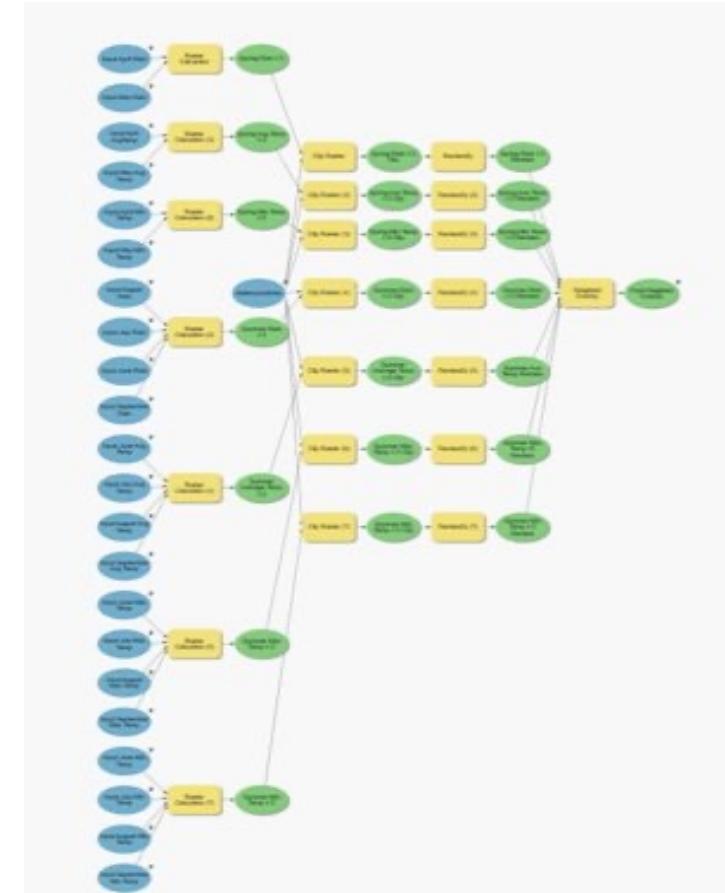
Suitable Crop Land CMIP6 4.5 Scenario 2021-2040 Projection



Projected area of Optimal land for Corn and Soybean growth weighing RCP 4.5 Scenario predictions of daily minimum temperatures during Spring and Summer, maximum temperatures during Summer, average temperatures during Spring and Summer, and rainfall during Spring and Summer. Rail lines are overlayed because they are the most efficient way to transport crops.

Notice: Central Midwest states remain highly ideal, expansion of adequate conditions North.

