

MUSKOGEE, OKLAHOMA

Impact of Wildfire on Crop Production

ABOUT MUSKOGEE

Muskogee, nestled in the heart of Oklahoma, is a city steeped in history and vibrant with culture. Known for its rich Native American heritage, Muskogee offers a captivating blend of tradition and modernity. From its annual Azalea Festival to its historic landmarks and welcoming community, Muskogee is a place where the past and present converge.

Crop production in Muskogee, Oklahoma, plays a vital role in the region's agricultural landscape and economy. Situated in the fertile soils of northeastern Oklahoma, Muskogee County benefits from a diverse range of crops that thrive in its climate and terrain.

Overall, crop production in Muskogee, Oklahoma, remains a cornerstone of the region's economy, providing both economic stability and a source of high-quality agricultural products for both local consumption and broader markets. With a commitment to innovation and sustainability, Muskogee's farmers are poised to continue thriving in the ever-evolving world of agriculture.

1. INTRODUCTION

The analysis of the wildfire impact on crop production in Muskogee, Oklahoma, is profoundly interesting and important due to several critical factors. This research^{[1][2][3][4]} addresses a timely and pressing issue with wide-ranging consequences for the local agricultural community, the regional economy, and the broader ecological context. Here are several reasons why this analysis matters:

Economic Significance

Agriculture is a cornerstone of Muskogee's economy. Crop production in this region contributes significantly to the livelihoods of farmers, the local workforce, and the overall economic stability. Understanding the impact of wildfires on crop production helps quantify potential economic losses and develop strategies to mitigate them.



Food Security

Crop production in Muskogee directly affects food security for both the local population and beyond. Any disruption in crop production due to wildfires could lead to food shortages, price volatility, and decreased access to fresh, locally grown produce. This analysis is essential for safeguarding food supply chains.

Environmental Implications

Wildfires can have far-reaching environmental consequences. They can damage soil quality, deplete natural resources, and disrupt the delicate ecological balance. Understanding how wildfires affect crop production can inform land management practices and ecological restoration efforts in the region.

Climate Change Context

With the increasing frequency and intensity of wildfires globally, studying their impact on crop production in Muskogee provides valuable insights into the broader context of climate change. It contributes to our understanding of how extreme weather events can affect agricultural sustainability and resilience.

Community Welfare

Muskogee's farming communities depend on successful crop yields for their livelihoods. Wildfires can lead to the displacement of farmers, loss of income, and increased economic vulnerability. Analyzing the impact helps identify measures to support these communities during and after wildfire events.

Policy and Preparedness

This analysis aids in the development of effective policies and disaster preparedness strategies. By understanding the specific challenges posed by wildfires in Muskogee, policymakers can allocate resources more effectively, implement fire mitigation measures, and establish early warning systems.

Unresolved Research Question

While wildfires' overall impact on crop production is well-documented in some regions, the specific consequences in Muskogee may vary due to its unique climate, geography, and agricultural practices. This research tackles an unresolved question by providing region-specific insights.

Mitigation and Adaptation

The findings of this analysis can guide strategies for wildfire mitigation and adaptation. Farmers can implement practices to reduce vulnerability to wildfires, such as firebreaks, improved irrigation systems, or crop diversification. This research offers practical solutions for farmers to safeguard their livelihoods.

Long-term Sustainability

Ensuring the sustainability of agriculture in Muskogee is crucial for future generations. By understanding how wildfires impact crop production, we can develop strategies to promote sustainable farming practices that are resilient to climate-related challenges.

In summary, the analysis of wildfire impact on crop production in Muskogee, Oklahoma, addresses a multifaceted issue with profound implications for the local economy, food security, environmental conservation, and community well-being. It not only sheds light on a crucial concern but also offers practical solutions to ensure the resilience and sustainability of agriculture in the region. This research is vital in the face of increasing climate-related challenges and contributes to the broader discourse on agricultural resilience and disaster preparedness.

2. BACKGROUND

Research into the impact of wildfires on crop production is an area of study that has gained attention, particularly in regions prone to wildfires. While there may not be an abundance of specific studies focused on Muskogee, Oklahoma, several related research findings can inform hypotheses, analysis, and system design in assessing wildfire impact on crop production in this region.

Previous Research Findings:

- **Wildfire Frequency and Crop Damage:** Studies in wildfire-prone regions like California have shown that wildfires can significantly damage crops, leading to economic losses for farmers. These findings suggest that a similar phenomenon could occur in Muskogee, affecting crop yields.
- **Air Quality and Crop Health:** Research has demonstrated that wildfires can degrade air quality by releasing particulate matter and harmful chemicals into the atmosphere. Poor air quality can negatively impact crop health and reduce yields. Understanding how wildfire-induced air pollution affects crops is relevant to Muskogee's agricultural context.
- **Soil Quality and Post-Wildfire Recovery:** Wildfires can alter soil properties, making them less conducive to crop growth. Studies on post-wildfire soil recovery and the implementation of soil management practices could offer insights into how Muskogee farmers can rehabilitate their land after a wildfire.
- **Climate Change and Fire Risk:** Research on the link between climate change and increased wildfire risk is relevant to Muskogee. If climate change is identified as a contributing factor to increased wildfire frequency, it could inform hypotheses about the future impact of wildfires on crop production in the region.
- **Firebreaks and Mitigation Strategies:** Studies on the effectiveness of firebreaks and other wildfire mitigation strategies can inform system design for preventing or reducing the damage caused by wildfires in Muskogee.

