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# ALY 6060

# Final Project

# Signature Assessment

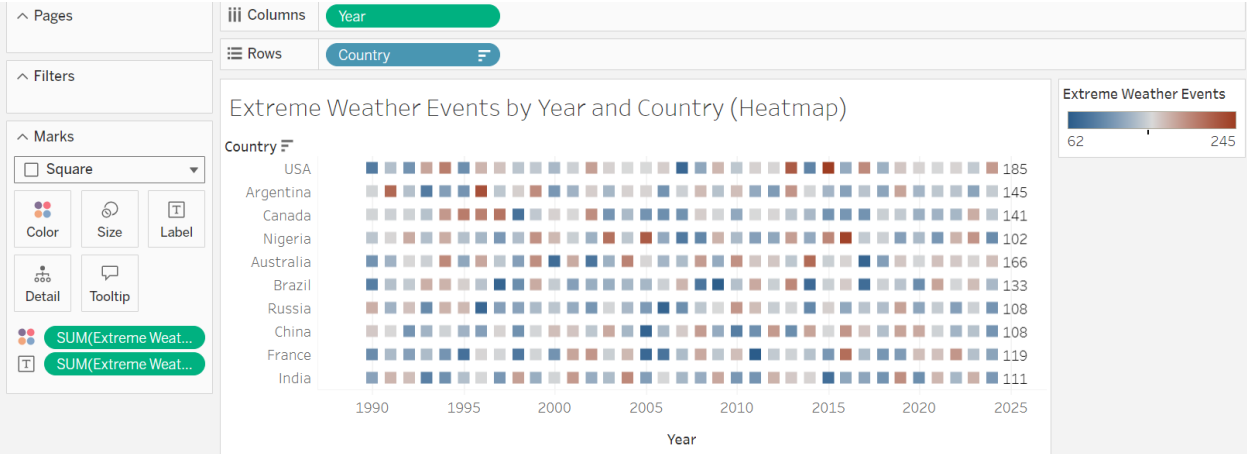
## Introduction

The focus of the model being studied is on climate change that has affected the agricultural industry and the steps taken to mitigate the changes over time. The graph begins in the year 1990 and shows how in the past 25 years each part of the world has soldiered on with the production of important crops for economic prosperity. The graph also provides agricultural metrics that can impact crop yields like irrigation, soil index, and fertilizer applications. Using different analytical methods, the numbers are evaluated to show what has transpired in the past and what can be done in the future when climate change can be detrimental to the industry.

## Analysis

A heatmap was created to display the number of extreme weather events that each country experienced since 1990. When looking at each country, they share similarities in the cycle of many extreme weather events and less than average numbers. An assessment of each year shows that some years there were a share of countries that faced higher or lower amounts of extreme weather events, providing evidence of the effects of global warming. The last five years across the board show higher levels of events which are not seen in other time periods in the graph.

This recent trend in elevated extreme weather events indicates that this could continue in the future and if emissions continue to rise. Each country will need to continue to adapt to these changes even when there are some years higher than others. There will also need to be economic priorities when crop yields could affect costs and revenue. And continuing to find ways to lower emissions during production will be essential to slowing down the effects of climate change.




Five horizontal bar charts were designed to highlight the total crop yield by adaptation strategies per country. The chart was edited so the total crop yield which is displaying metric tons of crop yield per hectare of area begins at 300 metric tons per hectare area that better displays the difference between the countries. When converted, one metric ton per hectare is equal to .405 metric tons per acre while one metric ton equals 2,204.62 pounds (Iowa State University, 2024). The five adaptation strategies used in the dataset are crop rotation, drought-resistant crops, no adaptation, organic farming, and water management.

The total amount of crop yield when compared with each adaptation strategy over the 25-year period per country shows how each country has adapted to climate change. Highlighted in yellow below are the leading countries for each adaptation strategy with no countries having more than one. Canada had the highest number of drought resistant crops by its crop yield, and Nigeria led all countries in organic farming. In terms of water management, the United States were at the top, and India had the highest crop yield where there was no adaptation methods incorporated in the crop yield. These numbers indicate that each country is using their money and resources differently for how they adjust their model facing global warming threats that could affect their annual crop yields. Countries like Nigeria have placed more emphasis on

organic farming practices while India has decided to respond less than other countries in particular cases. And some nations might have the luxury of having more funding and policy to adapt to extreme weather events or droughts over others. I believe these crop yield numbers will change over time with climate change continuing to affect the agricultural sector in the future which means that different adaptation strategies will be implemented to certain crops.

