

Our Signed Team Agreement: [COMPSCI 1710 Team Agreement](#)

Our Process Book: [COMPSCI 1710 Process Book - cocoa bytes draft](#)

# Cacao Production in West Africa

## Process Book

Nhaomi Lartey  
Richael Saka  
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# Team Members

cocoa bytes

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# Team Agreement

Our Signed Team Agreement: [!\[\]\(21199eb166cc97331a0c54c649195dcc\_img.jpg\) COMPSCI 1710 Team Agreement](#)

# Project Proposal

**Project Title:** Cacao Production in West Africa

**Team Members:**

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**Team Name:** cocoa bytes

## Abstract

Our project seeks to uncover the hidden realities of cocoa farming in West Africa and challenge the glossy promises of “fair trade” in the global chocolate industry. While Ghana and Côte d’Ivoire produce over 60% of the world’s cocoa, the farmers behind your favorite chocolate bar often live in poverty, earning only a small fraction of the profits. Every time we buy a bar of chocolate, we participate in this global system, yet most consumers never see the costs carried by the people who grow the beans. Using data on production, exports, farmer income, and deforestation, we will build an interactive, story-driven visualization that reveals the full journey of cocoa, from farm to shelf. Through visualizations such as supply chain flow diagrams, chocolate bar breakdowns, sustainability scorecards, narrative dashboards, etc., we will illustrate both the global economic power of chocolate and the everyday human sacrifices behind it. Our goal is to help viewers, whether casual chocolate lovers or conscious consumers, question what “fair trade” really means and recognize the gap between corporate claims and farmer realities.

## Background and Motivation

As Ghanaians, we are personally connected to the story of cocoa: Ghana is one of the world’s largest producers, yet farmers often receive only a small fraction of the global chocolate market’s profits. Our motivation comes not only from this national connection, but also from personal experiences. For instance, one of us studied the economics of chocolate in an entrepreneurship course, while others have visited chocolate museums in Switzerland and Japan and observed how cacao sourced from Ghana is displayed and marketed abroad. These experiences highlighted the disconnect between consumer perceptions of chocolate and the lived realities of cocoa farmers.

Coursework in African and African American Studies has also deepened our understanding of colonial histories and global trade inequalities, providing a theoretical lens for our project. By combining our academic insights with personal connections, we hope to create a compelling

data-driven story that challenges the notion of “fair trade” and centers the voices of cocoa farmers. (Feel free to edit Wini)

## Data

To reveal the realities of cocoa farming and fair trade, our project draws on datasets covering production, trade, pricing, farmer income, certification, and deforestation. These sources are authoritative, publicly accessible, and machine-readable (CSV, XLSX, etc.), allowing us to build reproducible visualizations.

### 1. Production & Trends

- [FAOSTAT – Cocoa Beans Production](#) (by country, yearly, 1960s–present).
- [Our World in Data – Cocoa Production](#) ( CSV derived from United Nations FAO, useful for quick mapping).
- [DOAJ \(open access\) – Mapping cocoa research \(\*Theobroma cacao L.\*\) in Africa:](#) (Bibliometric survey of African cocoa research + production/trade overview; handy for background/context framing).

### 2. Trade Flows

- [UN Comtrade Database](#) (HS 1801 = cocoa beans; HS 1803–1805 = processed cocoa products; trade by partner country).
- [OEC – Ghana Cocoa Profile](#) (snapshot of Ghana’s top export partners).

### 3. Prices (World vs. Farmgate)

- [World Bank “Pink Sheet” Commodity Prices](#) (monthly International Cocoa Organization (ICCO) composite price for cocoa).
- [Ghana COCOBOD Farmgate Prices](#) (annual fixed producer price announcements per season).
- [ICCO Quarterly Bulletin of Cocoa Statistics](#) (premium dataset, accessible via Harvard Hollis for more detailed breakdowns).

### 4. Farmer Income & Fair Trade Benchmarks

- [Fairtrade International – Living Income Reference Prices](#) (benchmarks for Ghana and Côte d’Ivoire).
- [Fairtrade West Africa Cocoa Programme Monitoring Report \(2024\)](#) (program outcomes and farmer impacts).
- [World Cocoa Foundation – Cocoa Household Income Study \(2024\)](#) (methods for assessing living income and farmer livelihoods).

### 5. Deforestation & Traceability

- [Trase – Cocoa Supply Chain & Deforestation Data](#) (annual cocoa-linked deforestation, district-level data).
- [Global Forest Watch – Ghana Cocoa Deforestation](#) (forest loss stats and cocoa-plot heatmaps).

- [EU Deforestation Regulation \(EUDR\) Guidance](#) (rules requiring geolocation of cocoa farms, no deforestation after 2020).

## **6. Certification Coverage**

- [Rainforest Alliance – 2024 Cocoa Certification Data](#) (farm and area coverage by country).
- [Company Sustainability Reports \(e.g., Barry Callebaut, Mondelēz Cocoa Life\)](#) (case studies on certified sourcing, useful for spotlights).

## **Data Preparation Plan**

1. Ingest & Standardize: Download CSV/XLSX/GeoJSON files from FAO, UN Comtrade, World Bank, COCOBOD, Fairtrade, Trase, and Rainforest Alliance.
2. Harmonize Keys & Units: Convert currencies to USD/ton; standardize country codes (ISO-3).
3. Compute Indicators:
  - Farmer Share = farmgate ÷ world price.
  - Living Income Gap = Fairtrade benchmark – actual farmgate.
  - Deforestation Intensity = cocoa-linked forest loss ÷ cocoa area.
  - Certification Coverage = certified area ÷ total cocoa area.
4. Cross-Check: Validate trade flows by comparing UN Comtrade with OEC snapshots; reconcile price series across World Bank and ICCO.

# Map

<https://tinyurl.com/hkxab4n6>

## Who is your audience?

- *Gen Z chocolate lovers*
- Trade organizations and policymakers
- Cocoa producers

**Describe your target audience in more detail. What do they know? What are their interests?**

**What visualization literacy do they have? At what level of detail will you present information to them?**

- Chocolate lovers span all demographics, from age to ethnicity to location.
- We assume that the average chocolate lover has very limited information on how chocolate production works, from cocoa farming to production factories, and we'd like to better educate them. They enjoy consuming chocolate, maybe in different forms, and may be distant from the impact of their chocolate purchases.
- Growing up in the tech era, Gen Z chocolate lovers may be familiar with digital data visualizations but not necessarily strong instincts to validate said visualizations. Coupled with shorter attention spans, it's important that our visualizations are clear, entertaining, and visually appealing.
- Knowing that chocolate lovers are more focused on enjoying the treat than on the environmental implications of cocoa production, we have to present our information in a compelling way. We'll focus on highlighting data that is closely related to their lived experience (i.e. toll it takes on cocoa farmers to harvest cacao for one chocolate bar).

## What questions about your data will be interesting for your audience?

- Which cocoa-producing regions face the highest climate risk?
- Which regions are experiencing the most deforestation due to cocoa?
- Which countries actually profit the most from cocoa, like those that grow the beans, or those that process and sell chocolate products?
- Which countries have processed the most chocolate from cocoa in the past decade?
- How have global consumer preferences (dark vs. milk, chocolate vs. chocolate products) shifted the demand for different types of cocoa beans?
- Which countries have produced the most cocoa beans in the past decade?

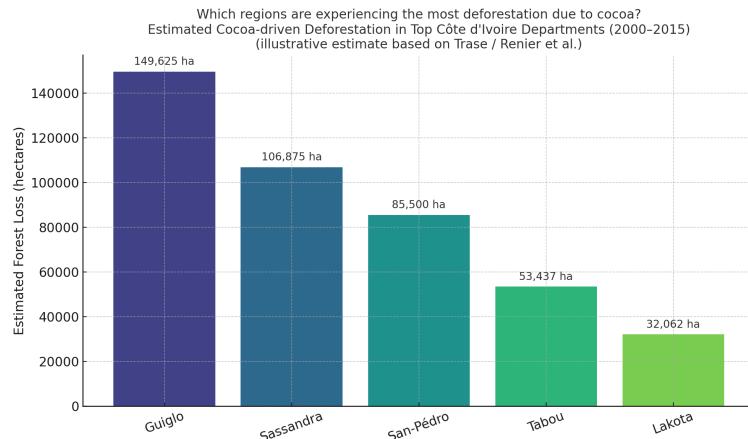
- How have global cocoa prices evolved?
- Are emerging cocoa-growing regions producing higher-quality or lower-quality beans than long-established areas?
- How has the gap between what cocoa farmers earn and what consumers pay for chocolate evolved over time?
- Which countries have been the largest importers of raw cocoa beans in the past decade?
- How does cocoa production compare between Africa, Asia, and Latin America today?
- Which regions have had the largest share of coca production on average since the 2000s?
- Which countries have been the top exporters of chocolate products on average since the 2000s?
- How does cocoa production compare between Africa, Asia, and Latin America?

**What data do you have or plan to obtain? Briefly describe the data you envision to use and the respective data types (categorical, ordinal, or quantitative)**

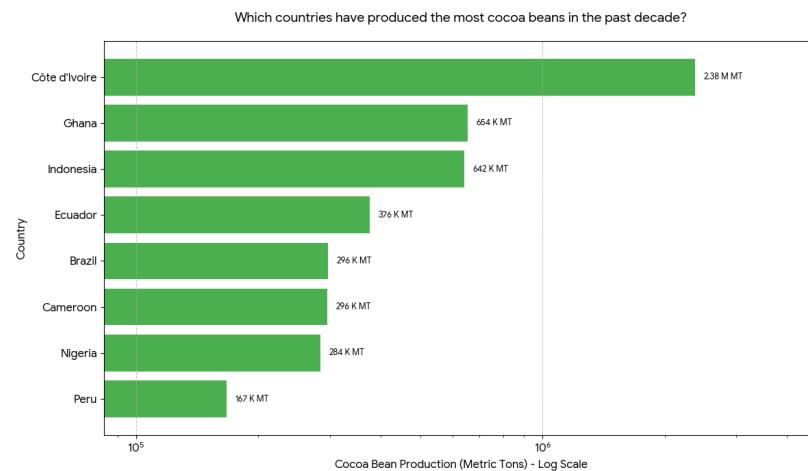
Our analysis draws from datasets spanning 6 key dimensions of cocoa production and trade.

- **Production & Trends** – Annual country-level data on cocoa output, harvested area, and yield over time.  
*Data types: quantitative (tonnes, hectares), temporal (year), categorical (country/region).*
- **Trade Flows** – Import and export data for cocoa beans and processed cocoa products by partner country.  
*Data types: quantitative (value, volume), categorical (country, HS code, trade flow), temporal (year).*
- **Prices (World vs. Farmgate)** – Global cocoa price benchmarks compared with Ghana's farmer-level producer prices.  
*Data types: quantitative (prices, exchange rates), temporal (month/season).*
- **Farmer Income & Fair Trade Benchmarks** – Household income levels, living income reference prices, and fair trade benchmarks.  
*Data types: quantitative (income, farm size, yield), categorical (certification status, off-farm income), ordinal (income sufficiency bands).*
- **Deforestation & Traceability** – Data linking cocoa production to forest loss and farm geolocation compliance under new regulations.  
*Data types: quantitative (forest loss area, risk scores), categorical (region, compliance status), geospatial (lat/long, polygons), temporal (year).*
- **Certification Coverage** – Information on certified cocoa farms and sourcing programs from Rainforest Alliance and companies.  
*Data types: quantitative (number of farms, hectares certified, % certified), categorical (certification scheme, country), temporal (year).*

## Nhaomi's Visualizations



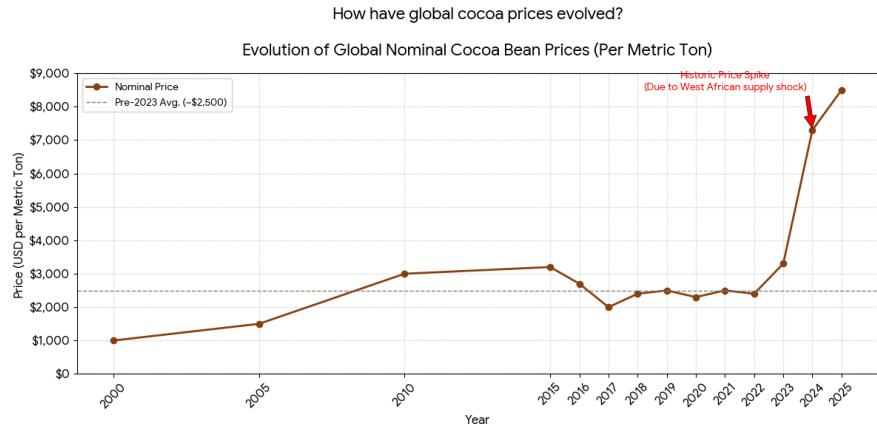
Data: <https://trase.earth/open-data?commodity=COCOA>



M MT = Million Metric Tons

K MT = Thousand Metric Tons

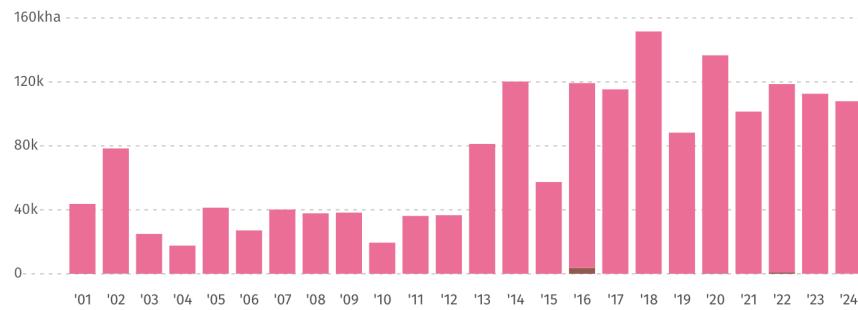
Data: <https://ourworldindata.org/grapher/cocoa-bean-production>



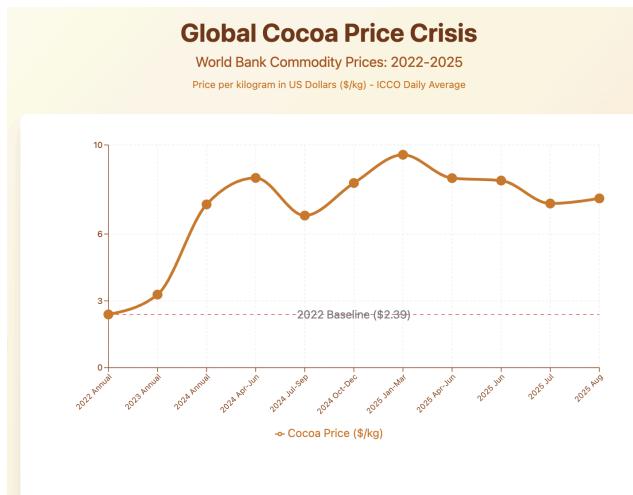
Data: <https://www.worldbank.org/en/research/commodity-markets>

## Richael's Visualizations

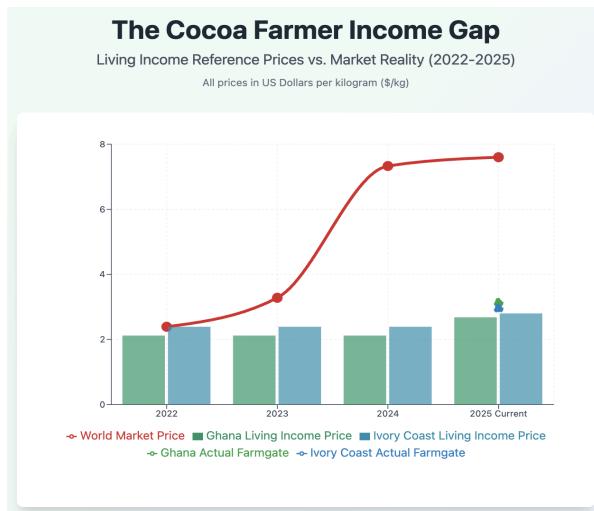
Which regions are experiencing the most deforestation due to cocoa?  
(This graph depicts tree cover in Ghana over the years)



How have global cocoa prices evolved?



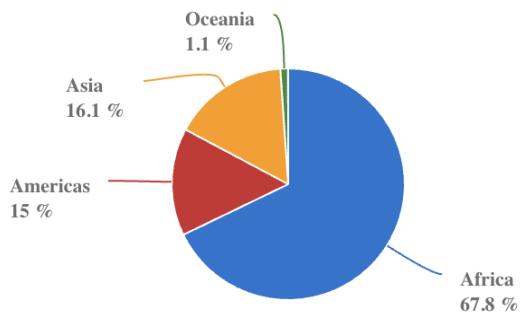
How has the gap between what cocoa farmers earn and what consumers pay for chocolate evolved over time?



### Winifred's Visualizations

(<http://www.fao.org/faostat/en/#data/OCL>)

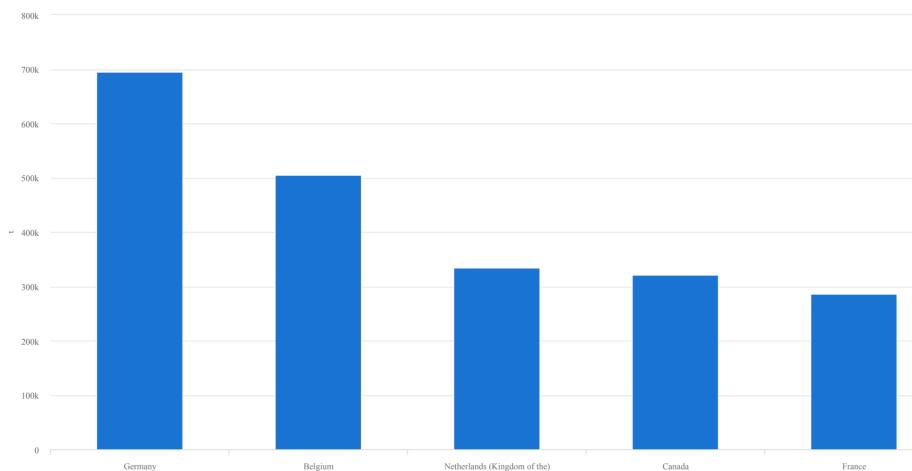
Which regions have had the largest share of coca production on average since the 2000s?



Which countries have produced the most cocoa beans since the early 2000s?



Which countries have been the top exporters of chocolate products on average since the 2000s?



### Reflections:

#### Nhaomi

The questions addressed in my sketches overlap greatly with our team's original answers, however, some answer more specific aspects of the question. For example, in my first visualization, my data focuses specifically on regions within the Ivory Coast and less on a general geographical region where deforestation due to cocoa is most apparent. However, my second and third visualizations pretty accurately answer their respective questions using the data provided. This happened because our questions are related to the findings in our dataset. I think some questions help give a clearer story (i.e., seeing the evolution in global cocoa prices over time) to our target audience who might not have much background on the cocoa industry, however, together, they seemingly depict a stronger story (i.e., Ivory Coast producing the most cocoa beans in the decade and having lots of deforestation as a byproduct). Overall, our questions and visualizations better contextualize the reality of cocoa farming.