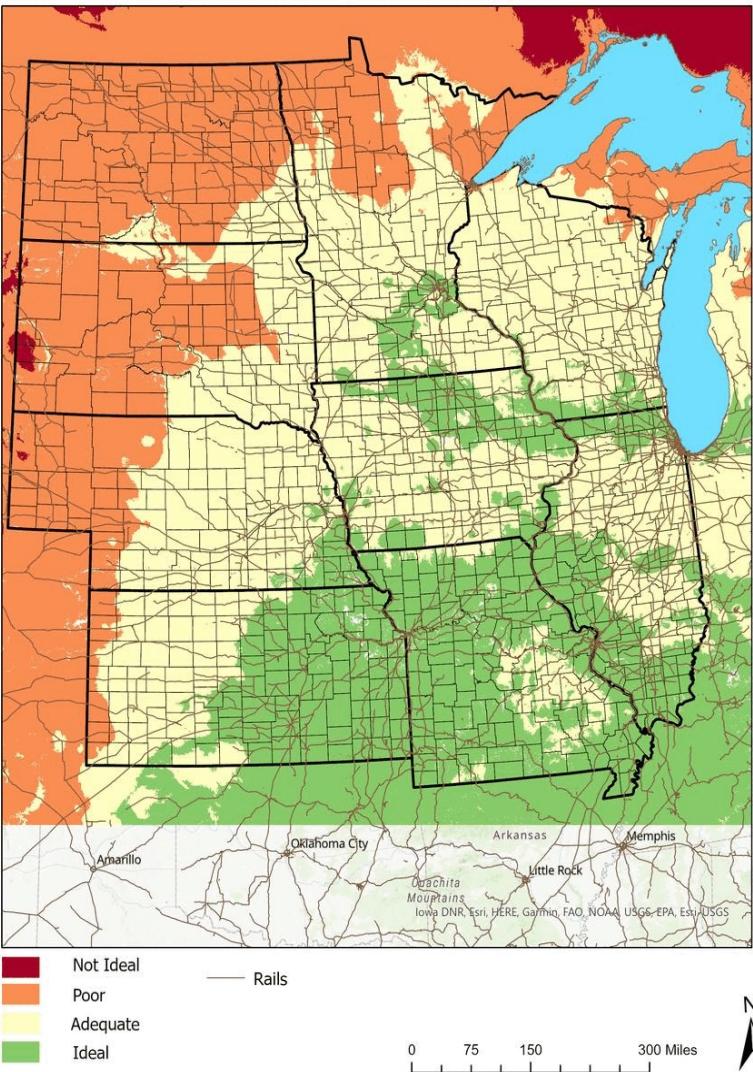
Model Design



Site Suitability Model

Ryan Krakowiak

Suitable Crop Land CMIP6 8.5 Scenario 2021-2040 Projection

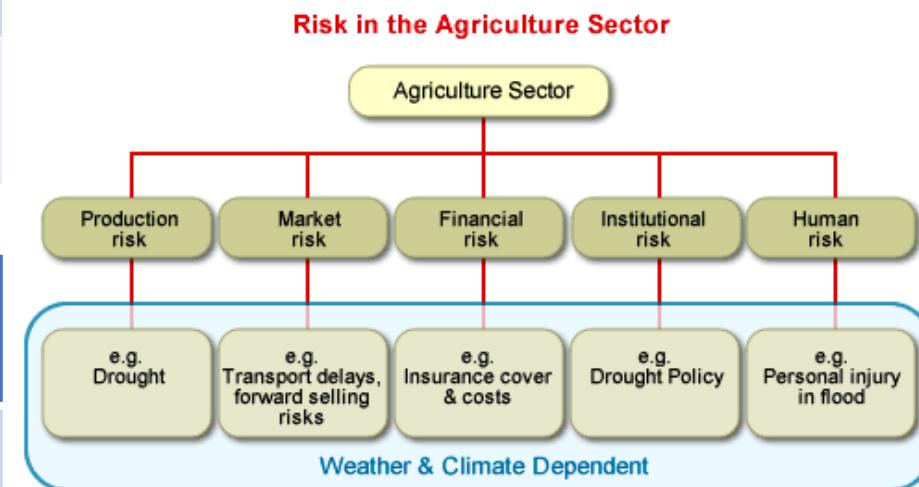


Projected area of Optimal land for Corn and Soybean growth weighing RCP 8.5 Scenario predictions of daily minimum temperatures during Spring and Summer, maximum temperatures during Summer, average temperatures during Spring and Summer, and rainfall during Spring and Summer. Rail lines are overlayed because they are the most efficient way to transport crops.

Takeaway: Notice Southern Midwest States lost optimality in severe scenario outlook, possible that they may be more suited towards traditionally Southern grown crops.

