Cotton Data Analysis APP

User's guide

Developer: Dr. Abdinardo Moreira Barreto de Oliveira

Coordinators: Dr. Yuri Clemens Daglia Calil
Dr. Juan Landivar-Bowles
Dr. Luis A. Ribera

Corpus Christi, TX
2024

Summary

1. Introduction....3
2. Spot Price Tab....4
   2.1. Spot Prices Chart....4
   2.2. Spot Prices Boxplot....5
   2.3. Spot Prices Change-Point....5
   2.4. Spot Prices Table....6
3. Futures Price Tab....8
   3.1. Futures Prices Chart....8
   3.2. Futures Prices Boxplot....9
   3.3. Futures Prices Change-Point....9
   3.4. Futures Prices Table....10
4. Cotton Program Tab....12
   4.1. Bales Chart....12
   4.2. Bales Table....13
5. Static Hedging Strategies Tab....14
   5.1. Price Series Chart....14
   5.2. Basis Chart....15
      5.2.1. Raw Values....15
      5.2.2. Boxplot....16
      5.2.3. Change-point....16
   5.3. Minimum variance and Mean-variance....17
      5.3.1. Total Revenue....17
      5.3.2. Hedge Ratio....18
      5.3.3. Effectiveness....19
      5.3.4. Results Table....20
   5.4. Data Table....21
6. Costs (USDA) Tab....22
   6.1. Estimates....22
      6.1.1. Estimates Chart....22
      6.1.2. Data Table....23
   6.2. Breakevens....23
      6.2.1. Breakevens Chart....24
      6.2.2. Breakevens Boxplot....24
      6.2.3. Breakevens Change-point....25
      6.2.4. Data Table....26
7. Costs (Texas) Tab....27
   7.1. Estimates....27
      7.1.1. Estimates Chart....27
      7.1.2. Data Table....28
   7.2. Breakevens....28
      7.2.1. Breakevens Chart....29
      7.2.2. Breakevens Boxplot....30
      7.2.3. Breakevens Change-point....30
      7.2.4. Data Table....31
8. Forecasting Tab....33

8.1. Forecast Chart.....34
8.2. Forecast Metrics.....34
8.3. Console.....35
References.....37

1. Introduction

This manual offers general guidelines for using the U.S. cotton data analysis App[1]. Users can use the App to make queries and forecasts, as well as download data and graphs online. The data in this system are provided by the USDA (Agricultural Market Service, Economic Research Service, and National Agricultural Statistics Service) and Texas A&M (Department of Agricultural Economics – Extension Agricultural Economics).

The primary goal of this App is to provide valuable, interactive visual information on the prices, costs, and bales of cotton produced in the United States. This App aims to positively contribute to the business intelligence of all stakeholders involved in producing and marketing cotton in the United States while reducing the effects of information asymmetry.

The App has seven primary tabs: Spot Price, Futures Price, Cotton Program, Static Hedging Strategies, Costs (USDA), Costs (Texas), and Forecasting. The Info tab contains this user's guide. The chapters in this manual follow this order, explaining how each tab works. Additionally, tips are provided on how to use the information shown in the graphs and tables for the user's decision-making process.

The primary tabs are split into two parts: on the left-hand side is the control panel for users to configure their queries, and on the right-hand side are the sub-tabs containing query results, such as charts, tables, or additional information about predictive models.

On all interactive charts in this App, a submenu will appear in the top right corner when you hover over it. Among several features that the users can explore, there is the option to save the chart by clicking on the icon that looks like a camera. The chart legend is also interactive. Users can hide and show displayed elements by clicking on their descriptions.

Experience the power of our App as it guides you in making informed decisions about the US cotton market. Enjoy the journey!

1 https://agecd11.shinyapps.io/tamucotton/

2. Spot Price Tab

In Figure 1, you can see the home screen of the App, specifically the spot price tab. On the left-hand side, there's a control panel where the user can select a market, a time period of at least one year, and at least one type of cotton to perform a query. Users can also adjust the color palette for color blindness and download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are divided into four subtabs: spot prices chart, spot prices boxplot, spot prices change-point, and spot prices table. The explanation of the results in each subtab is given in the following sub-sections.

Figure 1. The main screen of the App: Spot Price tab.

2.1. Spot Prices Chart

The spot prices chart subtab (Figure 1) displays an interactive line chart. Users can access detailed information about each point by hovering over it. By default, the App shows two types of cotton time series. These time series are organized according to the U.S. cotton crop calendar[2]: None (purple), Plant (green), MidSeason (gray), and Harvest (orange). Additionally, black dots indicate the highest prices observed at each stage of the crop calendar.

2 https://ipad.fas.usda.gov/rssiws/al/crop_calendar/us.aspx

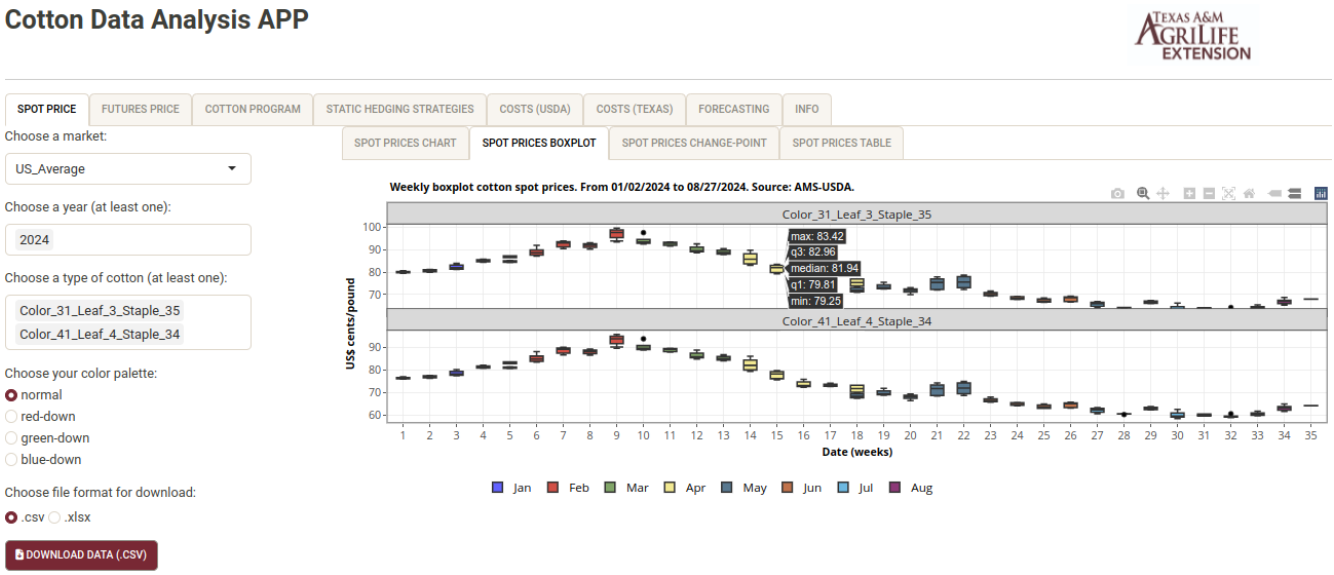
The spot prices chart **allows you to**:

- track the change in daily spot cotton prices throughout the crop calendar;
- identify the dates and values of the highest spot prices.

2.2. Spot Prices Boxplot

In the spot prices boxplot subtab (Figure 2), the query result is an interactive boxplot chart[3]. Users can obtain weekly detailed information about each point by hovering over it. A boxplot is a standardized way of displaying a dataset based on a summary of five numbers: the minimum, maximum, sample median, and the first and third quartiles.

Figure 2. The Spot Prices Boxplot subtab.



The spot prices boxplot **allows you to**:

- observe the weekly variation in cotton spot prices, grouped by month;
- track the changes in weekly cotton spot prices over time, organized by month.

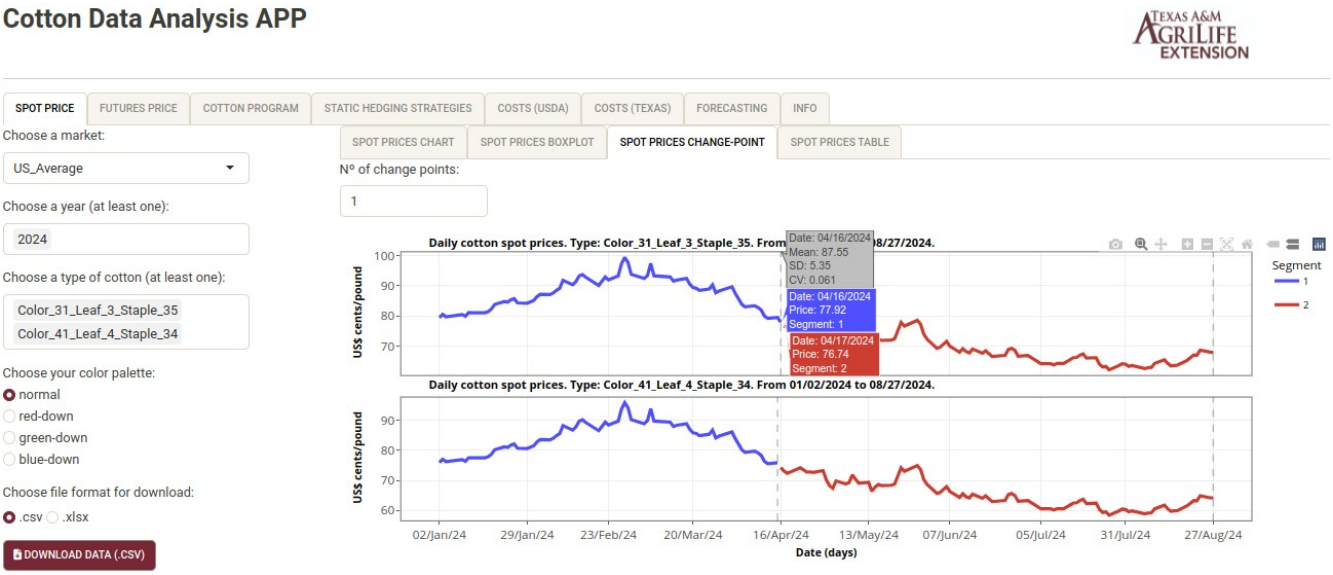
2.3. Spot Prices Change-Point

The spot prices change-point subtab (Figure 3) displays an interactive line chart in the query result. This chart shows the change points marked by vertical dashed lines in gray. Users can obtain detailed information about each point by hovering over it.