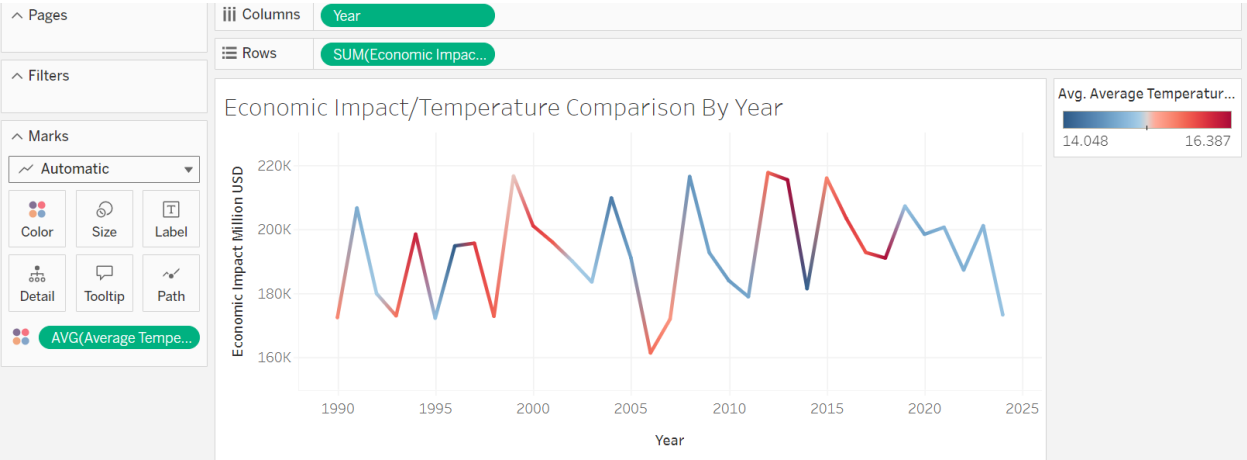
Total Crop Yield By Adaptation Strategies Per Country

| | Country | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Adaptation Strategies | Argenti.. | Australia | Brazil | Canada | China | France | India | Nigeria | Russia | USA |
| Crop Rotation | 413.4 | 494.9 | 402.1 | 446.6 | 444.4 | 452.1 | 458.9 | 460.3 | 437.1 | 435.6 |
| Drought-resistant Crops | 439.6 | 458.0 | 414.1 | 495.8 | 476.8 | 434.8 | 439.0 | 428.8 | 416.0 | 474.8 |
| No Adaptation | 460.9 | 417.2 | 433.9 | 411.7 | 487.3 | 404.4 | 523.7 | 511.1 | 410.8 | 468.7 |
| Organic Farming | 435.4 | 438.7 | 395.1 | 436.1 | 451.3 | 454.5 | 452.1 | 496.5 | 458.2 | 402.4 |
| Water Management | 465.0 | 495.2 | 461.3 | 403.5 | 470.6 | 426.8 | 432.1 | 448.8 | 395.6 | 528.2 |

To understand how climate change has had an economic impact on the agricultural industry, a line chart that also shows the average temperature per year was charted. The economic impact is measured in U.S. dollars by the millions, and the average temperature from the time ranges from just over 14 degrees to about 16.4 degrees Celsius. What stands out with the economic impact and the global temperatures are the fluctuations with each variable, showing no patterns in how one could affect the other. The average spending from the first year to 2015 shows a positive linear trend with the amount increasing by almost $50 million.

