

data_report

June 6, 2024

0.0.1 Data Report: “The Interplay of Crop Plantation and Climate Change: Cultivating Understanding for a Sustainable Future”

The question is: “Which crops are most impactful on climate change, and which alternatives could be pursued for reduced environmental impact?”

1 1. Introduction

1.1 Overview This project looks at how various types of crops had affected the climate change. We want to find if there is a link about increase of countries temprature and amount of crop that is being harvested. Here different measures of crop production such as seeds, yields and gross production are considred as well. My intention is to use statistics and some machine learning methods to find out a relation between crops and global warming so that we get better understanding of the most dangerous crops for environment as well.

1.2 Datasets in details

1.0.1 Datasource1:Climate Change: Earth Surface Temperature Data

- Metadata URL: <https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data>
- Data URLs: can be downloaded through the Kaggle API in this project the data of countries are being used <https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data?select=GlobalLandTemperaturesByCountry.csv>
- Data Type: CSV

This datasets shows the trend of daily tempreture of different cities, regions and countries in the world.

- date
- Average temperature
- Average temperature uncertainty
- City
- Country
- Latitude
- Longitude

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1.0.2 Datasource2: Global Food & Agriculture Statistics

- Metadata URL: <https://www.kaggle.com/datasets/unitednations/global-food-agriculture-statistics>
- Data URL: Only the data regarding crops is being used https://www.kaggle.com/datasets/unitednations/global-food-agriculture-statistics?select=fao_data_crops_data.csv
- Data Type: CSV

Given data set has the information of various crops harvested in different countries. There are different types of crops and their respective elements since agriculture has different abstracts of products.

- country_or_area
- element_code
- element
- year
- unit
- value
- value footnotes
- category

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<https://data.un.org/Host.aspx?Content=UNdataUse>

1.1 2. Methods

1.1.1 2.1 Installing dependencies

Initially, install required dependencies. The SQLAlchemy is being used to work for data base management. Pandas being used for data etl processes. Scikit learn to work machine learning and statistics for finding the relations.

nbformat allows the use of the “notebook” formatter for the plot, others can not be rendered to HTML.

Kaggle is used to get data from kaggle datasets

Seaborn is a Python data visualization library built on top of Matplotlib. It's specifically designed for statistical plotting and works well with pandas data structures.

Required packages' versions are: * pandas 1.5.3 * SQLAlchemy 2.0.25 * kaggle 1.5.16 * Scikit-learn 1.4.2

```
[68]: %pip install nbformat
%pip install pandas
%pip install SQLAlchemy
%pip install kaggle
%pip install seaborn
%pip install matplotlib
```

```
%pip install plotly  
%pip install scikit-learn  
%pip install statsmodels
```

```
Requirement already satisfied: nbformat in  
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (5.9.2)  
Requirement already satisfied: fastjsonschema in  
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Requirement already satisfied: jsonschema-specifications>=2023.03.6 in  
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from  
jsonschema>=2.6->nbformat) (2023.7.1)  
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Requirement already satisfied: pandas in  
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Requirement already satisfied: numpy<2,>=1.23.2 in  
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from pandas)  
(1.26.4)  
Requirement already satisfied: python-dateutil>=2.8.2 in  
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from pandas)  
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Requirement already satisfied: pytz>=2020.1 in  
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(2024.1)
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Requirement already satisfied: six>=1.5 in
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Requirement already satisfied: typing-extensions>=4.6.0 in
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SQLAlchemy) (4.11.0)
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bleach->kaggle) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in
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slugify->kaggle) (1.3)
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requests->kaggle) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
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requests->kaggle) (3.7)
Requirement already satisfied: colorama in
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tqdm->kaggle) (0.4.6)
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Requirement already satisfied: fonttools>=4.22.0 in
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Requirement already satisfied: kiwisolver>=1.3.1 in
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matplotlib!=3.6.1,>=3.1->seaborn) (1.4.4)
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c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from
matplotlib!=3.6.1,>=3.1->seaborn) (24.0)
Requirement already satisfied: pillow>=8 in
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matplotlib!=3.6.1,>=3.1->seaborn) (10.3.0)
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matplotlib!=3.6.1,>=3.1->seaborn) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from
matplotlib!=3.6.1,>=3.1->seaborn) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in
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pandas>=0.25->seaborn) (2024.1)
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Requirement already satisfied: six>=1.5 in
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from python-
dateutil>=2.7->matplotlib!=3.6.1,>=3.1->seaborn) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
Requirement already satisfied: matplotlib in
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Requirement already satisfied: cycler>=0.10 in
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from
matplotlib) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in
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matplotlib) (4.51.0)
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matplotlib) (10.3.0)
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matplotlib) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in
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matplotlib) (2.8.2)
Requirement already satisfied: six>=1.5 in
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dateutil>=2.7->matplotlib) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
Requirement already satisfied: plotly in
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c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from plotly)
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```
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Note: you may need to restart the kernel to use updated packages.
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learn) (1.26.4)
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learn) (1.4.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in
c:\users\asus\anaconda3\envs\data_engineering\lib\site-packages (from scikit-
learn) (2.2.0)
Note: you may need to restart the kernel to use updated packages.
```

1.1.2 2.2 Importing modules

```
[125]: import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import plotly.express as px
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
import statsmodels.api as sm

print("All modules imported!")
```

All modules imported!

1.1.3 2.3 Load data

There is another procedure for exploring data and datasets we had. called data_exploration.ipynb. There you could fine the extensive step by step data process and all the things done according to cleaning and checking the data sources. Filtering and grouping the datas based on year or only accessing the required measures.

In this part we only use the final data that I had to work on and create results and discuss on them. if you want to know more about exploriring the datasets and having final version you can see it in :

data-exploration.ipynb

```
[70]: # loading our final dataset to work on
df = pd.read_sql_table('data_final', 'sqlite:///data_final.db')
```

```
# see 10 first rows to get familiar with it's structure
df.head(10)
```

```
[70]:   element    year    unit    value      category    Country \
0    Yield  2007.0  Hg/Ha  12571.0  agave_fibres_nes  Colombia
1    Yield  2006.0  Hg/Ha  12571.0  agave_fibres_nes  Colombia
2    Yield  2005.0  Hg/Ha  12571.0  agave_fibres_nes  Colombia
3    Yield  2004.0  Hg/Ha  12430.0  agave_fibres_nes  Colombia
4    Yield  2003.0  Hg/Ha  11997.0  agave_fibres_nes  Colombia
5    Yield  2002.0  Hg/Ha  11433.0  agave_fibres_nes  Colombia
6    Yield  2001.0  Hg/Ha  10994.0  agave_fibres_nes  Colombia
7    Yield  2000.0  Hg/Ha  10760.0  agave_fibres_nes  Colombia
8    Yield  1999.0  Hg/Ha  12459.0  agave_fibres_nes  Colombia
9    Yield  1998.0  Hg/Ha  12629.0  agave_fibres_nes  Colombia

average_yearly_temperature
0                  25.494000
1                  25.476583
2                  25.670833
3                  25.553917
4                  25.655333
5                  25.570750
6                  25.411917
7                  25.030167
8                  24.870667
9                  25.879167
```

1.1.4 2.3 Set up the Data and visualization

Map visualization We want to create a map for showing the number of yield in every country to get a better understanding of top players in this warming trend. maps are good choice here since we are working with countries.

```
[71]: # Setting up dataset
data = df
# Group by 'country' and sum the 'quantity' for each country
total_crops_by_country = data.groupby('Country')['value'].sum().reset_index()

# Rename the 'value' column to something more descriptive, if desired
total_crops_by_country.rename(columns={'value': 'total_quantity'}, inplace=True)
# Plotting the bubble map
fig = px.scatter_geo(total_crops_by_country, locations='Country',
                     locationmode='country names',
                     size='total_quantity', color='total_quantity',
                     hover_name='Country',
                     projection='natural earth', title='Bubble Map of Sum by
                     Country')
```

```
fig.show()
```

Here we will check the relation between pair of datas that have numbers and statistics

```
[72]: sns.pairplot(data)
plt.show()
```

```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-
packages\seaborn\_oldcore.py:1119: FutureWarning:
```