3 https://en.wikipedia.org/wiki/Box_plot

Change point detection refers to identifying the point at which the statistical properties (such as mean and variance) of a sequence of observations (like a time series) change. This App uses the binary segmentation algorithm (Killick & Eckley, 2014) to detect up to nine change points in the cotton time series.

Figure 3. The Spot Prices Change-Point subtab.



The spot prices change-point **allows you to**, for each gray dashed vertical line[4]:

- observe the date the change point occurred;
- obtain the mean, standard deviation, and coefficient of variation of the cotton time series before the change point.

2.4. Spot Prices Table

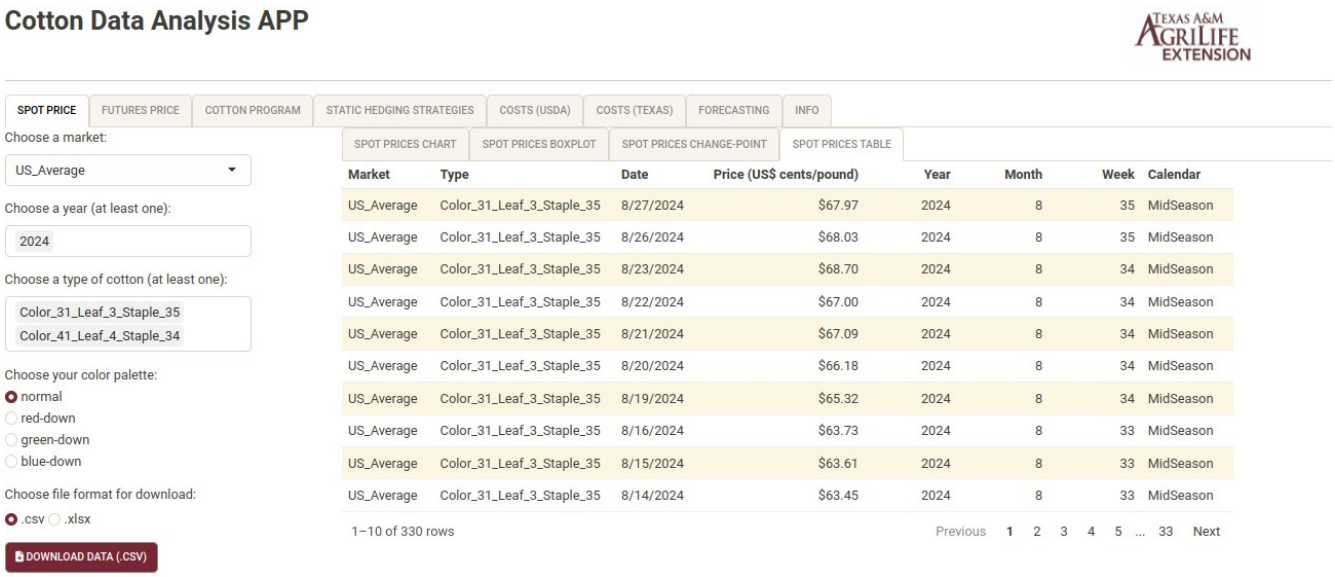
Finally, the spot price table subtab displays the data utilized by the subtabs in subsections 2.1, 2.2, and 2.3 (Figure 4). At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

The spot prices table **allows you to**:

- retrieve data relating to market, type, date, price (US$ cents/pound), year, month, week, and calendar.

4 For example, if you request *one* change point, it will show *two* gray vertical dashed lines, and so on.

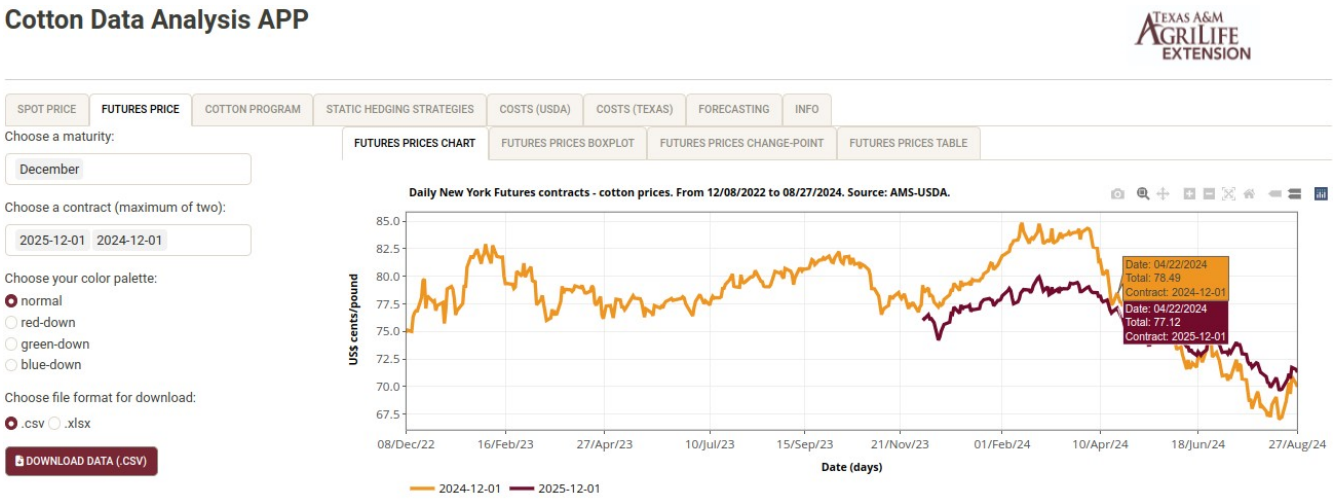
Figure 4. The Spot Prices Table subtab.



3. Futures Price Tab

In Figure 5, you can see the futures price tab. On the left-hand side, there's a control panel where the user can select a maturity, and a maximum of two contracts to perform a query. Users can also adjust the color palette for color blindness and download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are divided into four subtabs: futures prices chart, futures prices boxplot, futures prices change-point, and futures prices table. The explanation of the results in each subtab is given in the following sub-sections.

Figure 5. The Futures Price tab.



3.1. Futures Prices Chart

The futures prices chart subtab (Figure 5) displays an interactive lines chart. Users can access detailed information about each point by hovering over it. By default, the App does not display any results; users need to set their preferences for maturity (at least one) and contracts (maximum of two).

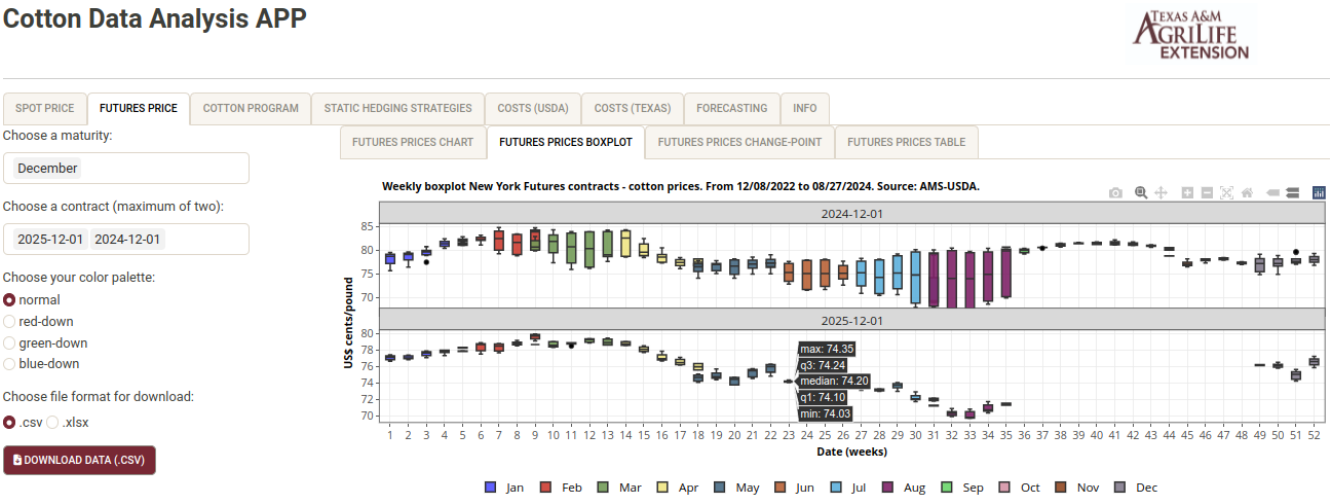
The futures prices chart **allows you to**:

- observe the trend evolution of the daily futures cotton price;
- compare the evolving trend of daily futures cotton prices across different maturities and contracts;

3.2. Futures Prices Boxplot

In the futures prices boxplot subtab (Figure 6), the query result is an interactive boxplot chart. Users can obtain weekly detailed information about each point by hovering over it. A boxplot is a standardized way of displaying a dataset based on a summary of five numbers: the minimum, maximum, sample median, and the first and third quartiles.

Figure 6. The Futures Prices Boxplot subtab.



The futures prices boxplot **allows you to**:

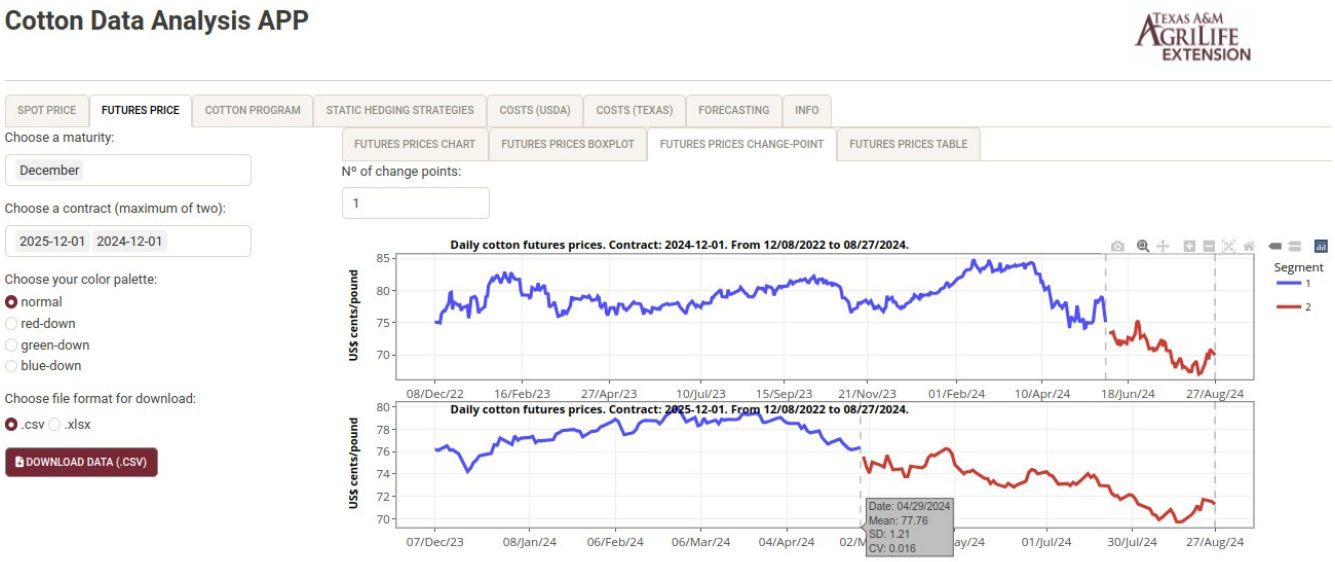
- observe the weekly variation in cotton futures prices, grouped by month;
- observe the trend evolution of weekly cotton futures prices, grouped by month.