### **Richael**

My visualizations directly addressed three of our team's original questions about deforestation trends, global price evolution, and the farmer income gap; they align with our strongest datasets and tell a cohesive story about cocoa's environmental and economic costs. I think the farmer income gap visualization was the most valuable because it used multiple data sources to reveal that farmers only recently began earning above living income thresholds despite years of high global prices. Some original questions, like consumer preference shifts or quality comparisons, would require data we don't have yet, so the questions I chose are more feasible and impactful for the data we have currently.

### **Winifred**

The questions addressed in my sketches were more focused on the production of cocoa beans and chocolate. More specifically, they looked at which regions have had the largest share of cocoa production, which countries have produced the most cocoa beans, and which countries were the top exporters of chocolate products. Overall, these questions were much more centered on the supply chain of cocoa and chocolate production, whereas the ones my team focused on were more about the environmental and economic costs of cocoa production. Despite this difference, the majority of our data examined trends over a span of years, which is extremely useful for analyzing how the industry has changed over time. The question asking which countries have produced the most cocoa beans since the early 2000s was particularly effective because it allowed for clear visualization of long-term trends and showed how different countries' roles have shifted over time. However, a question like which regions have had the largest share of cocoa production on average since the 2000s was less effective, since it presented a more static view that offered less insight into changes or dynamics within the industry. In other words, questions that revealed patterns of change over time were more impactful than those that only summarized averages, because they helped explain not just what the industry looks like, but how and why it has evolved.

## **Data**

### [FAOSTAT: Crops and Livestock Products - Cocoa Beans](#)

**Data Source:** Food and Agriculture Organization of the United Nations (FAO)

**Source Platform:** FAOSTAT, the primary statistical database of the FAO

**Specific Query:**

- **Item:** Cocoa beans
- **Elements:** Production Quantity, Area Harvested, Yield, Stocks
- **Countries:** 195, as recognized by the UN
- **Years:** 1961 - Present (last updated in 2023)

**File Format:** CSV, Excel

**Usage Restrictions:** Open access under the [FAO Open Data License](#)

Variable Name	Data Type	Description & Value Range	Collection Method / Notes
<b>Domain Code</b>	Categorical	A code identifying the FAOSTAT domain	assigned by FAO, static for this dataset
<b>Domain</b>	Categorical	The full name of the FAOSTAT domain	assigned by FAO, static for this dataset
<b>Area Code (M49)</b>	Geographic / Categorical	UN code for the country/region	standardized by the UN, used for consistent geographic referencing.
<b>Area</b>	Geographic / Categorical	The name of the country, region, or territory	reported and standardized by FAO
<b>Element Code</b>	Categorical	A code identifying the type of measurement	assigned by FAO
<b>Element</b>	Categorical	The description of the measurement type: Production Quantity Area Harvested Yield Stocks	defined by FAO
<b>Item Code (CPC)</b>	Categorical	Central Product Classification code	assigned by FAO, static for this dataset
<b>Item</b>	Categorical	The name of the agricultural product	as classified by FAO
<b>Year Code</b>	Temporal	The year of the record	
<b>Year</b>	Temporal	The year of the record 1961 - 2023	data is reported annually
<b>Unit</b>	Categorical	The unit of measurement for the Value column: Production: t (tonnes) Area Harvested: ha (hectares) Yield: kg/ha (kilograms per hectare) Stocks: t (tonnes)	very important for interpretation because you cannot compare values across elements without unit conversion
<b>Value</b>	Quantitative	The numerical measurement for the	collected through official figures, FAO

		given Element, Year, and Area	estimates, imputed data, etc
<b>Flag</b>	Categorical	A short code indicating the data status: A, E, I, X, M	extremely important for assessing data quality and reliability
<b>Flag Description</b>	Categorical	A plain-language description of the Flag. A, official figure E, estimated value I, imputed by a receiving agency X, figure external organization M, missing value	makes the Flag column readable

### Identify data cleaning needs:

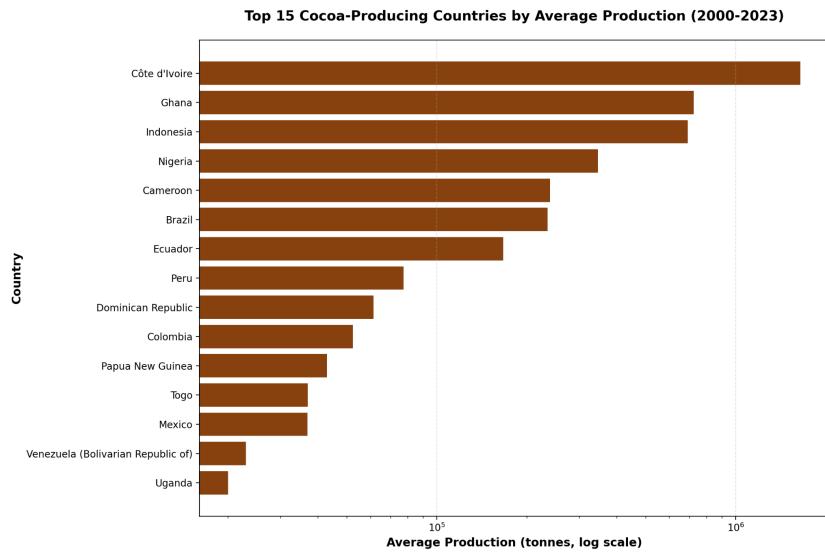
- **Missing values:**
  - The main gap in our dataset occurs where missing values appear as blank cells in the Value column with an M flag, indicating that the FAO was unable to provide or estimate the data.
- **Inconsistencies:**
  - One of the main inconsistencies in the dataset comes from the mix of sources and reliability levels. Some entries are from highly reliable official data (A), while others are estimated (E) or imputed (I). Being aware of this is important when interpreting the data, because not all values carry the same level of certainty.

**Clean Data:**  Clean w/o Blank Values FAOSTAT Production Quantity, Area Harvested, Sto...

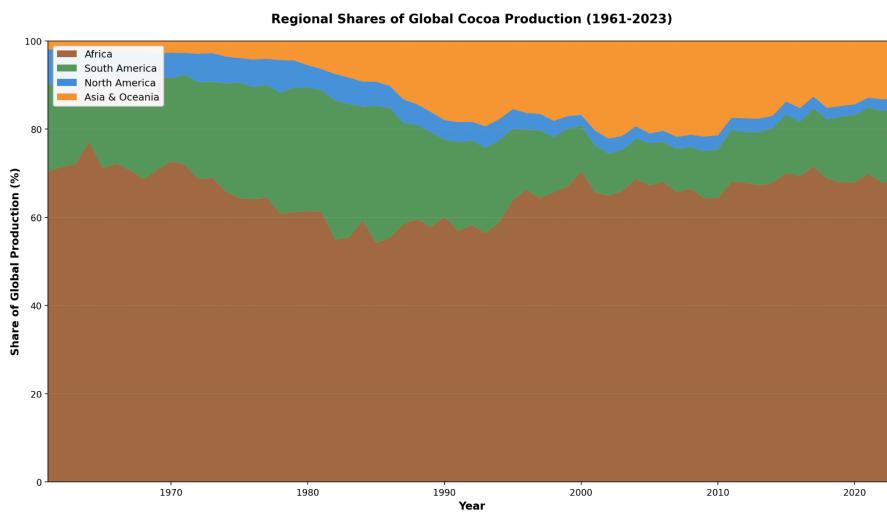
- Removed all of these:
  - **Domain Code:** will always be QCL
  - **Domain:** will always be Crops and livestock products
  - **Item Code (CPC):** will always be 1640
  - **Item:** will always be "cocoa beans"
  - **Year Code:** same as the year column
  - **Flag Description:** explanations for the Flag column, unnecessary
  - Rows with blank values and an M flag from the dataset

### Data Exploration

- Generate a bar chart showing the top 15 cocoa-producing countries by average production from 2000-2023. Use a log scale if necessary due to large value ranges.

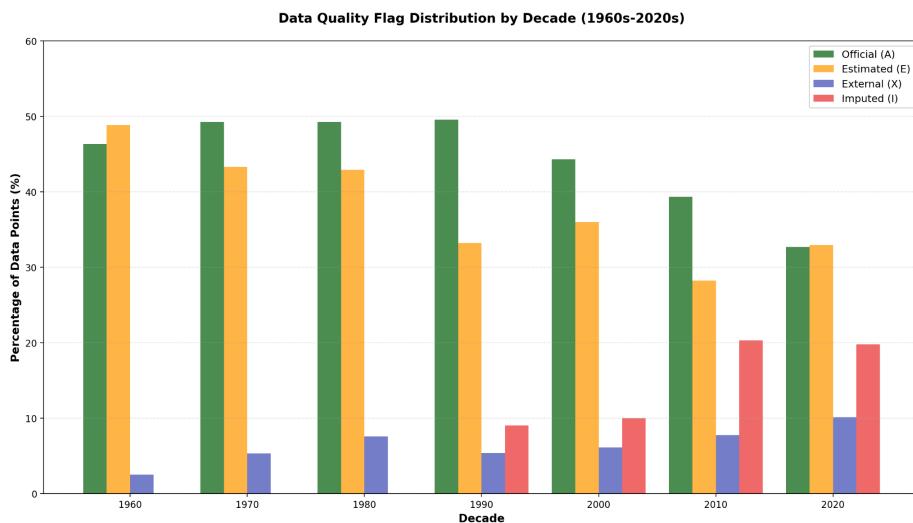


- Create a stacked area chart showing how regional shares (Africa, North America, South America, Asia) have evolved since 1961.

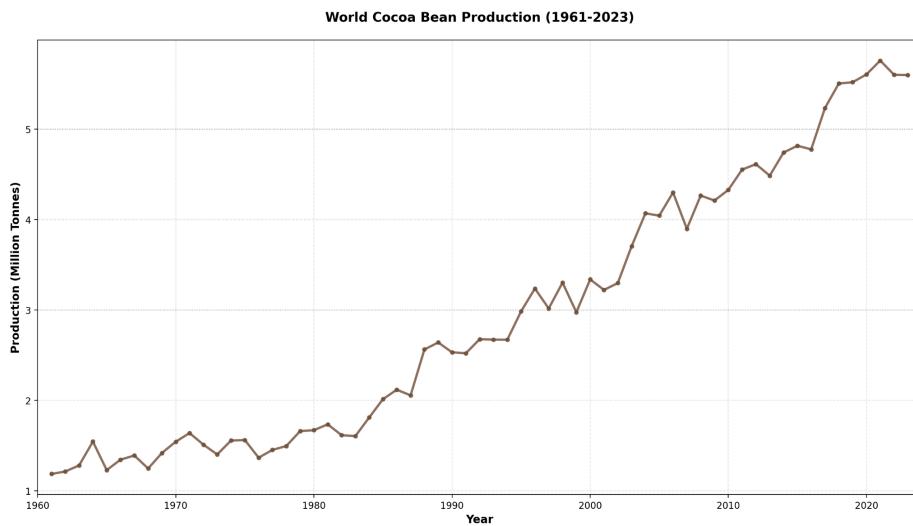


- Analyze the distribution of data quality flags in my dataset. Create a multiple bar chart showing the percentage of Official (A), Estimated (E), External (X), and Imputed (I) data

points by decade. How has data quality changed over time?



- Create a line plot showing world cocoa bean production from 1961 to 2023. Group by year and sum production



## Global Forest Watch – Ghana Cocoa Deforestation

**Data Source:** Global Forest Watch (FAO)

**Source Platform:** FAOSTAT, the primary statistical database of the FAO

**Specific Query:**

- **Item:** Deforestation in Ghana as a result of Cocoa production
- **Elements:** Land cover, Forest Change, Land Use, Fires, Climate
- **Country:** Ghana
- **Years:** 2001 - 2024

**File Format:** CSV, Excel

**Usage Restrictions:** Open access under the [FAO Open Data License](#)

## Data on Country Tree Cover Loss

Variable	Type	Value Range / Categories	Missing Count
country	Geographic	['Ghana']	0
threshold	Quantitative	0 – 75	0
area_ha	Quantitative	23,947,397 (constant)	0
extent_2000_ha	Quantitative	207,425 – 23,947,397	0
extent_2010_ha	Quantitative	169,270 – 23,947,397	0
loss_ha	Quantitative	0 – 387,150	0
gain_ha	Quantitative	0 – 9,159	0
emissions_MtCO2	Quantitative	0 – 148	some missing
drivers	Categorical	e.g., "Shifting agriculture", "Urbanization", etc.	some missing
year	Temporal	2001 – 2022	0

### Identify data cleaning needs:

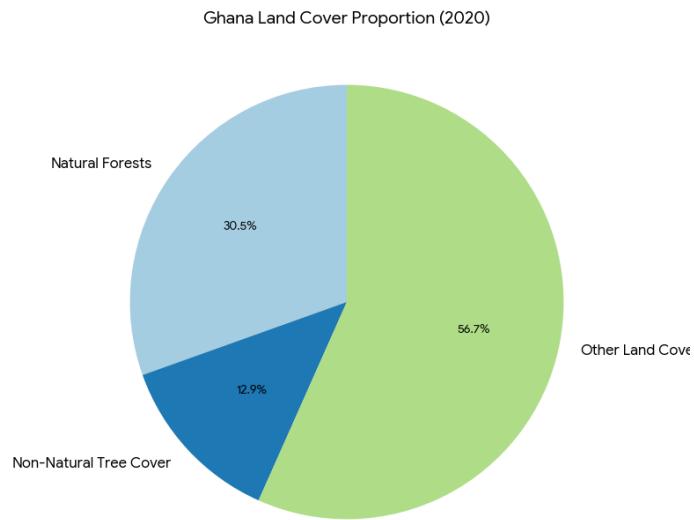
- **Missing values:**
  - This dataset is missing some values in the emissions and drivers count as some column values are left blank.
- **Inconsistencies:**
  - One of the main inconsistencies is that the 2023 and 2024 data haven't been verified yet, so they might just be projections and should be taken with a grain of salt.

### Clean Data: Cleaned Ghana Deforestation Data

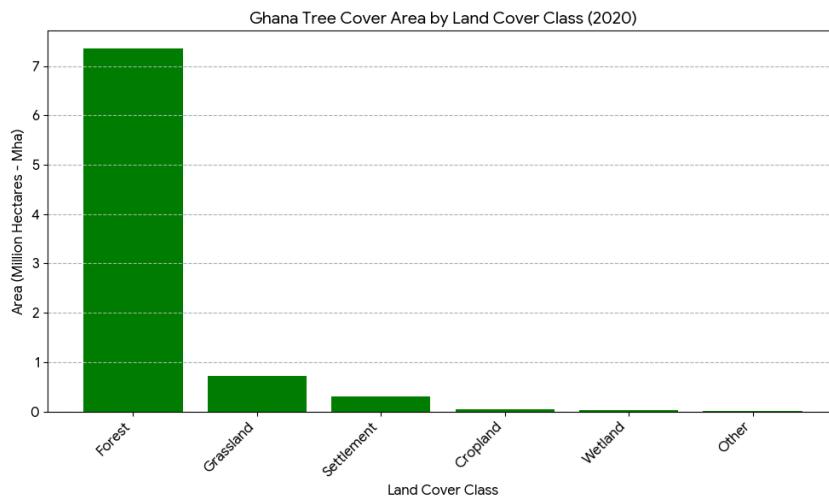
- Changes made:
  - **Ensure no negatives** in all numeric columns.
  - **Reshape data:** Instead of 30 columns of yearly loss (`tc_loss_ha_2001`, etc.), convert to a **long format** with `year` and `loss_ha` columns.
  - **Check consistency:** ensure `loss_ha` ≤ `extent_2000_ha` for each threshold.

### Explore data

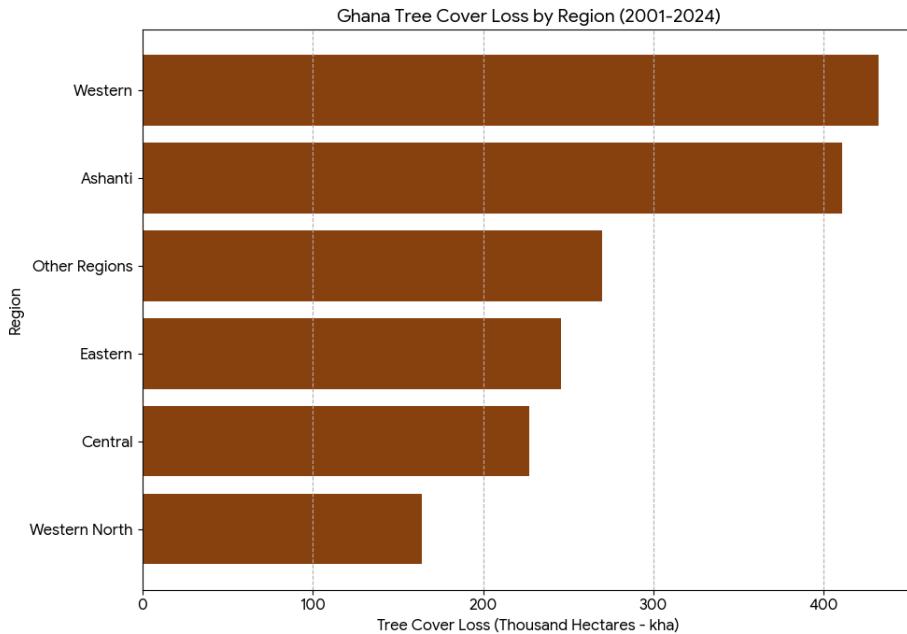
- Generate a pie chart showing the breakdown of Ghana's total land area into three major categories based on the 2020 data.



- Create a bar graph that shows where tree cover (with >30% canopy density) is located across different land cover classes.



- Create a horizontal bar chart that shows the cumulative tree cover loss across Ghana's regions from 2001 to 2024, highlighting the areas with the most deforestation.