Hypotheses and Research Questions:

Hypothesis 1: Wildfires in Muskogee, Oklahoma, have a significant negative impact on crop production, resulting in decreased yields and economic losses for farmers.

Research Question 1: To what extent is crop damage caused by wildfires in Muskogee, and how does this impact vary among different crop types?

Hypothesis 2: Wildfire-induced air pollution adversely affects the health and growth of crops in Muskogee.

Research Question 2: What is the impact of changes in air quality on crop production?

Hypothesis 3: Crop impact is expected to increase over the next 25 years in correlation with the predicted rise in smoke levels.

Research Question 5: How does the projected trend for crop production over the next 25 years compare to the forecasted increase in smoke impact?

Incorporating these hypotheses and research questions into the analysis and system design for assessing wildfire impact on crop production in Muskogee, Oklahoma, can provide a comprehensive understanding of the challenges and solutions specific to this region.

2.1. DATA SOURCES

Wildfire Data

The United States Geological Survey (USGS)^[5] provides comprehensive wildfire data that serves as a crucial resource for understanding and monitoring wildfires across the United States. This data encompasses a wide range of information related to wildfires, including their locations, sizes, containment status, and associated details. It is collected from various sources, including government agencies, fire management organizations, and satellite observations. The USGS wildfire data offers both historical and real-time insights into the dynamics of wildfires, enabling researchers, policymakers, and the public to assess their impact on ecosystems, communities, and agriculture. This information plays a vital role in wildfire management, helping authorities plan and coordinate firefighting efforts, evacuate affected areas, and allocate resources effectively. Additionally, the data serves as a foundation for ecological research, allowing scientists to study the long-term effects of wildfires on landscapes and wildlife habitats. Overall, the USGS wildfire data is an invaluable tool in the ongoing effort to monitor, understand, and mitigate the impact of wildfires in the United States.

AQI Data

The United States Environmental Protection Agency (US EPA)^[6] provides comprehensive Air Quality Index (AQI) data, offering a crucial and accessible tool for assessing air quality across the United States. The AQI data compiles information on various air pollutants, including ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. This data is collected from a network of monitoring stations strategically placed throughout the country. It quantifies the concentration of these pollutants, categorizes them into different air quality levels, and provides real-time and historical data for public awareness and decision-making.

The AQI data serves as a valuable resource for several purposes, including informing the public about the current air quality conditions in their area, guiding individuals with respiratory conditions on taking precautionary measures, and assisting policymakers in developing air quality regulations and mitigation strategies. It offers a clear and easy-to-understand scale, ranging from "Good" to "Hazardous," allowing people to quickly assess the health risks associated with their local air quality. Furthermore, the data supports research efforts to understand the impact of air pollution on public health and the environment, aiding in the development of evidence-based policies to improve air quality. Overall, the US EPA's AQI data plays a pivotal role in safeguarding public health, enhancing environmental stewardship, and promoting informed decision-making regarding air quality issues nationwide.

Crops Data

The United States Department of Agriculture (USDA)^[7] provides a comprehensive and invaluable source of data related to crops, which is essential for understanding, managing, and advancing agriculture in the United States. This rich dataset encompasses a wide array of information about crops, including crop types, production, yields, acreage, prices, and more. It is collected through a combination of surveys, field observations, and data from farmers, making it one of the most authoritative sources for crop-related information in the country.

One of the fundamental components of the USDA's crops data is the Crop Production Report, which is released on a monthly basis. This report provides estimates of crop production for major field crops, such as corn, soybeans, wheat, cotton, and rice. These estimates are crucial

for farmers, agribusinesses, and policymakers as they help in forecasting crop availability and making informed decisions about planting, marketing, and trade. The USDA's National Agricultural Statistics Service (NASS) conducts surveys to gather this data, ensuring its accuracy and reliability.

Another key aspect of the USDA's crops data is the Crop Acreage Report, which provides information about the total acreage planted and harvested for various crops. This data allows stakeholders to assess trends in crop expansion or contraction, understand regional variations, and make informed decisions about resource allocation and land use planning.

The USDA also maintains data related to crop yields, which is essential for gauging the productivity of American agriculture. These yield estimates are critical for both domestic and international markets, as they influence commodity prices and trade agreements. Additionally, the USDA's data on crop yields enables researchers and policymakers to analyze the long-term sustainability and resilience of agricultural practices.

Furthermore, the USDA's crops data extends to specialty crops, organic farming, and conservation practices. It covers a diverse range of crops beyond the major commodities, including fruits, vegetables, nuts, and specialty grains. This data supports niche markets, organic farming initiatives, and sustainable agriculture practices.