3.3. Futures Prices Change-Point

The futures prices change-point subtab (Figure 7) displays an interactive line chart in the query result. This chart shows the change points marked by vertical dashed lines in gray. Users can obtain detailed information about each point by hovering over it.

Change point detection refers to identifying the point at which the statistical properties (such as mean and variance) of a sequence of observations (like a time series) change. This App uses the binary segmentation algorithm (Killick & Eckley, 2014) to detect up to nine change points in the cotton time series.

Figure 3. The Futures Prices Change-Point subtab.



The futures prices change-point **allows you to**, for each gray dashed vertical line:

- observe the date the change point occurred;
- obtain the mean, standard deviation, and coefficient of variation of the cotton time series before the change point.

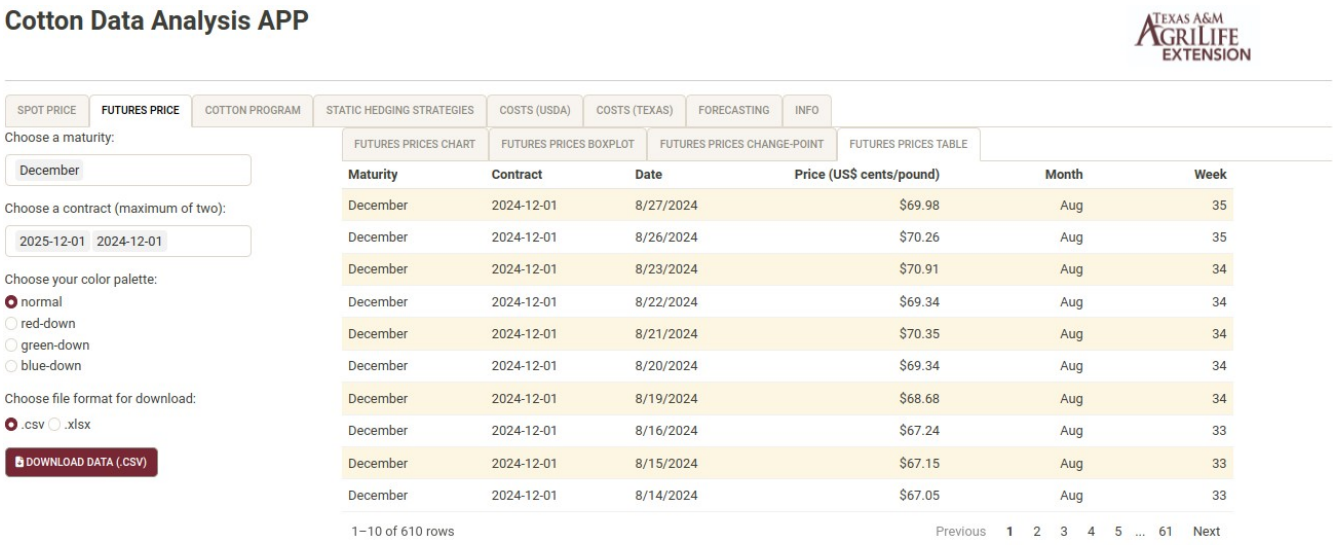
3.4. Futures Prices Table

Finally, the futures prices table subtab displays the data utilized by the subtabs in subsections 3.1, 3.2, and 3.3 (Figure 8). At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

The futures prices table **allows you to**:

- retrieve data relating to maturity, contract, date, price (US$ cents/pound), month, and week.

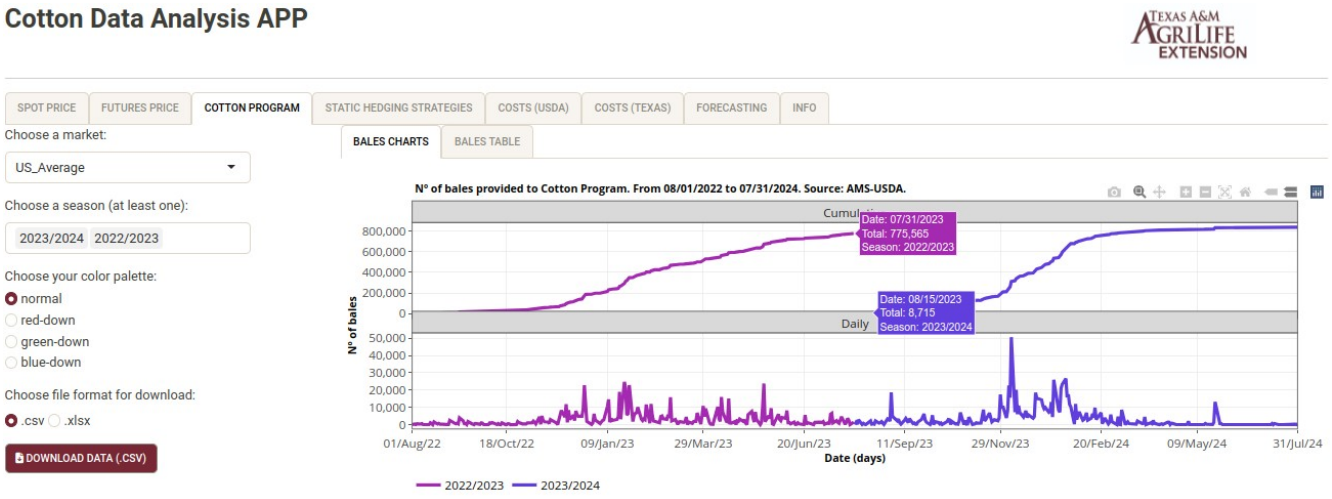
Figure 8. The Futures Prices Table subtab.



4. Cotton Program Tab

In Figure 9, you can see the cotton program tab. On the left-hand side, there's a control panel where the user can select a market, and, at least, one season to perform a query. Users can also adjust the color palette for color blindness and download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are divided into two subtabs: bales chart, and bales table. The explanation of the results in each subtab is given in the following sub-sections.

Figure 9. The Cotton Program tab. The Bales charts subtab.



4.1. Bales Chart

The bales chart subtab (Figure 5) displays interactive cumulative and daily line charts. Users can access detailed information about each point by hovering over it. By default, the App shows the results for US_Average market and the most recent season.

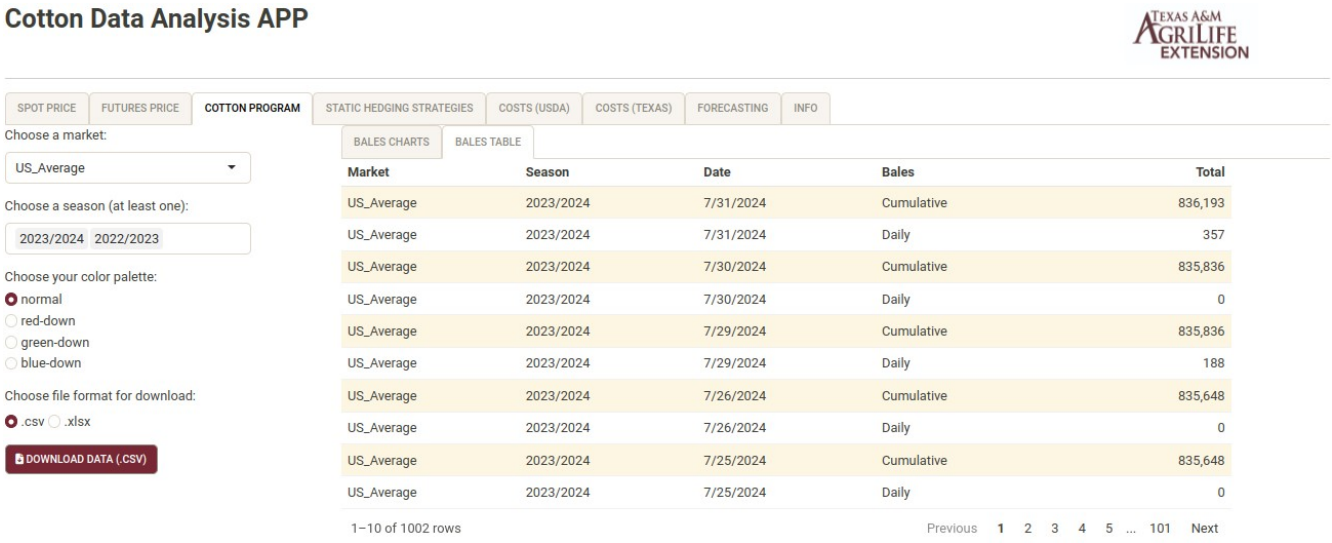
The bales chart **allows you to**:

- observe the cumulative and daily trend evolution of the number of bales;
- compare the cumulative and daily trend evolution of the number of bales for different seasons;

4.2. Bales Table

Lastly, the bales table subtab displays the data utilized by the subtab in subsection 4.1 (Figure 10). At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

Figure 10. The Bales Table subtab.