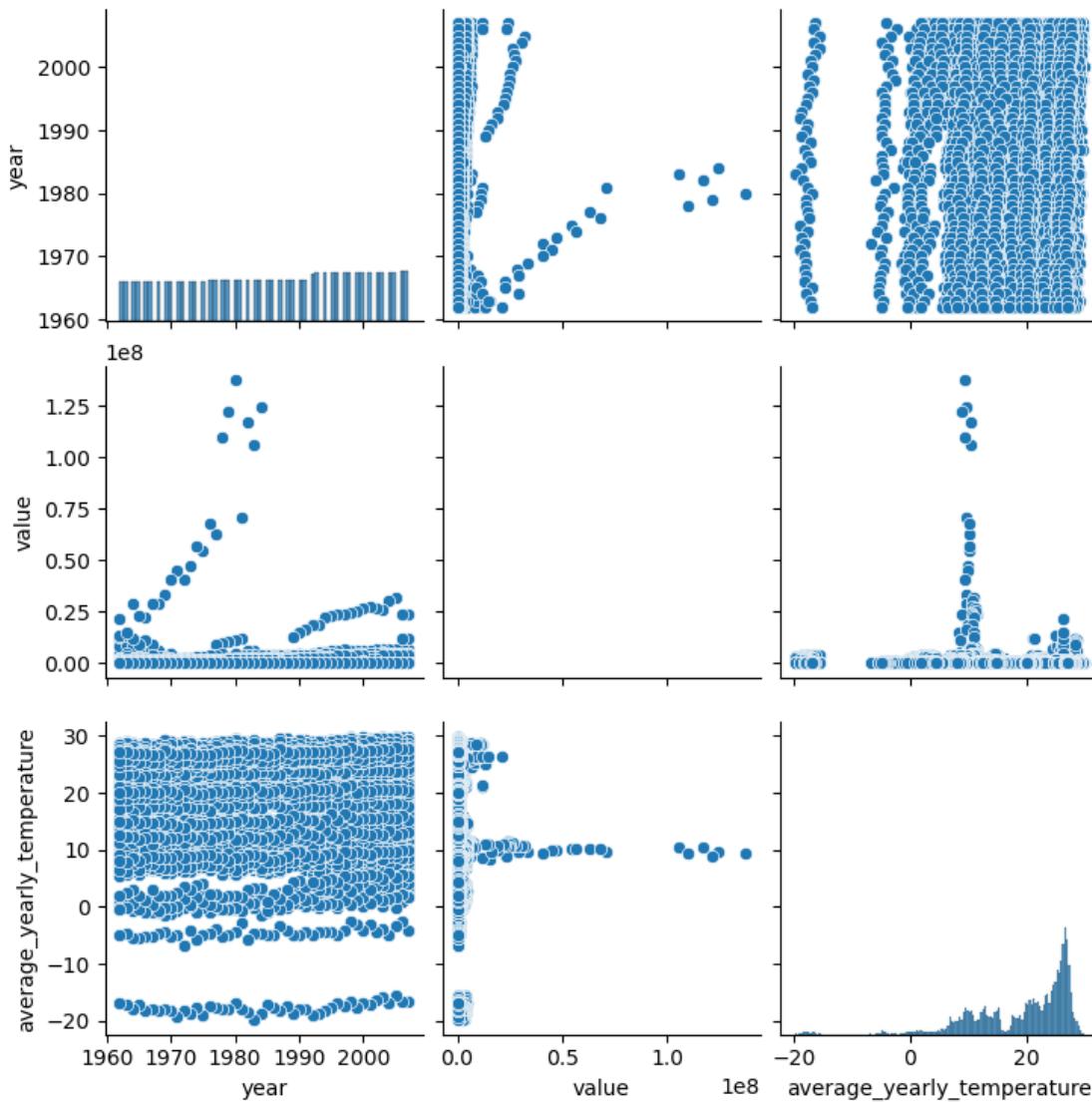
```
use_inf_as_na option is deprecated and will be removed in a future version.
Convert inf values to NaN before operating instead.
```

```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-
packages\seaborn\_oldcore.py:1119: FutureWarning:
```

```
use_inf_as_na option is deprecated and will be removed in a future version.
Convert inf values to NaN before operating instead.
```

```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-
packages\seaborn\_oldcore.py:1119: FutureWarning:
```

```
use_inf_as_na option is deprecated and will be removed in a future version.
Convert inf values to NaN before operating instead.
```



As you can see during specific yearly tempreture the values are mostly centred which is not the highest. Therefore, constant increase of tempreture had adverse effect on the crop harvest as well.

1.1.5 calculating correlation matrix for final data set

A correlation matrix is used to summarize data, specifically to understand the relationships between different variables in a dataset. It's a square matrix where the variables are displayed on both rows and columns, and each cell shows the correlation coefficient between the variables.

```
[73]: #Correlation Analysis
data_core= data
numeric_df = df.select_dtypes(include=['float64','int64'])
correlation_matrix = numeric_df.corr()
```

```

sns.heatmap(correlation_matrix, annot=True)
plt.show()

data_Q= data

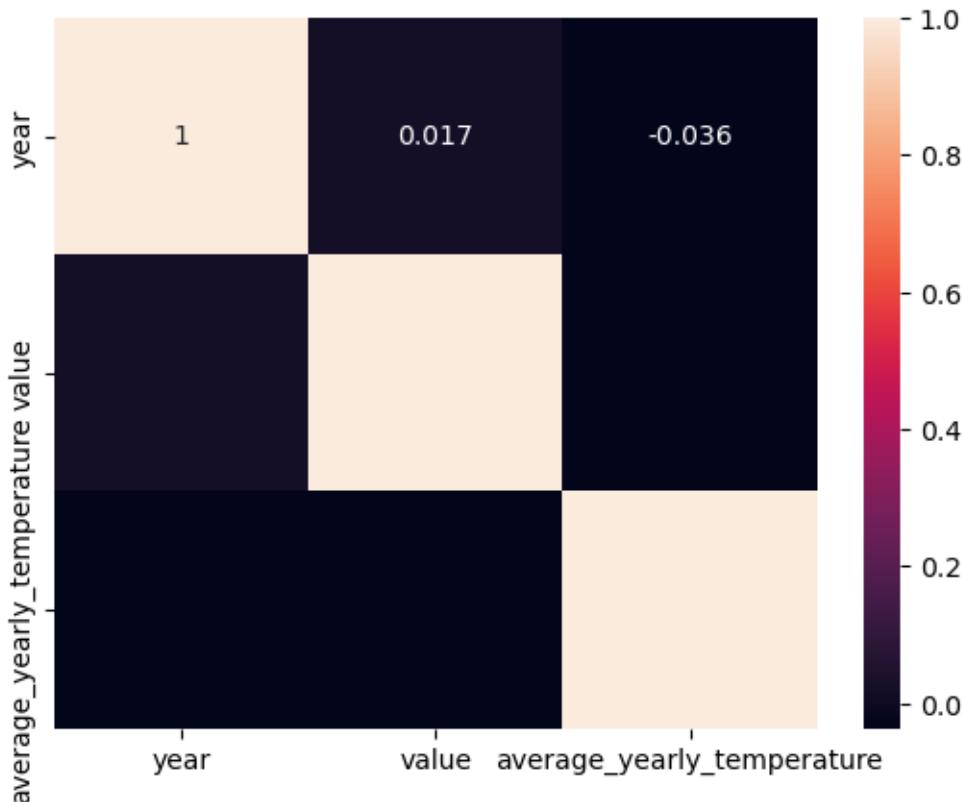
# One-hot encode the 'crop' column
df_encoded = pd.get_dummies(data_Q, columns=['category'])

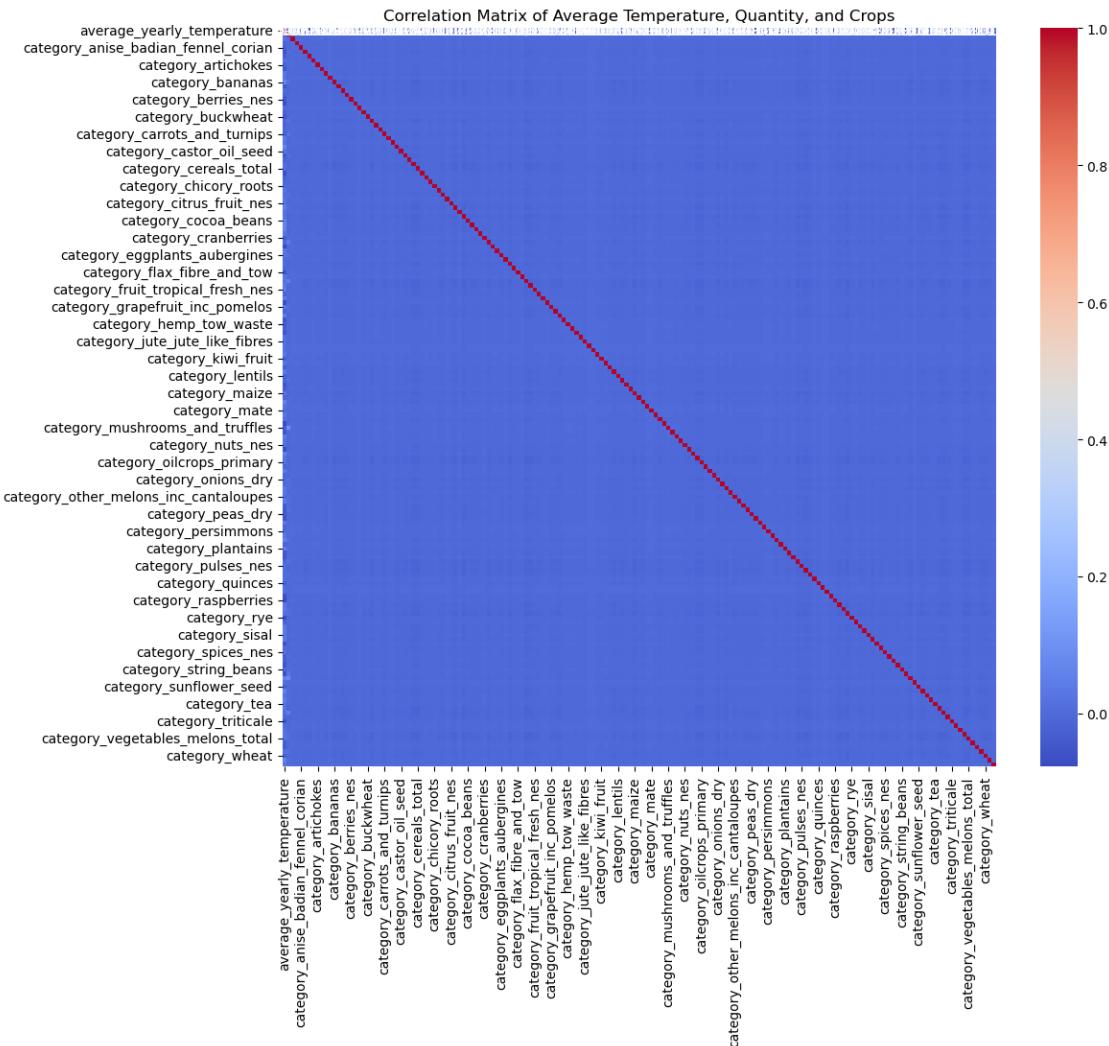
# Select the relevant columns
data_Z = df_encoded[['average_yearly_temperature', 'value'] + [col for col in df_encoded.columns if col.startswith('category_')]]

# Calculate the correlation matrix
correlation_matrix = data_Z.corr()

# Plot the correlation matrix as a heatmap
plt.figure(figsize=(12, 10))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2f')
plt.title('Correlation Matrix of Average Temperature, Quantity, and Crops')
plt.show()

```





Covariance Matrix: Look at the values to see how the variables co-vary. Higher absolute values indicate stronger relationships, but the units make direct comparison tricky.