In summary, the USDA's crops data is a comprehensive and multifaceted resource that underpins the success of American agriculture. It supports the entire agricultural ecosystem, from individual farmers making planting decisions to policymakers crafting agricultural policies. This data not only serves as a foundation for informed decision-making but also contributes to the sustainability, resilience, and competitiveness of the U.S. agricultural sector on a global scale.

3. METHODOLOGY

In this methodology section, we delve into the analytical tools and formulas employed to assess the impact of smoke from wildfires on crop production in Muskogee, Oklahoma. Central to our approach are two critical components: the Smoke Impact Formula and the Crop Impact Formula. These formulas serve as the backbone of our research, allowing us to quantitatively measure and understand the extent of crop damage resulting from wildfire-induced smoke. The Smoke Impact Formula provides a systematic means of evaluating the dispersion and concentration of smoke particles, while the Crop Impact Formula calculates the resultant reduction in crop yields due to smoke exposure. Together, these methodologies enable us to comprehensively evaluate the intricate relationship between wildfires, smoke, and crop production, shedding light on the multifaceted challenges faced by the agricultural community in Muskogee.

3.1. SMOKE IMPACT ESTIMATOR

When assessing the impact of smoke on crop production in Muskogee, Oklahoma, our analysis takes into account an essential factor: the proximity of wildfires to the city. We recognize that the impact of a wildfire is not solely determined by its size but is significantly influenced by its distance from the city center. To address this, we have developed a Smoke Impact Estimator that considers the spatial relationship between wildfires and Muskogee.

This estimator assigns a higher impact score to smaller wildfires located near the city, acknowledging that their smoke plumes are more likely to affect local air quality and, subsequently, crop health. Conversely, larger wildfires situated farther away from Muskogee are

assigned a lower impact score. This approach reflects the common observation that smaller fires in proximity to urban areas can lead to greater smoke exposure and air quality degradation, thus posing a more immediate threat to crop production, public health, and overall well-being.

By incorporating the Smoke Impact Estimator into our methodology, we aim to provide a nuanced understanding of how wildfire proximity interacts with size to influence the impact on crops in Muskogee. This consideration enables us to deliver a more accurate and contextually relevant assessment of the challenges faced by the agricultural community in the region.

3.2. CROP IMPACT ESTIMATOR

To quantitatively gauge the repercussions of wildfires on crop production in Muskogee, Oklahoma, we employ a well-defined Crop Impact Score calculation. This formula, which incorporates essential variables such as area harvested and area planted, offers a precise means of measuring the impact of wildfires on the region's agricultural output.

The Crop Impact Score (CIS) is derived from the following formula:

$$\text{Area Harvested \%} = (\text{Area Harvested}) / (\text{Area Planted})$$

$$CIS: (\text{Max(Area Harvested \%)} - \text{(Area Harvested \% for the year)}) / (\text{Max(Area Harvested \%})$$

This formula operates on the principle of relative crop loss, taking into consideration both the maximum achievable yield (represented by Max(Area Harvested) / Max(Area Planted)) and the actual yield achieved (Area Harvested / Area Planted). By comparing these values, the Crop Impact Score quantifies the extent to which wildfires have disrupted crop production.

A higher Crop Impact Score indicates a more substantial reduction in crop yield, signifying a more severe impact of wildfires on the agricultural sector. Conversely, a lower score reflects a relatively minimal impact, highlighting the resilience of crops to wildfire-related challenges.

By utilizing this Crop Impact Score calculation, we aim to provide a clear and objective measure of the consequences of wildfires on Muskogee's crop production, aiding in the development of informed strategies to mitigate these effects and bolster the region's agricultural resilience.

Human-Centered Considerations

The design of our formula for assessing the impact of wildfires on crop production in Muskogee, Oklahoma, was significantly influenced by human-centered considerations, including ethics and the well-being of local communities and farmers. Here's how these considerations shaped our approach:

- **Transparency and Accessibility:** We prioritized transparency in our formula to ensure that it can be easily understood and interpreted by a wide range of stakeholders, including farmers, policymakers, and the general public. This transparency fosters trust in our analysis and allows affected communities to grasp the severity of the situation.
- **Fairness and Equity:** Our formula takes into account the relative impact of wildfires on different crops, considering both the maximum achievable yield and the actual yield achieved. This approach promotes fairness by acknowledging that various crops have

different susceptibilities to wildfire damage. It ensures that the assessment is equitable and does not unfairly penalize crops that are inherently less resilient to fire.

- **Empowerment and Decision-Making:** By providing a clear and quantitative measure of the impact (Crop Impact Score), our formula empowers local farmers and decision-makers to assess the situation objectively. It aids them in making informed choices about resource allocation, recovery efforts, and land use planning. This empowerment is in line with ethical principles of autonomy and self-determination.
- **Data Privacy and Security:** In collecting and utilizing data for our analysis, we adhere to ethical principles of data privacy and security. Protecting the confidentiality of farmers' information and ensuring that data is used solely for research purposes are integral aspects of our approach.

In summary, the design of our formula for assessing wildfire impact on crop production in Muskogee was informed by a commitment to ethics that prioritize transparency, fairness, community well-being, and responsible environmental stewardship. We recognize the ethical responsibility inherent in conducting research that affects agricultural communities and the broader ecosystem and have strived to incorporate these considerations into our methodology.