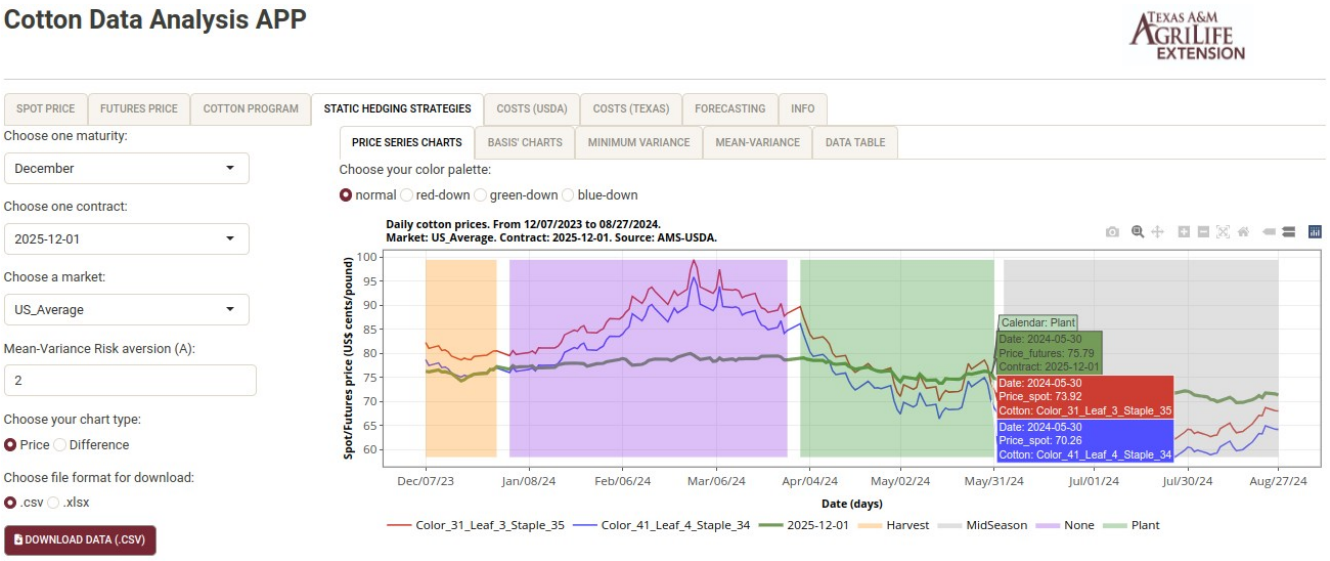
The bales table **allows you to**:

- retrieve data relating to market, season, date, bales, and total.

5. Static Hedging Strategies Tab

In Figure 11, you can see the static hedging strategies tab. On the left-hand side, there's a control panel where the user can select a single maturity, one contract, and one market. You can also define your risk aversion degree to perform a query. Users can also define the chart type (Price or Difference), and download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are divided into five subtabs: price series chart, basis chart, minimum variance, mean-variance, and data table. The option to adjust the color palette for color blindness is available in the price series chart, and it applies to all the charts in the remaining subtabs. The explanation of the results in each subtab is given in the following sub-sections.

Figure 11. The Static Hedging Strategies tab.



5.1. Price Series Chart

The price series chart subtab (Figure 11) displays an interactive line chart containing two available cotton spot price series and the futures price series for the selected contract on a daily basis. Users can access detailed information about each point by hovering over it. You can also view the daily price difference of these time series by selecting the “Difference” option in the control panel on the left-hand side. They are organized according to the U.S. cotton crop calendar: None (purple), Plant (green), MidSeason (gray), and Harvest (orange).

The price series chart **allows you to**, throughout the crop calendar:

- track the changes in the daily spot and futures cotton time series, either on the price or difference;
- determine if futures prices are higher (*contango*) or lower (*backwardation*) than spot cotton prices[5];

5.2. Basis Chart

The basis[6] charts subtab has three subtabs: raw values, boxplot, and change-point (Figure 12). Detailed explanations for each subtab are provided in the following sub-sections.

5.2.1. Raw Values

The subtab for raw values (Figure 12) displays an interactive line chart presenting the basis for the two available historical cotton series associated with the selected futures contract. The basis is the difference between spot and futures prices. Users can access detailed information about each point by hovering over it. They are organized according to the U.S. cotton crop calendar: None (purple), Plant (green), MidSeason (gray), and Harvest (orange).

Figure 12. The Basis Charts subtab.

5 https://en.wikipedia.org/wiki/Contango
6 https://www.cottoninc.com/cotton-production/ag-resources/cotton-farming-decision-aids/cotton-basis-tools/

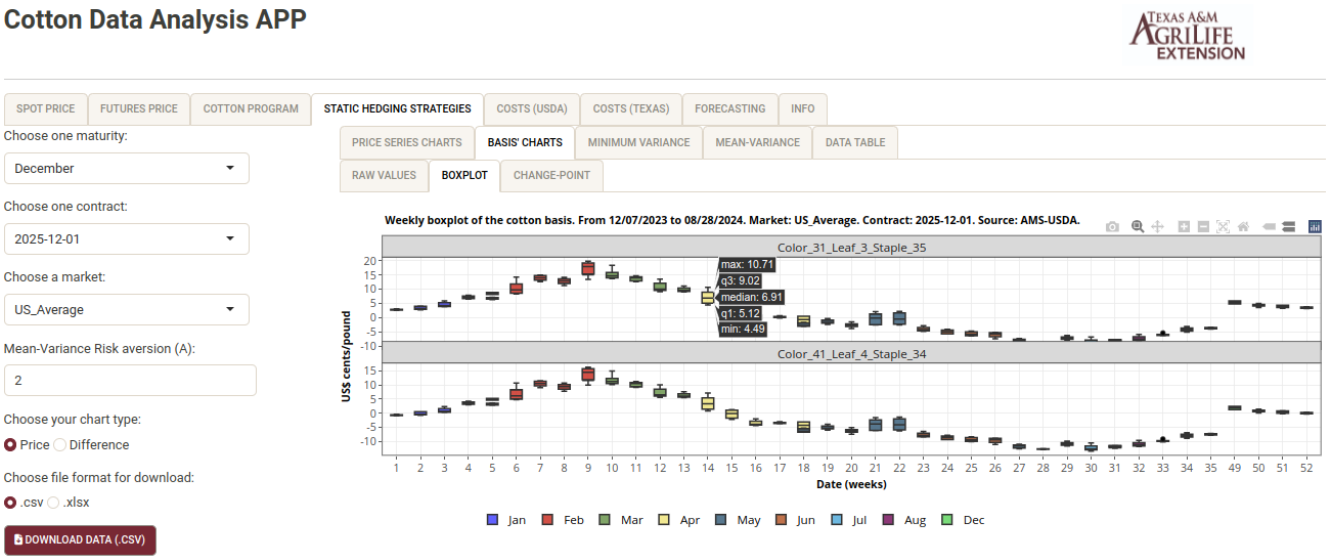
The raw values **allows you to**, throughout the crop calendar:

- determine whether the basis time series is strengthening (positive values) or weakening (negative values).

5.2.2. Boxplot

In the boxplot subtab for the basis (Figure 13), the query result is an interactive boxplot chart. Users can obtain weekly detailed information about each point by hovering over it. A boxplot is a standardized way of displaying a dataset based on a summary of five numbers: the minimum, maximum, sample median, and the first and third quartiles.

Figure 13. The Boxplot subtab.



The boxplot for the basis **allows you to**:

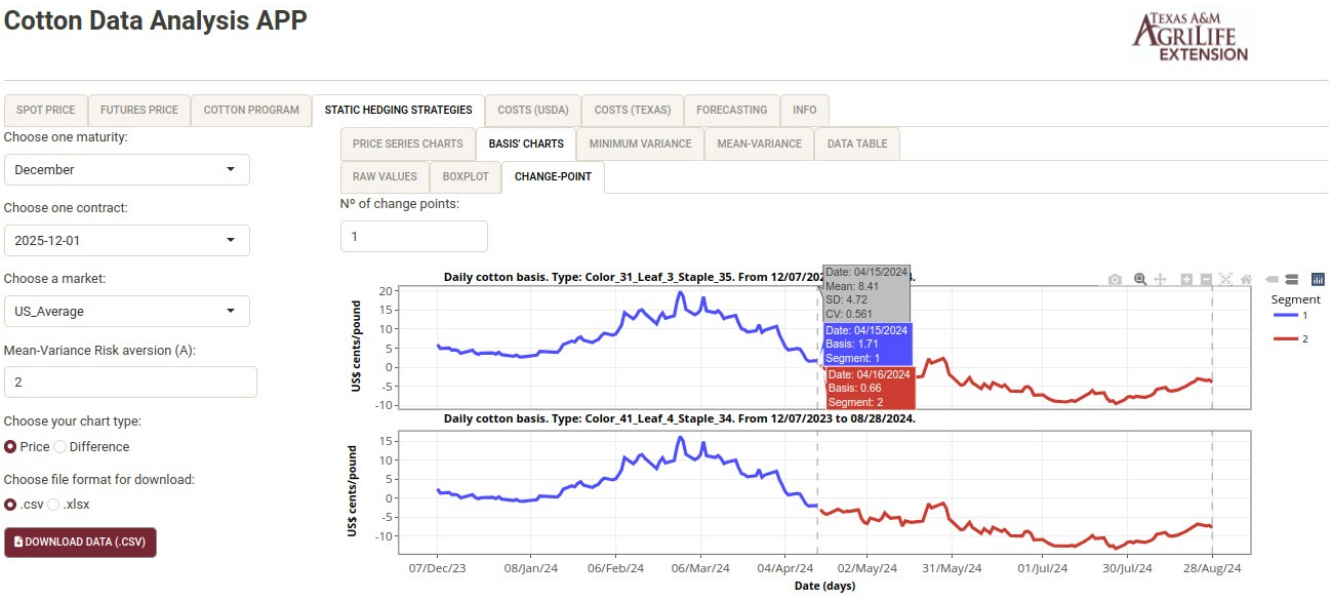
- observe the weekly variation in basis, grouped by month;
- observe the trend evolution of weekly basis, grouped by month.

5.2.3. Change-point

The change-point subtab for the basis (Figure 14) displays an interactive line chart that shows the change points marked by vertical dashed lines in gray. Users can obtain detailed information about each point by hovering over it. Change point detection refers to identifying the point at which the statistical properties (such as mean and variance) of a sequence of observations (like a time series) change.

This App uses the binary segmentation algorithm (Killick & Eckley, 2014) to detect up to nine change points in the cotton time series.

Figure 14. The Boxplot subtab.



The change-point for the basis **allows you to**, for each gray dashed vertical line:

- observe the date the change point occurred;
- obtain the mean, standard deviation, and coefficient of variation of the cotton time series before the change point.