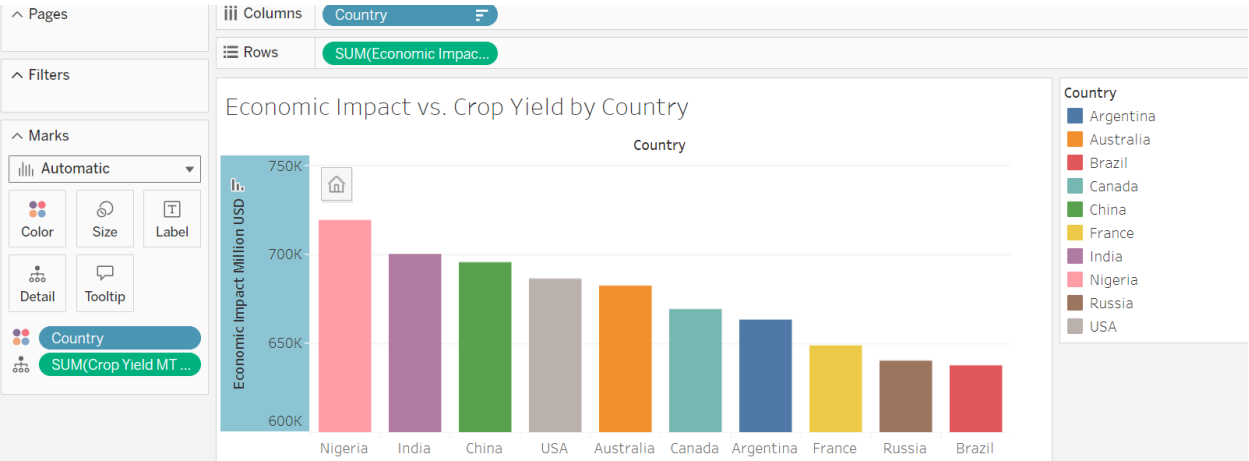
If the relationship between economic impact and temperatures are broken down into decades, there are more consistent fluctuations in the 1990's and 2010's, with the 2000's showing a more spontaneous pattern of the economic impact values. One noticeable trend since around 2015 is that the economic impact has decreased overall, and since 2019 there has been a trend of cooler temperatures. It is the only period where there seems to be a correlation between the two, indicating that this behavior will continue if temperatures remain on the lower side in

the future. A rise in global temperatures could affect particular crops that could lead to higher returns that could increase overall economic numbers.



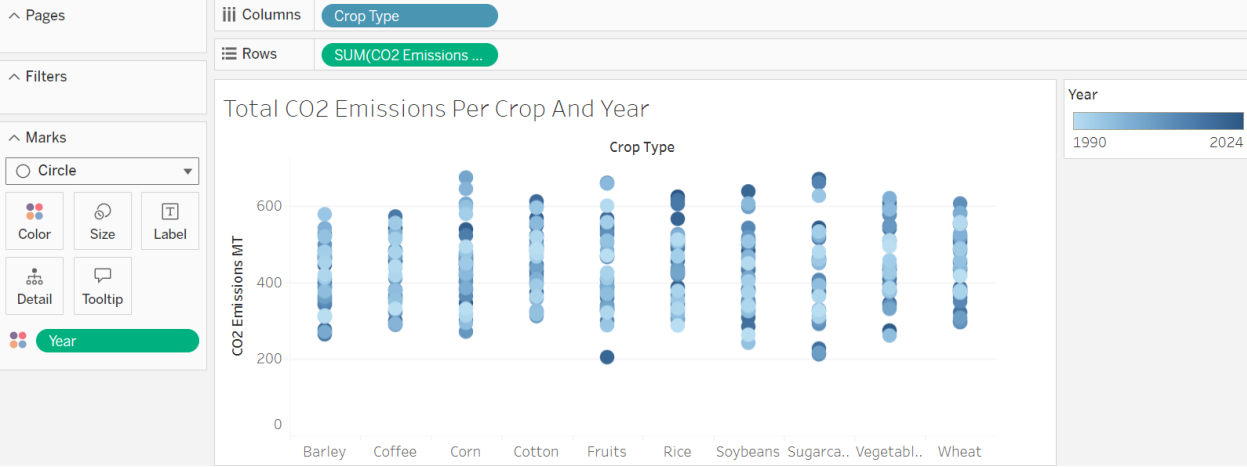

The economic impact of the countries in the dataset are measured based off the crop yield per country as provided in a bar chart. Since the beginning of the time period researched, each country has seen fairly equal levels of economic impact with Nigeria having the highest crop yield economic returns overall. There are no noticeable differences between parts of the world where the countries are located, indicating that over time global warming has not hurt some areas over others. The countries have all managed to adjust to changing global climate patterns that have allowed them to not fall behind economically.

How the following years will change economic conditions will depend on the changing global warming patterns and how it can impact individual crops. A more detailed evaluation can entail looking at how economic times have changed since 1990 and if past recessions or strong economies have affected the agricultural sector. This can also help determine if certain crops are hampered by these patterns and if there is a correlation between the economy and climate in certain years and time range. An assessment of other countries in the region could also be useful to areas where crop yields are subpar.