## Cocoa Beans Export Reporter

**File Format:** CSV, Excel

**Size:** 3,852 rows x 9 columns

**Usage Restrictions:** Open access under OEC

**Identify data cleaning needs:**

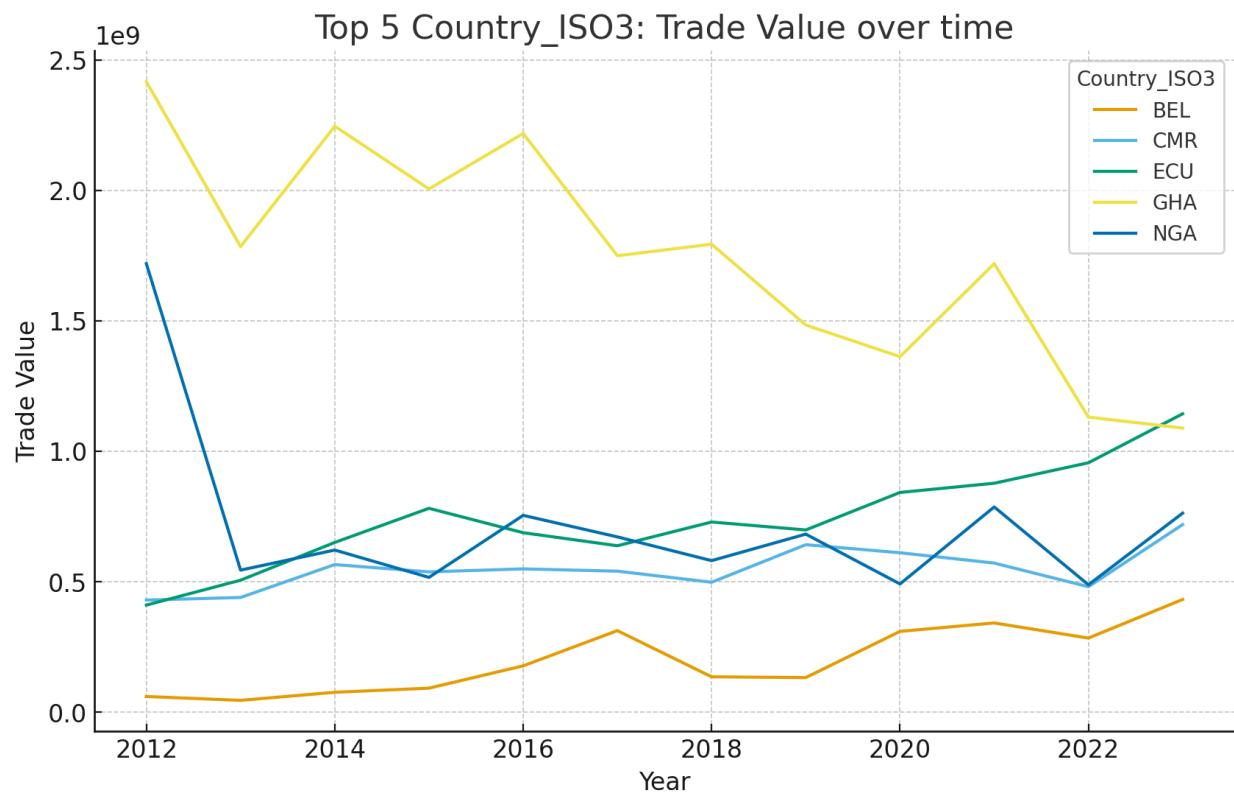
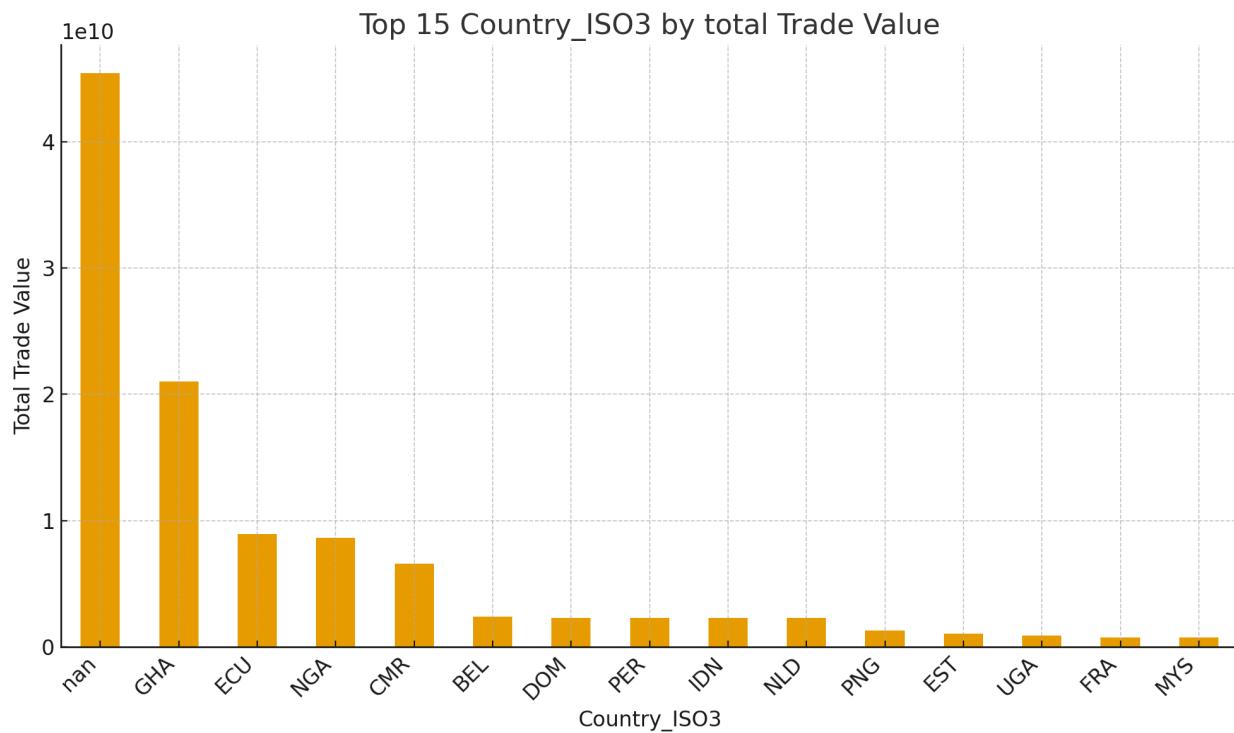
- Missing values: present in several columns.
- Inconsistencies: mixed numeric formatting (commas/\$) in value columns; stray whitespace in text fields; possible mixed country naming conventions (e.g., “Côte d’Ivoire” vs “Cote d’Ivoire”).
- Standardize country names to ISO-3 (for easy joins)
- Duplicates: exact duplicate rows were detected and dropped in the cleaned file.
- Transformations needed for analysis/visualization:
  - Transform Year → integer  
Normalize trade value columns → numeric (strip commas/\$)
  - Trim whitespace in all string columns

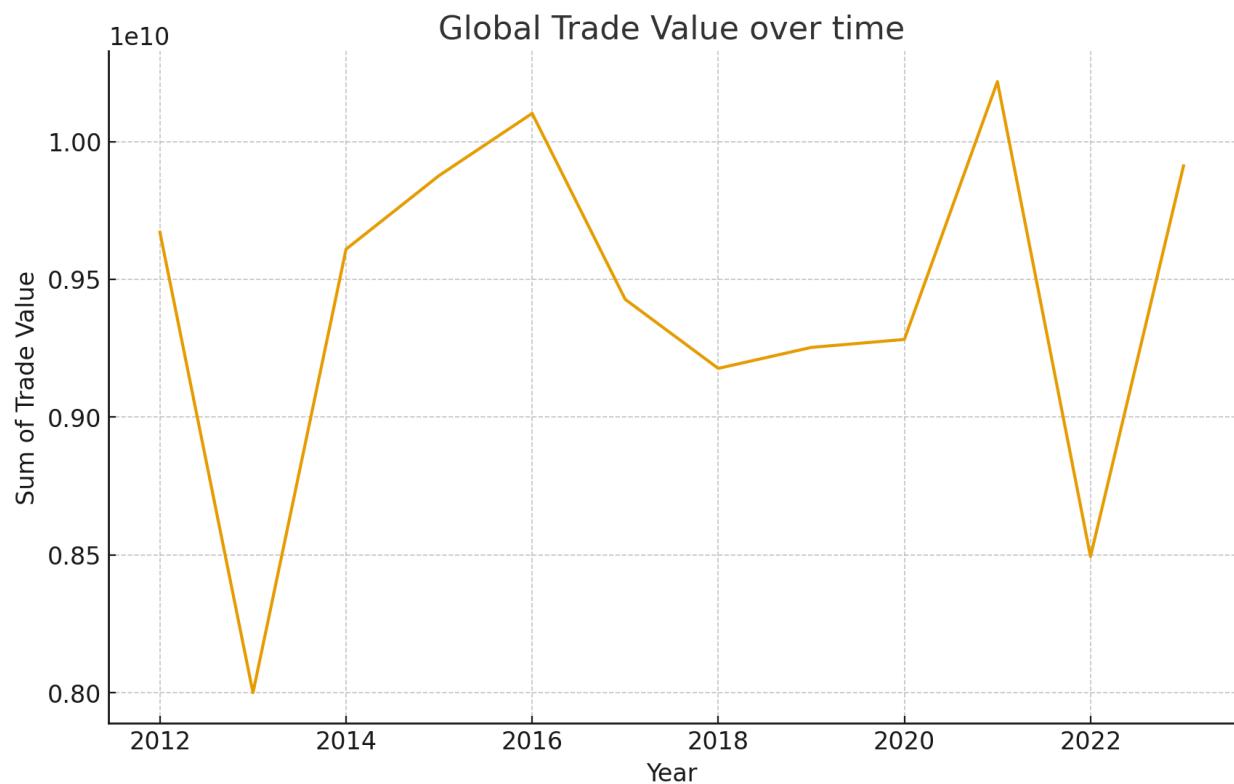
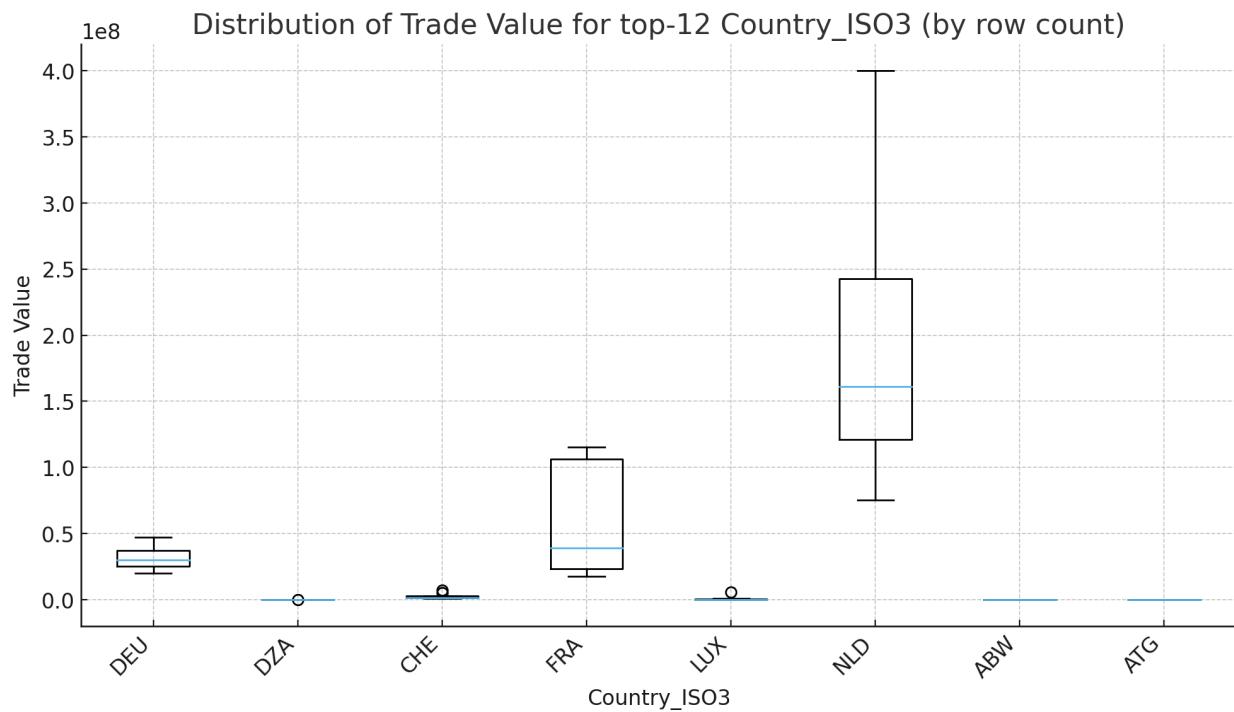
**Cleaned Data:**  [exports-of-cocoa-beans-by-country-1.cleaned](#)

Variable Name	Data Type	Description & Value Range	Collection Method / Notes
Continental Region ID	Geographic / Categorical (code)	Numeric code for continental region (dataset-specific identifier). Examples: 1, 2, 3, 4, 5	Aggregate category; not a single country.
Continental	Geographic /	Continental region name (aggregate)	Aggregate category;

Region	Categorical (name)	grouping). Examples: Northern Africa, Eastern Africa, Middle Africa, Southern Africa, Western Africa	not a single country.
Country ID	Geographic / Categorical (code)	Numeric code for country (dataset-specific identifier). Examples: afdza, afegy, afesh, aflby, afmar	
Country	Geographic / Categorical (name)	Country or territory name (as reported in source). Examples: Algeria, Egypt, Western Sahara, Libya, Morocco	Consider normalizing names (diacritics, historical names).
Country_ISO3	Geographic / Categorical (ISO-3)	Three-letter ISO 3166-1 alpha-3 country code. Examples: DZA, EGY, ESH, LBY, MAR	Standardized via by country; unmapped region labels remain blank.
Year	Temporal	Calendar year of the record (annual frequency). 1970-01-01 – 1970-01-01	Parsed to integer where possible; annual.
Trade Value	Quantitative (currency/amount)	Trade value or quantity measure for cocoa beans. 1 – 4.19346e+09	Parsed to numeric (commas/\$ removed). Check unit/deflator before comparisons.
Continent	Categorical	Examples: Africa, Antarctica, Asia, Europe, North America	
Continent ID	Categorical	Examples: af, an, as, eu, na	
Share	Quantitative (float)	0 – 44.6927	

## Data Exploration





### **Overall Reflections:**

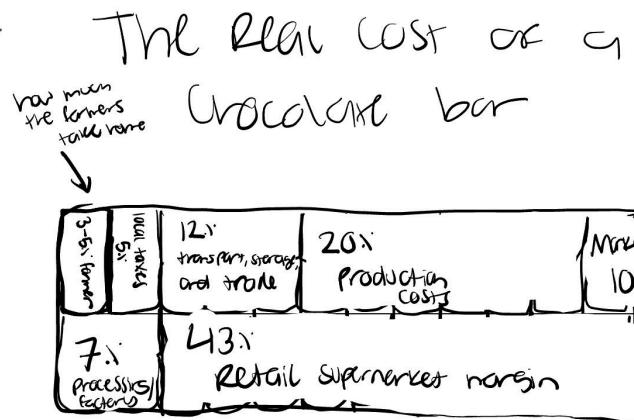
Our data actually ended up aligning pretty closely with our original vision, allowing us to explore questions about production, exports, deforestation, and pricing in West Africa. Using AI-assisted exploration helped us quickly identify clear patterns, like Ghana and Côte d'Ivoire dominating global cocoa production and deforestation intensifying alongside rising export values. We could also visualize global cocoa price trends and the persistent gap between world prices and what farmers earn. However, some audience questions, especially around fair-trade violations by major chocolate conglomerates, remain unanswered because public, company-level transparency data is harder to find.

The biggest challenges we faced were data consistency and completeness. Units, currencies, and naming conventions differed across datasets, requiring careful cleaning and standardization (e.g., converting to ISO-3 country codes). Some data, like farmgate prices or deforestation emissions, had missing or estimated values, making cross-source comparisons tricky. Despite this, our cleaned datasets now provide a good foundation for us to visualize the global cocoa story, and we know exactly where to focus next: filling the gap on corporate accountability and fair-trade enforcement.

# Sketch

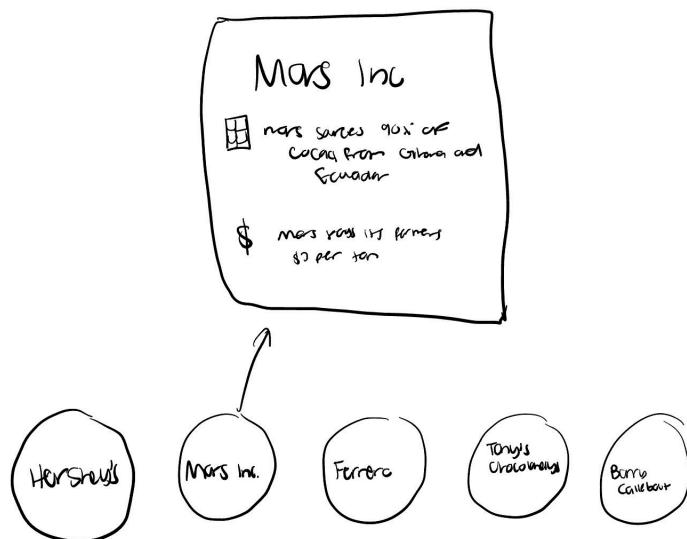
Richael's Sketches

How much do cocoa farmers make?



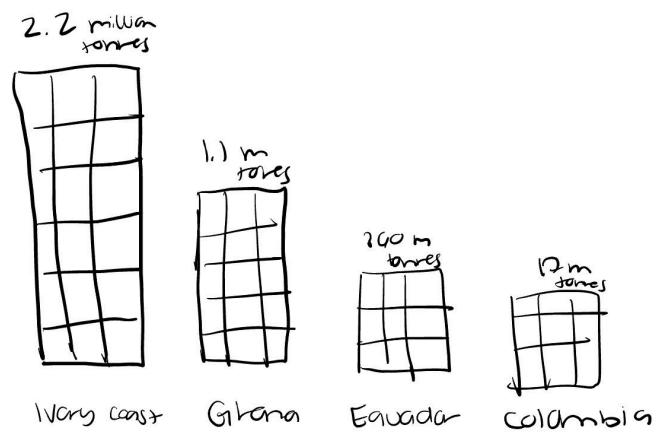
which companies have the most/least sustainable trade policies