5.3. Minimum variance and Mean-variance

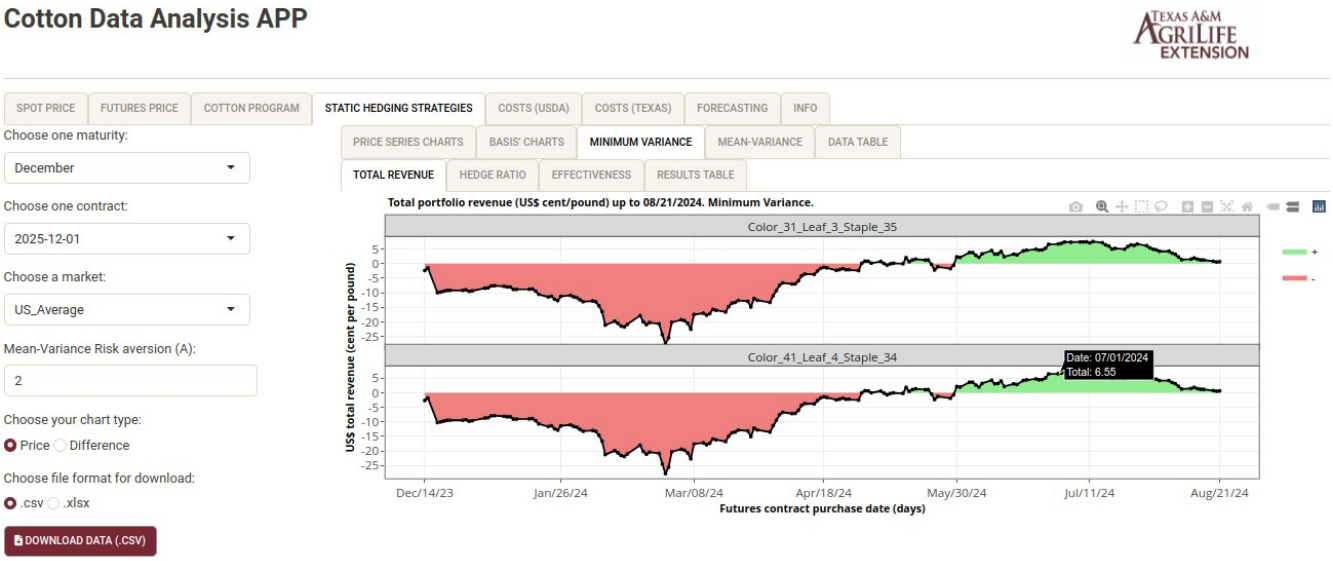
The Minimum variance and Mean-variance subtabs have four subtabs: total revenue, hedge ratio, effectiveness, and results table (Figure 15). In order to gain a better understanding of the theory that explains both techniques, we suggest reading Lee et al. (2023), chapter 21. Detailed explanations for each subtab are provided in the following sub-sections.

5.3.1. Total Revenue

The total revenue subtab (Figure 15) shows an interactive line chart that displays the total revenue for the spot price/futures price portfolio for a specific contract up to the present date. Each point on the graph represents a specific date on which the user purchased futures

contracts, based on a previously calculated hedge ratio (see sub-section 5.3.2), and held that contract until today. Therefore, each point on the graph indicates the profit (green) or loss (red) the user would have if they closed today's futures contract. The chart title in Figure 15 displays the date of the last simulated purchase before the contract expires.

Figure 15. The Minimum Variance subtab. The Total Revenue subtab.



The total revenue chart for Minimum variance / Mean-variance **allows you to**:

- monitor the changes in the simulated revenue series over time;
- decide when it is worthwhile to purchase futures contracts.

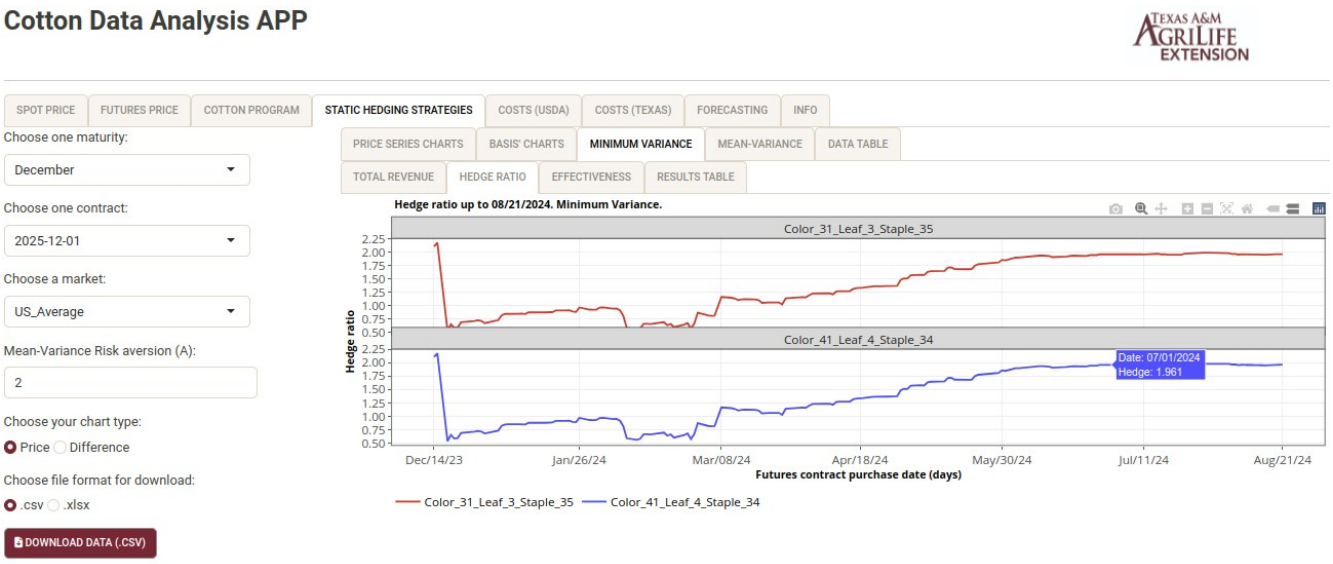
5.3.2. Hedge Ratio

The Hedge Ratio subtab (Figure 16) presents an interactive line chart illustrating the hedge ratio values that should be used for purchasing futures contracts on a specific date (see sub-section 5.3.1).

For the Mean-variance technique, the hedge ratio calculation is influenced by the user's level of risk aversion. Higher levels of risk aversion lead to hedge ratio results that closely resemble those of the Minimum variance technique.

Therefore, the mean-variance technique is recommended for users seeking a balance between return and risk, while the minimum-variance technique is recommended for users seeking the lowest possible risk.

Figure 16. The Hedge Ratio subtab.



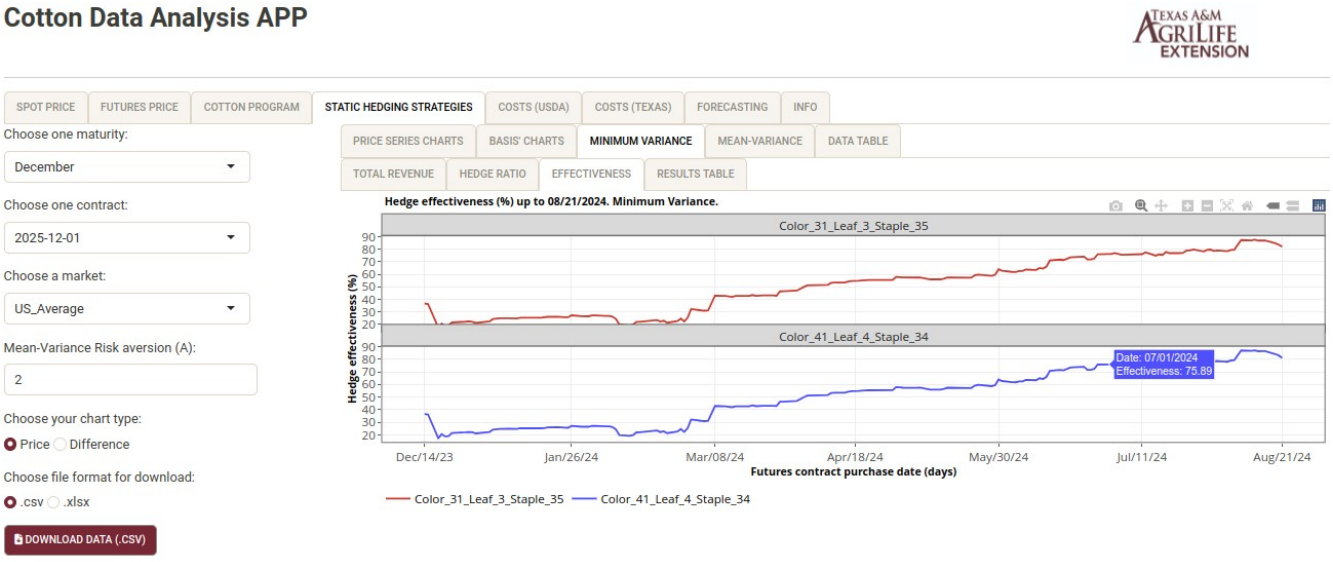
The hedge ratio chart for Minimum variance / Mean-variance **allows you to**:

- obtain the optimal hedge ratio for purchasing futures contracts on a specific date.

5.3.3. Effectiveness

The Effectiveness subtab (Figure 17) displays an interactive line chart that illustrates the portfolio's effectiveness based on a hedge ratio.

Figure 17. The Effectiveness subtab.



Effectiveness refers to the benefit that the combination of spot price and futures price contracts provides to users who choose to use these contracts for diversifying risk or improving the return-risk ratio of their investments. The higher the effectiveness, the better.