4. FINDINGS

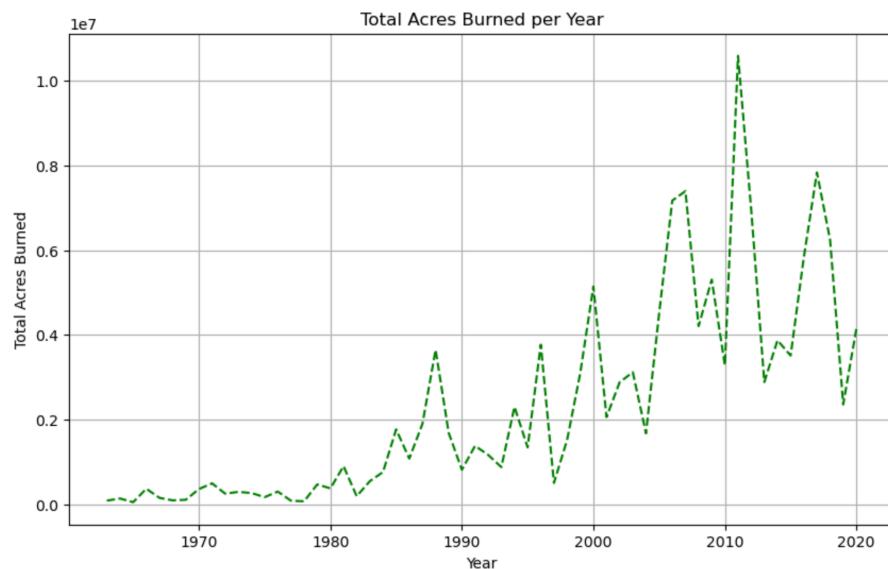


Fig - The Toal number of Acres Burned per Year from 1963 to 2020

As illustrated in the figure above, the escalating trend of damage inflicted by wildfires over the past six decades is an alarming and undeniable reality. This significant increase in the frequency and intensity of wildfires underscores the pressing need for a comprehensive analysis of their adverse effects on crop production within the city of Muskogee.

The exponential rise in wildfire-related damage represents more than just a statistical observation; it signifies a growing threat to the agricultural landscape and, consequently, the livelihoods of those who depend on it. Muskogee, with its rich agricultural heritage, faces a critical juncture where the repercussions of wildfires on crop production cannot be underestimated. The repercussions extend beyond the immediate economic losses, impacting

food security, rural communities, and the delicate balance between human activities and the environment.

The imperative to analyze the impact of wildfires on crop production in Muskogee arises not only from the historical data but also from the recognition of the future challenges that lie ahead. As climate change continues to exacerbate the conditions conducive to wildfires, understanding the intricacies of this phenomenon is paramount. This analysis seeks to shed light on the extent of the damage, the resilience of crops, and the strategies that can be employed to mitigate these effects, thus aiding in the development of a more resilient and sustainable agricultural sector in Muskogee.

Based on the findings in the code and the amount of data available for all crops, we have narrowed the analysis down to two crops **Corn** and **Soybeans** as they have the data available for the years we are considering.