Here with using labeling we can understand that on which temprature there are more elements available. Using label we can get on which part there are more crops. We are using scatter plot for finding it.

```
[92]: data_s=data
print(data_s.head)
# One-hot encode the 'crop' column
df_encoded = pd.get_dummies(data_s, columns=['category'])

# Select the relevant columns
```

```

data_r = df_encoded[['average_yearly_temperature', 'value'] + [col for col in df_encoded.columns if col.startswith('category_')]]

# Calculate the covariance matrix
cov_matrix = data_r.cov()

# Extract the covariance values between average temperature and crop quantities
cov_with_temp = cov_matrix.loc['average_yearly_temperature', [col for col in cov_matrix.columns if col.startswith('category_')]]]

# Find the crop with the highest covariance with average temperature
max_cov_crop = cov_with_temp.idxmax()
max_cov_value = cov_with_temp.max()

print(f'The crop with the highest effect on climate change trends is {max_cov_crop} with a covariance value of {max_cov_value}')

# Plot scatter plots for each crop
fig, axes = plt.subplots(nrows= 9 , ncols=1, figsize=(10, 20))

for i, crop in enumerate([col for col in df_encoded.columns if col.startswith('category_')]):
    sns.scatterplot(ax=axes[i], x='average_yearly_temperature', y=crop, data=df_encoded)
    axes[i].set_title(f'Scatter Plot: Average Temperature vs {crop}')
    if( i == 8):
        break

plt.tight_layout()
plt.show()

# Plot the covariance values as a bar plot
plt.figure(figsize=(22, 6))
cov_with_temp.sort_values().plot(kind='bar', color='skyblue')
plt.title('Covariance of Crops with Average Temperature')
plt.xlabel('Crops')
plt.ylabel('Covariance Value')
plt.xticks(rotation=90)
plt.show()

```

			element	year	unit	value
category	Country	\				
0	Yield	2007.0	Hg/Ha	12571.0	agave_fibres_nes	Colombia
1	Yield	2006.0	Hg/Ha	12571.0	agave_fibres_nes	Colombia
2	Yield	2005.0	Hg/Ha	12571.0	agave_fibres_nes	Colombia
3	Yield	2004.0	Hg/Ha	12430.0	agave_fibres_nes	Colombia
4	Yield	2003.0	Hg/Ha	11997.0	agave_fibres_nes	Colombia

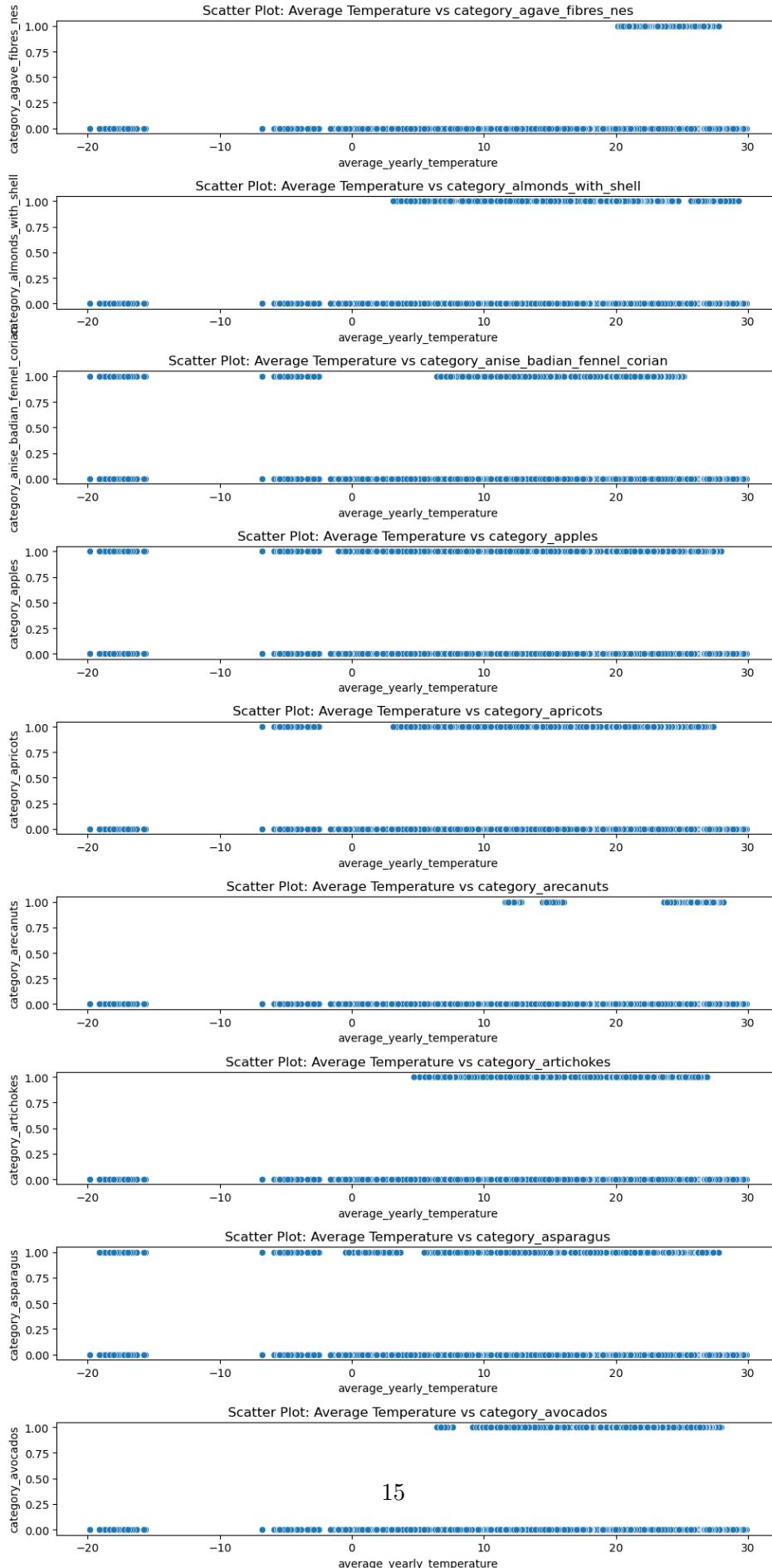
```
...   ...   ...   ...   ...   ...   ...
371863 Yield 1966.0 Hg/Ha 50000.0    ...   ...
371864 Yield 1965.0 Hg/Ha 50000.0    yautia_cocoyam Saint Lucia
371865 Yield 1964.0 Hg/Ha 50000.0    yautia_cocoyam Saint Lucia
371866 Yield 1963.0 Hg/Ha 50000.0    yautia_cocoyam Saint Lucia
371867 Yield 1962.0 Hg/Ha 50000.0    yautia_cocoyam Saint Lucia
```

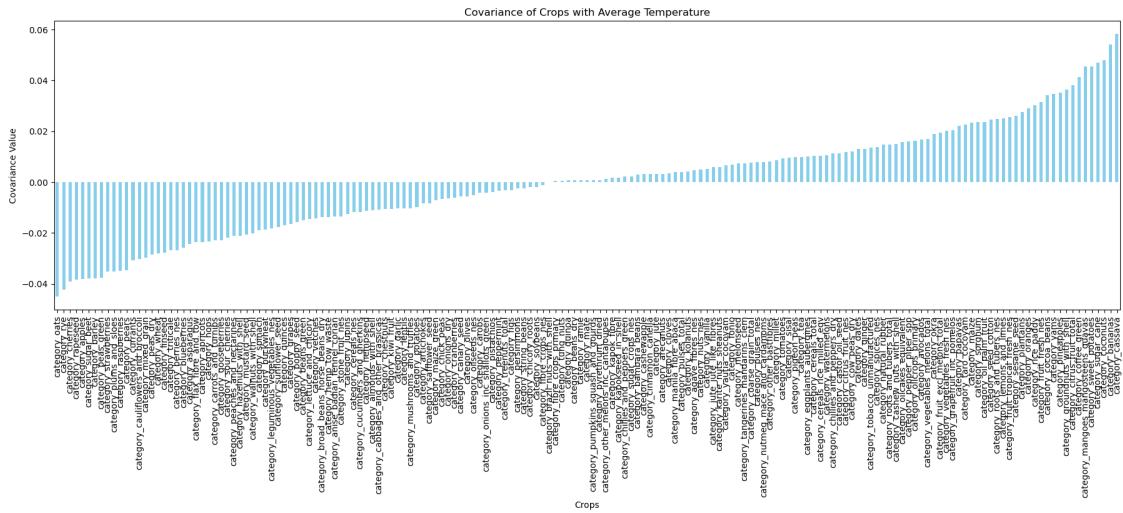
average_yearly_temperature

```
0           25.494000
1           25.476583
2           25.670833
3           25.553917
4           25.655333
...
371863      26.925333
371864      26.812667
371865      26.871083
371866      27.149583
371867      27.027333
```