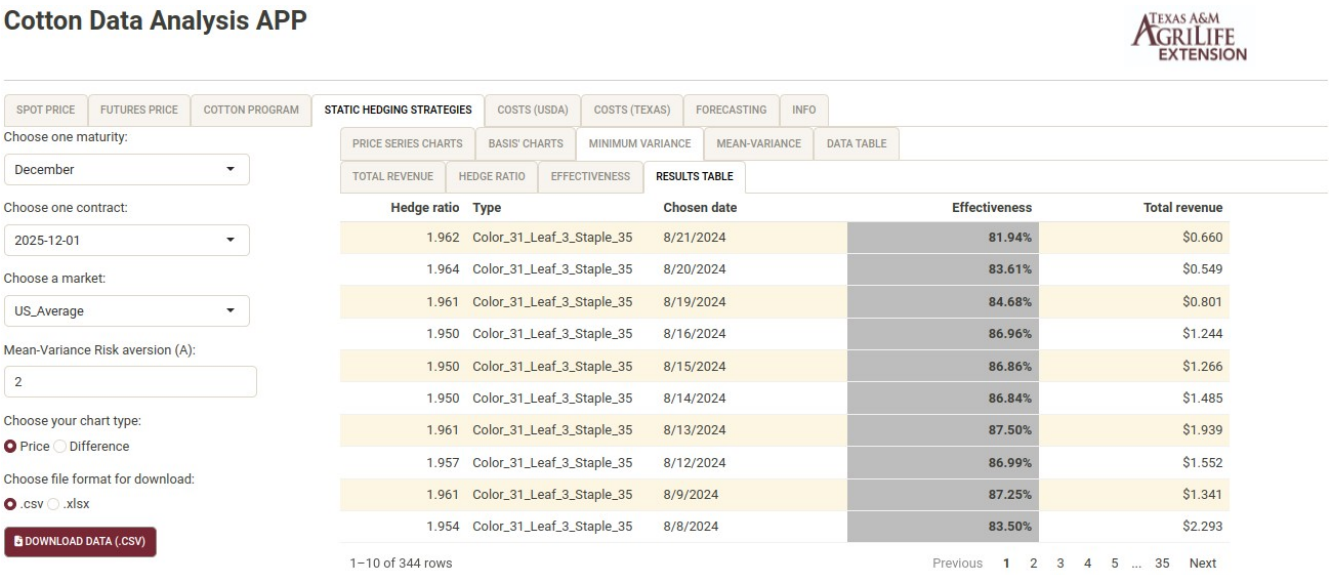
The effectiveness chart for Minimum variance / Mean-variance **allows you to**:

- obtain the effectiveness for having purchased futures contracts on a specific date.

5.3.4. Results Table

Lastly, the results table subtab has the data displayed by the subtabs in subsections 5.3.1, 5.3.2, and 5.3.3 (Figure 18). At the bottom of the table, in the left corner, you'll find the total number of observations generated from the calculations. In the right corner, there is a data paging menu. Effectiveness values are highlighted if they are 80% or higher.

Figure 18. The Results table subtab.



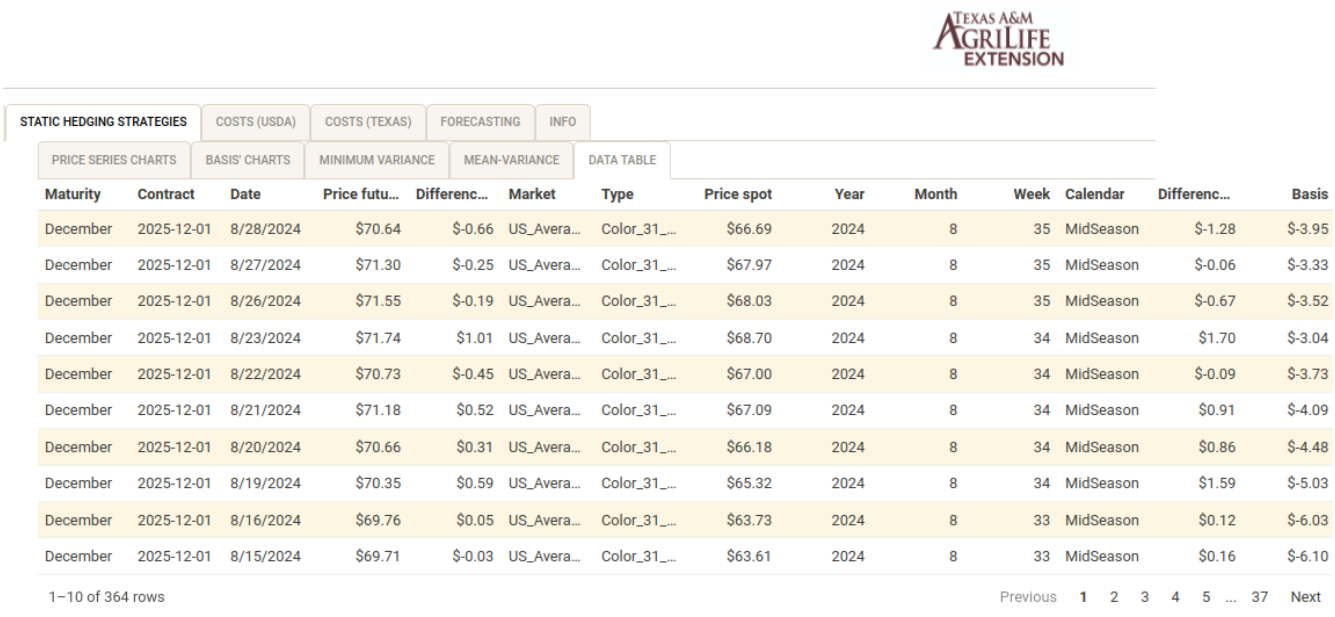
The results table for Minimum variance / Mean-variance **allows you to**:

- retrieve data relating to hedge ratio, type, chosen date, effectiveness, and total revenue.

5.4. Data Table

The data table subtab (Figure 19) displays the data utilized by the subtabs in subsections 5.1, 5.2, and 5.3. At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

Figure 19. The Data Table subtab.



The data table subtab **allows you to**:

- retrieve data relating to maturity, contract, date, price futures, difference futures, market, type, price spot, year, month, week, calendar, difference spot, and basis.

6. Costs (USDA) Tab

In Figure 20, you will find the costs (USDA) tab, which includes two subtabs: estimates and breakevens. Each subtab has its control panel and set of subtabs for viewing data. The explanation of each subtab is provided in the following sub-sections.

6.1. Estimates

Figure 20 also features the main screen of the Estimates subtab. On the left-hand side, there is a control panel where the user can select a year, category, and item. Additionally, users can download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are categorized into two subtabs: estimates chart and data table (see subsections 6.1.1 and 6.1.2). The estimates chart offers the option to adjust the color palette for color blindness. Finally, users can hover over each point to get detailed information.

Figure 20. The Costs (USDA) tab. The Estimates subtab. The Estimates chart subtab.

6.1.1. Estimates Chart

The estimates chart subtab (Figure 20) displays an interactive dot plot. It shows items for Costs listed, Operating costs, and Allocated overhead annually. By default, total listed costs, total operating costs, and total allocated costs are shown. The *USDA-ERS Cost-of-Production Forecasts* report provides estimates for all of these values twice a year.

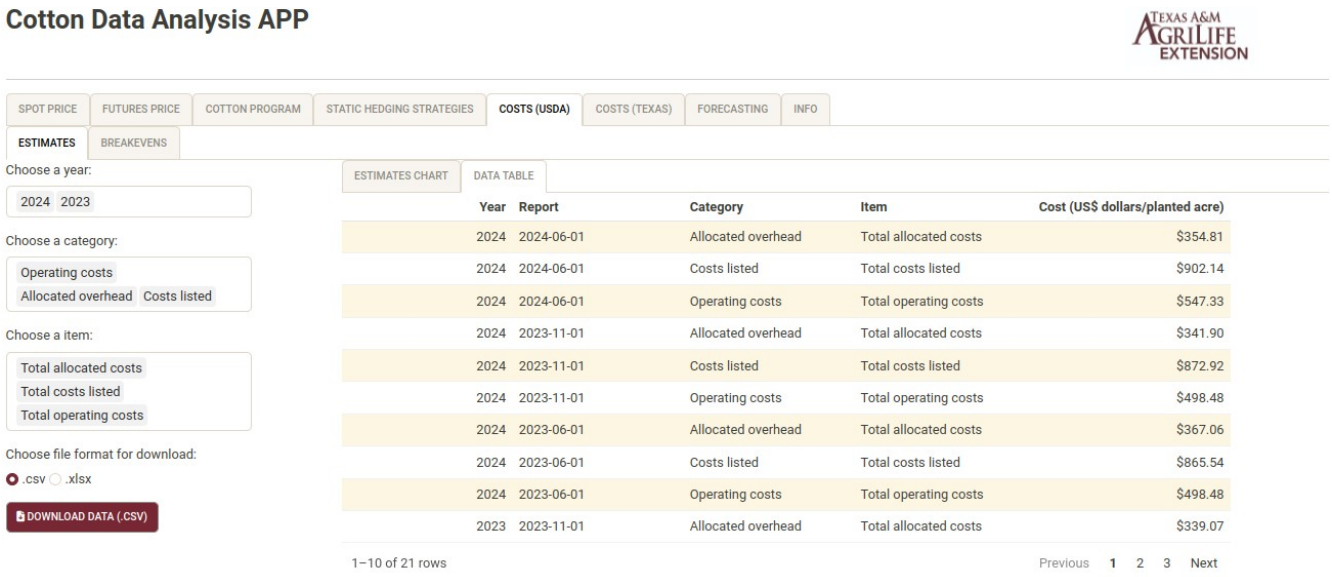
The estimates chart subtab **allows you to**:

- track the yearly changes of the items for Costs listed, Operating costs, and Allocated overhead;
- view the contribution of each item to the final composition of its respective cost category.

6.1.2. Data Table

The data table subtab (Figure 21) displays the data utilized by the subtab in subsection 6.1.1. At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

Figure 21. The Data Table subtab.



The data table subtab **allows you to**:

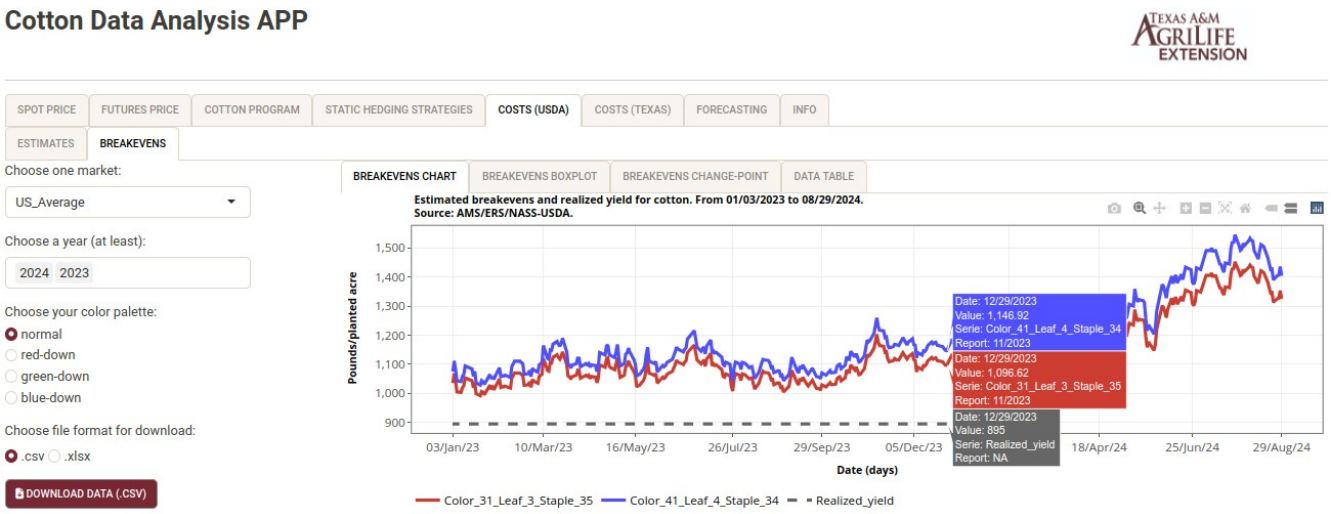
- retrieve data relating to year, report, category, item, and costs (US$ dollars/planted acre).