Chocolate Scorecard

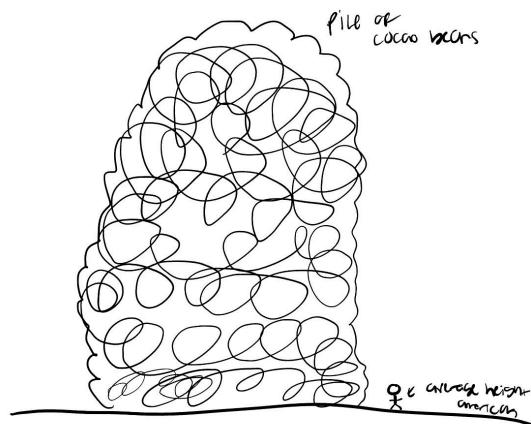


Who are the worlds biggest cacao producers

### Chocolate visualization

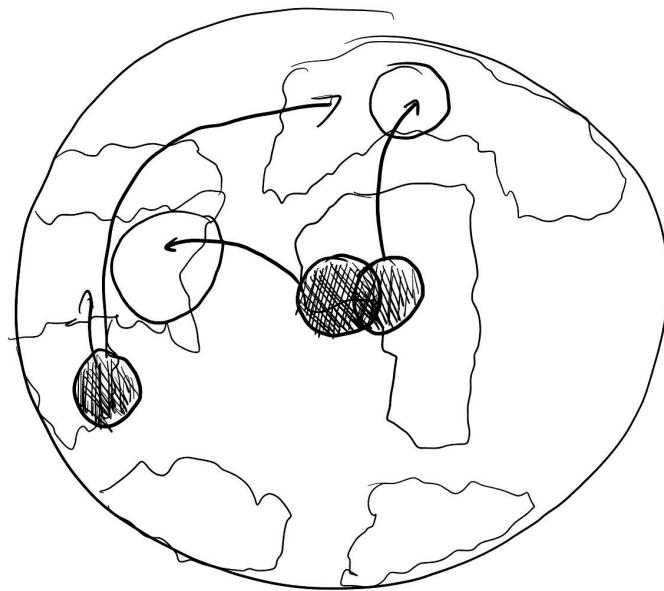


How much cacao is carried annually through  
cocoa products



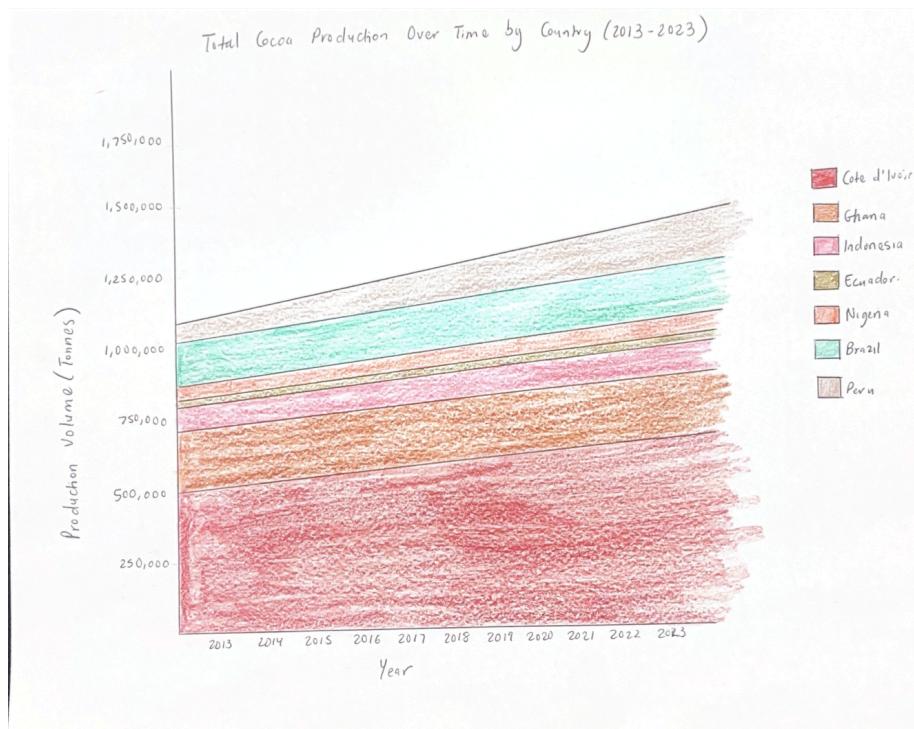
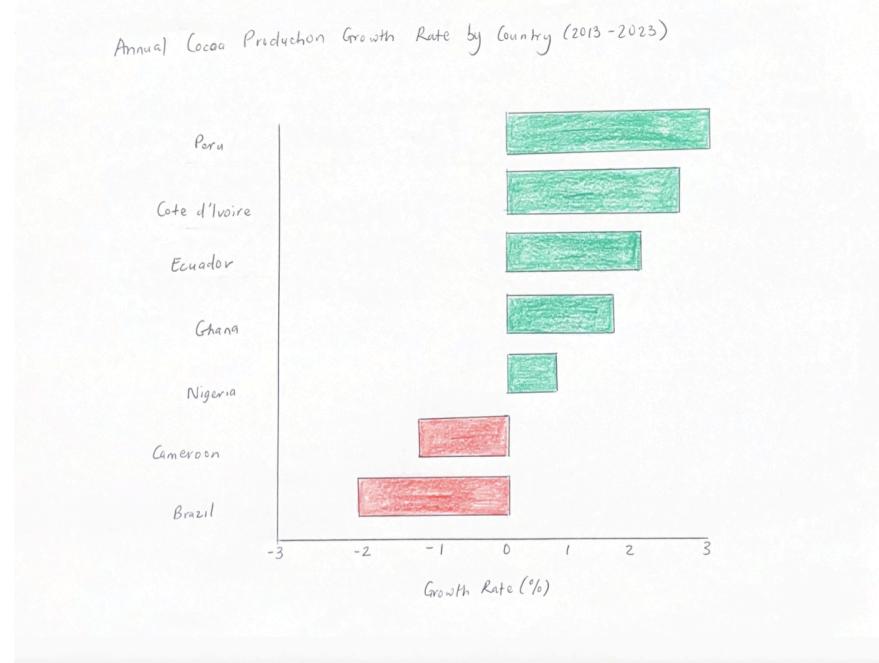
which countries import/export the most cocoa

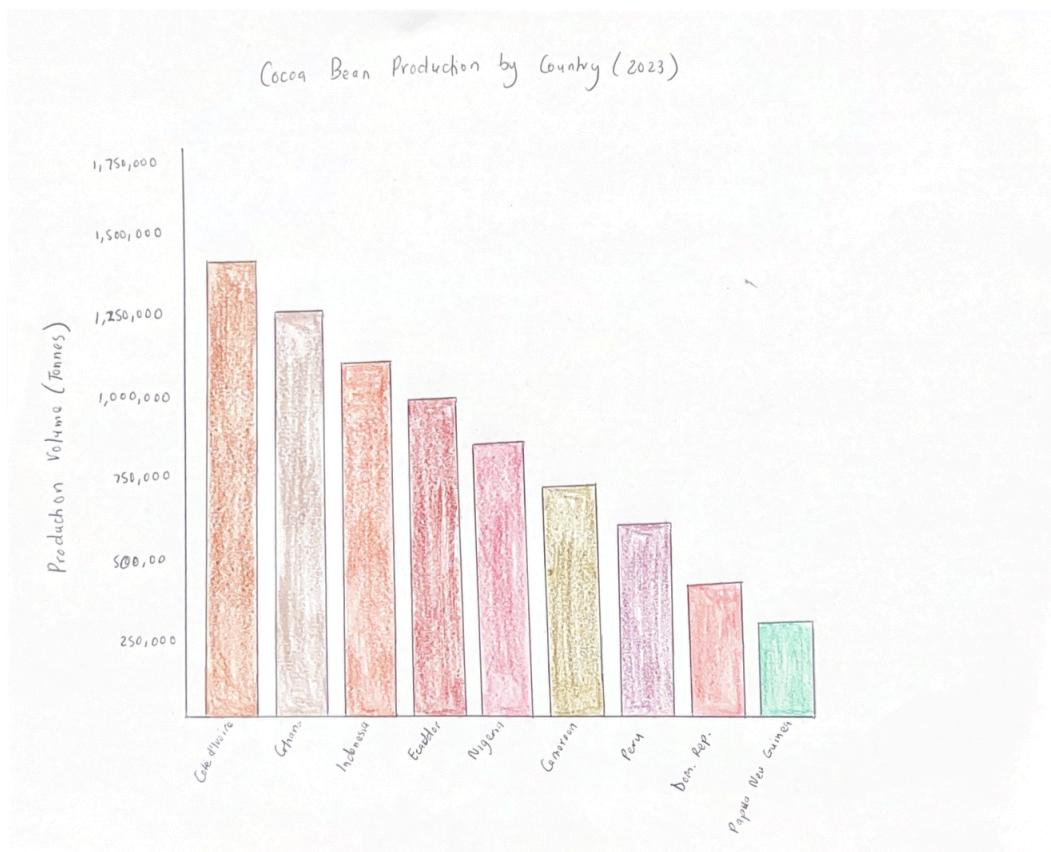
Globe, world map



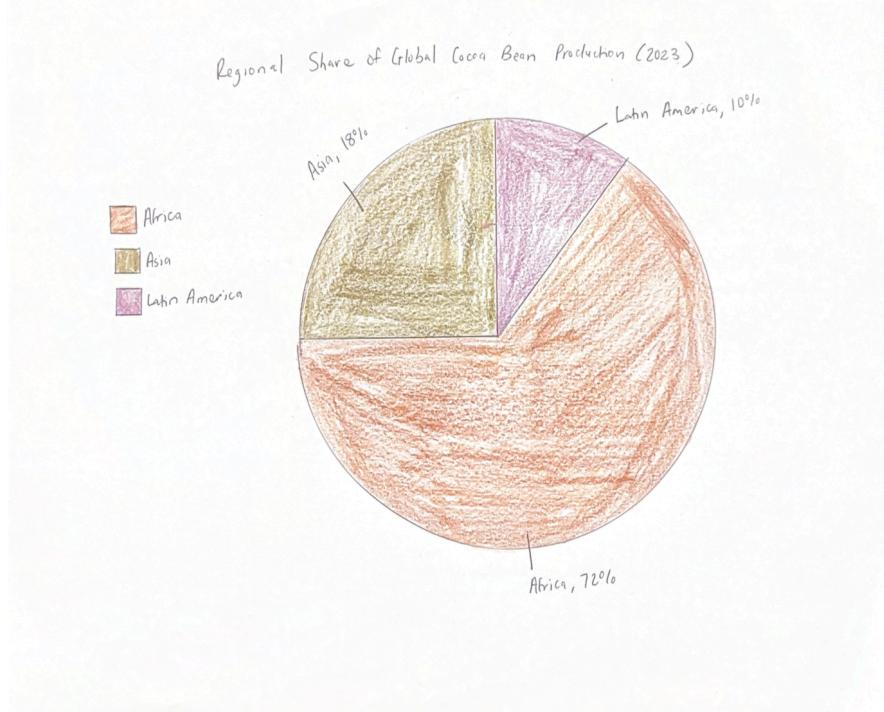
## Winifred's Sketches

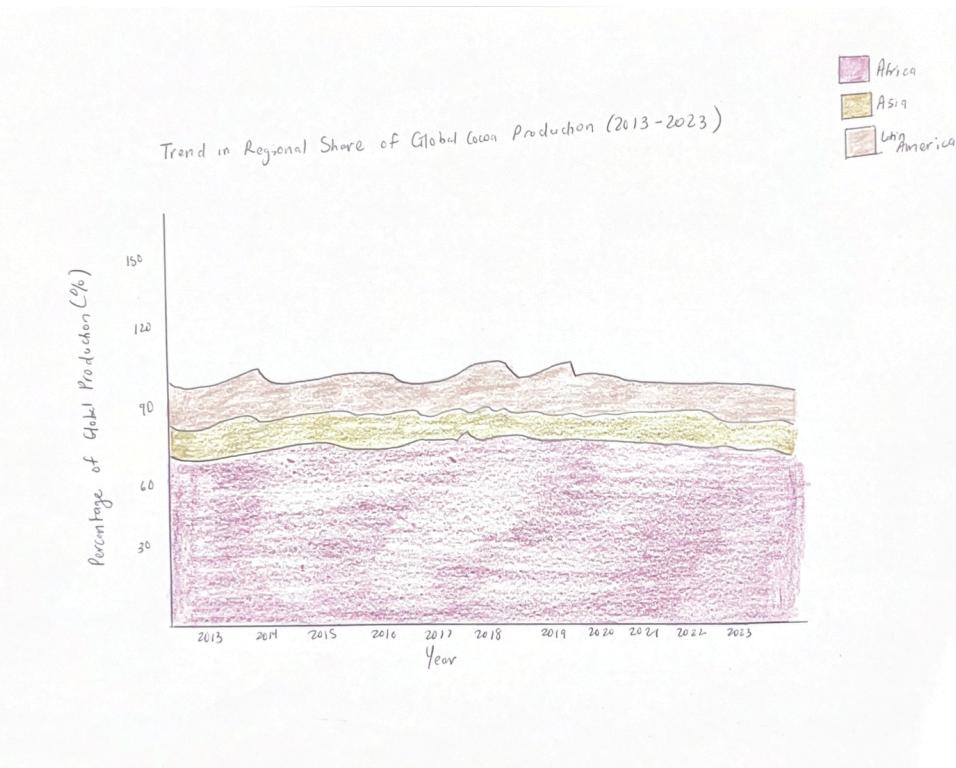
Which countries have produced the most cocoa beans in the past decade?



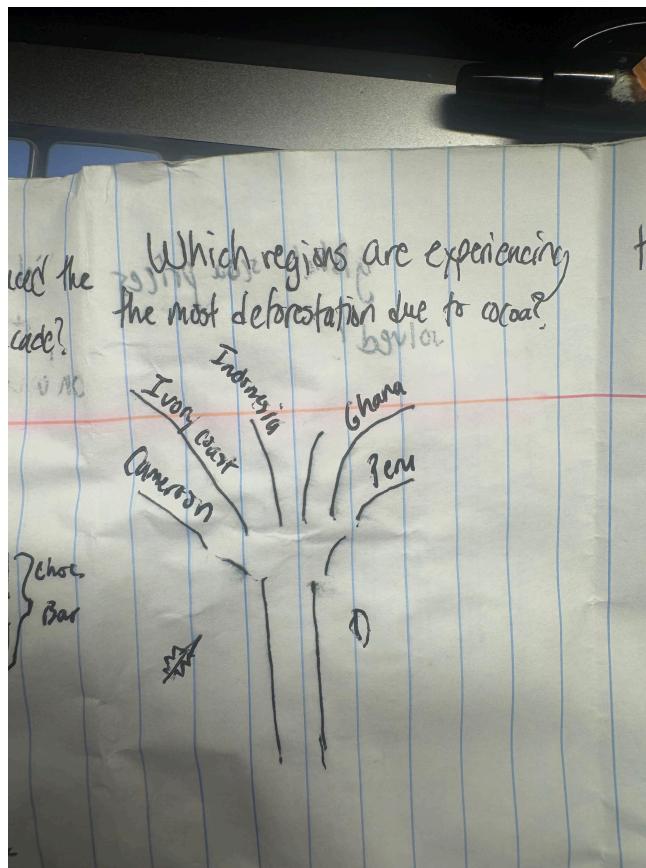
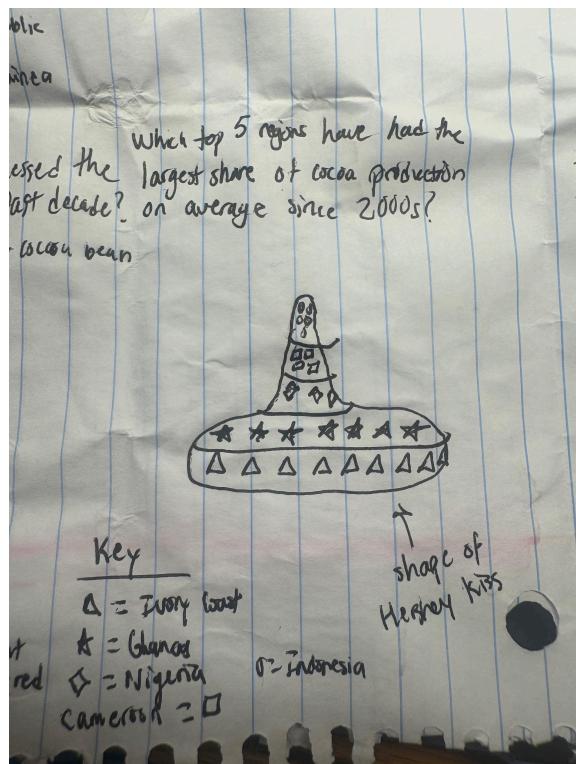


### How does cocoa production compare between Africa, Asia, and Latin America?



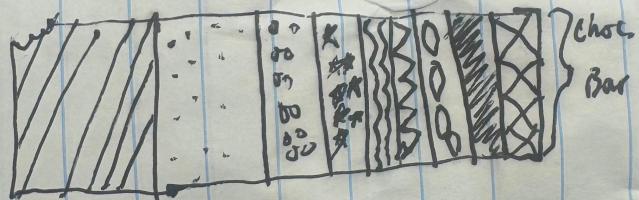


## Nhaomi's Sketches



Which countries have produced the most cocoa beans in the past decade?

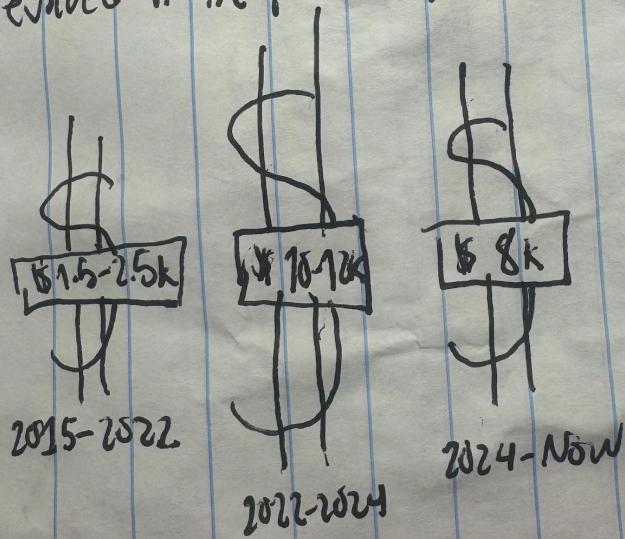
12500C wt w/ 18 spp. 10 NO



Key:

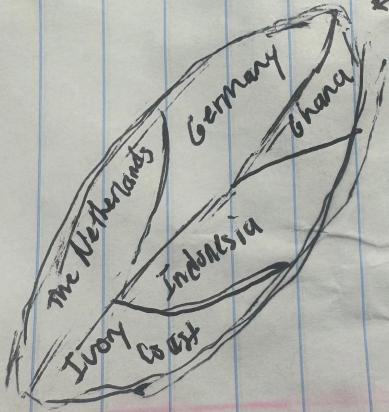
- |                  |                         |
|------------------|-------------------------|
| II = Ivory Coast | 3 = Cameroon            |
| .. = Ghana       | 0 = Peru                |
| 00 = Indonesia   | ** = Dominican Republic |
| •* = Ecuador     | X = Papua New Guinea    |
| SS = Nigeria     |                         |

How have global cocoa prices evolved in the past 10 years?