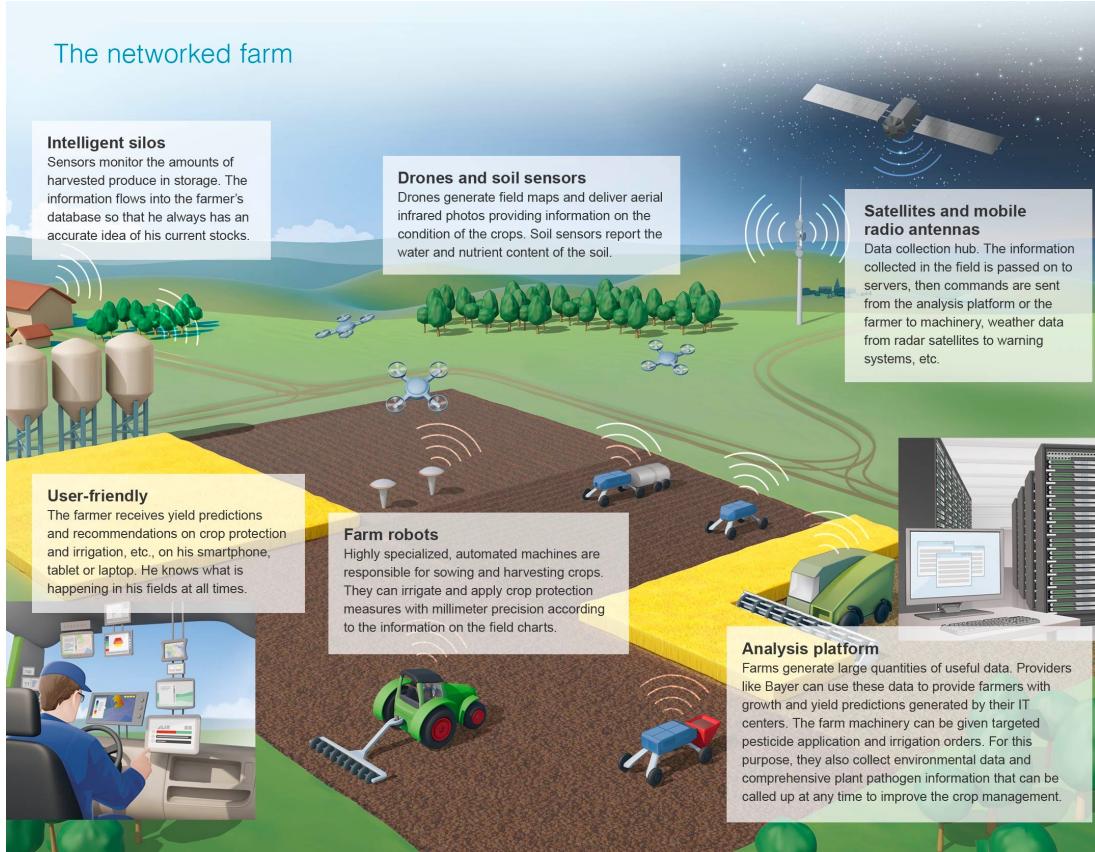
Top Risks

Physical	Changes in temperature, precipitation, and CO₂ lead to unpredictability in the Growth window and Percent yield
Financial Implications	These unpredictable climate conditions may require investments in insurance, R&D, Repairs, Training, etc.
Forms of physical risks	<ul style="list-style-type: none"> - Supply Chain - Changes in growing season - Droughts - Extreme Weather events
Transitional	Changes in market patterns, tech, and policy leads to advancements of the agriculture market
Financial Implications	A shift to a low-carbon and climate-resilient economy involves evolving market thresholds and investments
Forms of transition risks	<ul style="list-style-type: none"> - Regulatory changes - Technological advancement - Market preferences - Access to capital



Solutions (Digital Twins)

The networked farm



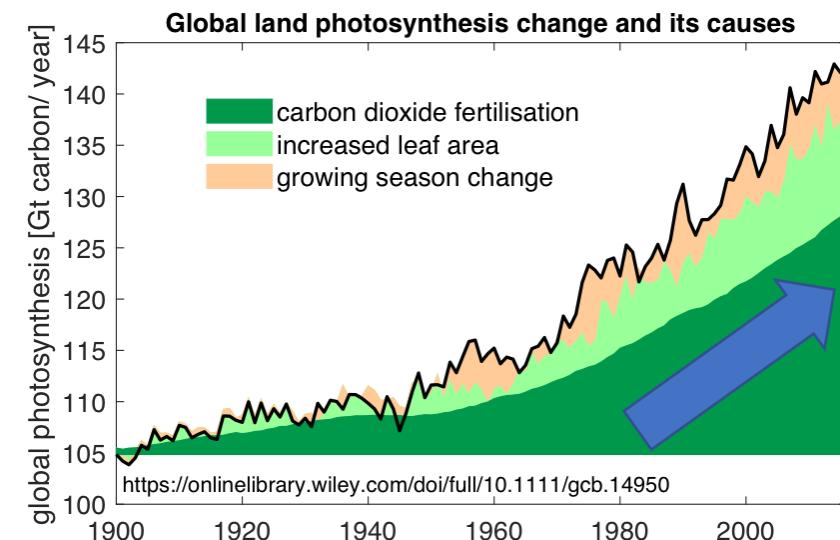
PRIMARY STAKEHOLDERS

- | | | | | |
|-------------------------|----------------|-----------------------------|--------------------------|--------------------|
| • Seed suppliers | • Farmers | • Mills | • Traders | • Wholesalers |
| • Fertilizer suppliers | • Associations | • Food processing companies | • Distribution companies | • Retailers |
| • Irrigation businesses | • Cooperatives | • Packaging companies | | • Export companies |