[371868 rows x 7 columns]>

The crop with the highest effect on climate change trends is category_cassava
with a covariance value of 0.05822470488181252





```
[75]: unique_elements = data['category'].unique()
print(unique_elements)
```

```
['agave_fibres_nes' 'almonds_with_shell' 'anise_badian_fennel_corian'
'apples' 'apricots' 'arecanuts' 'artichokes' 'asparagus' 'avocados'
'bambara_beans' 'bananas' 'barley' 'beans_dry' 'beans_green'
'berries_nes' 'blueberries' 'brazil_nuts_with_shell'
'broad_beans_horse_beans_dry' 'buckwheat' 'cabbages_and_other_brassicas'
'canary_seed' 'carobs' 'carrots_and_turnips' 'cashew_nuts_with_shell'
'cashewapple' 'cassava' 'castor_oil_seed' 'cauliflowers_and_broccoli'
'cereals_nes' 'cereals_rice_milled_eqv' 'cereals_total' 'cherries'
'chestnuts' 'chick_peas' 'chicory_roots' 'chillies_and_peppers_dry'
'chillies_and_peppers_green' 'cinnamon_canella' 'citrus_fruit_nes'
'citrus_fruit_total' 'cloves' 'coarse_grain_total' 'cocoa_beans'
'coconuts' 'coffee_green' 'cow_peas_dry' 'cranberries'
'cucumbers_and_gherkins' 'currants' 'dates' 'eggplants_aubergines'
'fibre_crops_nes' 'fibre_crops_primary' 'figs' 'flax_fibre_and_tow'
'fonio' 'fruit_excl_melons_total' 'fruit_fresh_nes'
'fruit_tropical_fresh_nes' 'garlic' 'ginger' 'gooseberries'
'grapefruit_inc_pomelos' 'grapes' 'groundnuts_with_shell'
'hazelnuts_with_shell' 'hemp_tow_waste' 'hempseed' 'hops' 'jute'
'jute_jute_like_fibres' 'kapok_fibre' 'kapokseed_in_shell'
'karite_nuts_sheanuts' 'kiwi_fruit' 'kolanuts'
'leguminous_vegetables_nes' 'lemons_and_limes' 'lentils'
'lettuce_and_chicory' 'linseed' 'lupins' 'maize' 'maize_green'
'mangoes_mangosteens_guavas' 'manila_fibre_abaca' 'mate' 'melonseed'
'millet' 'mixed_grain' 'mushrooms_and_truffles' 'mustard_seed'
'natural_rubber' 'nutmeg_mace_and_cardamoms' 'nuts_nes' 'oats'
```

```
'oil_palm_fruit' 'oilcakes_equivalent' 'oilcrops_primary' 'oilseeds_nes'
'okra' 'olives' 'onions_dry' 'onions_inc_shallots_green' 'oranges'
'other_bastfibres' 'other_melons_inc_cantaloupes' 'papayas'
'peaches_and_nectarines' 'pears' 'peas_dry' 'peas_green'
'pepper_piper_spp' 'peppermint' 'persimmons' 'pigeon_peas' 'pineapples'
'pistachios' 'plantains' 'plums_and_sloes' 'poppy_seed' 'potatoes'
'pulses_nes' 'pulses_total' 'pumpkins_squash_and_gourds'
'pyrethrum_dried' 'quinces' 'quinoa' 'ramie' 'rapeseed' 'raspberries'
'rice_paddy' 'roots_and_tubers_nes' 'roots_and_tubers_total' 'rye'
'safflower_seed' 'seed_cotton' 'sesame_seed' 'sisal' 'sorghum'
'sour_cherries' 'soybeans' 'spices_nes' 'spinach' 'stone_fruit_nes'
'strawberries' 'string_beans' 'sugar_beet' 'sugar_cane' 'sugar_crops_nes'
'sunflower_seed' 'sweet_potatoes' 'tangerines_mandarins_clem'
'taro_cocoyam' 'tea' 'tobacco_unmanufactured' 'tomatoes' 'treenuts_total'
'triticale' 'tung_nuts' 'vanilla' 'vegetables_fresh_nes'
'vegetables_melons_total' 'vetches' 'walnuts_with_shell' 'watermelons'
'wheat' 'yams' 'yautia_cocoyam']
```

```
[93]: # Specify the subset of categories
subset_categories = ['Category1', 'Category2', 'Category3'] # replace with your actual categories

# Filter the dataset
filtered_df = df[df['category'].isin(subset_categories)]
# Box plot to visualize the temperature distribution across categories
info_data= data
# Descriptive statistics
descriptive_stats = df.groupby('category')['average_yearly_temperature'].
    describe()
print(descriptive_stats)

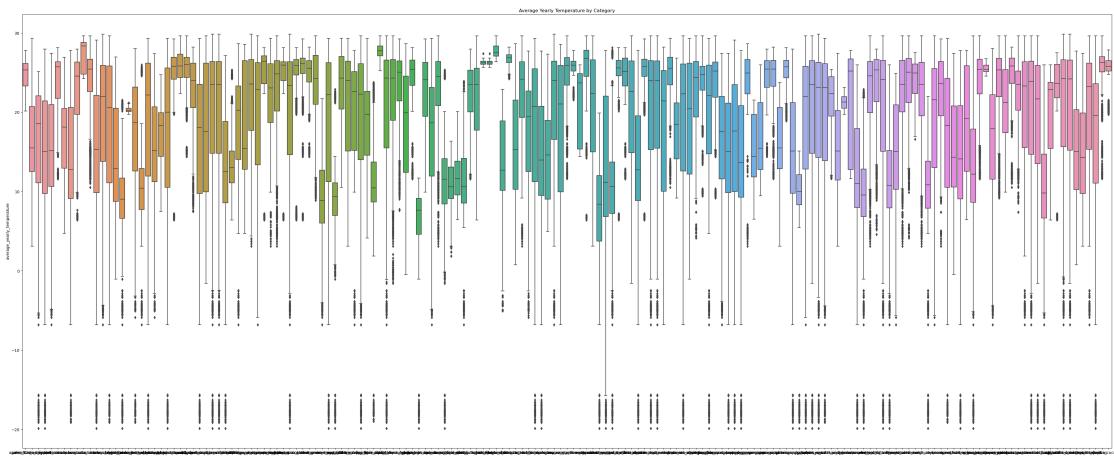
plt.figure(figsize=(50, 20))
sns.boxplot(x='category', y='average_yearly_temperature', data=info_data)
plt.title('Average Yearly Temperature by Category')
plt.show()

# Line plot to visualize temperature changes over years for each category
plt.figure(figsize=(50, 30))
sns.lineplot(x='year', y='average_yearly_temperature', hue='category', data=info_data)
plt.title('Average Yearly Temperature over Years by Category')
plt.show()
```

	count	mean	std	min	25%	\
category						
agave_fibres_nes	353.0	24.660921	1.984825	20.145667	23.323167	
almonds_with_shell	1406.0	16.721233	5.845212	3.116167	12.506083	
anise_badian_fennel_corian	1230.0	15.528381	9.321352	-19.857750	11.100062	

apples	2945.0	14.832565	8.224666	-19.857750	9.753667
apricots	2166.0	15.598535	6.431768	-6.802917	10.629104
...
walnuts_with_shell	1553.0	14.796894	5.825623	3.116167	9.742417
watermelons	3681.0	20.717211	6.843271	-6.802917	15.326250
wheat	4127.0	17.130821	8.508407	-19.857750	11.055708
yams	2219.0	25.449708	3.004170	11.629417	25.079333
yautia_cocoyam	460.0	25.023997	2.312349	19.729333	25.206958
		50%	75%	max	
category					
agave_fibres_nes	25.341333	26.154500	27.779417		
almonds_with_shell	15.498583	20.723375	29.298417		
anise_badian_fennel_corian	18.560083	22.078917	25.133667		
apples	15.035750	21.444833	27.946000		
apricots	15.154750	20.960333	27.436167		
...		
walnuts_with_shell	14.284833	19.896583	27.436167		
watermelons	23.236250	26.204500	29.637833		
wheat	19.581000	23.579458	29.637833		
yams	26.283500	27.013833	29.637833		
yautia_cocoyam	25.805750	26.492542	27.858667		

[169 rows x 8 columns]



```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-
packages\seaborn\_oldcore.py:1119: FutureWarning:
```

```
use_inf_as_na option is deprecated and will be removed in a future version.
Convert inf values to NaN before operating instead.
```

```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-
```

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packages\seaborn\_oldcore.py:1119: FutureWarning:  
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c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-  
packages\seaborn\_oldcore.py:1075: FutureWarning:  
  
When grouping with a length-1 list-like, you will need to pass a length-1 tuple  
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silence this warning.  
  
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When grouping with a length-1 list-like, you will need to pass a length-1 tuple to get_group in a future version of pandas. Pass `(name,)` instead of `name` to silence this warning.

```
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```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-
```

```
packages\seaborn\_oldcore.py:1075: FutureWarning:
```

When grouping with a length-1 list-like, you will need to pass a length-1 tuple to get_group in a future version of pandas. Pass `(name,)` instead of `name` to silence this warning.

```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-  
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```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-packages\seaborn\_oldcore.py:1075: FutureWarning:
```

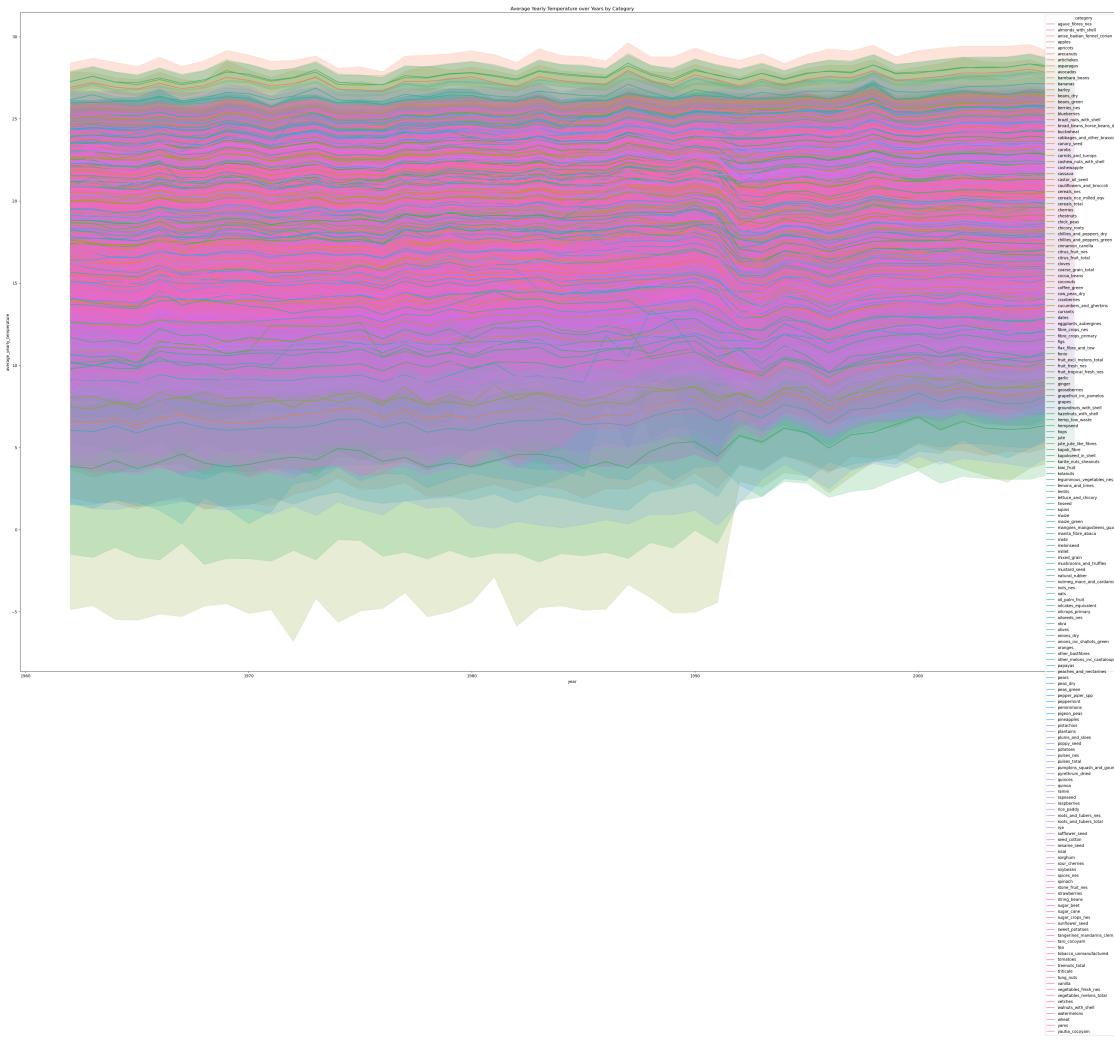
When grouping with a length-1 list-like, you will need to pass a length-1 tuple to get_group in a future version of pandas. Pass `(name,)` instead of `name` to silence this warning.

```
c:\Users\Asus\anaconda3\envs\Data_Engineering\Lib\site-packages\seaborn\_oldcore.py:1075: FutureWarning:
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```

When grouping with a length-1 list-like, you will need to pass a length-1 tuple to get_group in a future version of pandas. Pass `(name,)` instead of `name` to silence this warning.



Here we defined top three categories by their product to see their effect on temprature.