6.2. Breakevens

Figure 22 shows the Breakevens subtab. On the left-hand side, there is a control panel where the user can select one market, and a year. Additionally, users can adjust the color palette for color blindness and download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are categorized into four subtabs:

breakevens chart, breakevens boxplot, breakevens change-point, and data table (see subsections 6.2.1 to 6.2.4). Finally, users can hover over each point to get detailed information.

Figure 22. The Breakevens subtab. The Breakevens chart subtab.



6.2.1. Breakevens Chart

The breakevens chart subtab (Figure 22) shows an interactive line chart based on the chosen market. For the two available cotton types, the breakeven point indicates the estimated amount of cotton (in pounds per planted acre) that must be produced and sold at a specific market price (in US cents per pound) to cover all estimated costs (in US dollars per planted acre). The graph also displays annual production values provided by USDA-NASS when they are made available (see dashed gray line).

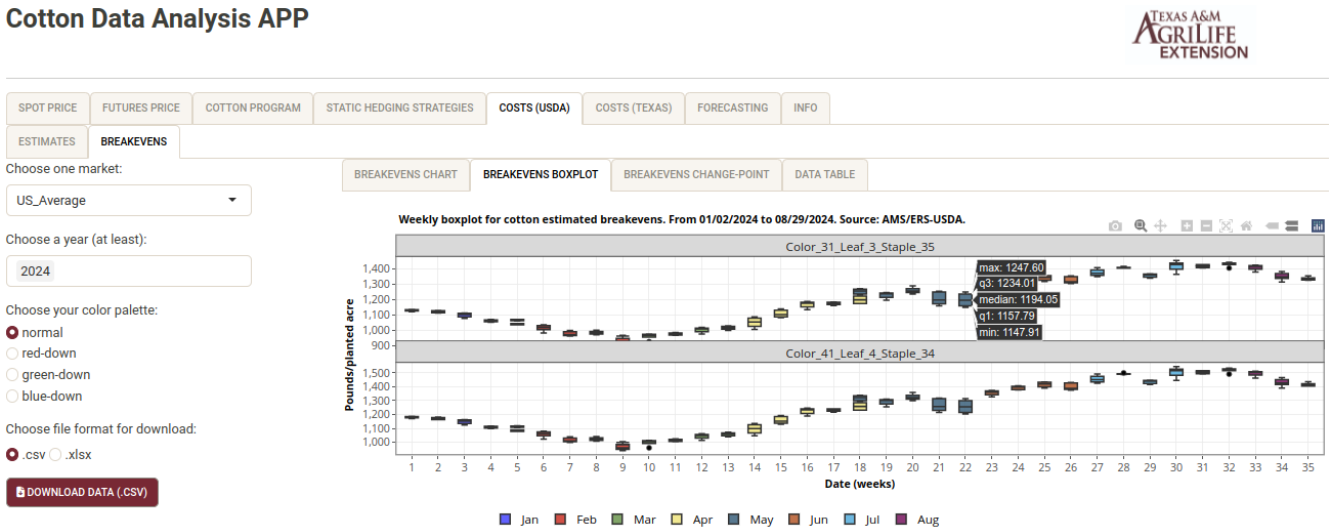
The breakevens chart chart **allows you to**:

- observe the trend evolution of the daily breakevens;
- compare whether annual production exceeded or fell short of the estimated breakeven points.

6.2.2. Breakevens Boxplot

In the breakevens boxplot subtab (Figure 23), the query result is an interactive boxplot chart showing data for the two available cotton types in a selected market. A boxplot is a standardized way of displaying a dataset using five summary numbers: the minimum, maximum, sample median, and the first and third quartiles.

Figure 23. The Breakevens boxplot subtab.



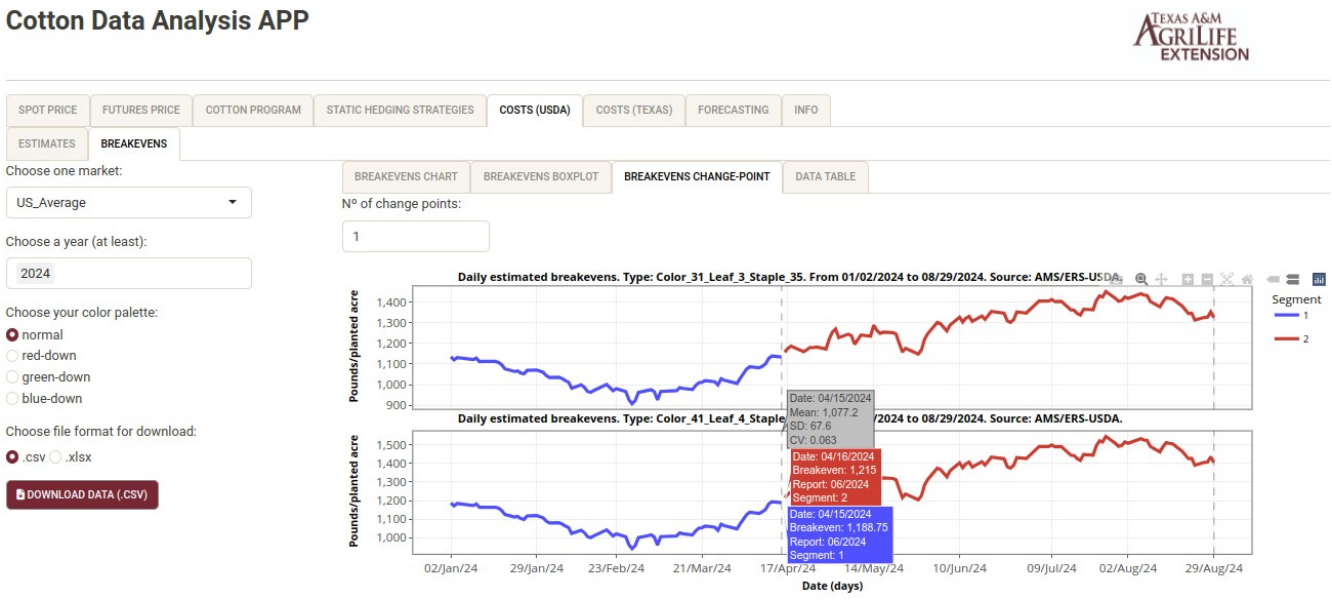
The breakevens boxplot **allows you to**:

- observe the weekly variation in breakevens, grouped by month;
- observe the trend evolution of weekly breakevens, grouped by month.

6.2.3. Breakevens Change-point

The breakevens change-point subtab (Figure 24) displays, for the two available cotton types in a selected market, an interactive line chart that shows the change points marked by vertical dashed lines in gray.

Figure 24. The Breakevens Change-point subtab.



Change point detection refers to identifying the point at which the statistical properties (such as mean and variance) of a sequence of observations (like a time series) change. This App uses the binary segmentation algorithm (Killick & Eckley, 2014) to detect up to nine change points in the cotton time series.

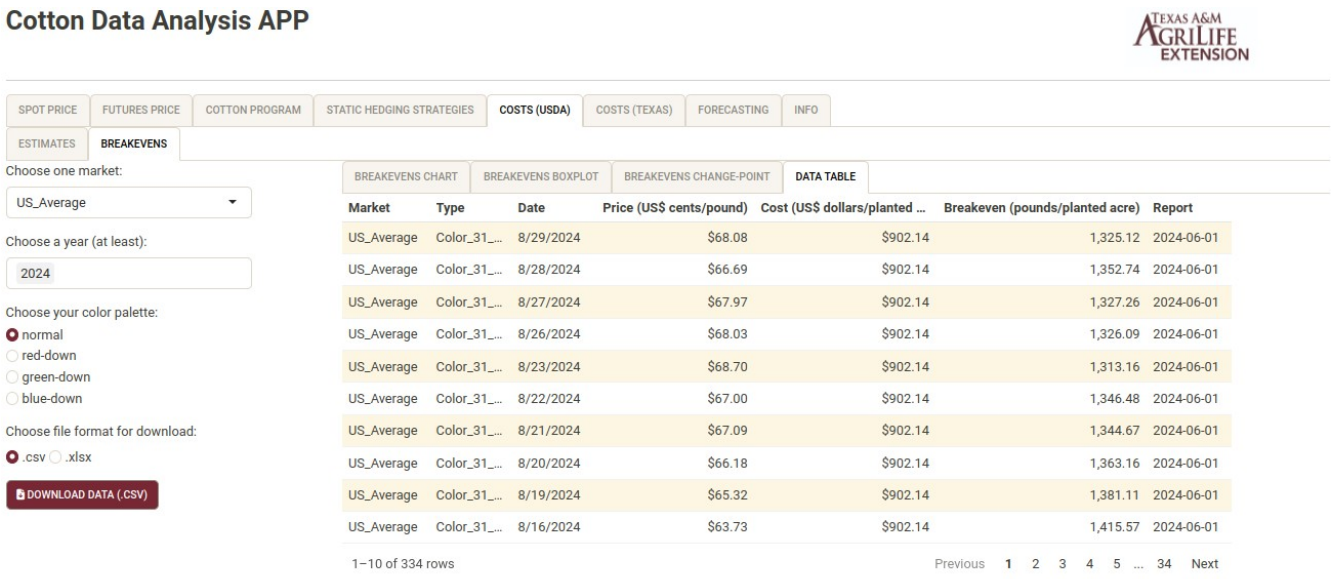
The breakeven change-point **allows you to**, for each gray dashed vertical line:

- observe the date the change point occurred;
- obtain the mean, standard deviation, and coefficient of variation of the breakeven time series before the change point.

6.2.4. Data Table

The data table subtab (Figure 25) displays the data utilized in subsections 6.2.1. to 6.2.4. At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

Figure 25. The Data Table subtab.