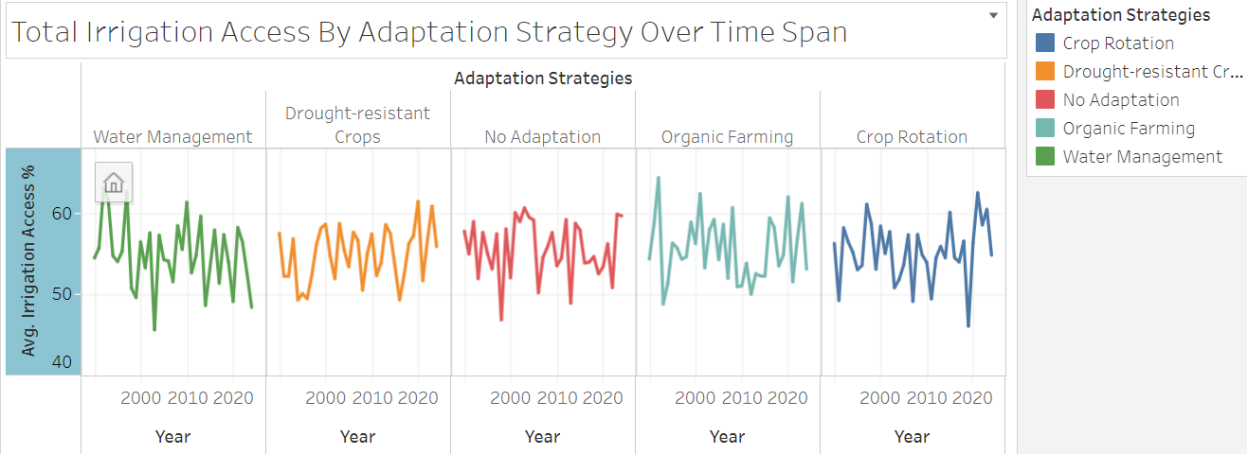

The total carbon emissions per year on each crop in the dataset was constructed into a scatterplot. The emissions are measured by metric Tonnes, where one Tonne is equivalent to 1,000 kilograms of carbon dioxide (gov.ie, 2024). Some of the crops appear to have wider ranges of carbon emissions like corn and vegetables, indicating that more emissions over time might have been needed to grow the crop. Other crops have much smaller but more consistent ranges of carbon emissions like coffee and cotton, suggesting that climate change might have had not as much of effect on its production. The crops that have generated the most carbon emissions are corn, fruits, and sugarcane.

There are several crops like fruits, soybeans, and sugarcane that have outliers in carbon emissions produced in a year. Some of the outliers are from more recent years which might mean that the global temperatures could be the result of how much carbon is being emitted during crop production. These numbers will change over time depending on the demand for these crops and whether changes are made to production that will lower carbon emissions, but this could also depend on location and whether some countries act sooner than others.



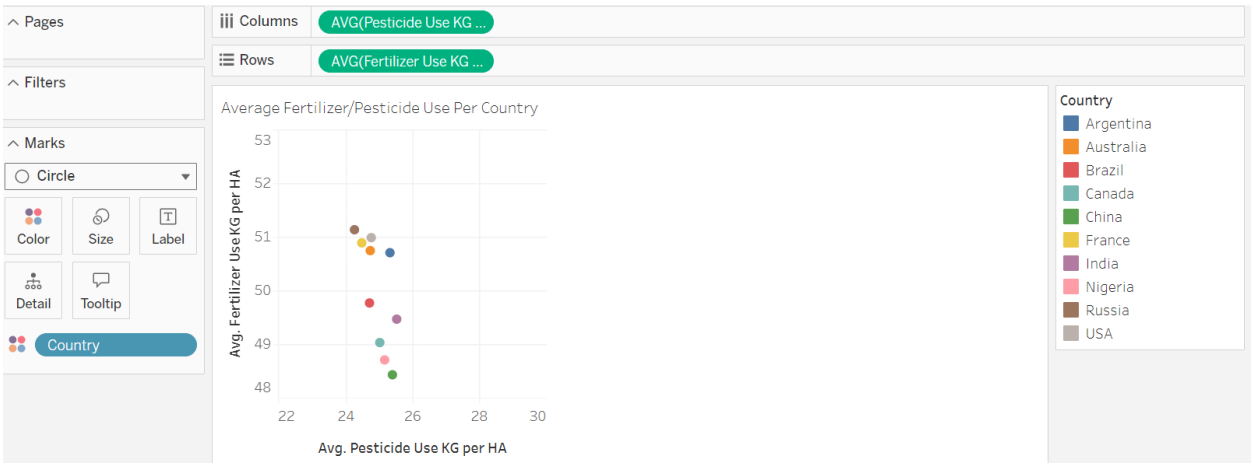

An assessment of how adaptation strategies were used in response to irrigation access was compiled with the formulation of a line chart of the five adaptation strategies. Irrigation access is the average percentage of land irrigated by year, and the average calculated by the adaptation strategy and year falls under in the dataset (USDA, 2024). The chart is condensed to highlight the pattern that each graph goes in, so the y-axis that shows average irrigation access starts at 40 percent.