```
[87]: # Define the number of top categories to show
top_n = 3
data_check= data
# Identify the top N categories based on average yearly temperature
top_categories = data_check.groupby('category')['average_yearly_temperature'].
    mean().nlargest(top_n).index

# Filter the dataset to include only these top categories
filtered_df = data_check[data_check['category'].isin(top_categories)]
```

```

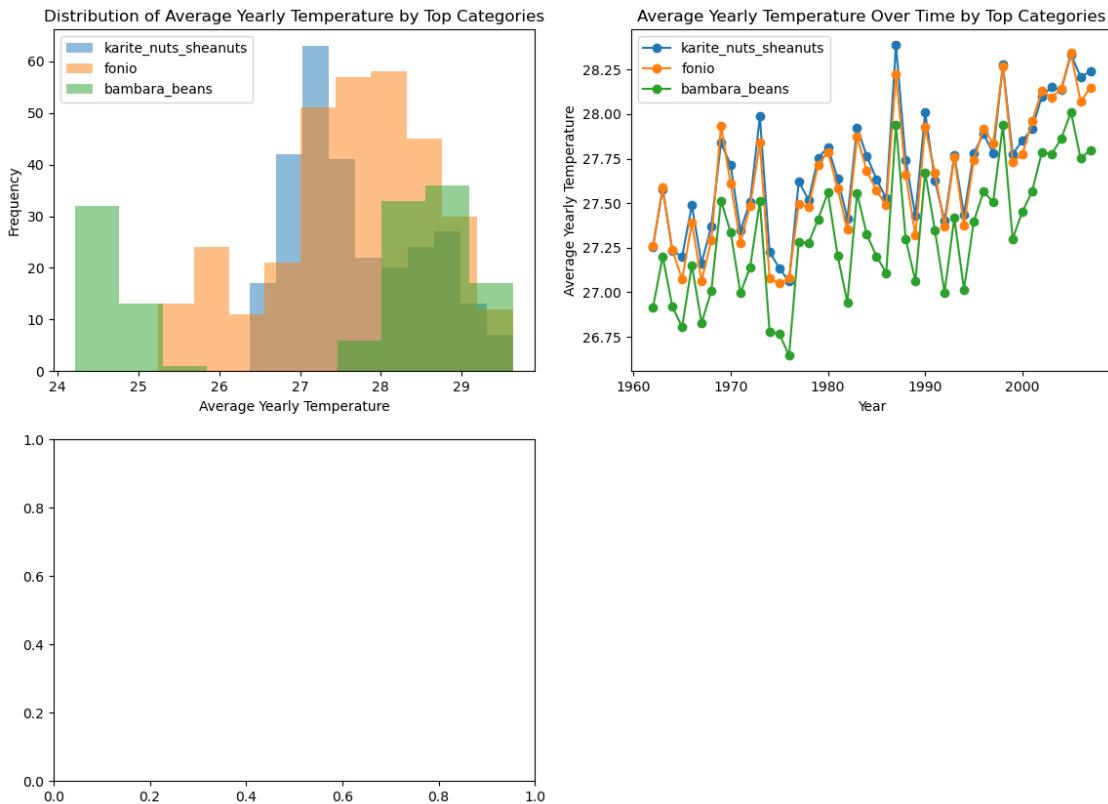
# Distribution of Average Yearly Temperature
plt.subplot(2, 2, 1)
for category in top_categories:
    subset = filtered_df[filtered_df['category'] == category]
    plt.hist(subset['average_yearly_temperature'], bins=10, alpha=0.5, label=category)
plt.title('Distribution of Average Yearly Temperature by Top Categories')
plt.xlabel('Average Yearly Temperature')
plt.ylabel('Frequency')
plt.legend()

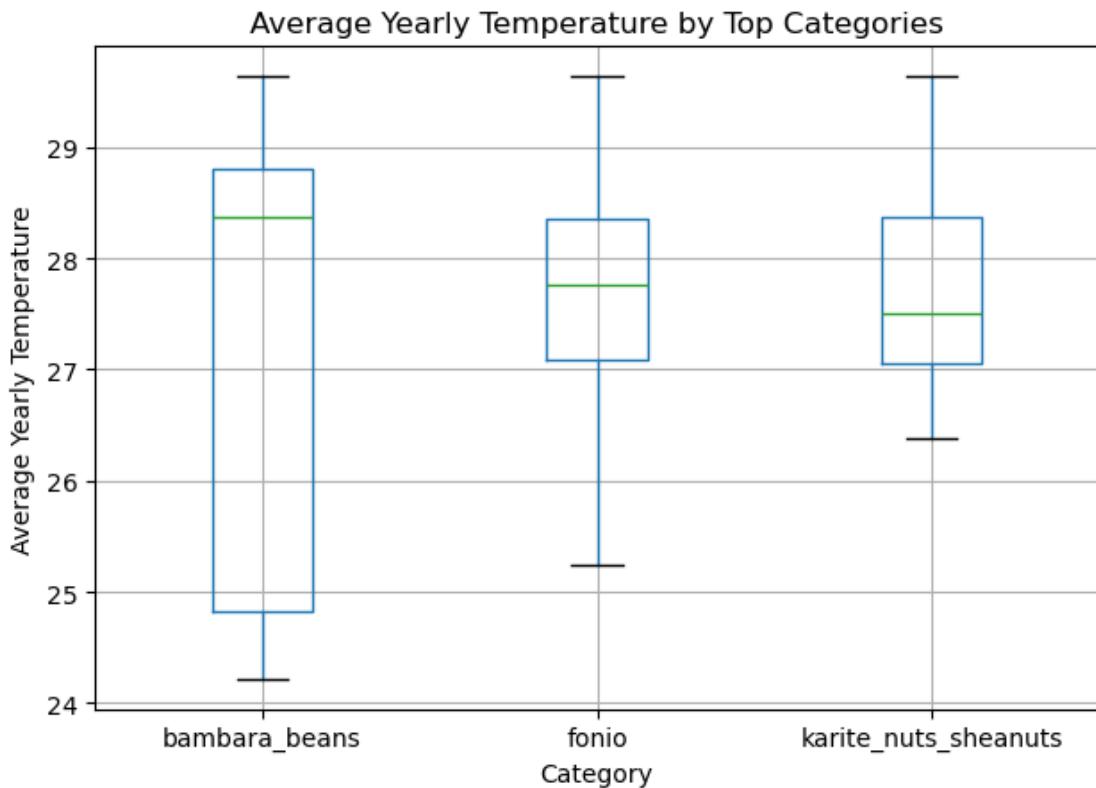
# Trend Over Time
plt.subplot(2, 2, 2)
for category in top_categories:
    subset = filtered_df[filtered_df['category'] == category]
    yearly_avg_temp = subset.groupby('year')['average_yearly_temperature'].mean()
    plt.plot(yearly_avg_temp, marker='o', label=category)
plt.title('Average Yearly Temperature Over Time by Top Categories')
plt.xlabel('Year')
plt.ylabel('Average Yearly Temperature')
plt.legend()

# Category Comparison
plt.subplot(2, 2, 3)
filtered_df.boxplot(column='average_yearly_temperature', by='category')
plt.title('Average Yearly Temperature by Top Categories')
plt.suptitle('')
plt.xlabel('Category')
plt.ylabel('Average Yearly Temperature')