Which countries have processed the  
most cocoa beans in the past decade? on

↙ cocoa bean



Key

Q =  
K =  
◇ =  
C =

\* in color, different  
shades of brown & red

# Decide

## Question ID

Question ID	Question	Author
1	Which countries have produced the most cocoa beans in the past decade?	WO, RS, NL
2	How does cocoa production compare between Africa, Asia, and Latin America?	WO
3	Which countries import/export the most cocoa	RS
4	Which companies have the most sustainable trade practices	RS
5	How much do cocoa farmers make	RS
6	What top 5 regions have had the largest share of cocoa production on average since the 2000s?	NL
7	Which regions are experiencing the most deforestation due to cocoa?	NL
8	How have global prices evolved in the past 10 years?	NL
9	Which countries have processed the most cocoa beans in the past decade?	NL

## Affinity Diagramming

Sketch ID	Question ID	Sketches	Author	Total # of Votes																
1	1	<p>Annual Cocoa Production Growth Rate by Country (2013-2025)</p> <table border="1"> <thead> <tr> <th>Country</th> <th>Annual Growth Rate (%)</th> </tr> </thead> <tbody> <tr> <td>Peru</td> <td>~2.5%</td> </tr> <tr> <td>Côte d'Ivoire</td> <td>~2.0%</td> </tr> <tr> <td>Ecuador</td> <td>~1.5%</td> </tr> <tr> <td>Ghana</td> <td>~1.0%</td> </tr> <tr> <td>Nigeria</td> <td>~0.5%</td> </tr> <tr> <td>Cameroon</td> <td>-1.0%</td> </tr> <tr> <td>Brazil</td> <td>-2.0%</td> </tr> </tbody> </table>	Country	Annual Growth Rate (%)	Peru	~2.5%	Côte d'Ivoire	~2.0%	Ecuador	~1.5%	Ghana	~1.0%	Nigeria	~0.5%	Cameroon	-1.0%	Brazil	-2.0%	WO	0
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2	1	<p>Total Cocoa Production Over Time by Country (2013-2023)</p> <p>Production Volume (Thousands)</p> <p>Year</p> <ul style="list-style-type: none"> <li>Côte d'Ivoire</li> <li>Ghana</li> <li>Indonesia</li> <li>Ecuador</li> <li>Nigeria</li> <li>Brazil</li> <li>Peru</li> </ul>	WO	0																				
3	1	<p>(Cocoa Bean Production by Country (2023))</p> <p>Production Volume (Thousands)</p> <p>Countries</p> <table border="1"> <thead> <tr> <th>Country</th> <th>Production Volume (Thousands)</th> </tr> </thead> <tbody> <tr> <td>Côte d'Ivoire</td> <td>~1,450,000</td> </tr> <tr> <td>Ghana</td> <td>~1,350,000</td> </tr> <tr> <td>Indonesia</td> <td>~1,100,000</td> </tr> <tr> <td>Ecuador</td> <td>~950,000</td> </tr> <tr> <td>Nigeria</td> <td>~850,000</td> </tr> <tr> <td>Brazil</td> <td>~650,000</td> </tr> <tr> <td>Peru</td> <td>~550,000</td> </tr> <tr> <td>Ivory Coast</td> <td>~450,000</td> </tr> <tr> <td>Nigeria</td> <td>~350,000</td> </tr> </tbody> </table>	Country	Production Volume (Thousands)	Côte d'Ivoire	~1,450,000	Ghana	~1,350,000	Indonesia	~1,100,000	Ecuador	~950,000	Nigeria	~850,000	Brazil	~650,000	Peru	~550,000	Ivory Coast	~450,000	Nigeria	~350,000	WO	0
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8	1	<p>Who are the worlds biggest cocoa producer</p> <p>Chocolate visualization</p> <p>2.2 million tonnes</p> <p>1.1 m tonnes</p> <p>200 m tonnes</p> <p>12 m tonnes</p> <p>Ivory Coast      Ghana      Ecuador      Colombia</p>	RS	2																				

9	1	<p>How much cacao is carried annually through cocoa products</p>	RS	0								
14	1	<p>Which countries have produced the most cocoa beans in the past decade?</p> <p>Key:</p> <ul style="list-style-type: none"> <li>// = Ivory Coast</li> <li>... = Ghana</li> <li>○ = Indonesia</li> <li>■ = Ecuador</li> <li>○ = Peru</li> <li>□ = Dominican Republic</li> <li>X = Papua New Guinea</li> </ul>	NL	2								
4	2	<p>Regional Share of Global Cocoa Bean Production (2023)</p> <table border="1"> <thead> <tr> <th>Region</th> <th>Share (%)</th> </tr> </thead> <tbody> <tr> <td>Africa</td> <td>70%</td> </tr> <tr> <td>Asia</td> <td>18%</td> </tr> <tr> <td>Latin America</td> <td>10%</td> </tr> </tbody> </table>	Region	Share (%)	Africa	70%	Asia	18%	Latin America	10%	WO	0
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5	2	<p>Trend in Regional Share of Global Cacao Production (2013-2023)</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Africa (%)</th> <th>Asia (%)</th> <th>Latin America (%)</th> </tr> </thead> <tbody> <tr><td>2013</td><td>~20</td><td>~15</td><td>~40</td></tr> <tr><td>2015</td><td>~22</td><td>~17</td><td>~40</td></tr> <tr><td>2017</td><td>~24</td><td>~19</td><td>~42</td></tr> <tr><td>2019</td><td>~26</td><td>~21</td><td>~44</td></tr> <tr><td>2021</td><td>~28</td><td>~23</td><td>~46</td></tr> <tr><td>2023</td><td>~30</td><td>~25</td><td>~48</td></tr> </tbody> </table>	Year	Africa (%)	Asia (%)	Latin America (%)	2013	~20	~15	~40	2015	~22	~17	~40	2017	~24	~19	~42	2019	~26	~21	~44	2021	~28	~23	~46	2023	~30	~25	~48	WO	2
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10	3	<p>Which countries import/export the most cacao</p>	RS	1																												
7	4	<p>Which companies have the most/least sustainable trade practices</p> <p>Chocolate Scorecard</p> <table border="1"> <tbody> <tr> <td>Mars Inc</td> </tr> <tr> <td>▪ mars sources 90% of cacao from Ghana and Ecuador</td> </tr> <tr> <td>\$ mars pays its farmers \$7 per ton</td> </tr> </tbody> </table> <p>Hershey's      Mars Inc.      Ferrero      Tony's Chocolonely      Barry Callebaut</p>	Mars Inc	▪ mars sources 90% of cacao from Ghana and Ecuador	\$ mars pays its farmers \$7 per ton	RS	2																									
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6	5	<p>How much do cocoa farmers make?</p> <p>The Real Cost of a Chocolate bar</p> <p>Very little the farmers take home</p> <p>Retail supermarket margin</p>	RS	3
11	6	<p>What top 5 regions have had the largest share of cocoa production over the last decade? On average since 2000s?</p> <p>shape of Ivory Coast</p> <p>Key</p> <ul style="list-style-type: none"> <li>Black triangle = Ivory Coast</li> <li>Black diamond = Ghana</li> <li>Red triangle = Côte d'Ivoire</li> <li>Red diamond = Nigeria</li> <li>Blue square = Cameroon</li> </ul>	NL	0
15	7	<p>Which regions are experiencing the most deforestation due to cocoa?</p> <p>Which regions are experiencing the most deforestation due to cocoa?</p> <p>Ivory Coast Cameroon</p>	NL	1

13	8	<p>How have global cocoa prices evolved in the past 70 years?</p> <p>1915-1922      1922-1924      2024-Now</p>	NL	0
12	9	<p>Which countries have processed the most cocoa beans in the past decade?</p> <p>Key: Δ = The Netherlands K = Germany □ = France △ = Ivory Coast ▽ = Indonesia ○ = China</p>	NL	2

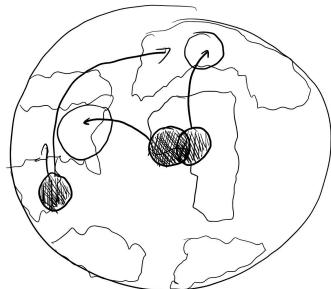
## Voting Results

Selected Sketches and their Questions

Relevance (1 - most, 6 - least)	Sketches	Questions They Answer												
1	<p>How much do cocoa farmers make?</p> <p>The real cost of a chocolate bar</p> <table border="1"> <tr> <td>5%</td> <td>12%</td> <td>20%</td> <td>10%</td> </tr> <tr> <td>Processing costs</td> <td>Transport, storage and trade</td> <td>Production costs</td> <td>Making</td> </tr> <tr> <td colspan="4">43% RETAIL SUPERMARKET MARGIN</td> </tr> </table>	5%	12%	20%	10%	Processing costs	Transport, storage and trade	Production costs	Making	43% RETAIL SUPERMARKET MARGIN				How much do cocoa farmers make
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2	<p>Which countries have processed the most cocoa beans in the past decade?</p> <p>Key: △ = USA ▲ = UK ◆ = France ◇ = China</p>	<p>Which countries have processed the most cocoa beans in the past decade?</p>																								
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6

*which countries import/export the most cocoa**(global, world map)*

Which countries have produced the most cocoa beans in the past decade?

### Rationale Paragraph

When deciding the most appropriate sketches to implement, we prioritized how visually appealing, relevant, and realistic our ideas were. We know that our audience will gravitate towards visualizations that are aesthetically pleasing, so we decided to choose sketches that included elements of chocolate and picturesque features that could turn into creative and interactive designs. Additionally, we wanted to ensure that the sketches addressed the most important questions to our project that our audience would find engaging. With this, we had to transparently think how realistic it would be to translate these sketches into larger-scale visualizations based on the datasets we have. Overall, we want our visuals to be alluring, informative, and feasible to integrate.

# Storyboard

## Identify Your Main Message

### Nhaomi's Individual Exploration:

#### 1. Cocoa Supply Chain & Deforestation

This dataset provides great insight into how global cocoa supply chains contribute to environmental changes, primarily in countries like Côte d'Ivoire and Ghana. There's a primary focus on how cocoa has been a major driver of tropical forest loss in some producing countries.

#### 2. Cocoa Prices over time

By looking at the evolution of cocoa prices over time, we can see the stark incline over the past decade. This was mainly due to the high demand and supply tightness across West Africa.

### Richael's Individual Exploration:

#### 1. The Persistent Farmer Income Gap

By comparing COCOBOD's farmgate prices with the World Bank's global cocoa price data, I observed that farmers consistently receive less than 10% of the world market price. Even when international prices rose after 2015, farmer incomes barely increased, showing that market gains rarely reach producers.

#### 2. Cocoa Prices vs. Living Income Thresholds

Cross-referencing Fairtrade International's living income benchmarks with Ghana's actual producer prices revealed that farmers only began approaching the living income threshold in the past few years. This highlights how economic gains have been uneven, even amid record-high chocolate consumption.

### Winifred's Individual Exploration:

1. **Concentration of Cocoa Production in Two Countries:** The world's chocolate supply is overwhelmingly sourced from just two countries, Côte d'Ivoire and Ghana. This highlights the chocolate industry's strong reliance on these key producers.
2. **Africa's Dominance in Cocoa Production:** Africa produces the vast majority of the world's cocoa, making it the backbone of the global industry. Its production far surpasses that of all other continents combined.

### Central Message (Main Insight):

Although cocoa production in Ghana and Côte d'Ivoire dominates the global chocolate industry and has generated significant market gains, farmers' incomes have remained low, and environmental costs, particularly deforestation and land degradation, have continued to rise.

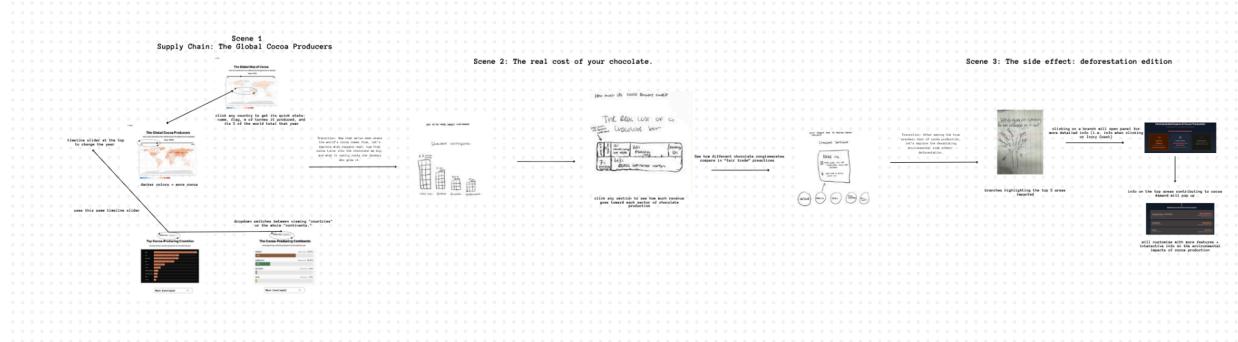
### Why our team selected this:

Our team selected this as the main insight because it brings together all of the different findings that emerged from our data. The audience we are focusing on is chocolate lovers who usually know a lot about their favorite chocolate and major Western brands. However, many of them are unaware of the deeper history of chocolate, including who produces the cocoa, the ethical issues involved in its production, and how problems such as low wages for farmers and deforestation continue to exist. This insight is a largely non-Western perspective and encourages people to learn more about the origins and realities behind the chocolate they enjoy.

## Data Storyboard

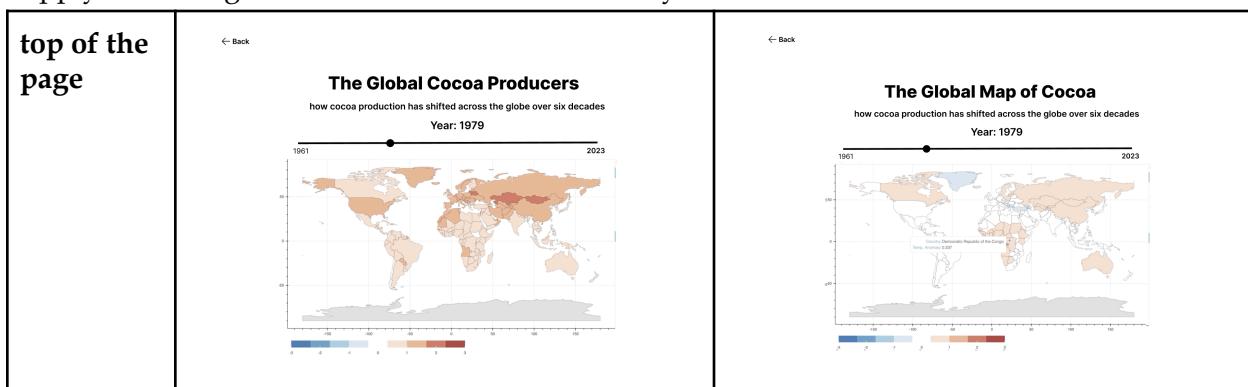
### Link to Our Digital Storyboard:

[https://www.canva.com/design/DAG28weBWwQ/wRrrmMkrzY\\_WQM7x8axdYO/edit?utm\\_content=DAG28weBWwQ&utm\\_campaign=designshare&utm\\_medium=link2&utm\\_source=sharebutton](https://www.canva.com/design/DAG28weBWwQ/wRrrmMkrzY_WQM7x8axdYO/edit?utm_content=DAG28weBWwQ&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton)

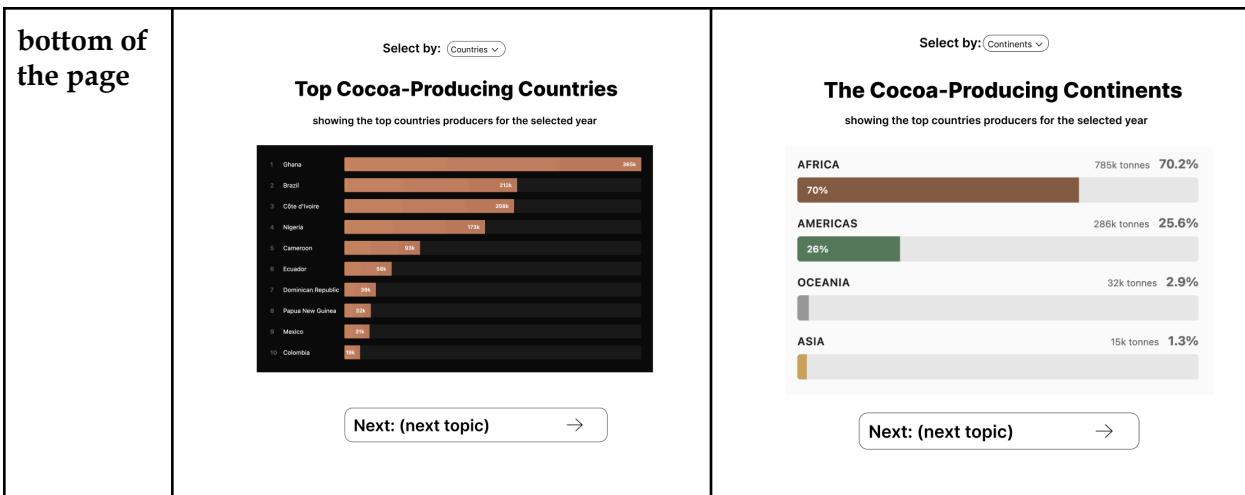


### Personal Notes

Supply Chain Page: The Global Cocoa Producers by Winifred



bottom of  
the page



Everything updates live when you pick a year to see how cocoa power has shifted over the decades.

### Chloraph Map

- It's a world map where darker colors = more cocoa.
- Use the big timeline slider at the top to change the year and watch the colors change.
- Click any country to get its quick stats: name, flag, how many tonnes it produced, and its % of the world total that year.

### Ranking Bar Chart

- This bar chart shows the top countries/continents.
- Use a dropdown to switch between viewing "Countries" or the whole "Continents."
- It automatically resets itself when you change the year on the slider.
- When you hover over a bar, and it lights up the corresponding country/continent on the world map, show the relationship between the ranked list and the geographic view.

# Prototype 1

## Team member documentation

Nhaomi Lartey

Richael Saka

Winifred Ofori-Manu

## Data pipeline

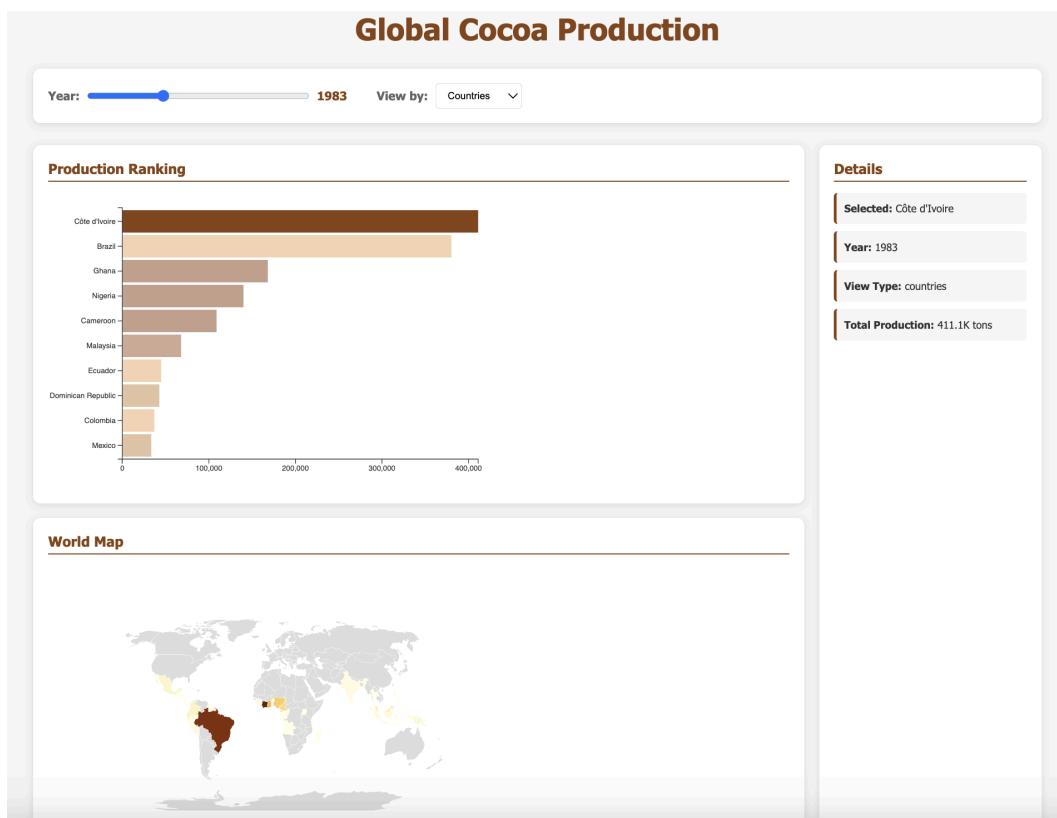
Noted in the Data section!

## Two Functional D3 Visualizations

### Nhaomi's Visualization



## Winifred's Visualization



## Additional visualization drafts (2-3 more)

### "The Melting Forest" - Multi-Threshold Comparison Dashboard

Core Concept: Instead of showing one threshold at a time, visualize ALL thresholds simultaneously to reveal how deforestation impacts different forest densities differently. Think of it like a chocolate layer cake - each layer (threshold) tells part of the story.

