

Fields of Tomorrow

COM-480 DATA VISUALIZATION SPRING 2025

GROUP PROJECT BY YAKETY

TEAM MEMBERS

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1. Introduction and Project Significance

This project embarks on a data visualization journey titled *Fields of Tomorrow*, aiming to present the complex narrative behind global food production and sustainability in an intuitive and engaging way to a diverse audience. We extracted multi-source data from the UN's FAO-STAT and the World Bank, covering the years 1961–2007, including the production volumes of major grain crops and key environmental sustainability indicators (agricultural land use, fertilizer consumption, water usage, etc.). Through interactive maps, dynamic charts, and multivariate radar plots, we guide readers to explore the spatiotemporal evolution and challenges of global agriculture.

This process book reviews our entire creative journey, from early feasibility research and sketching to the final implementation of a high-performance interactive web platform built with D3.js and TopoJSON. Along the way, we confronted challenges such as data cleaning, performance bottlenecks, and cross-view interaction design, continuously improving on our initial concept. We aim to clearly present our methods and key ideas, while encouraging thought on sustainable agriculture..

2. Dataset and Preprocessing

Data selection and cleaning: We imported crop production data from FAOSTAT for all countries from 1961 to 2007, as this period offers the broadest coverage and the highest data quality.

Continent-level aggregation: Using the `pycountry-convert` package in Python, we mapped country-level data to continental regions and aggregated production and resource consumption values. The outputs were saved as JSON files for visualization.

Sustainability indicators acquisition: From the World Bank, we downloaded data on agricultural land area, fertilizer use, and cereal production from 1960–2023. After reformatting and imputing missing values, we integrated these into the main dataset.

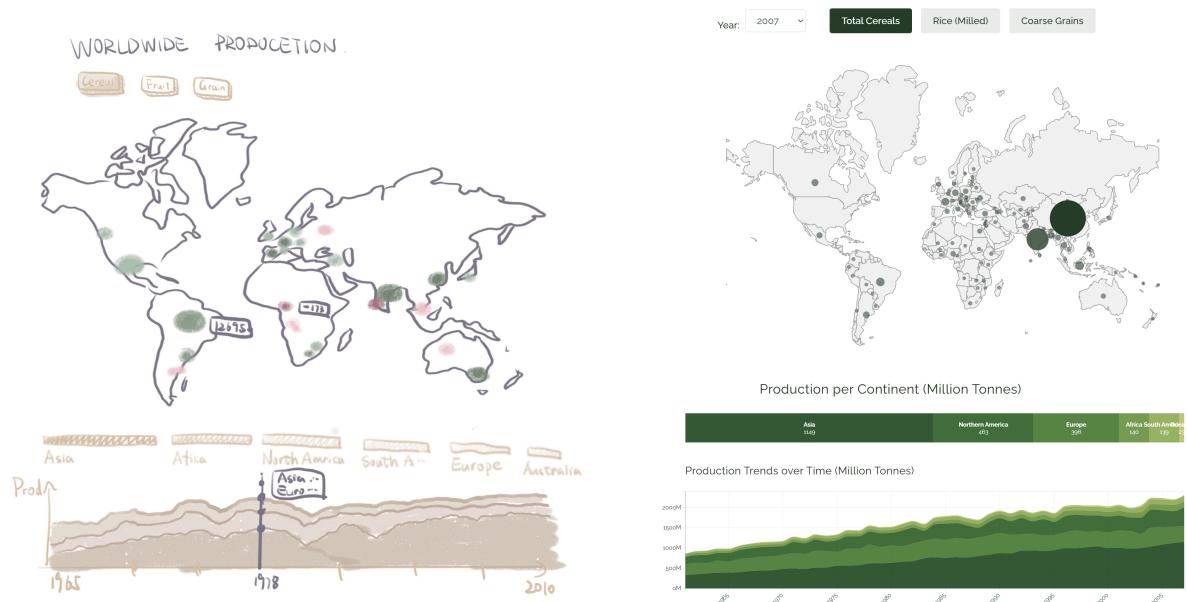
Preprocessing and standardization: We applied Z-score normalization to independent variables and natural logarithmic transformation to dependent variables like yield. Data clean-

ing logs and sample outputs were preserved for reproducibility.