While most of the strategies remain relatively consistent over time, they all have different ebbs and flows over the course of 25 years. The water management strategy is the only one that seems to decrease over time, indicating that water shortages have been an issue, and more management practices have been put in place to mitigate these concerns. Drought-resistant crops and organic farming have seen a slight increase over time, which could suggest these strategies have become more popular and effective against the decline of irrigation access. How to tackle the challenges of losing more irrigation access will be an issue in the future, so experimenting with new cost-effective strategies should be a priority if climate change continues.



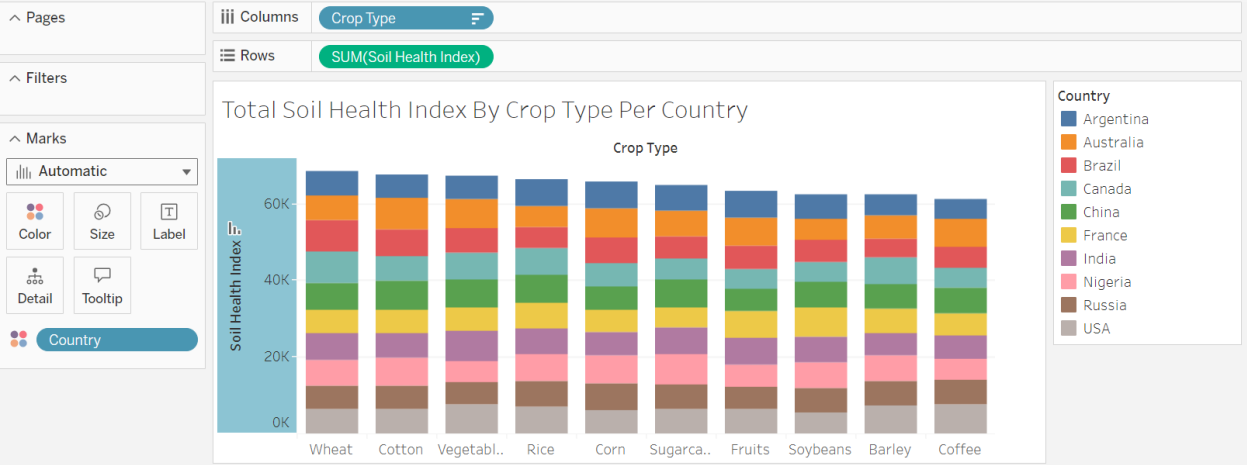

A look at average pesticide use and fertilizer use per country was displayed by building a scatterplot. The plot was brought in to provide a better glimpse of each country's usage, so the average fertilizer value on the y-axis begins at 48 kilograms per hectare and the average pesticide value on the x-axis starts at 22 kilograms per hectare. Each attribute is measured by kilograms per hectare which was explained in detail earlier with previous variables in the dataset.

The country that uses the most fertilizer on average is Russia, and they also use the least amount of pesticide in their crops. On the other end of the spectrum, China has the highest average pesticide use while having one of the smallest average fertilizer uses among the countries. Argentina stands out from the rest of the countries as they use on average high amounts of pesticide and fertilizer. These values could change in the future depending on whether regulations in some countries are enacted restricting the use of pesticides. The use of each chemical can also be affected by climate change in the future so these averages could change over time.




The total soil health index by crop type for each country is evaluated with the creation of a bar chart. The index is a weighted score based off several factors that assess the overall quality of the soil, with the score ranging between 0 and 100 (Amgain, Xu, Rabbany, Fan, Bhadha, 2022). The bar chart shows the totals of the soil health index over the quarter century period for each crop from each country.

When combined with each country's total soil health indexes, wheat is the crop that has the highest soil health index score, followed by cotton and vegetables. The crop with the lowest score when combined from all the nations is coffee. Several factors in the future can potentially influence how these scores change, like land management and differing levels of groundwater. Other factors like pesticide use could play a role in the health of the soil, so policy directed at conservation of water and chemical use can help maintain or improve the health of soil in each country.




## Conclusion

The visualizations provided show a pattern that global warming has been a recurring theme in the last 25 years and has affected all parts of the world. These cycles have affected agricultural practices like irrigation and crop yields and will continue unless emissions can be reduced. And more technologies need to be developed for better preparation of extreme weather events and precipitation levels that are inconsistent. This will ensure that the agricultural sector's economic concerns will be addressed properly, and supply will continue to match demand.

## References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