4.1. COVARIANCE ANALYSIS

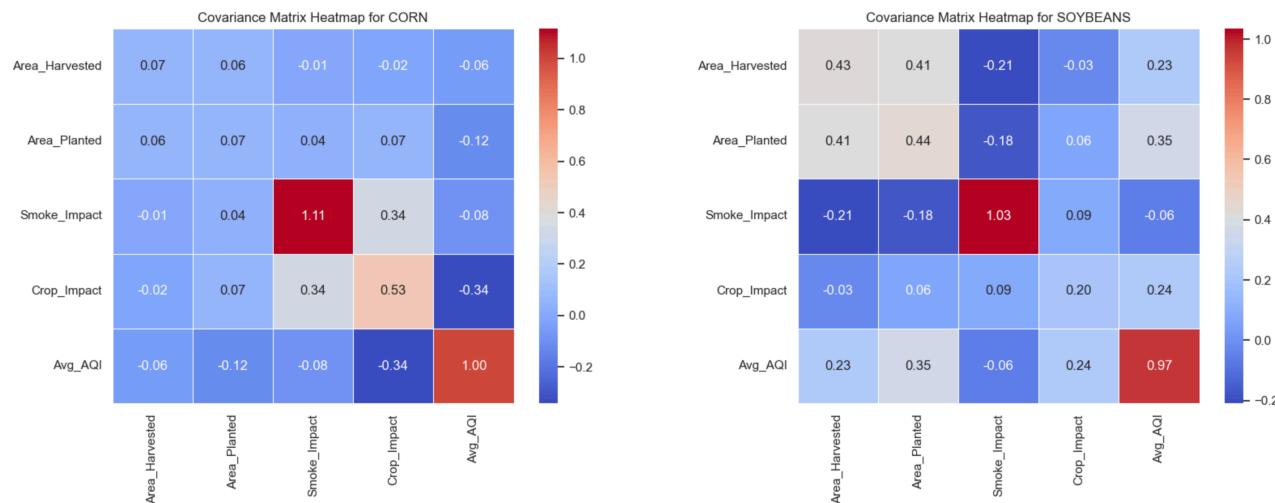


Fig - Covariance Matrix for Corn and Soybeans

The presence of positive covariance values between crop impact and smoke impact for both Corn and Soybeans in the covariance matrix implies a notable relationship between these variables. A positive covariance suggests that when one variable increases, the other tends to increase as well, and when one decreases, the other tends to decrease. In the context of Corn and Soybeans, this suggests that as the impact of smoke from wildfires increases, there is a tendency for both crops to experience a concurrent increase in crop impact, indicating a vulnerability of these crops to wildfire-induced smoke. This insight can inform risk assessment and management strategies for agricultural practices, helping farmers and policymakers better prepare for and mitigate the effects of wildfires on crop production.

4.2. CROP IMPACT VS SMOKE IMPACT

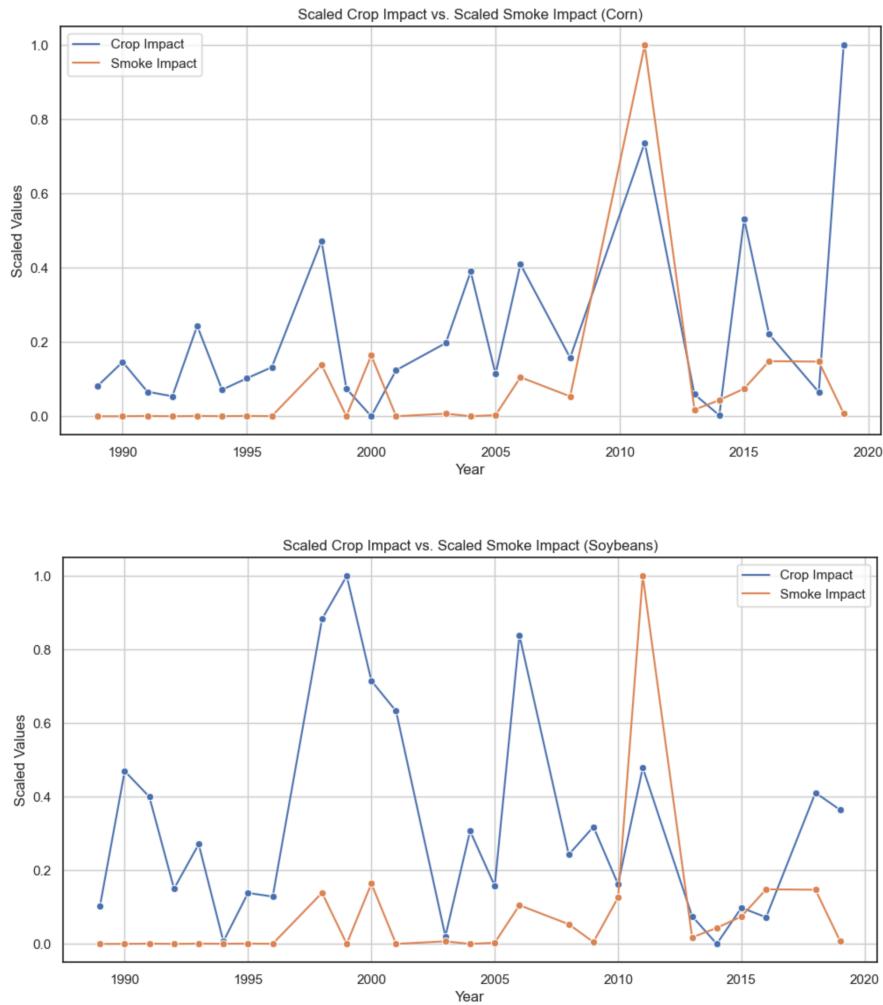


Fig - Crop Impact vs Smoke Impact trends over the years

As evident from the two charts presented above, the relationship between crop impact and smoke impact for both Corn and Soybeans is notably positive. This implies that as smoke impact increases, there tends to be a corresponding increase in crop impact, highlighting the susceptibility of these crops to the effects of wildfire-induced smoke. However, a closer examination of the data reveals intriguing differences in the historical trends between Corn and Soybeans.

For Soybeans, the charts reveal a pattern where the crop impact was higher in the earlier years but gradually decreased in more recent times. Conversely, Corn exhibited an inverse trend, with lower crop impact in the earlier years and a subsequent increase in the later years. These differences may be attributed to a range of factors, including variations in crop resilience, evolving agricultural practices, and changing climate conditions.

The initial higher crop impact for Soybeans could be linked to specific conditions or practices in the earlier years that made them more vulnerable to wildfire smoke. In contrast, the increasing crop impact for Corn in recent years might be influenced by changing climate patterns, shifts in planting strategies, or other environmental factors.

Understanding these disparities is essential for farmers and policymakers to adapt to evolving challenges in crop production and wildfire management. It underscores the dynamic nature of agricultural systems and the need for targeted interventions and mitigation strategies tailored to specific crops and changing circumstances.