#### Main Visualization: Stacked Stream Graph

- **Layout:** Flowing, organic "stream" chart showing all 8 thresholds as layered bands
- **Color Scheme:** Gradient from light (milk chocolate) at bottom to dark (extra dark) at top
- **Key Insight:** Shows which forest types are most vulnerable - sparse forests vs dense forests
- **Interactivity:**
  - Click a layer to isolate and highlight it
  - Hover shows proportional loss for that threshold in that year
  - Toggle between "stacked" and "normalized" views (showing percentages vs absolute values)

#### Secondary Visualization: Cumulative Loss Bars

- **Position:** Top right panel
- **Purpose:** Show total loss 2001-2022 for each threshold as horizontal bars
- **Chocolate metaphor:** Bars look like melting chocolate bars
- **Annotation:** Percentage of original forest extent lost

#### Third Visualization: Year-over-Year Change Heatmap

- **Position:** Bottom panel
- **Grid:** Years (columns) × Thresholds (rows)
- **Color:** Darker chocolate = more loss, lighter = less loss
- **Pattern Recognition:** Quickly spot "bad years" (2013-2014, 2017-2018, 2020) across all thresholds
- **Interactivity:** Click cell to highlight that year in stream graph

#### Fourth Element: "Forest Density Cascade" Sankey Diagram

- **Position:** Left sidebar
- **Purpose:** Show the relationship between forest extent at different thresholds
- **Flow:** Thick flows from 0% → 10% → 15% → ... → 75%
- **Width:** Represents remaining forest area at each threshold level
- **Insight:** Visualizes how much forest exists at each density classification

#### Key Metrics Dashboard

- **Total loss across all years:** Large number with chocolate drip animation
- **Worst year:** Highlighted with flame icon

- **Best year** (least loss): Small celebration indicator
- **Average annual loss**: With trend arrow (increasing/decreasing)
- **Dense forest crisis meter**: Shows 75% threshold loss rate

## Interactive Features

1. **Time Scrubber**: Drag slider to animate through years, watching streams grow/shrink
2. **Threshold Toggle**: Checkbox list to show/hide specific thresholds
3. **Comparison Mode**: Select two years to see side-by-side comparison
4. **Export Stats**: Button to generate summary statistics for selected range/threshold

## Chocolate Theme Elements

- **Background**: Cocoa bean pattern, very subtle
- **Transitions**: "Melting" animations when switching views
- **Loading state**: Chocolate bar filling up
- **Button styles**: Look like chocolate squares
- **Hover effects**: Subtle "shimmer" like chocolate gloss

## Data Stories to Highlight

- **Annotation boxes** that appear pointing to:
  - 2013-2014 spike: "What caused this dramatic increase?"
  - Dense forest (75%) relative stability compared to sparse forest
  - 2018 peak: "Highest recorded loss year"
  - Post-2020 patterns

## Technical Implementation Notes

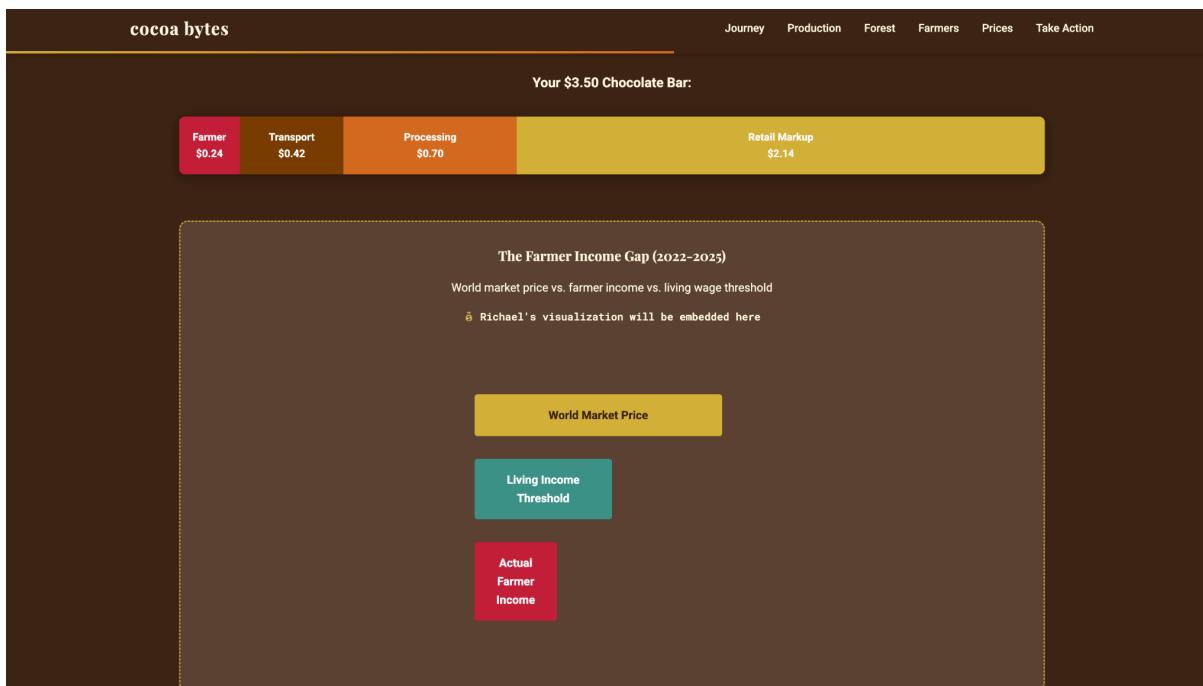
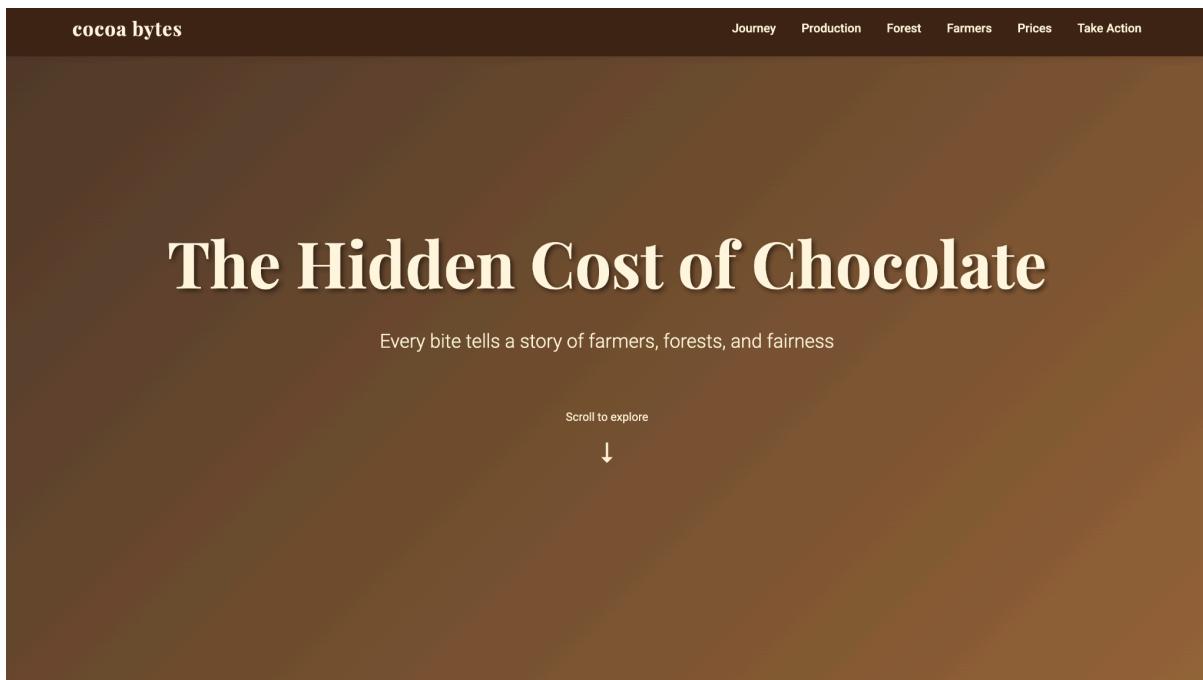
- **D3 layouts needed**:
  - d3.stack() for stream graph
  - d3.sankey() for cascade diagram
  - Custom grid for heatmap
- **State management**: Track selected year, visible thresholds, view mode
- **Performance**: Use canvas for heatmap if needed for smooth interaction
- **Responsive**: Collapse to vertical layout on mobile, prioritize stream graph

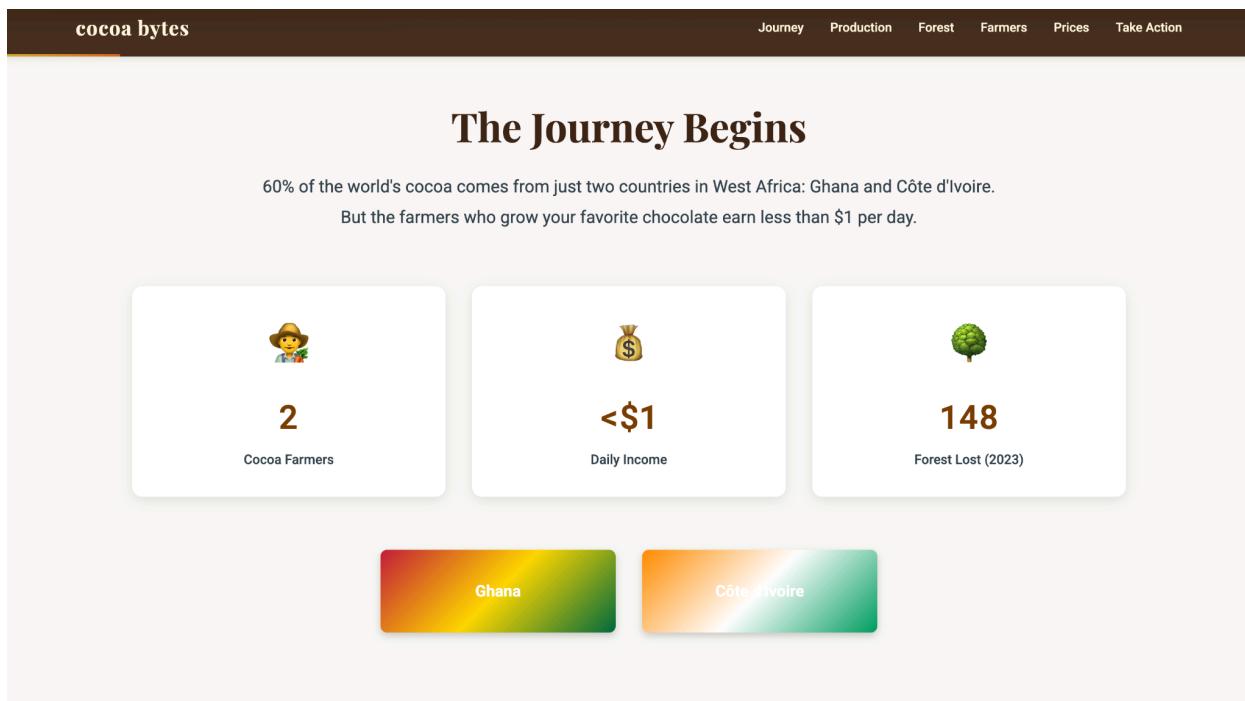
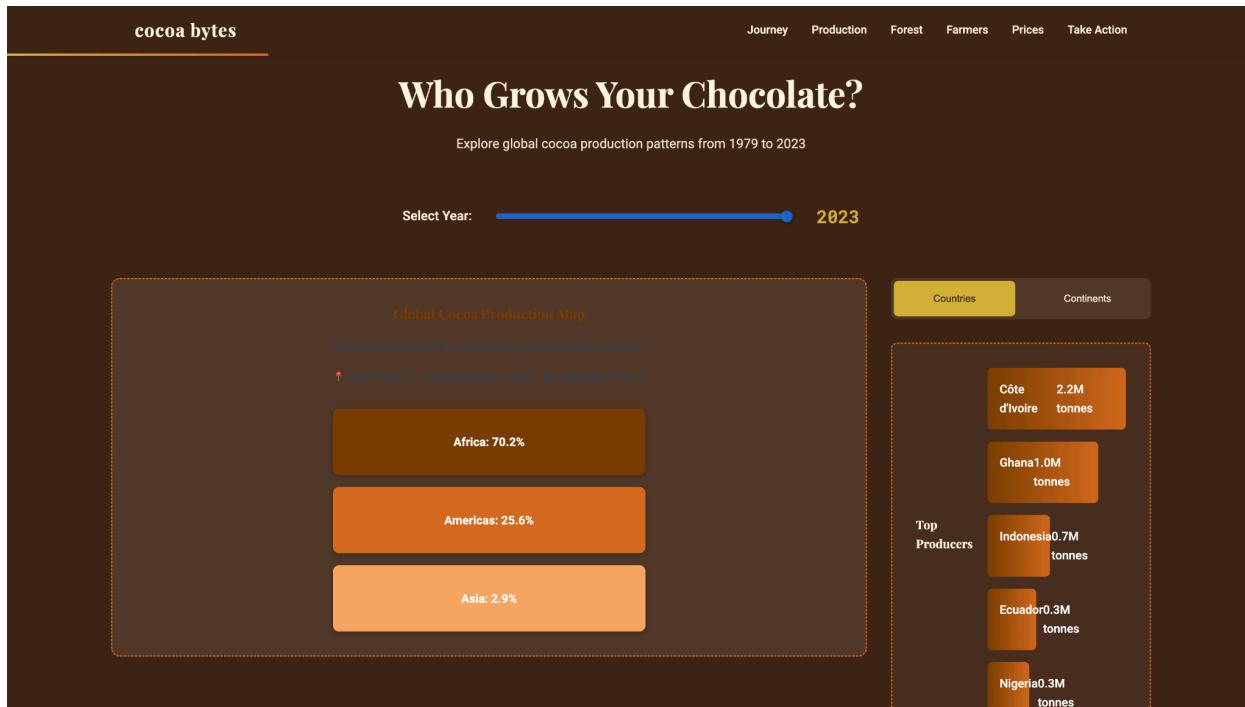
## Unique Insights This Reveals

1. **Differential vulnerability**: Are dense forests more protected or equally at risk?
2. **Threshold relationships**: How does loss at 30% correlate with 50%?
3. **Temporal patterns**: Do all forest types experience loss simultaneously or in sequence?
4. **Scale understanding**: Seeing all thresholds together shows true magnitude

This would create a comprehensive "command center" for understanding Ghana's deforestation across all dimensions - time, intensity, and forest density - all wrapped in that delicious chocolate aesthetic!

## Richael's Website Structure Prototype





# Prototype 2

We decided to change our approach to make our project more interactive. We came up with a gamified version in order to be more appealing to users. Our storyline contains 5 chapters, primarily from the point of view of “a day in the life of a cocoa farmer.”

## Storyline: A Day in the Life of a Cocoa Farmer

- **Chapter 1: Global Cocoa Production**
  - The primary goal of Chapter 1 is to seamlessly transition the user from a macro, global view of the cocoa industry to the micro, on-the-ground reality of the West African cocoa farmer, who will be our protagonist for the rest of the five-chapter storyline. Chapter 1 is the user’s quick, interactive history lesson on where cocoa actually comes from. Its purpose is to show the user, not just tell them, that Africa grows most of the world’s cocoa. The user is immediately presented with a massive number: 5.6 million tonnes, the amount of cocoa the world harvested last year. Next, the screen fills with colorful circles, each representing a country. The larger the circle, the more cocoa that country produces. As the circles are sorted, the user realizes that the African cluster is enormous, far bigger than all the other continents combined, emphasizing that the world’s chocolate depends overwhelmingly on this one region. Finally, the user can play with a time slider. By dragging it, they watch cocoa production dominance shift over the last sixty years, confirming that Africa’s role is not new but has become permanent.
  - The goal is to fully gamify in future iterations of this prototype.
- **Chapter 2: Environmental sustainability in farming**
  - Players explore how cocoa production transforms Ghana’s landscapes over two decades. Through interactive farming choices, they witness the environmental toll of deforestation and the significance of their one chocolate bar purchase can have. A time-line simulation reveals how short-term gains in yield can lead to long-term ecological damage. By the end, players grasp how responsible land management safeguards both the planet and cocoa’s future.

Future expansions:

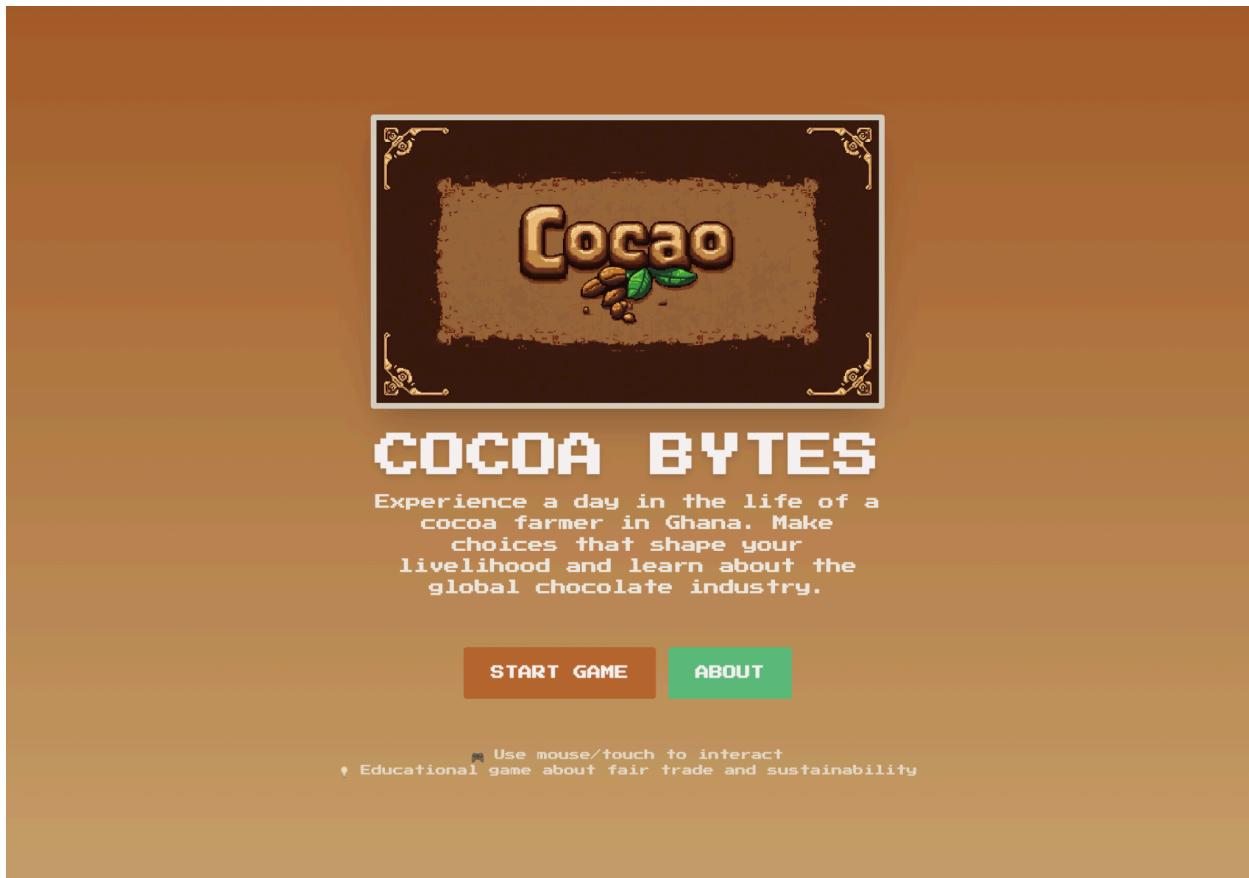
- **Chapter 3: Market pressures and fair trade**
  - This chapter puts players in the shoes of Ghanaian cocoa farmers navigating global price swings and trade contracts. They experience how market volatility and buyer demands shape daily decisions on harvest and sales. A negotiation simulation highlights the tension between fair trade’s slower profits and conventional buyers’ quick but exploitative deals. Players see how collective choices impact community stability and worker welfare. Ultimately, the story

reveals how fair trade systems create economic resilience and ethical supply chains.