plt.tight_layout()
plt.show()

```



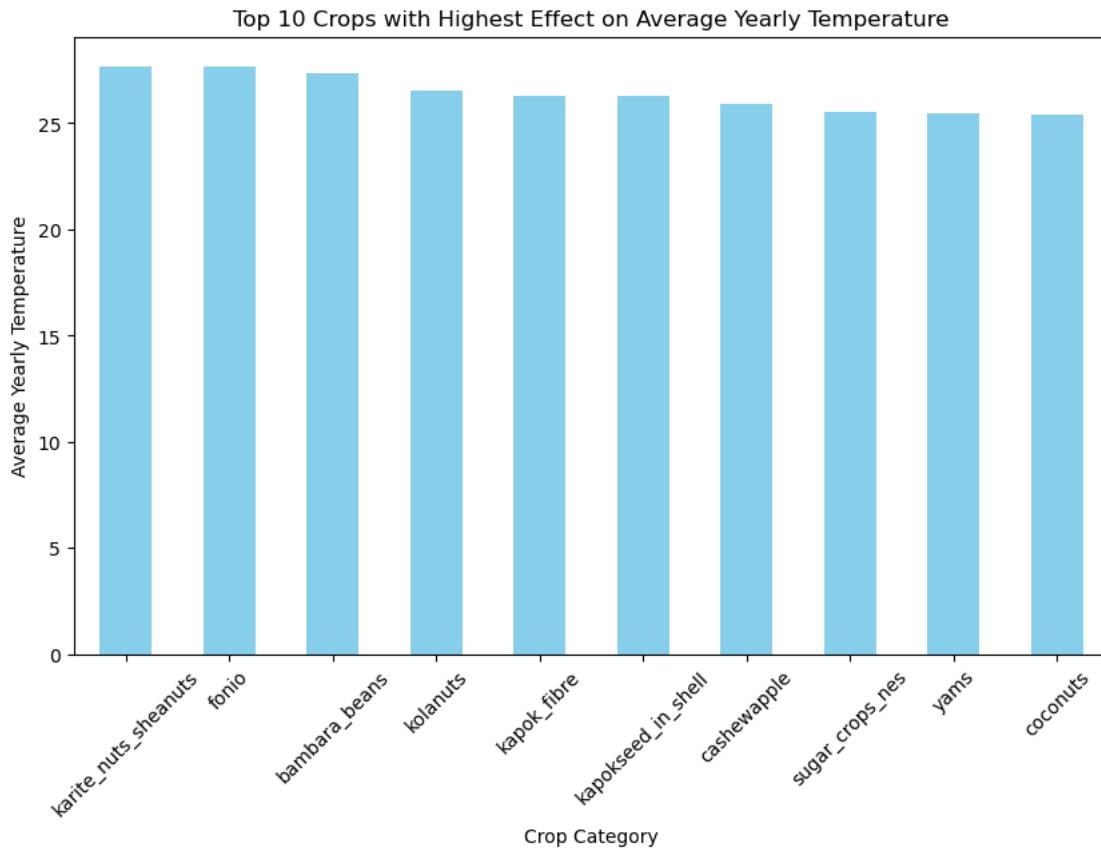


```
[96]: data_check = data

# Calculate the average effect for each crop category
average_effects = data_check.groupby('category')['average_yearly_temperature'].mean()

# Sort and select the top ten crops
top_crops = average_effects.nlargest(10)

# Visualization
top_crops.plot(kind='bar', figsize=(10, 6), color='skyblue')
plt.title('Top 10 Crops with Highest Effect on Average Yearly Temperature')
plt.xlabel('Crop Category')
plt.ylabel('Average Yearly Temperature')
plt.xticks(rotation=45)
plt.show()
```



[126] :

1.1.6 Time series analysis

- first concept is to see if through time series and machine learning how much is the yield increased
- Second is to see how much is the temperature for those elements increase as well
- choosing a subset for better examination

```
[117]: # Select a random subset of categories
unique_categories = data['category'].unique()
random_categories = np.random.choice(unique_categories, size=20, replace=False)
# Select 5 random categories

# Filter the dataset for the selected categories
filtered_df = data[data['category'].isin(random_categories)]

# Aggregate the data by year and category to get the sum of 'value'
agg_df = filtered_df.groupby(['year', 'category'])['value'].sum().reset_index()
```

```

# Function to perform trend analysis
def check_trend(data, category):
    # Fit a linear regression model
    X = data['year'].values.reshape(-1, 1)
    y = data['value'].values
    model = LinearRegression().fit(X, y)

    # Get the slope of the regression line
    slope = model.coef_[0]

    # Determine the trend
    trend = "increasing" if slope > 0 else "decreasing" if slope < 0 else "no trend"
    return slope, trend

# Perform trend analysis for each selected category and visualize
plt.figure(figsize=(14, 8))
trends = {}
for category in random_categories:
    subset = agg_df[agg_df['category'] == category]
    slope, trend = check_trend(subset, category)
    trends[category] = trend
    plt.plot(subset['year'], subset['value'], label=f'{category} ({trend})')

plt.title('Value Over Time for Random Subset of Categories')
plt.xlabel('Year')
plt.ylabel('Value')
plt.legend()
plt.show()

# Display the trends
trends

# Filter the dataset for the selected categories
filtered_df = data[data['category'].isin(random_categories)]

# Aggregate the data by year and category
agg_df = filtered_df.groupby(['year', 'category'])['average_yearly_temperature'].mean().reset_index()

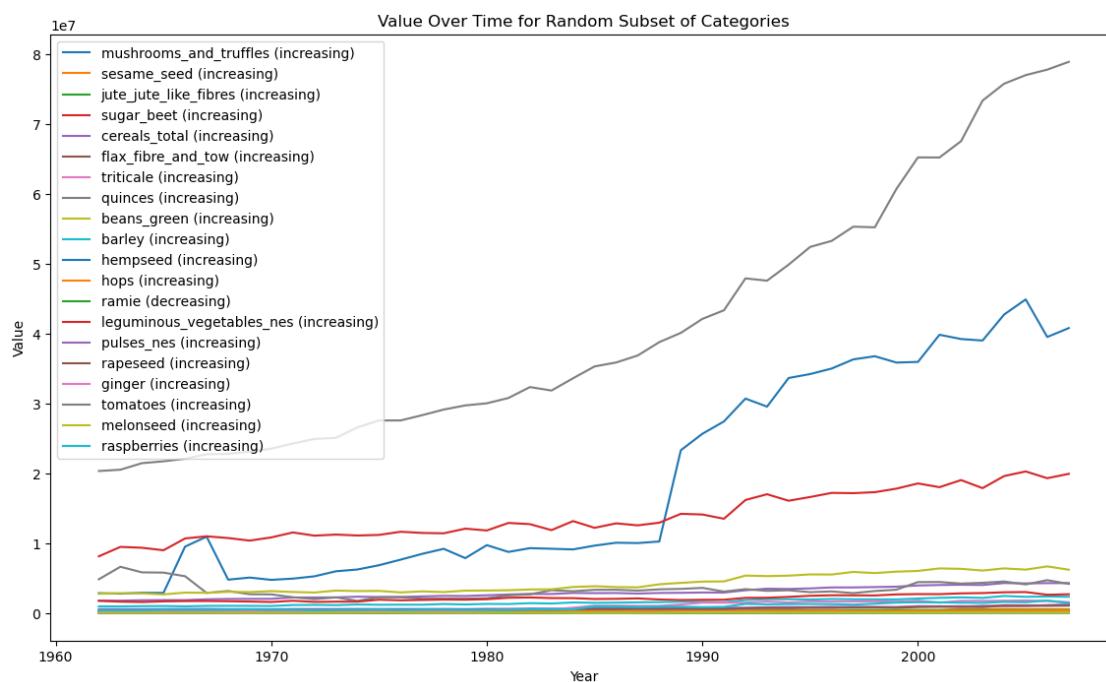
# Visualize the time series data
plt.figure(figsize=(14, 8))
for category in random_categories:
    subset = agg_df[agg_df['category'] == category]
    plt.plot(subset['year'], subset['average_yearly_temperature'], label=category)

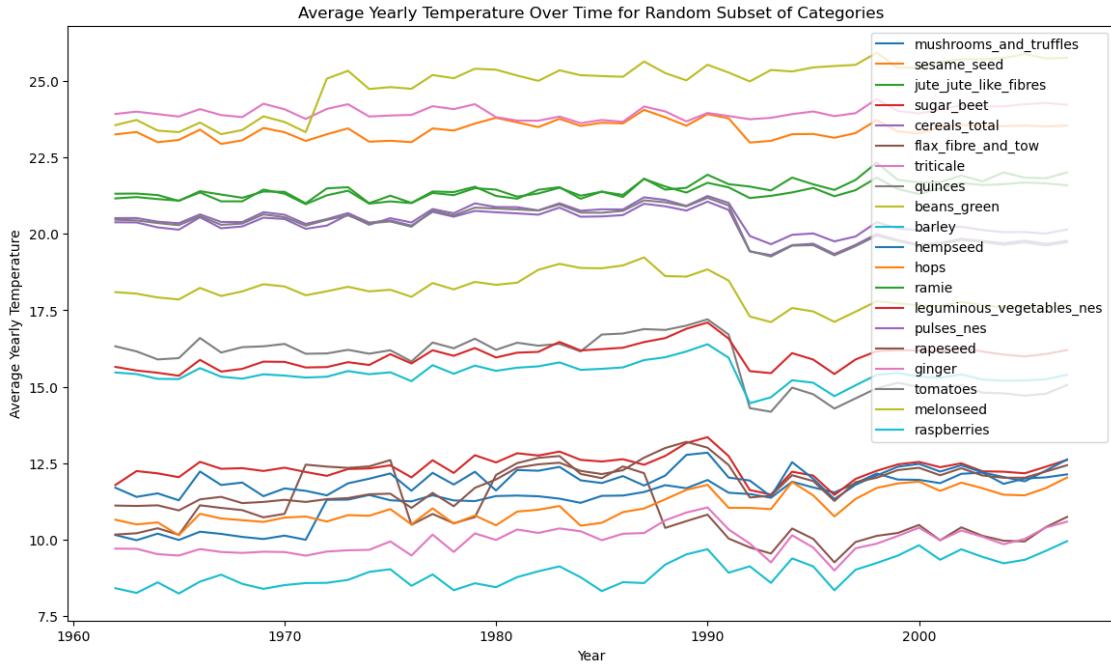
```

```

plt.title('Average Yearly Temperature Over Time for Random Subset of Categories')
plt.xlabel('Year')
plt.ylabel('Average Yearly Temperature')
plt.legend()
plt.show()

```





ANother data set to further clarify the trends

```
[116]: # Select a random subset of categories
unique_categories = data['category'].unique()
random_categories = np.random.choice(unique_categories, size=5, replace=False)
# Select 5 random categories

# Filter the dataset for the selected categories
filtered_df = data[data['category'].isin(random_categories)]

# Aggregate the data by year and category to get the sum of 'value'
agg_df = filtered_df.groupby(['year', 'category'])['value'].sum().reset_index()

# Function to perform trend analysis
def check_trend(data, category):
    # Fit a linear regression model
    X = data['year'].values.reshape(-1, 1)
    y = data['value'].values
    model = LinearRegression().fit(X, y)

    # Get the slope of the regression line
    slope = model.coef_[0]

    # Determine the trend
    if slope > 0:
        trend = "Upward"
    elif slope < 0:
        trend = "Downward"
    else:
        trend = "Stable"
    return trend
```