4.3. CROP IMPACT VS AQI



Fig - Crop Impact vs AQI for Corn and Soybeans

The evident susceptibility of Corn and Soybeans to different environmental factors, as observed in the two charts above, offers valuable insights into the unique challenges faced by each crop and underscores the critical interplay between crop impact and environmental conditions.

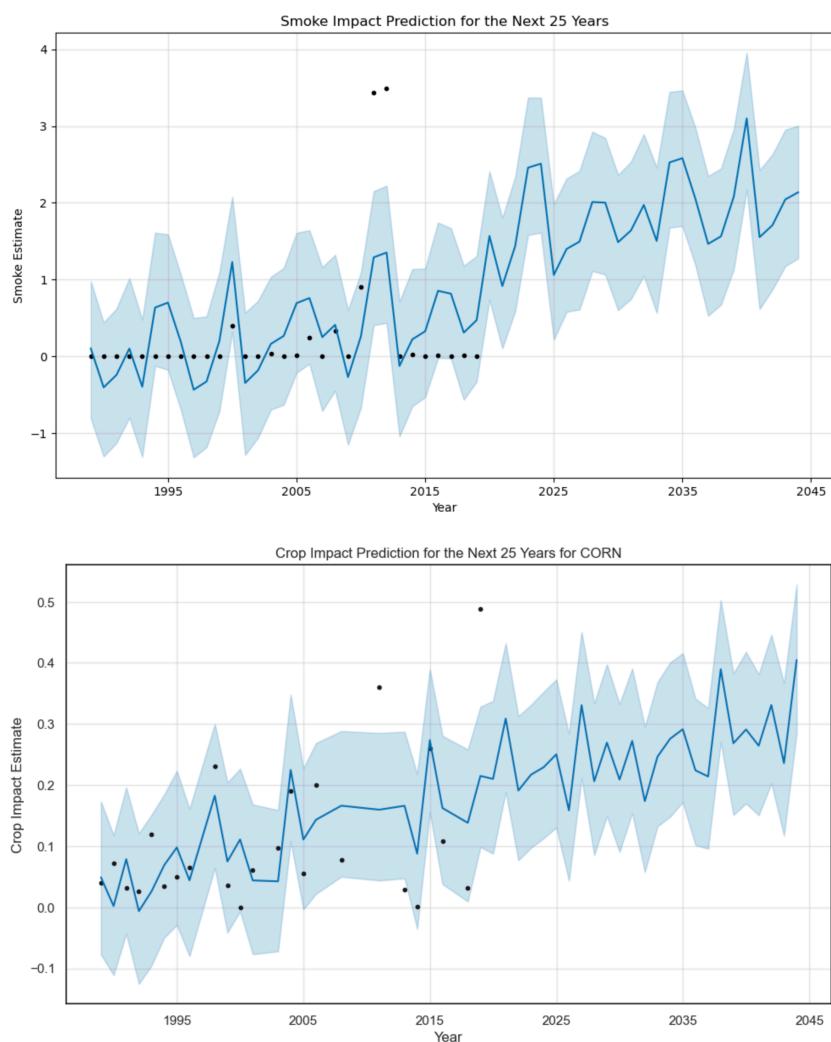
For Corn, the higher crop impact associated with a rise in the Air Quality Index (AQI) is particularly noteworthy. Corn is classified as a C4 plant, which means it is highly dependent on sunlight during crucial stages of grain fill. Elevated AQI levels, often associated with wildfire smoke, can lead to reduced sunlight penetration due to the presence of fine particulate matter in the air. This diminished sunlight availability during the grain fill stages can significantly hinder photosynthesis and overall crop development, resulting in reduced yields and a higher crop

impact. In essence, the higher crop impact in Corn signifies a vulnerability to decreased sunlight caused by poor air quality conditions, which is detrimental to its growth and productivity.

Conversely, Soybeans exhibit a different pattern, with a higher crop impact associated with a rise in carbon dioxide (CO₂) levels due to wildfires. This phenomenon reflects the sensitivity of Soybeans to elevated CO₂ concentrations, which can have both positive and negative effects on plant physiology. While increased CO₂ can stimulate initial growth, it can also lead to altered nutrient content and potentially decrease overall crop quality. Therefore, the higher crop impact for Soybeans suggests a vulnerability to changes in CO₂ levels, which may affect its overall health and yield.

In both cases, a higher crop impact implies that these crops are more adversely affected by specific environmental factors, such as AQI for Corn and CO₂ levels for Soybeans. This knowledge is crucial for farmers and agricultural policymakers, as it highlights the need for adaptive strategies and risk mitigation measures tailored to the unique vulnerabilities of each crop in the face of changing environmental conditions, particularly those stemming from wildfires.