- **Chapter 4: Supply chain profit distribution**
  - Players trace a single cocoa bean's journey from Ghanaian soil to a store-bought chocolate bar. Each stop along the supply chain exposes who profits most — and who earns the least. Interactive visuals break down the price of a chocolate bar, showing farmers' tiny share compared to corporate margins. A balancing game challenges players to design a fairer profit system without collapsing the market. The takeaway: chocolate's sweetness often hides deep economic inequality.
- **Chapter 5: Consumer impact and action steps**
  - In the final chapter, players step into the role of conscious consumers making everyday choices. They scan chocolate labels to uncover hidden sustainability scores, carbon footprints, and ethical certifications. A personalized impact calculator shows how small changes in buying habits ripple through the global supply chain. Players unlock real-world pledges that promote fair trade, reforestation, and ethical consumption. The story ends with empowerment — showing that informed consumers can help reshape the chocolate industry for good.

We have finished the website flow and our visualizations for the most part. What we have left to do is refine our visualizations so that they integrate well into our website flow

[Click here to use our prototype](#)



[... BACK](#)

## ABOUT COCOA BYTES

**The Story**  
Cocoa Bytes is an interactive educational game that follows the journey of cocoa from farm to chocolate bar. Through four chapters representing different times of day, you'll experience the challenges faced by cocoa farmers in Ghana and learn about the global chocolate supply chain.

**The Chapters**

- . Dawn - Tending the Trees: Learn about cocoa cultivation, environmental impacts, and deforestation challenges
- . Midday - The Market Decision: Navigate global market pressures and negotiate fair prices for your harvest
- . Evening - The Store Shelf: Discover how your beans transform into chocolate and the profit distribution
- . Night - Full Circle: Reflect on the economic realities and explore ways to make a difference

**Key Facts**

- . Cocoa farmers in Ghana typically earn less than \$1 per day
- . Farmers receive only 3-6% of the final chocolate bar price
- . Deforestation for cocoa farming threatens biodiversity in West Africa
- . Fair trade practices can significantly improve farmer livelihoods

**How to Play**  
Make decisions throughout the game by clicking buttons and managing resources. Your choices will impact the farmer's earnings, environmental outcomes, and understanding of the supply chain. There are no wrong answers - the goal is to learn and reflect on the complexities of the cocoa trade.

[START PLAYING](#)

## CHAPTER 1: DAWN

Tending the Trees  
5:00 AM - Rural Ghana

### Daily Tasks

The sun rises over your cocoa farm. It's time to care for your trees before the midday heat arrives.

#### Water Trees

Trees need regular watering (20 water, 10 energy)

Watered: 0/5

**WATER**

#### Prune Trees

Remove dead branches (0.5 tools, 15 energy)

Pruned: 0/5

**PRUNE**

#### Rest

Take a break to recover energy (+30 energy)

**REST**

#### Harvest Pods

Collect ripe cocoa pods (min 3 watered & pruned)

NOT READY

### Resources

Energy 100/100

Water 100/100

Tools 3/3

### Today's Harvest

0 kg

Tip: Balance your energy and resources carefully!

### Critical Decision

Your neighbor offers to buy forest land next to your farm. Expanding could increase your yield by 50%, but it means cutting down trees. What do you choose?

**EXPAND FARM**

**PROTECT FOREST**

## CHAPTER 3: EVENING

The Store Shelf  
6:00 PM - Retail Store

### From Farm to Store

Your 90 kg of cocoa beans have traveled thousands of miles. They've been processed, manufactured, and packaged. Now they sit on a store shelf as chocolate bars, each costing \$5.

#### ◆ Your Beans' Journey

1. Farm .. Local Buyer	\$49.50
2. Processing & Manufacturing	\$80.00
3. Shipping & Distribution	\$45.00
4. Retail Markup	\$75.00
<b>Final Retail Price (per bar)</b>	<b>\$5</b>

#### Regular Chocolate



Price: \$5

Farmer receives: \$0.15 (3.0%)

Most chocolate bars provide minimal earnings to farmers

#### Fair Trade Chocolate



Price: \$6.00

Farmer receives: \$0.45 (7.5%)

Fair trade certification ensures better wages and sustainable practices

### Supply Chain Facts

#### ◆ Price Breakdown

Farmer: 3-6%  
Processing: 35-40%  
Distribution: 20-25%  
Retail: 30-40%

#### ◆ Global Impact

Over 5 million cocoa farmers worldwide, most earning less than \$2/day despite the \$130B chocolate industry.

#### ✓ Fair Trade Benefits

- Guaranteed minimum prices
- Community development premiums
- Environmental sustainability
- No child labor

#### Your Impact

You earned: \$49.50  
Chocolate value: \$180.00

Your share: 27.5%

#### Regular Chocolate



Price: \$5

Farmer receives: \$0.15 (3.0%)

Most chocolate bars provide minimal earnings to farmers

#### Fair Trade Chocolate



Price: \$6.00

Farmer receives: \$0.45 (7.5%)

Fair trade certification ensures better wages and sustainable practices

#### ★ Great Choice!

By choosing fair trade, consumers help farmers earn 3x more. For just \$1 extra, farmers receive \$0.45 instead of \$0.15 - a life-changing difference.

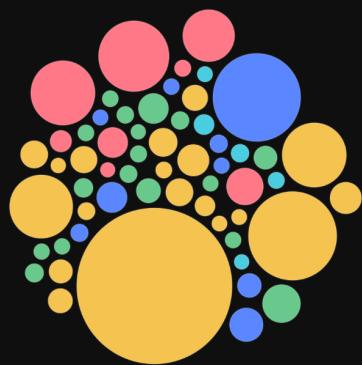
[CONTINUE TO CHAPTER 4](#)

# 5.6M

Tonnes of global cocoa harvested in 2023

Two countries provide most of it.

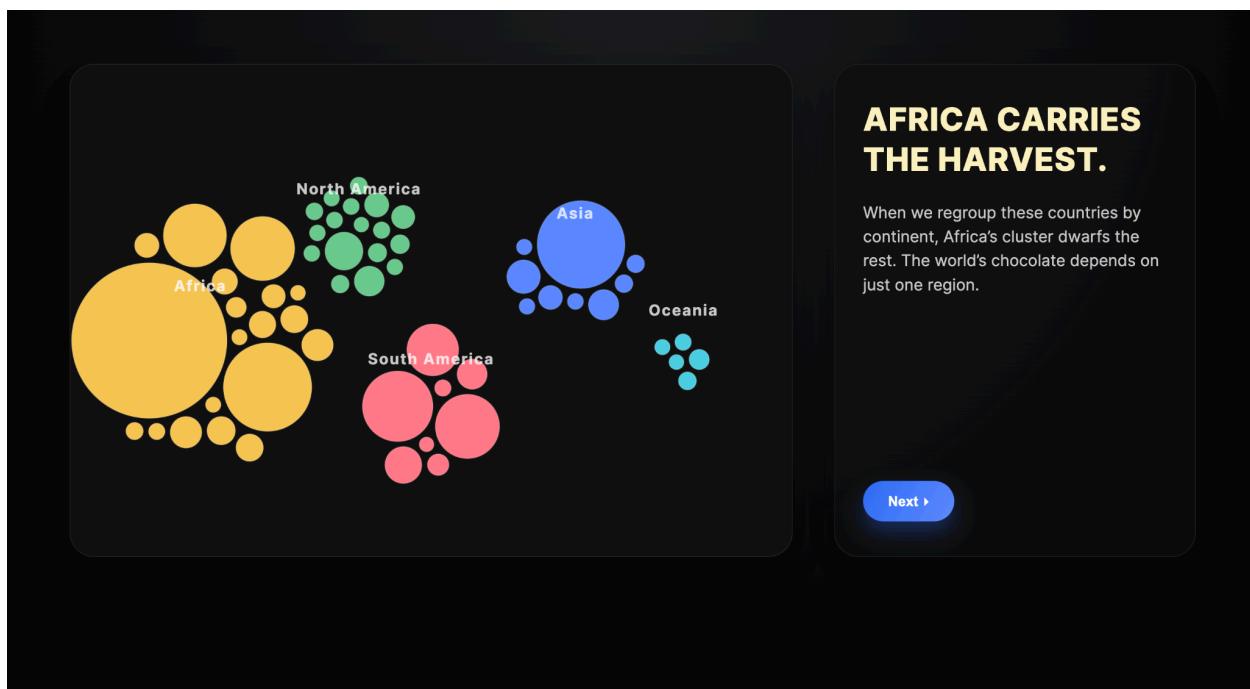
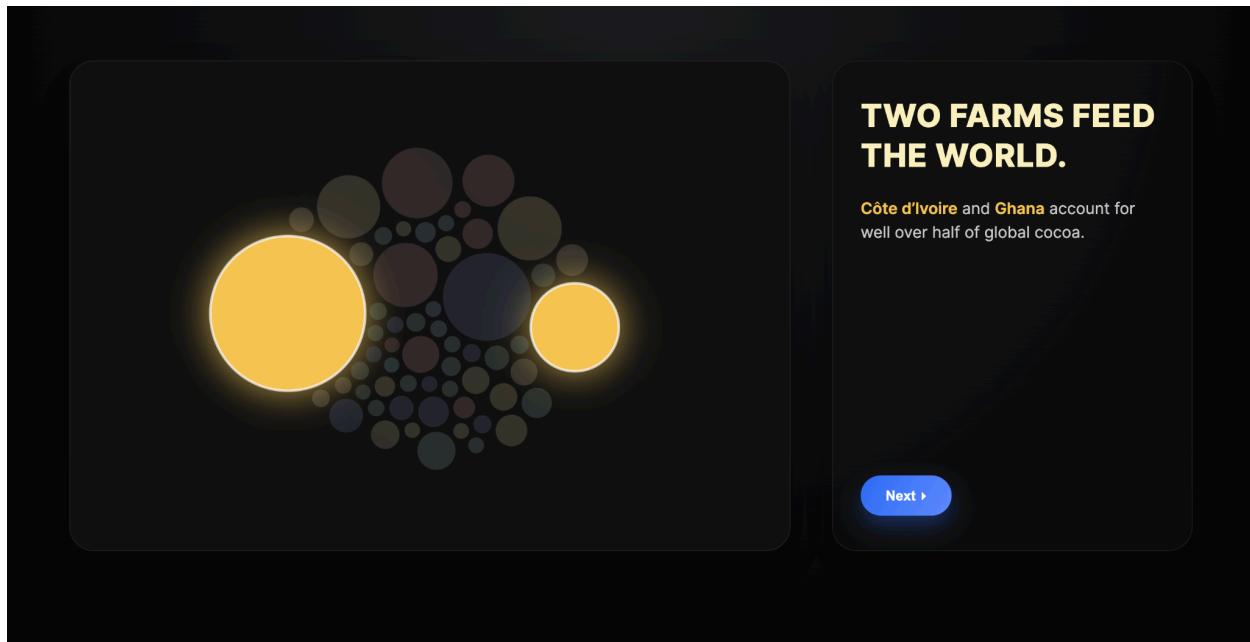
[Start the story ▶](#)



## WHERE DOES CHOCOLATE COME FROM?

Before you take your next bite, consider the supply chain. Every circle on the left is a country, sized by its cocoa harvest in 2023.

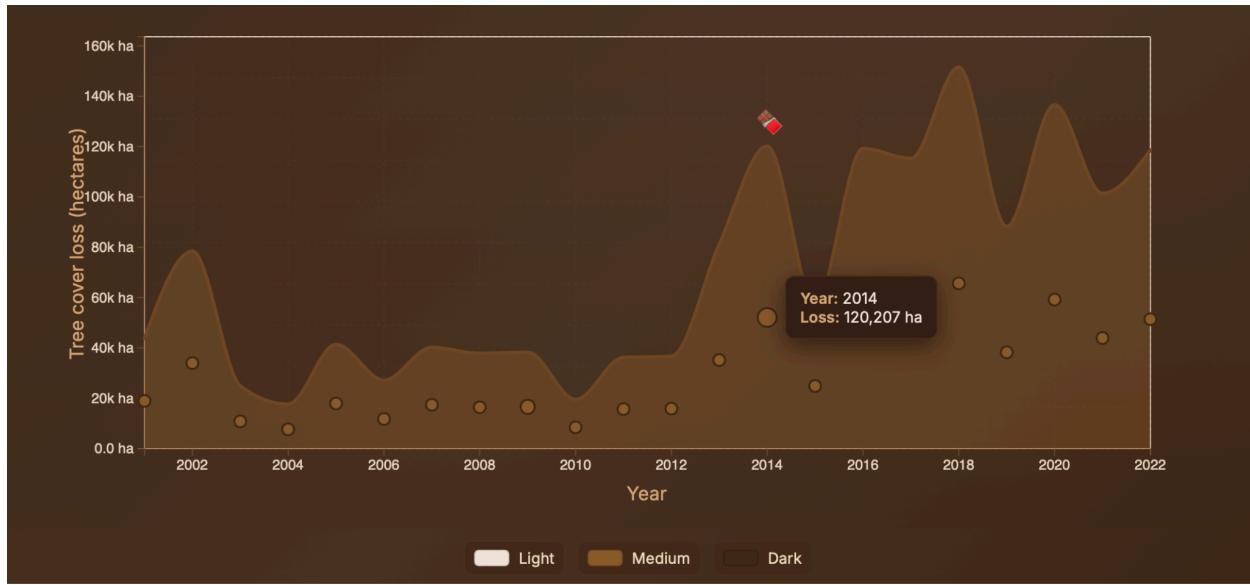
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## Chapter 2: Environmental Impacts of Cocoa Production:





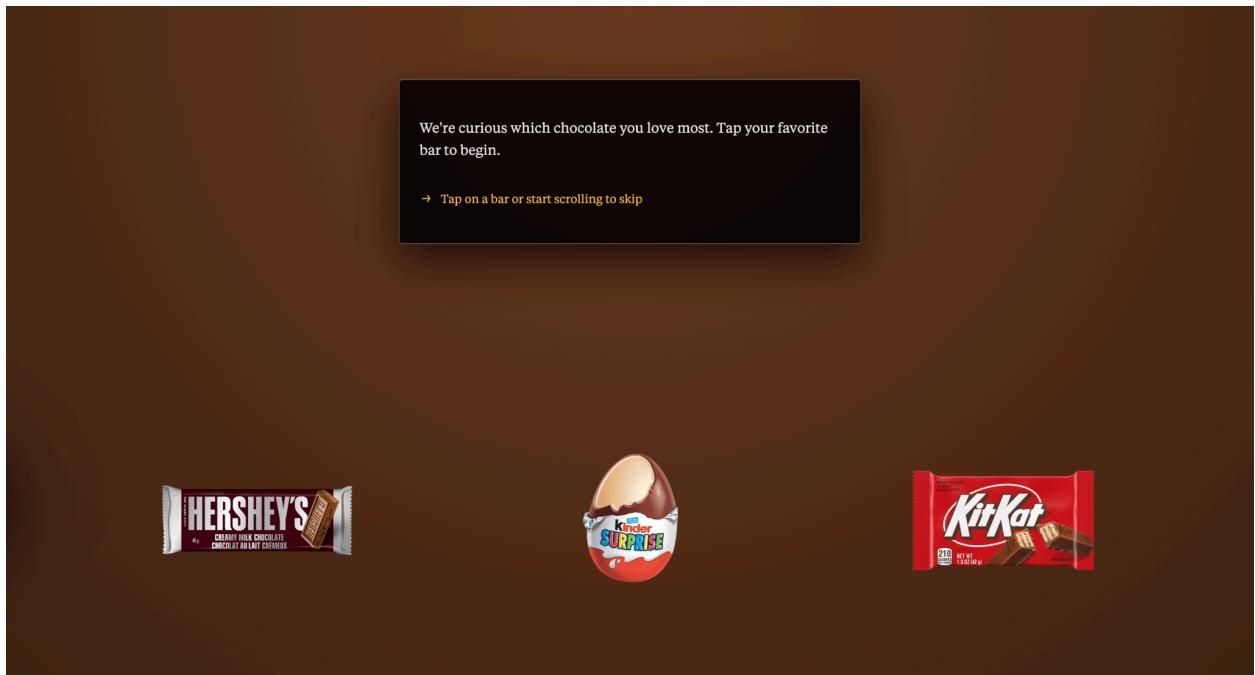
#### What does this loss mean for the chocolate in your hands?

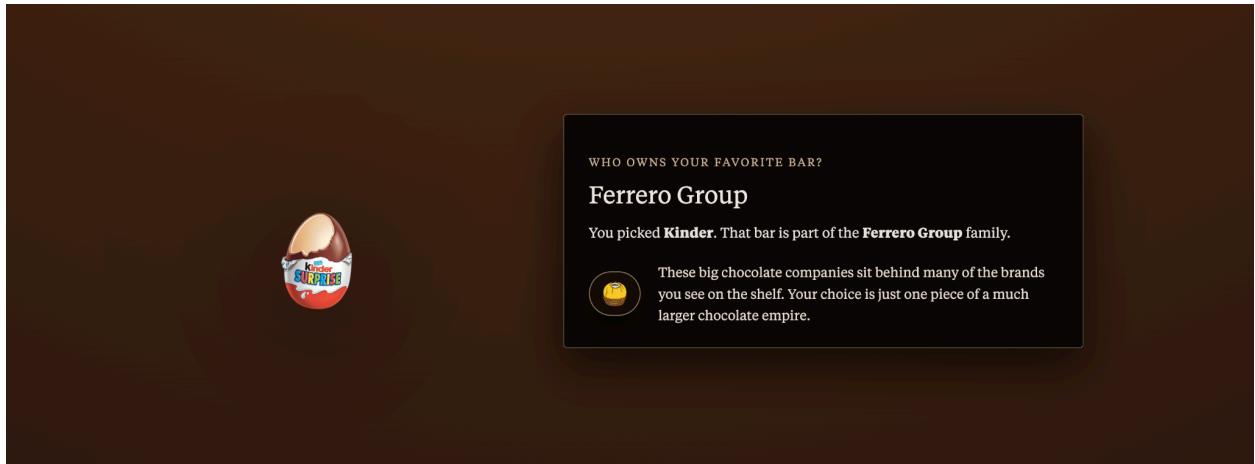
Use the slider and the *bars / hectare* estimate (editable) to translate hectares of tree cover loss into an illustrative number of chocolate bars potentially affected. This estimate is adjustable so you can explore different yield/production assumptions.