Regression modeling and variable scoring: We conducted polynomial regression for five key dimensions—land use, fertilizer intensity, farmland stability, agricultural economic advancement, and water-use efficiency. Compared to linear models sketched in the early draft, polynomial regression better captures the nonlinear trends and interactions common in agricultural systems over time. Despite relatively low R^2 values, the model reflects the inherent complexity of these dynamics.

3. Visualization Modules: Comparison and Enhancement

Figure 1: Production Patterns Bubble Chart and Yield Trend — Sketch vs. Final Version

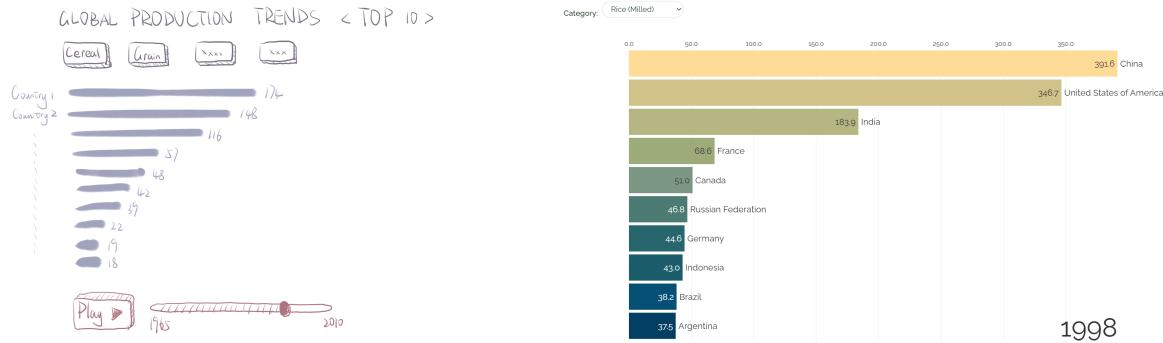


Production Patterns Bubble Chart: This bubble chart overlaid on a world map visually represents crop production across countries from 1961 to 2007. Each bubble's size reflects national crop output, and color intensity helps distinguish between major producers and low-yield regions.

Combined with trend data by continent, this visualization allows users to observe evolving production patterns across regions and over time. The interactive nature of the chart makes it easy to identify high-yield zones, low-yield areas, and potential food security risk zones.

We fully realized our initial idea and enhanced the interaction between the trend chart and the map. For example, clicking on a continent name in the trend chart highlights the corresponding countries on the map, creating a seamless link between data and geography.

Figure 2: Dynamic Top 10 Countries Ranking — Sketch vs. Final Version



Dynamic Top 10 Countries Ranking: To help users track the evolution of the top grain-producing countries from 1961 to 2007, we created a dynamic bar chart. It shows how production levels across nations increased, decreased, or remained stable over the decades. These animated transitions clearly identify regions that have emerged as key players in global food security.

We faithfully implemented our original concept and introduced enhancements such as a color gradient from blue to red and a cleaner layout. This emphasizes essential information like crop type, year, yield, and country name, making the ranking trends more intuitive for readers.