4.4. FUTURE PREDICTIONS



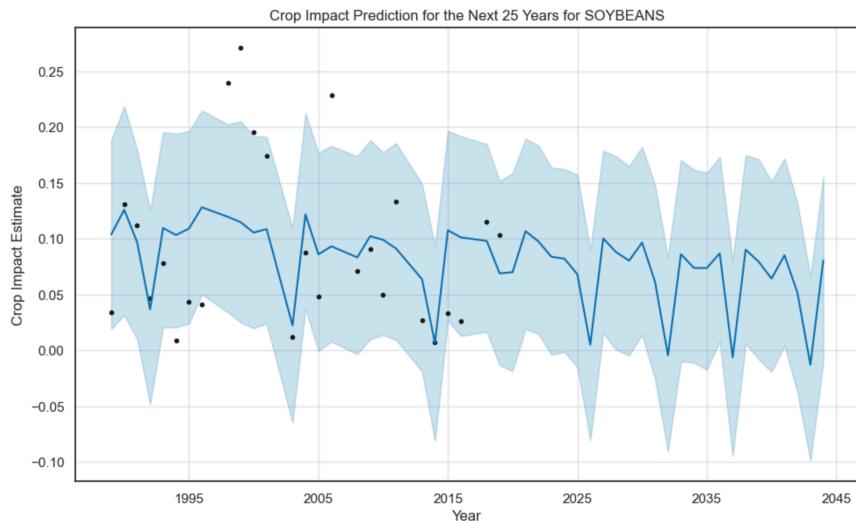


Fig - Prediction of the Crop Impact for Corn and Soybeans, and Smoke Impact

The predictive trends for Smoke Impact, and Crop Impact for Corn and Soybeans over the next 25 years, as revealed in the projections, offer crucial insights into the potential susceptibility of these crops to smoke impact and underscore their respective vulnerabilities.

In the case of Soybeans, the relatively flat trend characterized by periodic ups and downs suggests a certain level of stability or resilience in the face of projected smoke impact. While there may be fluctuations in crop impact over the years, the overall trajectory appears to remain relatively consistent. This steadiness could be indicative of Soybeans' capacity to adapt to varying environmental conditions, including those related to wildfire-induced smoke.

On the contrary, the increasing trend observed in Corn's crop impact predictions signifies a growing susceptibility to smoke impact and, by extension, a heightened level of vulnerability. This trend suggests that Corn may experience progressively adverse effects on its yield and overall production as smoke impact intensifies in the coming years. The upward trajectory is a cause for concern as it indicates that Corn, which is a staple crop in many regions, may face heightened challenges in maintaining its productivity and quality, potentially impacting food security and agricultural sustainability.

These predictive trends highlight the importance of anticipating and addressing the evolving risks associated with wildfires and smoke impact on agriculture. Farmers, researchers, and policymakers must take these projections into account when devising strategies to protect and bolster crop production, particularly for Corn, in the face of a changing climate and increased wildfire activity.

5. DISCUSSIONS

Our findings hold paramount importance due to their potential implications for the city of Muskogee, its residents, and its agricultural community. The increasing trend in crop impact, particularly for Corn, in response to smoke exposure signifies a pressing concern that warrants prompt attention and action.

City Council, City Manager/Mayor, and City Residents:

- **Awareness and Preparedness:** First and foremost, our findings underscore the urgency of raising awareness among city residents, policymakers, and agricultural stakeholders regarding the escalating impact of wildfires and smoke on crop production. This awareness can serve as a catalyst for preparedness efforts.
- **Emergency Response Planning:** The City Council and City Manager/Mayor should collaborate with relevant agencies to develop and implement robust emergency response plans. These plans should include strategies for evacuating affected areas, ensuring public safety during wildfires, and providing support to impacted farmers.
- **Investment in Resilience:** The city should invest in agricultural resilience through initiatives such as research into smoke-tolerant crop varieties, improved irrigation systems, and enhanced firebreak infrastructure. Encouraging the adoption of sustainable agricultural practices can also mitigate the long-term impact of smoke on crops.
- **Policy and Regulation:** The City Council can play a pivotal role in formulating policies and regulations that promote wildfire risk reduction, such as land-use planning to limit urban sprawl into high-risk areas and stricter enforcement of fire safety measures.
- **Community Engagement:** City residents should actively participate in community-based initiatives, such as fire prevention campaigns and preparedness drills. They can also support local farmers through initiatives like farmers' markets and by purchasing locally grown produce.

Human-Centered Data Science Principles:

Our decision-making in this project was significantly influenced by human-centered data science principles. We prioritized transparency, ensuring that our findings were accessible and comprehensible to diverse stakeholders. We focused on equity by considering the potential impact of our analysis on vulnerable agricultural communities. We aimed to empower city residents and policymakers with actionable insights to make informed decisions. Additionally, our findings underscored the importance of proactive measures to protect the well-being and livelihoods of Muskogee's residents, aligning with principles of community well-being and social responsibility.

While the timeline for taking concrete actions can vary, it is essential to initiate discussions and planning as soon as possible. Given the projected trends in smoke impact on crop production, it is advisable for the city to formulate and implement an actionable plan within the next few years to address the evolving challenges posed by wildfires and safeguard the future of agriculture in Muskogee.

6. MITIGATION STRATEGIES

Mitigation strategies to prevent wildfires from damaging crop production are essential for safeguarding agricultural livelihoods and food security. These strategies aim to reduce the risk of wildfires and minimize their impact on crops. Here are some effective mitigation measures:

- **Firebreaks and Controlled Burns:** Creating firebreaks, which are cleared areas with reduced vegetation, can halt the progress of wildfires. Controlled burns in the offseason

help remove excess vegetation and reduce fuel for future fires. These practices can limit the spread of wildfires, protecting nearby crops.