**382,560**

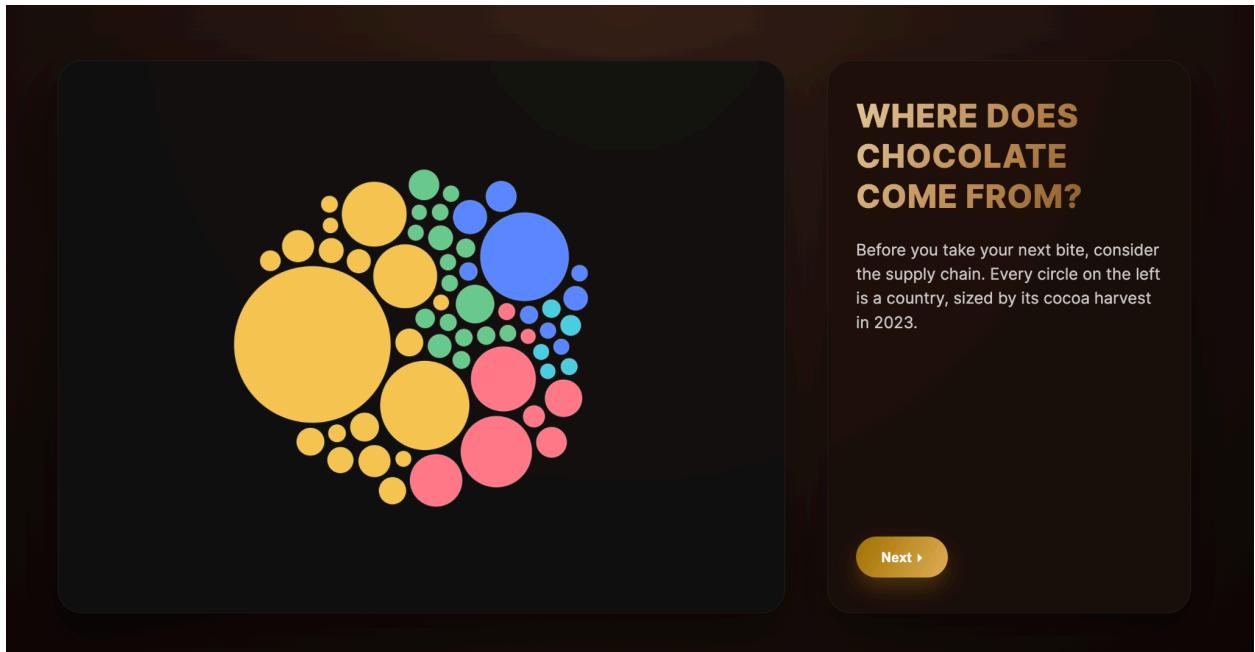
estimated chocolate-bar equivalents lost in 2009 (using 10 bars/ha)

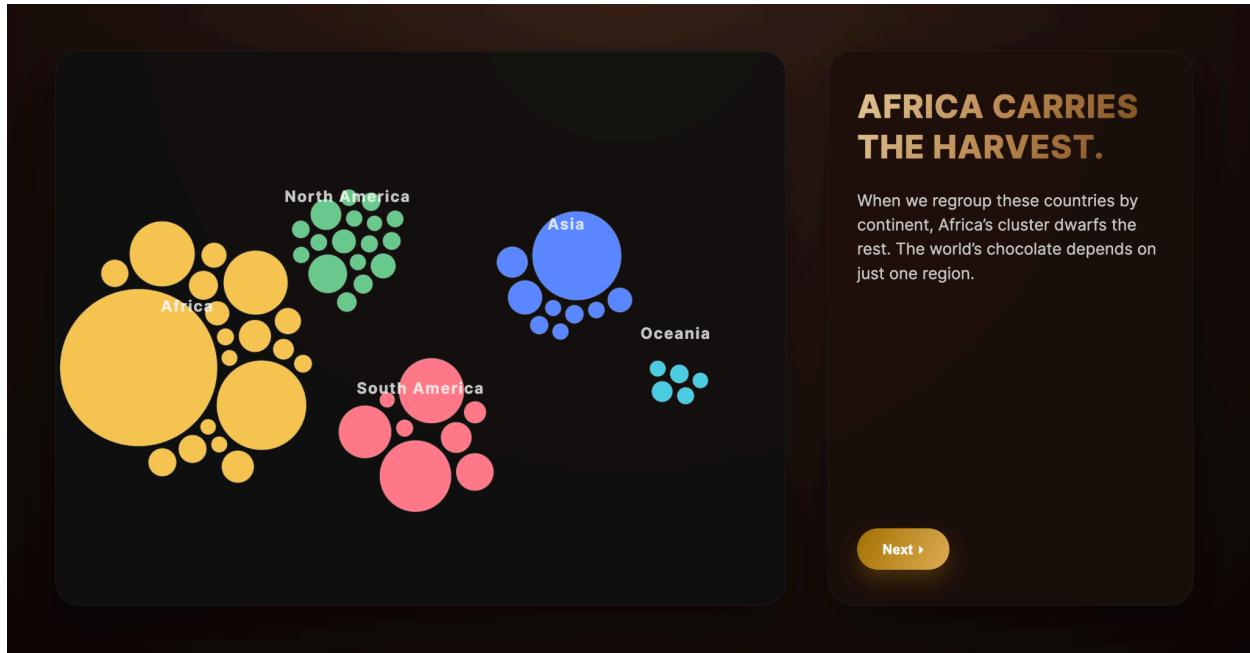
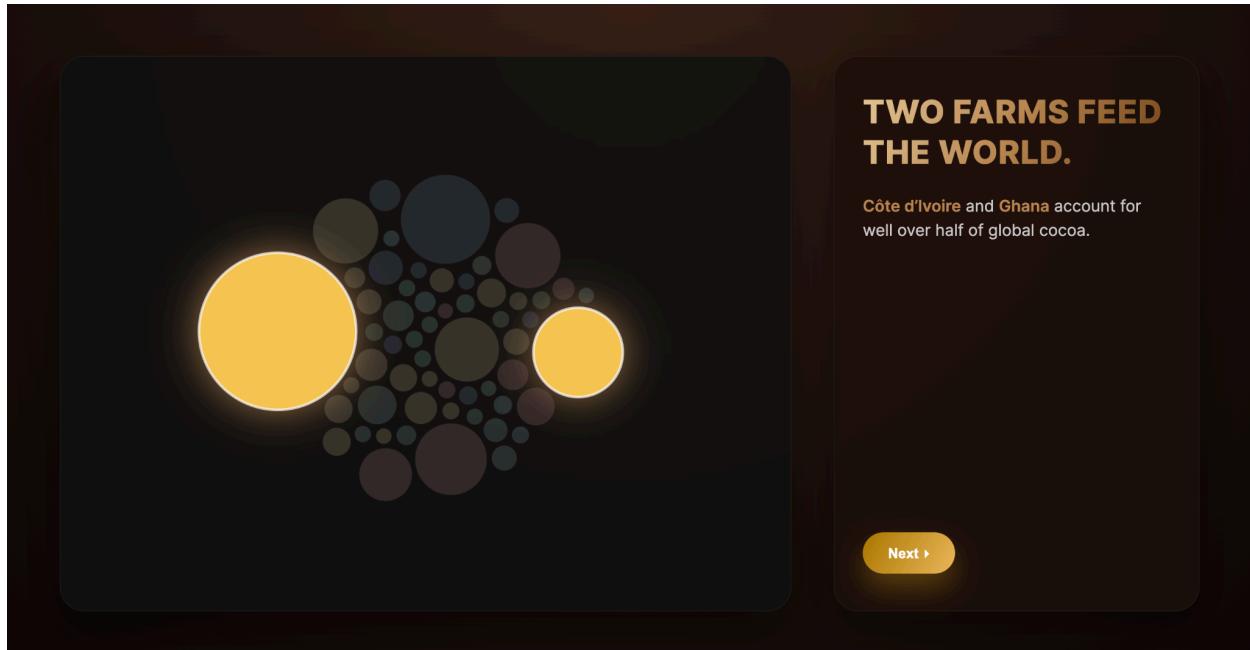
# Prototype 3





1. **INTRO:** The story begins with a simple choice: "We're curious which chocolate you love most"
  - a. Users can click the parent company to see the full family of brands it owns.
  - b. Once you choose, the page reveals the *real* company behind that bar, Hershey, Mars, Mondelez, Nestlé, Ferrero, etc.
  - c. Top Chocolate companies, click on them
    - i. i.e. click on Hershey and see the different brands it owns
  - d. Transition: these companies depend on one thing: cocoa. But where does actually come from?





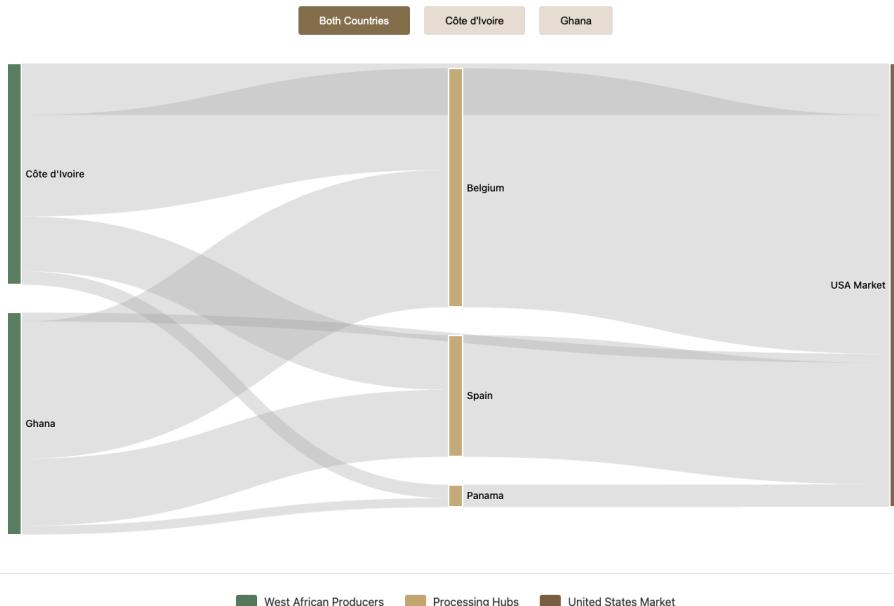


## 2. SECOND: Global Cocoa Production

- a. The Global Harvest by Country
  - i. VISUALIZATION: A bubble chart where each circle represents a cocoa-producing country, and the size of the circle is proportional to its cocoa harvest in 2023. The circles are initially presented in a single, mixed cluster.
- b. The Dominant Duo
  - i. INTERACTION: The mixed cluster of circles shifts, and the two largest bubbles become brightly highlighted and isolated from the rest.
  - ii. VISUALIZATION: The chart now emphasizes the two largest bubbles, with all other countries represented by smaller, dimmer circles clustered around them.
- c. Continent-Wide Dominance
  - i. INTERACTION: The bubbles are now grouped and colored by their respective continents
  - ii. VISUALIZATION: A grouped bubble chart showing the production clusters by continent. The Africa cluster is clearly the largest by a wide margin.
- d. Sixty Years of Supply Shift
  - i. INTERACTION: A slider appears at the bottom, labeled with years, allowing the user to scrub the data from 1963 to 2023.
  - ii. VISUALIZATION: The grouped bubble chart from Part 3 is animated. As the user moves the slider:

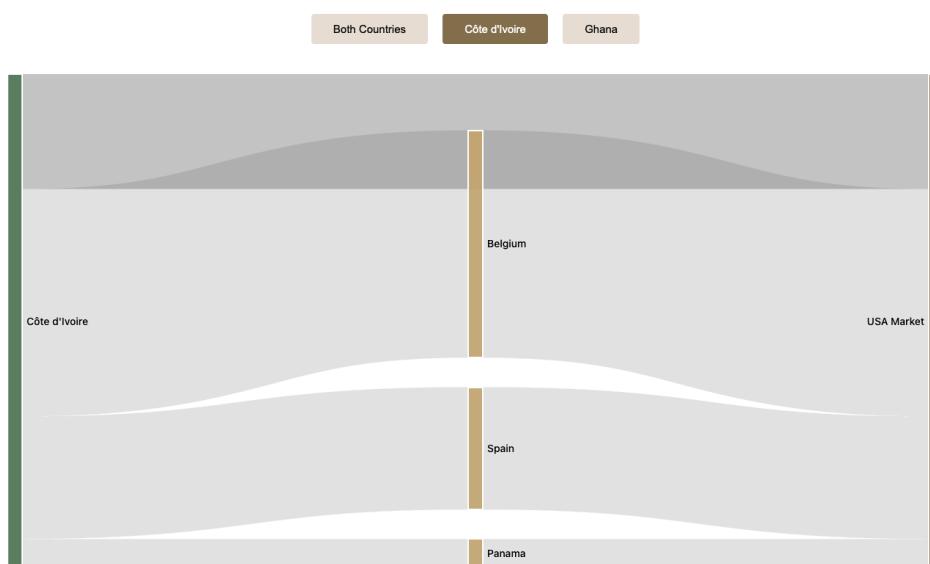
## Cocoa Supply Chain Flow

From West African Producers to Global Markets



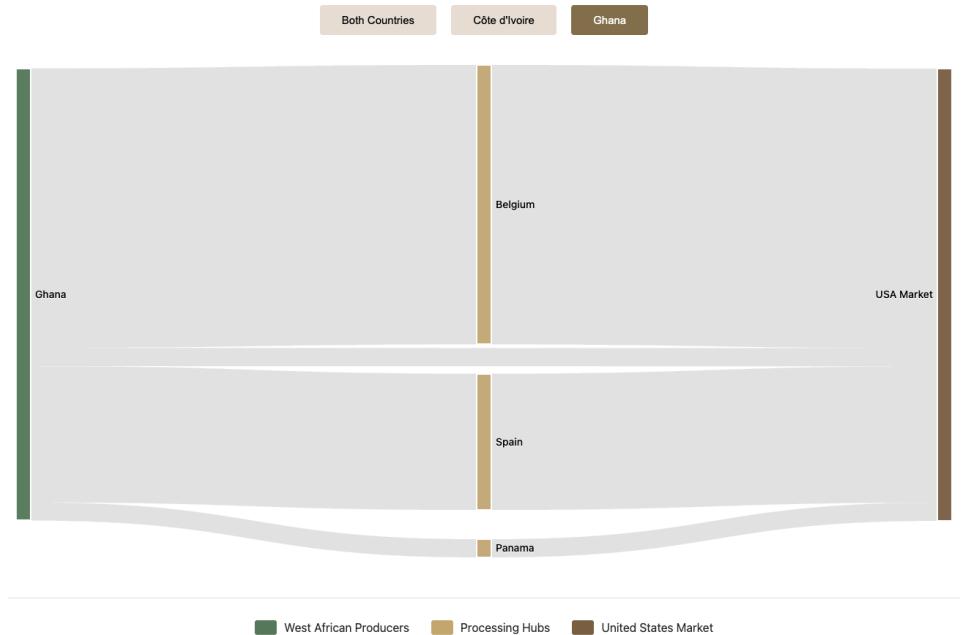
## Cocoa Supply Chain Flow

From West African Producers to Global Markets



## Cocoa Supply Chain Flow

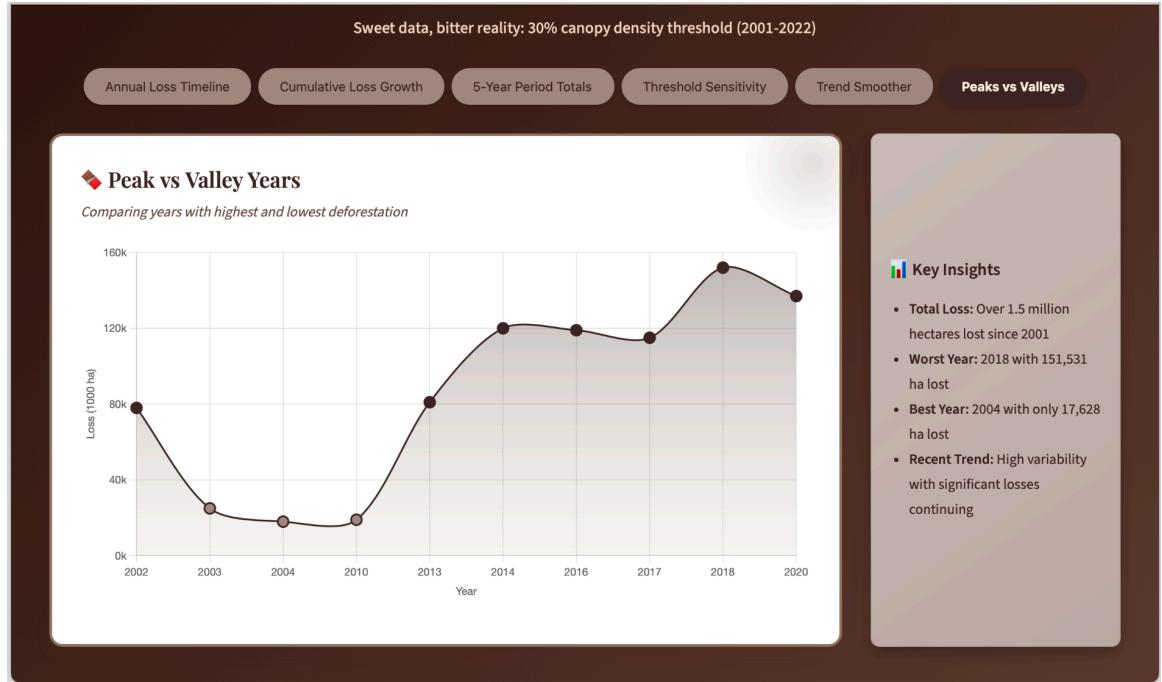
From West African Producers to Global Markets



### 3. THIRD: Cocoa Production Supply Chain,

- VISUALIZATION: Aankey diagram with interactive filters, allowing the user to view the full flow or isolate the source country. The width of the connecting bands (flows) represents the volume of cocoa.
- STAGES:
  - Origin (West African Producers): Côte d'Ivoire and Ghana.
  - Middle (Processing Hubs): Belgium, Spain, and Panama.
  - Destination (United States Market): The final consumer market shown.
- KEY OBSERVATIONS (Both Countries View):
  - Producer Dominance: Côte d'Ivoire appears to supply a larger total volume of cocoa than Ghana in this system, evidenced by its wider input band.
  - Central Hub: The combined cocoa flow from both countries is distributed among the three processing hubs, with Belgium receiving the largest share, positioning it as the primary central processing hub.
  - Market Convergence: The flows from Belgium, Spain, and Panama all converge and feed into the single USA Market column on the far right.





4. **FOURTH:** Economic Impact: How much money are countries making from cocoa production?
  - a. Visualizations on top chocolate producers vs profit cocoa farmers make
  - b. Chocolate bar that highlights % of revenue for producers vs farmers
  - c. Each top country has its own chocolate bar, how much these countries are making per chocolate bar vs how much they paid for cocoa imports
  - d. Potential addition: include chocolate bars (hershey, twix, cadbury, etc.) OR JUST ONE AVERAGE TO START, have user click on one and learn more about how much that bar costs to produce vs how much its being sold → have user selections affect the larger visualization
5. **FIFTH:** Cocoa Farmer POV: exploitation → deforestation
  - a. After focusing on the profit difference between cocoa producers & cocoa farmers, highlight the environmental aspects of cocoa production
  - b. Storylike visualization (clicking through)
    - i. Explore overall tree cover loss in Ghana
  - c. Quick fast facts to see how this has impacted Ghana over 20-year period
6. **FINAL:** Chocolate Scorecard - Extra
  - a. Now show how your favorite company fares in the scorecard