```

    trend = "increasing" if slope > 0 else "decreasing" if slope < 0 else "no ↴trend"
    return slope, trend

# Perform trend analysis for each selected category and visualize
plt.figure(figsize=(14, 8))
trends = {}
for category in random_categories:
    subset = agg_df[agg_df['category'] == category]
    slope, trend = check_trend(subset, category)
    trends[category] = trend
    plt.plot(subset['year'], subset['value'], label=f'{category} ({trend})')

plt.title('Value Over Time for Random Subset of Categories')
plt.xlabel('Year')
plt.ylabel('Value')
plt.legend()
plt.show()

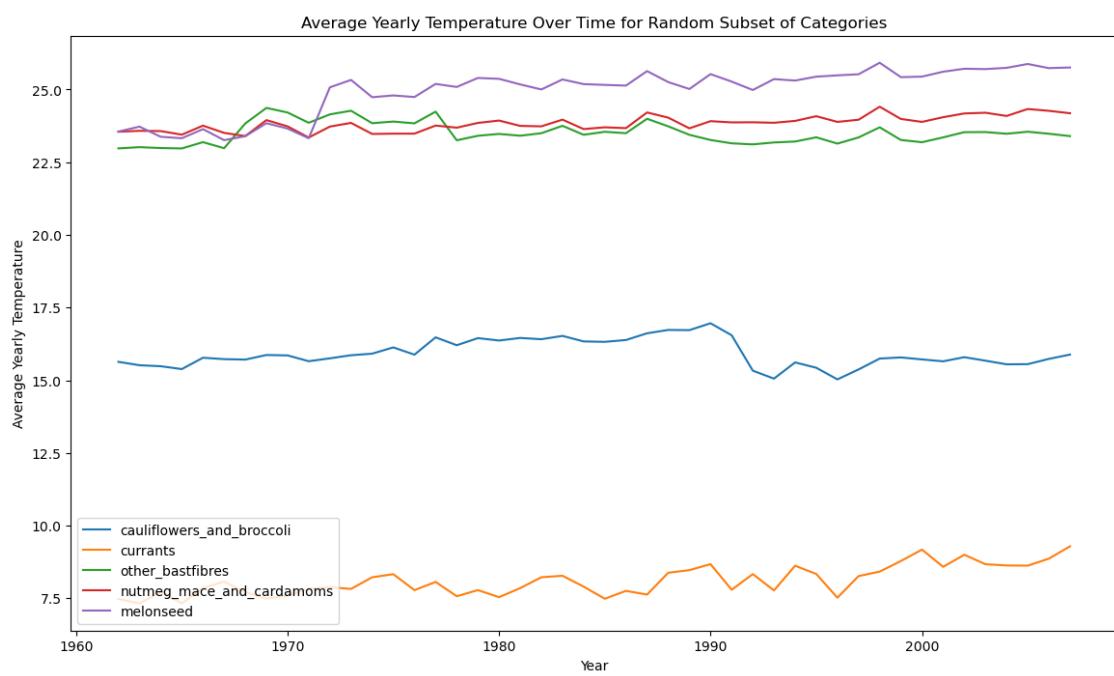
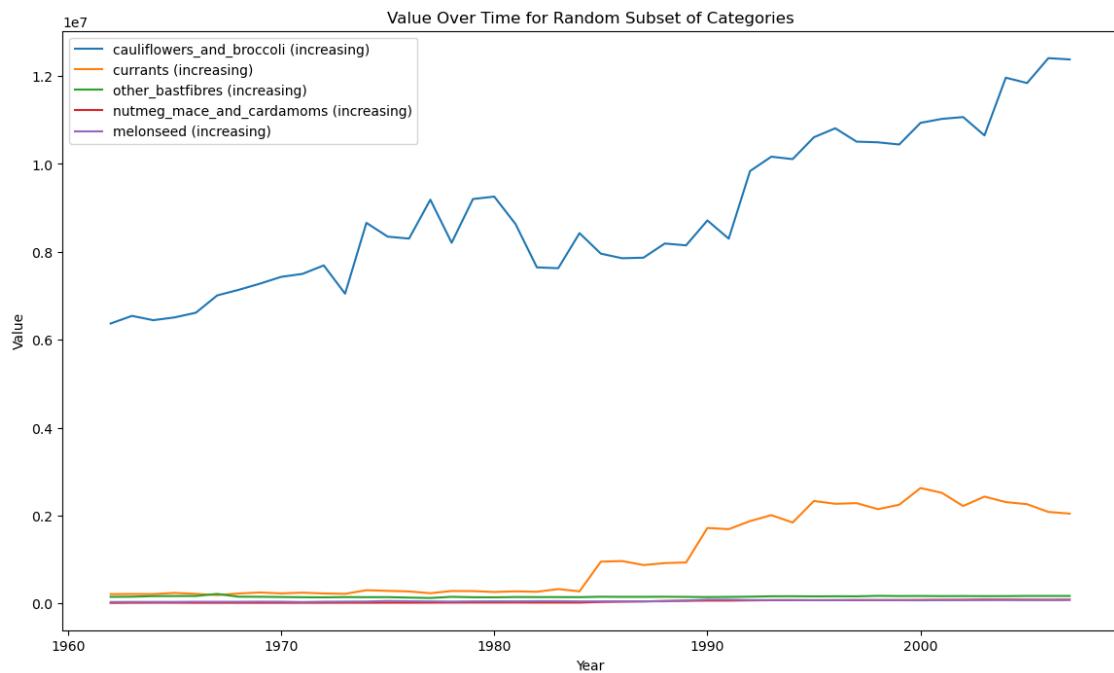
# Display the trends
trends

# Filter the dataset for the selected categories
filtered_df = data[data['category'].isin(random_categories)]

# Aggregate the data by year and category
agg_df = filtered_df.groupby(['year', ↴'category'])['average_yearly_temperature'].mean().reset_index()

# Visualize the time series data
plt.figure(figsize=(14, 8))
for category in random_categories:
    subset = agg_df[agg_df['category'] == category]
    plt.plot(subset['year'], subset['average_yearly_temperature'], ↴label=category)
plt.title('Average Yearly Temperature Over Time for Random Subset of ↴Categories')
plt.xlabel('Year')
plt.ylabel('Average Yearly Temperature')
plt.legend()
plt.show()

```



1.1.7 Top 10 categories

```
[121]: # Step 2: Calculate the average effect for each crop category
average_effects = df.groupby('category')['average_yearly_temperature'].mean()

# Step 3: Identify the top ten categories
top_categories = average_effects.nlargest(10).index

# Filter the dataset to include only these top ten categories
filtered_df = df[df['category'].isin(top_categories)]

# Step 4: Aggregate the data by year and category
agg_df = filtered_df.groupby(['year',
                             'category'])['average_yearly_temperature'].mean().reset_index()

# Step 5: Visualize the time series data
plt.figure(figsize=(14, 8))
for category in top_categories:
    subset = agg_df[agg_df['category'] == category]
    plt.plot(subset['year'], subset['average_yearly_temperature'], label=category)
plt.title('Average Yearly Temperature Over Time by Top 10 Categories')
plt.xlabel('Year')
plt.ylabel('Average Yearly Temperature')
plt.legend()
plt.show()

filtered_df = data[data['category'].isin(top_categories)]

# Aggregate the data by year and category to get the sum of 'value'
agg_df = filtered_df.groupby(['year', 'category'])['value'].sum().reset_index()

# Function to perform trend analysis
def check_trend(data, category):
    # Fit a linear regression model
    X = data['year'].values.reshape(-1, 1)
    y = data['value'].values
    model = LinearRegression().fit(X, y)

    # Get the slope of the regression line
    slope = model.coef_[0]

    # Determine the trend
    trend = "increasing" if slope > 0 else "decreasing" if slope < 0 else "no trend"
    return slope, trend
```

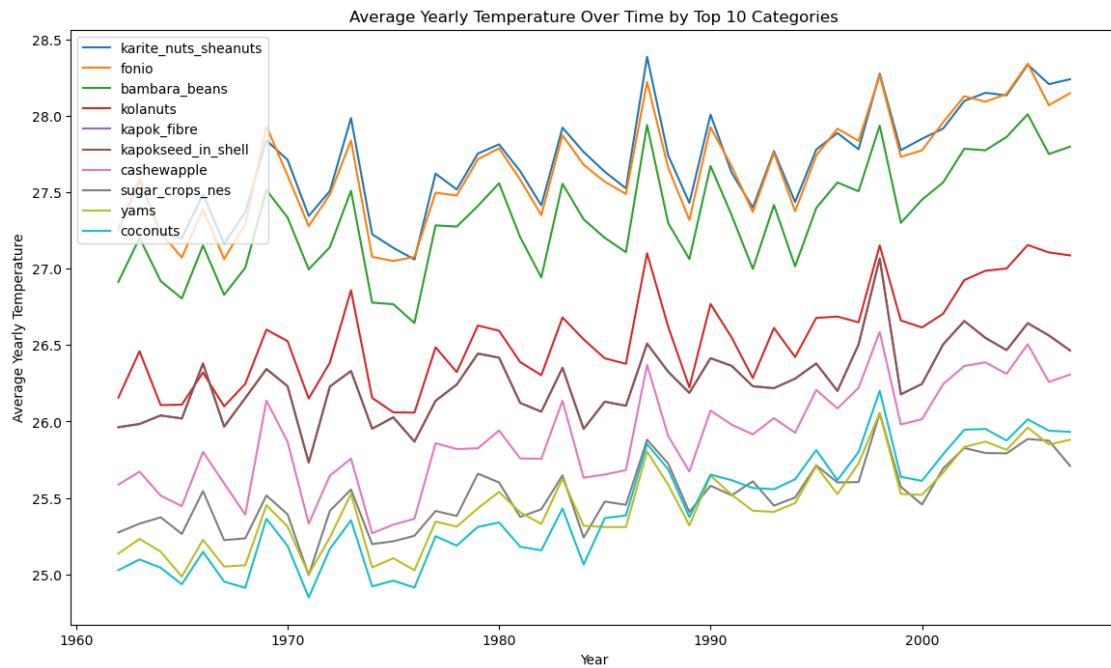
```