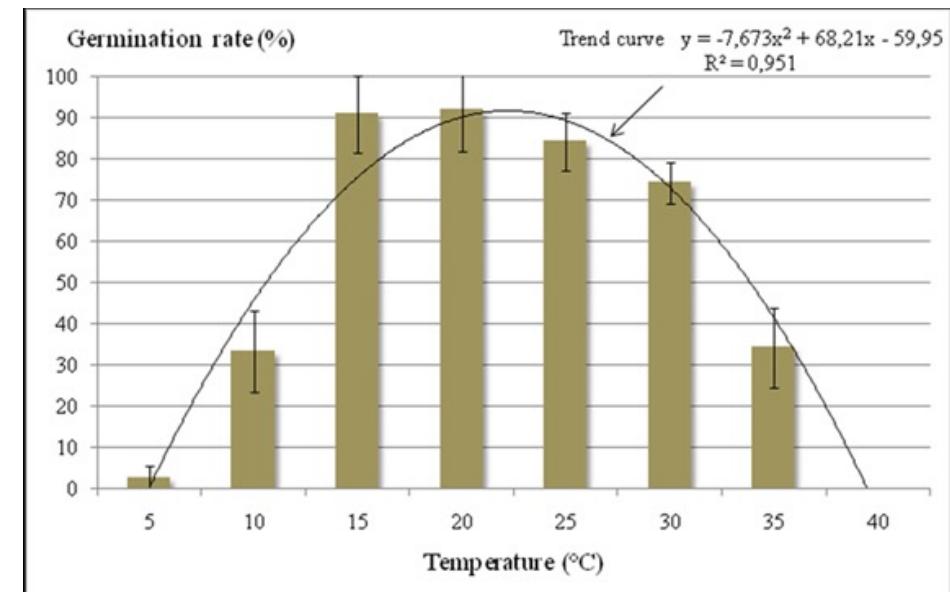


A digital twin in agriculture is a virtual representation or simulation of a real-world farm or agricultural system. It integrates various data sources, such as sensors, weather data, and satellite imagery, with advanced analytics, artificial intelligence, and machine learning to create a comprehensive digital model of the farm or agricultural process.

Climate Condition	Impact on financial performance
Increased CO ₂ emissions	<p>Impact on Growmark</p> <ul style="list-style-type: none"> <input type="checkbox"/> Venturing into Carbon Credit <input type="checkbox"/> Investing in electric equipment <p>Increased crop production for farmers</p> <ul style="list-style-type: none"> <input type="checkbox"/> Rising levels of CO₂ in the atmosphere drive an increase in plant photosynthesis <input type="checkbox"/> between 1982 and 2020, global plant photosynthesis grew 12%, as CO₂ levels in the atmosphere rose by 17% <input type="checkbox"/> Some crops such as wheat, rice and soybeans are expected to benefit from increased CO₂ with an increase in yields from 12% to 14% <input type="checkbox"/> However, crops such as corn are not affected