Figure 3: Sustainable Resource Use Map — Sketch vs. Final Version

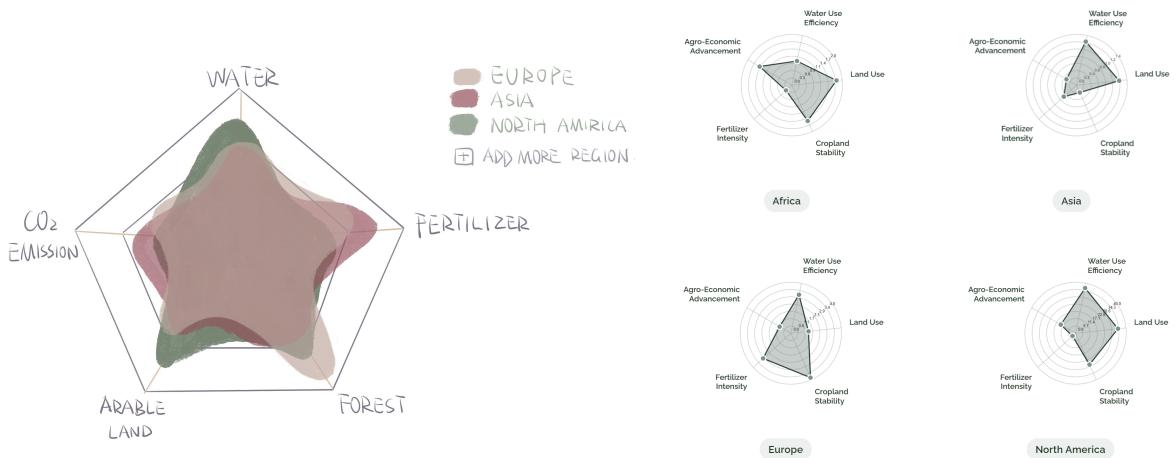


Sustainability: A Rising Priority in Agriculture: This visualization focuses on three key aspects of sustainable agriculture: land use, fertilizer application, and water use. For each continent, the map displays how agricultural land area, fertilizer consumption, and water withdrawal changed over time. Color intensity represents the magnitude of each indicator.

Compared to the original sketch, we replaced forest resources with agricultural land, as it more directly reflects human impact on ecosystems. While forest change is significant, it often correlates closely with agricultural expansion; hence, we chose to focus on more actionable agricultural indicators.

In the final version, we refined the color scheme to improve comparability across years and continents. To enhance user understanding, we added concise text annotations next to the map when a region is selected. These dynamic interactions allow users to observe global agricultural trends and detect signs of resource overuse in specific regions.

Figure 4: Regional Multivariate Radar Charts — Sketch vs. Final Version



Regional Multivariate Radar Charts: We created radar charts for each continent to compare key sustainability factors across regions, fully realizing and improving upon our initial sketches. Using agricultural production data from 1961 to 2007, we conducted polynomial regressions for five core dimensions: land use, fertilizer intensity, farmland stability, economic progress in agriculture, and water efficiency.

Unlike our original plan to use linear models, we opted for polynomial regression to account

for nonlinear trends and interactions over time—common in agricultural systems. The resulting coefficients, visualized in the radar charts, represent the relative influence of each factor on agricultural production in each region.

To help readers better interpret the data, we implemented mouse-hover interactions that reveal exact values and descriptive annotations on each radar chart.

4. Conclusion

Fields of Tomorrow explores global agricultural sustainability by visualizing the dynamic relationship between food production and resource use.

During development, we encountered three main technical challenges: large data volume, complex chart interactions, and readability. Our raw dataset spanned decades and included tens of thousands of entries across multiple indicators. To ensure smooth user experience, we used TopoJSON to compress map data and applied lazy loading techniques to import data in batches—significantly improving loading speed.

In preprocessing, we cleaned raw data, filled missing values, and aggregated it by continent using Python. Considering the nonlinear nature of agricultural data, we used polynomial regression to compute the main effects of different factors on yield changes. These were then visualized via radar charts to help users quickly identify key influences.

To strengthen interaction, we added an intuitive timeline slider to link the map, trend charts, and radar charts dynamically. These visualizations collectively reveal regional trends and vulnerabilities in global grain production (especially for wheat, rice, and coarse grains) and illustrate the constraints of resource use across continents. Whether offering insights for policymakers or case studies for researchers and educators, *Fields of Tomorrow* showcases the potential of data-driven approaches to agricultural sustainability.

From initial concept sketches to semi-functional prototypes and a fully realized online platform built with D3.js and TopoJSON, we continuously optimized our data structure, improved performance, and refined interaction logic. The result is a scientifically grounded, visually

accessible, and practical data visualization system.

We hope the development path and design philosophy of this project can serve as valuable references and inspiration for future work in agricultural data analysis and visualization.

Contribution

This project was collaboratively completed by three team members. All three members participated in the initial planning and sketch design phases.

Yuan Xiao: Responsible for the initial development of Figure 1 and Figure 3 on the website, and for building the overall framework of the webpage.

Jingyi Guo: The main contributor to data cleaning and preprocessing, she completed Figure 4 on the website and was primarily responsible for the final layout and polishing of the webpage.

Wenyu Liu: The main author of the Milestone 1, Milestone 2, and Milestone 3 reports, and responsible for the initial development of Figure 2 in the final website.