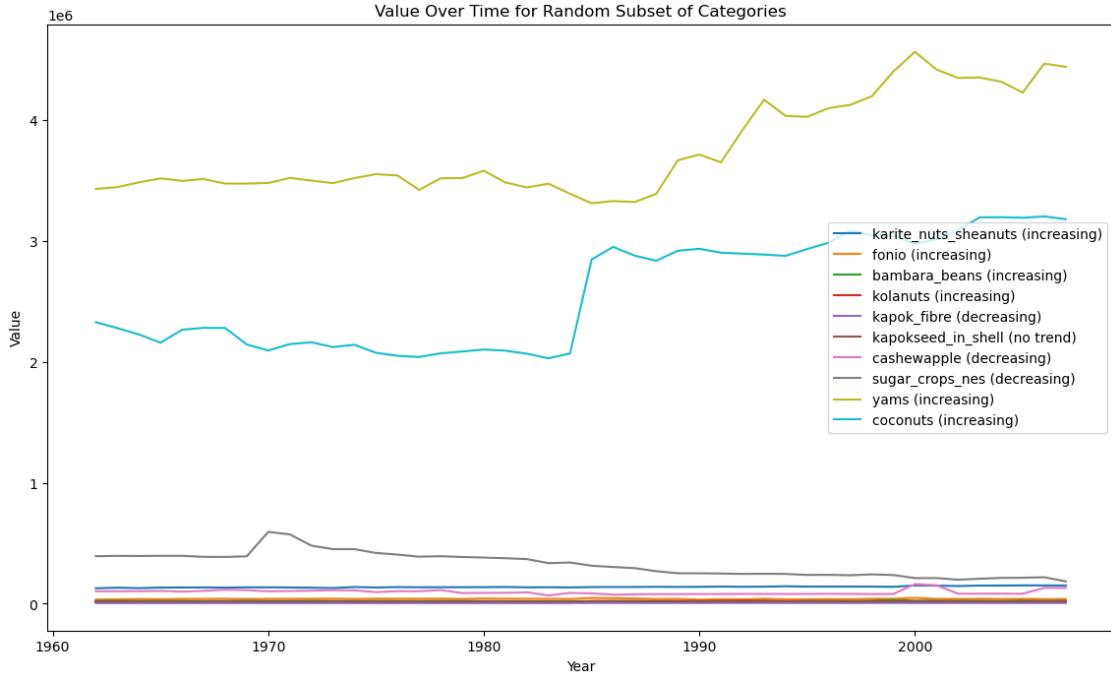
# Perform trend analysis for each selected category and visualize
plt.figure(figsize=(14, 8))
trends = {}
for category in top_categories:
    subset = agg_df[agg_df['category'] == category]
    slope, trend = check_trend(subset, category)
    trends[category] = trend
    plt.plot(subset['year'], subset['value'], label=f'{category} ({trend})')

plt.title('Value Over Time for Random Subset of Categories')
plt.xlabel('Year')
plt.ylabel('Value')
plt.legend()
plt.show()

# Display the trends
trends

```





```
[121]: {'karite_nuts_sheanuts': 'increasing',
      'fonio': 'increasing',
      'bambara_beans': 'increasing',
      'kolanuts': 'increasing',
      'kapok_fibre': 'decreasing',
      'kapokseed_in_shell': 'no trend',
      'cashewapple': 'decreasing',
      'sugar_crops_nes': 'decreasing',
      'yams': 'increasing',
      'coconuts': 'increasing'}
```

```
[124]: # Filter the dataset for shea nuts and coconut
filtered_df = data[data['category'].isin(['karite_nuts_sheanuts', 'coconuts'])]

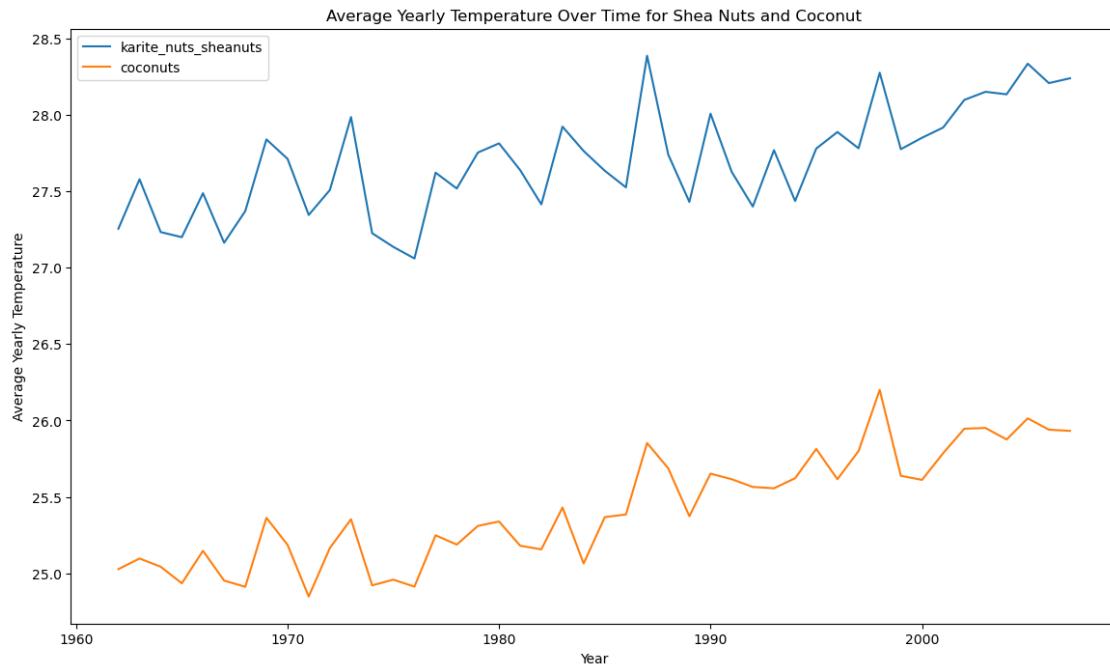
# Aggregate the data by year and category
agg_df = filtered_df.groupby(['year', 'category'])['average_yearly_temperature'].mean().reset_index()

# Visualize the time series data
plt.figure(figsize=(14, 8))
for category in ['karite_nuts_sheanuts', 'coconuts']:
    subset = agg_df[agg_df['category'] == category]
    plt.plot(subset['year'], subset['average_yearly_temperature'], label=category)
plt.title('Average Yearly Temperature Over Time for Shea Nuts and Coconut')
```

```

plt.xlabel('Year')
plt.ylabel('Average Yearly Temperature')
plt.legend()
plt.show()

```



1.1.8 3. Results

The question is: “Which crops are most impactful on climate change, and which alternatives could be pursued for reduced environmental impact?” Now we can go back to our initial question which was the above question and we can discuss it in more details.

Upon diving into the data from two different sources, a fascinating trend emerged. It appears that in most cases with an increase in the number of harvest from different countries, an increasing trend of temprature increase is seen as well. Also there is sudden jump in the temprature when we have a sudden surge in the proudction of a specific product such as ‘coconuts’.However with ‘sugar crops’ constant decrease we still see a little yet conspecuous surge in temprature. Over all in the final plot you can see the top ten effective crops on temprature and their production status.

{‘karite_nuts_sheanuts’: ‘increasing’, ‘fonio’: ‘increasing’, ‘bambara_beans’: ‘increasing’, ‘kolanuts’: ‘increasing’, ‘kapok_fibre’: ‘decreasing’, ‘kapokseed_in_shell’: ‘no trend’, ‘cashewapple’: ‘decreasing’, ‘sugar_crops_nes’: ‘decreasing’, ‘yams’: ‘increasing’, ‘coconuts’: ‘increasing’}

1.1.9 4. Discussion

4.1 Summary of Findings: Trend: Highlight the observed trend of higher temprature increase with an overall increase the crop harvest in different parts of worlds.

Alternative measures: for instance ‘karite_nuts_sheanuts’, ‘coconuts’ are two crops that are intensively examined and coconuts are known to be a good alternative in terms of usage to the karite. But there are several notions to be considered: * Climate: Tropical climate similar to regions where shea trees grow. * Uses: Coconut oil is a versatile product used in food, cosmetics, and industrial applications. * Harvest Energy: Manual or mechanical harvesting methods are available, with energy requirements for processing comparable to shea nuts. thus making it a viable alternative due to considering a broader outlook of alternation with regard to various aspects.

4.2 Possible Explanations: Fluctuation trend: Sudden increase in temprature even with decrease in production shows a direct effect of overall global population increase and great effect of alternative foods and harvestings to compensate for the evergrowing population of world. Social Structures and Behaviors: Better agricultural methods and modern approches and standards such as Netherlands methods which is a top player and most important producer makes great difference as the less advanced and efficent methods of south american countries.

Other underlying reasons: Global warming is affected by various factors and agriculture sector is indeed a key part of industrial world, however there are several other aspects such as production facilities and use of fossil resources that have their signifacnt effect on that specific period of time.

4.3 Considerations and Limitations: Data Quality and Variability: Acknowledging limitations related to data accuracy, completeness, and consistency across diverse countries is crucial.

Multifactorial Nature: Economic status alone may not fully explain infection rates; various factors like population density, governance, and cultural norms like eating certain crops might contribute significantly.

4.4 Future Research Directions: In-depth Analysis: Further studies are needed to unravel the specific factors underlying the observed trend.

Focused Analyses: Comparative studies targeting specific regions or countries could offer nuanced insights into the relationship between temprature and crop harvesting as some regions might not be able to stasify their needs with other alternative crops due to environment, cost and geo political sutiation.

Policy Implications: Understanding this relationship could influence long-term public health strategies and policy-making. As the trends of harvesting can greatly replace the other crop considering all the pros and cons.

4.5 Conclusion: The unexpected correlation between crops and temprature indicates a far more intricate and sophisticated look at this greatly mystrious project. As previously explained, there are several factors and elements with regard to choosing an alternative crop which will reduce the temprature to an extent but has other disadvantagous effects on economy and geo policy. Due to this fact, a far more comprehensive reasearch must be conducted with meticulous data regarding all the effectual aspects.