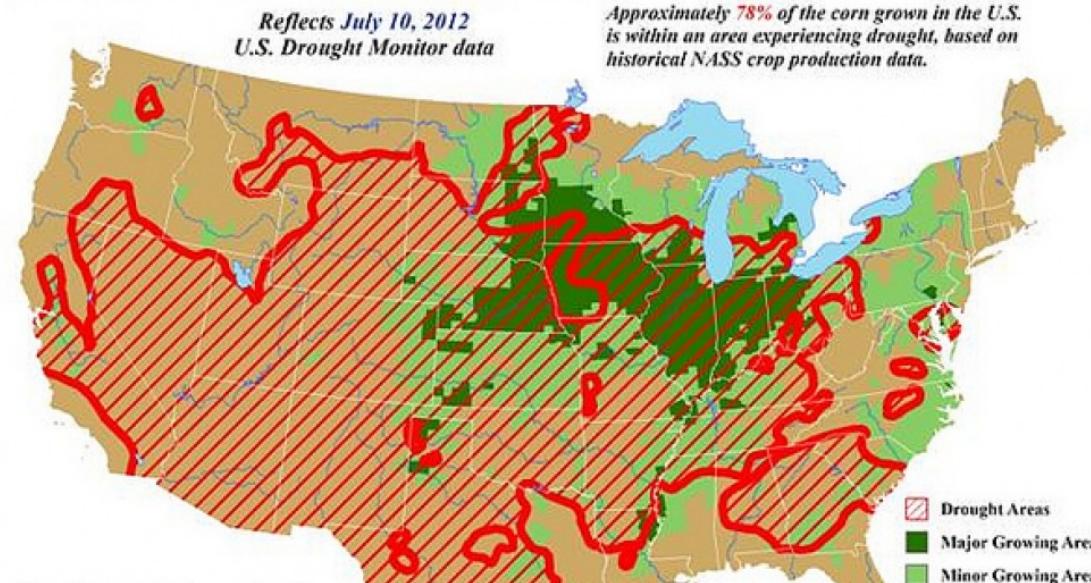
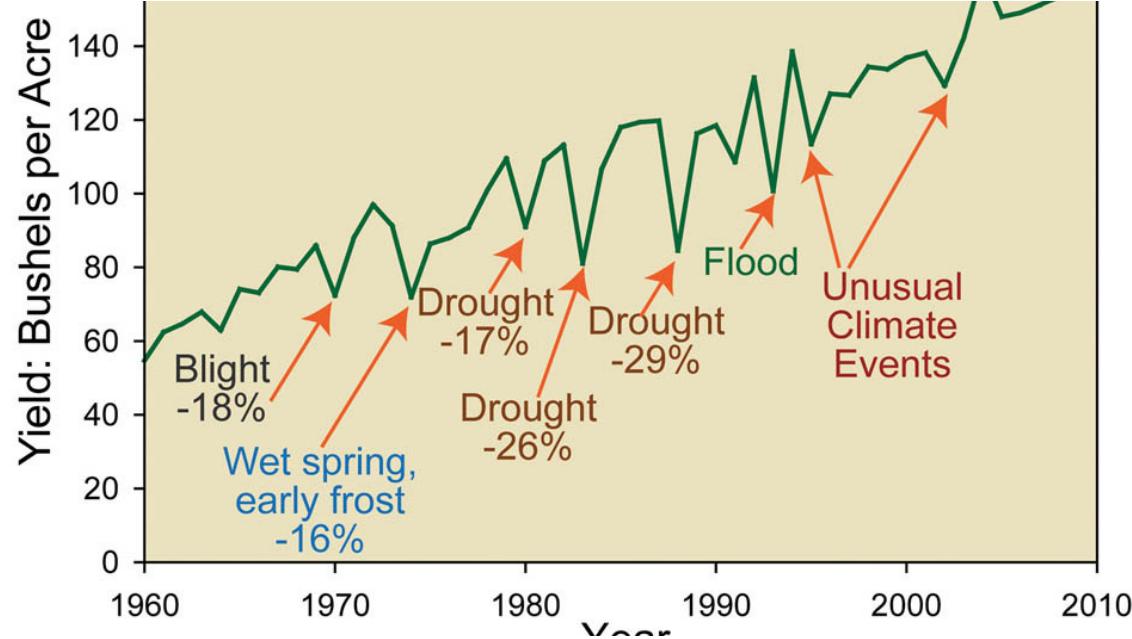


Climate Condition	Impact on financial performance
Increased temperatures	<p>Decrease in the quality and quantity of seed, business interruption</p> <ul style="list-style-type: none"> □ High temperatures during seed filling frequently disrupt normal seed development (Spears <i>et al.</i> 1997) □ Models show that each degree of added warmth can cause a 3% to 7% loss in the yields of some important crops, such as corn and soybeans