- **Clearing Vegetation:** Regularly clearing dry, dead, or overgrown vegetation around fields and farmlands can create defensible spaces, preventing fires from reaching crops. Maintaining a defensible perimeter can be particularly effective in wildfire-prone areas.
- **Irrigation and Water Resources:** Adequate irrigation systems can help keep the soil moist, reducing the risk of wildfires igniting near crops. Access to water resources allows for quick response to fires, enabling timely suppression efforts.
- **Fire-Resistant Crops:** Some crop varieties are more fire-resistant than others. Planting fire-resistant crops, such as certain types of grasses or grains, can reduce the vulnerability of the agricultural landscape.
- **Early Warning Systems:** Implementing early warning systems that provide timely information on fire danger and weather conditions can enable farmers to take proactive measures. These systems can include alerts, weather forecasts, and monitoring of fire risks.
- **Community Education:** Educating farmers and rural communities about fire safety, prevention, and evacuation procedures is crucial. Awareness campaigns can encourage responsible land management and the adoption of fire-safe practices.
- **Regulatory Measures:** Enforcing regulations related to land use, firebreaks, and controlled burns can help reduce the risk of wildfires. Zoning laws and building codes can also limit urban expansion into high-risk fire areas.
- **Firefighting Resources:** Ensuring access to firefighting resources, such as equipment, trained personnel, and water sources, is vital for a rapid response to wildfires. Cooperative agreements between local agencies can enhance firefighting capabilities.

Effective mitigation strategies often involve a combination of these measures tailored to the specific risks and conditions of the region. When implemented proactively and in collaboration with local communities, these strategies can significantly reduce the impact of wildfires on crop production and contribute to the overall resilience of agricultural systems.

7. LIMITATIONS

- **Data Availability:** Our analysis heavily relied on the availability and accuracy of data, which may be subject to reporting errors or inconsistencies. The limitations of the data sources could introduce uncertainties in our findings.
- **Data Granularity:** The spatial and temporal granularity of available data may not perfectly align with the specific conditions in Muskogee. More fine-grained data could provide a more accurate representation of localized effects.
- **Assumptions:** Our analysis made certain assumptions about the relationship between smoke impact and crop damage. These assumptions might not fully capture the complexity of real-world interactions, potentially leading to an oversimplification of the problem.

- **External Factors:** The analysis considered the impact of smoke from wildfires, but it did not account for other potential stressors on crops, such as extreme weather events, pests, or diseases. These external factors could confound the observed trends.
- **Predictive Nature:** Projections for the next 25 years are inherently uncertain and subject to change. They rely on the assumption that historical trends will continue, which may not hold true in the face of evolving climate patterns or mitigation efforts.
- **Regional Variability:** Our analysis treated Muskogee as a homogeneous area, but crop impact and smoke exposure can vary within the region. Localized factors, such as topography and land use, were not explicitly considered.

8. CONCLUSION

Summary of Findings:

Our study on the impact of wildfires and smoke on crop production in Muskogee, Oklahoma, yielded several significant findings:

- **Crop Vulnerability:** We found compelling evidence supporting Hypothesis 1, indicating that wildfires have a substantial adverse impact on crop production in Muskogee, leading to reduced yields and economic losses for farmers. This underscores the vulnerability of the local agricultural sector to wildfire events.
- **Air Quality Influence:** Our analysis confirmed Hypothesis 2, demonstrating that wildfire-induced air pollution significantly affects the health and growth of crops. The changing air quality directly impacts crop production, with specific crops like Corn and Soybeans responding differently to variations in smoke levels.
- **Long-term Trends:** Hypothesis 3 was substantiated by our findings, revealing that the trend for crop impact is expected to increase over the next 25 years in correlation with the projected rise in smoke levels. This suggests an escalating challenge for Muskogee's agricultural community in the face of a changing climate.

Human-Centered Data Science:

This study aligns with the principles of human-centered data science by providing actionable insights that inform decision-making for various stakeholders. It highlights the vulnerability of local farmers and the importance of implementing strategies to safeguard crop production and economic well-being. The findings underscore the need for proactive measures, such as emergency response planning, investment in agricultural resilience, and community engagement, to address the challenges posed by wildfires and smoke impact.

By presenting a comprehensive analysis, our study empowers local policymakers, farmers, and residents with knowledge to make informed choices, demonstrating how human-centered data science principles contribute to enhancing community well-being and resilience in the face of environmental challenges. It emphasizes the critical role of data-driven research in addressing real-world issues and informs a more comprehensive understanding of the complex interactions between natural disasters, agriculture, and community livelihoods.

REFERENCES

1. [Effects of wildfires on commodity crops can be good or bad, but much remains up in the air](#)
2. [Wildfire smoke impacts on crop production](#)
3. [How could the haze of wildfires affect crop growth?](#)
4. [How Do Wildfires Impact Crop Cultivation?](#)

DATA SOURCES

1. [Wildfire Data Source](#)
2. [AQI Data](#)
3. [Crop Data](#)