Climate Condition	Impact on financial performance
Warming Winters and Increased Atmospheric Moisture	<p>Increased cost: High demand for insecticides, weedicides</p> <ul style="list-style-type: none"> <li data-bbox="1077 505 2434 606"><input type="checkbox"/> More generations of pests reproduce as warmer temperatures speed up insect life cycles <li data-bbox="1077 678 2332 779"><input type="checkbox"/> Rising temperatures also driving some insects to invade new territories <li data-bbox="1077 851 2408 951"><input type="checkbox"/> Higher temperatures and an increase in moisture also make crops more vulnerable <li data-bbox="1077 1023 2408 1182"><input type="checkbox"/> Weeds, many of which thrive in heat and elevated CO₂, already cause about 34% of crop losses; insects cause 18% of losses, and disease 16%. Climate change will likely magnify these losses

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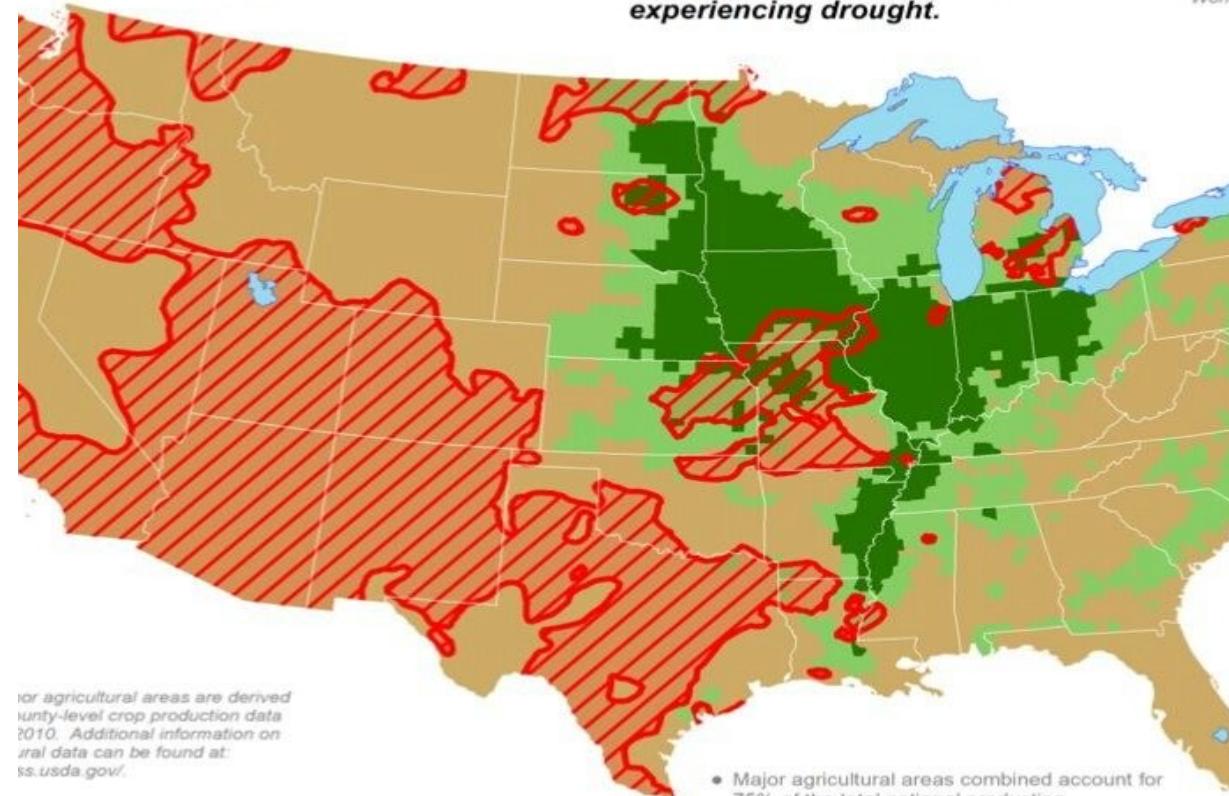


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Soybean Areas Experiencing Drought

Reflects August 28, 2018
U.S. Drought Monitor data

Approximately 12% of soybean production is within an area experiencing drought.



2

Conclusion

What does this all mean?

Although Growmark is having a hard time understanding the growing nature of climate change, there are resources that can reduce the impact and potentially innovate the market by implementing new methods and investing in preventative measures.

Risks:

- Increase in C02
- Increase in Temperature
- Drought Potential

Potential Solutions:

- Digital Twins
- Growing Earlier in the Year
- Precision Agriculture
- Suitability of Land for Growing

The TCFD format could be used for Growmark to identify specific risks as they show up. It could be used as a project format to plan for future events and innovate what they need to as they make predictions.

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Top risks

Risk drivers	Changes in temperature and precipitation	Regulatory Changes
Type	Physical	Transition
Scale	High	High
Likelihood	Very likely	Very likely
Timeframe	Long-term (30-year)	Long-term (30-year)
Impact	Unpredictability and fluctuation in grow window and percent yield	The implementation of stricter environmental regulations and policies aimed at reducing greenhouse gas emissions and promoting sustainable agricultural practices
Financial implications	These unpredictable climate conditions may require the use of new technologies, R&D, Repairs, Training, etc	Changing regulatory policies can lead to increased compliance costs, operational adjustments, and altered market dynamics for agricultural companies like Growmark. These changes may necessitate investment in low-carbon technologies and could result in stranded assets, impacting the company's financial performance and position.
Quantifications	754 Million USD	528 Million USD
Methodology	Estimated potential financial impact is annualized over a 30-year time horizon of estimated R&D costs and negative revenue impacts. Assuming over a 30-year period, agriculture-based companies spend 10% of revenue on innovations, based on open source data this is how much Growmark would be expected to spend.	Estimated potential financial impact is annualized over a 30-year time horizon, calculated using data based on what other agriculture companies are spending on regulatory changes per year

Financial impacts (Generalized)

Impact on financial performance	<ul style="list-style-type: none">Growmark is using the latest technologies for their grain marketing in order to provide the most efficient operations and strategic partnerships. Paired with their high-level logistics that include brokerage services and leading crop nutrients, they're able to increase revenue in times when climate impact is semi-predictableGrowmark faces increased costs due to climate-related factors such as carbon pricing policies, business interruptions, contingency planning, and repairs. Carbon pricing policies may raise costs related to direct and indirect emissions, while extreme weather events can disrupt operations and affect crop yields. Contingency planning and risk management efforts to address climate uncertainties also contribute to increased costs. Additionally, climate-related events may damage infrastructure and equipment, necessitating expensive repairs or replacementsAgricultural companies like Growmark can experience changes in operating cash flow due to factors such as commodity price fluctuations, sustainable sourcing, regulatory compliance, and water and energy costs. Climate-related events can impact commodity prices while prioritizing sustainability and environmentally-friendly practices may increase costs. New regulations for greenhouse gas emissions or sustainable agriculture can raise compliance expenses, and climate-related factors may affect water and energy costs. These changes in upstream costs can directly impact the operating cash flow of agricultural companiesGrowmark may face changes in total expected losses due to physical risks associated with climate change, such as crop yield losses, supply chain disruptions, and increased insurance premiums. Extreme weather events can negatively impact crop yields, affecting Growmark's financial performance and leading to higher total expected losses. Climate-related risks can also disrupt the supply chain, causing increased costs and operational inefficiencies. Additionally, as climate-related events become more frequent and severe, insurance premiums may rise, increasing Growmark's operating costs and contributing to higher total expected losses
Impact on financial position	<ul style="list-style-type: none">Growmark's expected portfolio value can be influenced by market opportunities, operational efficiency, regulatory changes, and transition risks. By tapping into the growing demand for sustainable products and services and improving operational efficiency through eco-friendly practices, Growmark can positively impact its portfolio value. However, regulatory changes and transition risks may present challenges that could negatively affect the portfolio value. Proactively managing these factors can help Growmark maintain competitiveness and drive growth in the agricultural sectorGrowmark's low-carbon capital investments can increase assets, improve operational efficiency, reduce emissions, and help the company adapt to regulatory changes. While these investments may initially raise liabilities, they can ultimately enhance equity through cost savings and new revenue streams