The data table subtab **allows you to**:

- retrieve data relating to market, type, date, price (US$ cents/pound), cost (US$ dollars/planted acre), breakeven (pounds/planted acre), and report.

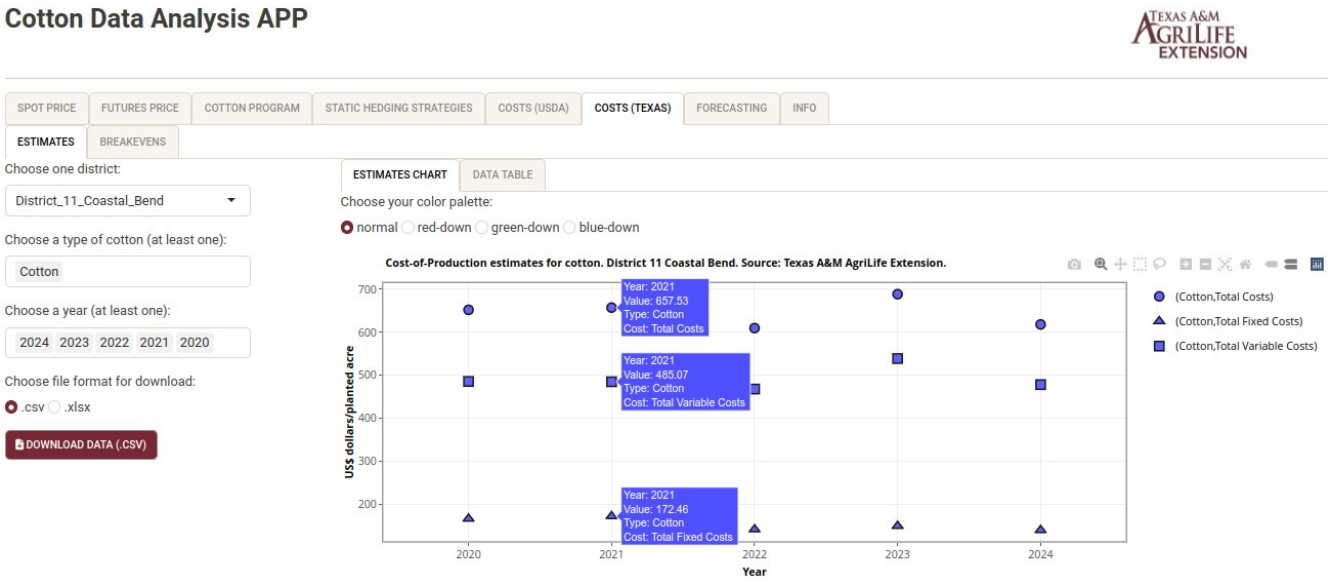
7. Costs (Texas) Tab

In Figure 26, you will find the costs (Texas) tab, which includes two subtabs: estimates and breakevens. Each subtab has its control panel and set of subtabs for viewing data. The explanation of each subtab is provided in the following sub-sections.

7.1. Estimates

Figure 26 also features the main screen of the Estimates subtab. On the left-hand side, there is a control panel where the user can select one district, a type of cotton, and a year. Users can download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are categorized into two subtabs: estimates chart and data table (see subsections 7.1.1 and 7.1.2). The estimates chart offers the option to adjust the color palette for color blindness. Finally, users can hover over each point to get detailed information.

Figure 26. The Costs (Texas) tab. The Estimates subtab. The Estimates chart subtab.



7.1.1. Estimates Chart

The estimates chart subtab (Figure 26) displays an interactive dot plot. It shows Total costs, Total fixed costs, and Total variable costs by district and type of cotton annually. The Texas A&M Department of Agricultural Economics – Extension Agricultural Economics provides estimates for all of these values once a year.

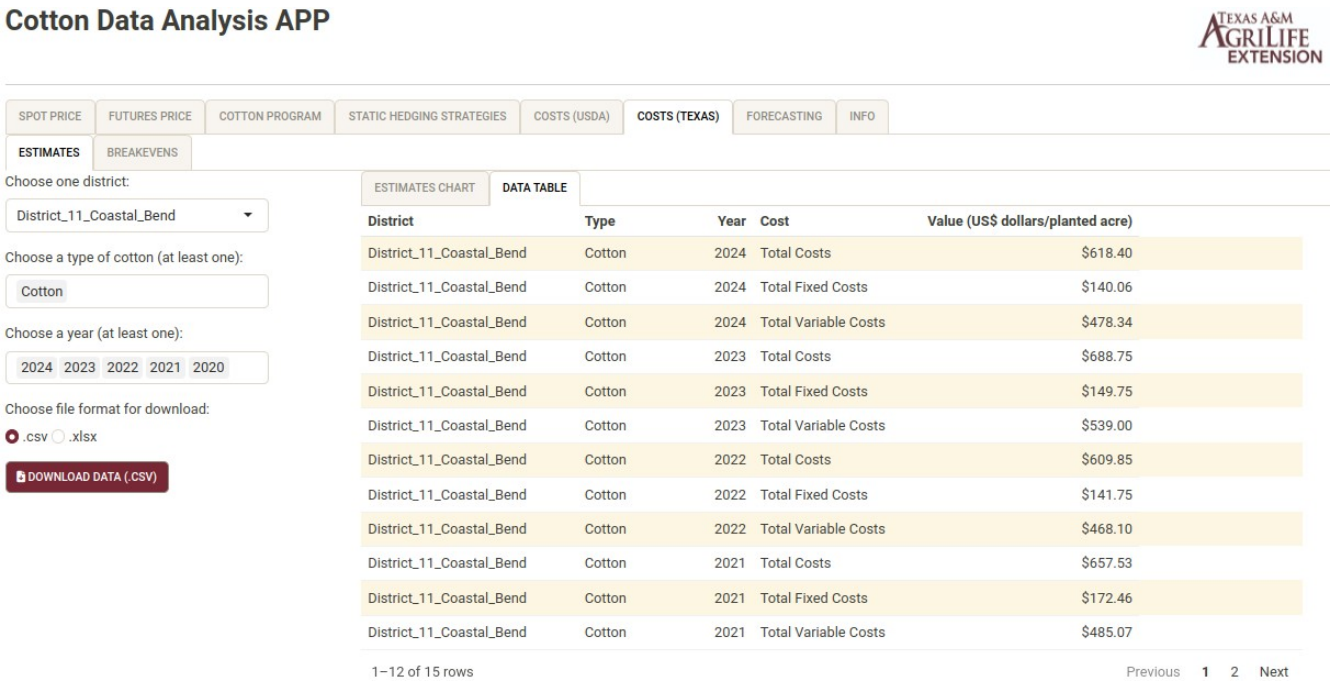
The estimates chart subtab **allows you to**:

- track the yearly changes of the total costs, total fixed costs, and total variable costs by district and type of cotton;
- analyze the contribution of both total fixed costs and total variable costs to the total costs.

7.1.2. Data Table

The data table subtab (Figure 27) displays the data utilized by the subtab in subsection 7.1.1. At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

Figure 27. The Data Table subtab.



The data table subtab **allows you to**:

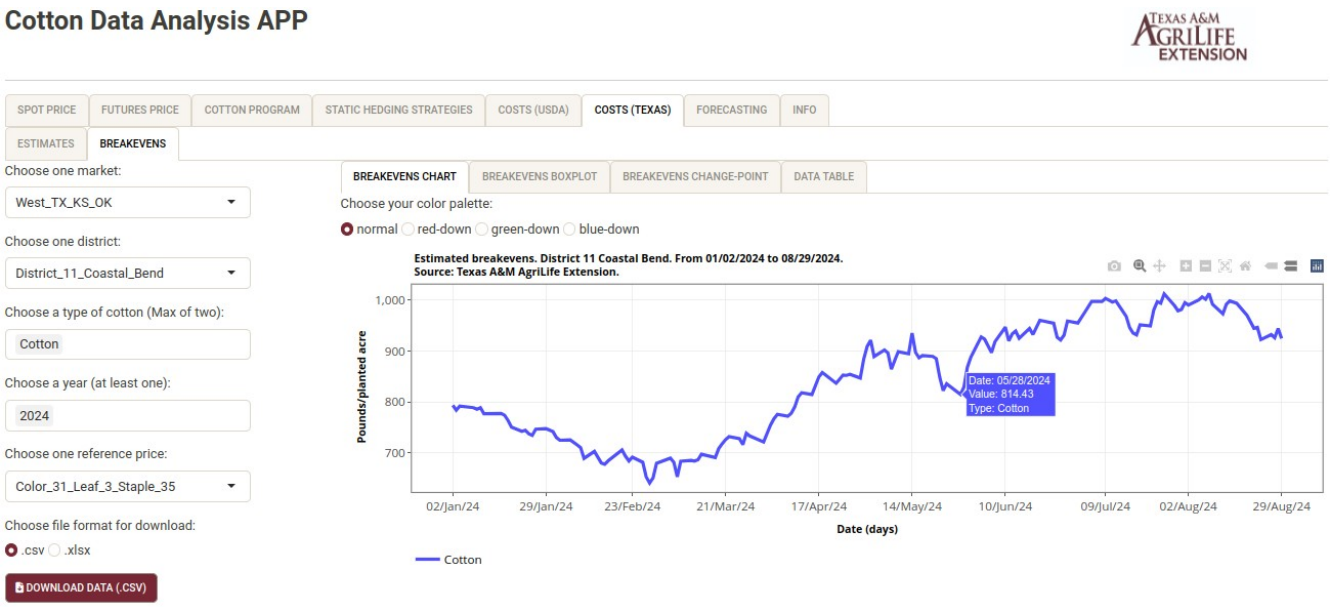
- retrieve data relating to district, type, year, cost, and value (US$ dollars/planted acre).

7.2. Breakevens

Figure 28 shows the Breakevens subtab. On the left-hand side, there is a control panel where the user can select one market, one district, a type of cotton, a year, and a reference

price. Users can adjust the color palette for color blindness and download the data in `.csv` or `.xlsx` formats. The query results are displayed on the right-hand side and are categorized into four subtabs: breakevens chart, breakevens boxplot, breakevens change-point, and data table (see subsections 7.2.1 to 7.2.4). Finally, users can hover over each point to get detailed information.

Figure 28. The Breakevens subtab. The Breakevens chart subtab.



7.2.1. Breakevens Chart

The breakevens chart subtab (Figure 28) shows an interactive line chart based on the chosen market, district, type of cotton, and reference price. The breakeven point indicates the estimated amount of cotton (in pounds per planted acre) that must be produced and sold at a specific market price (in US cents per pound) to cover all estimated costs (in US dollars per planted acre).

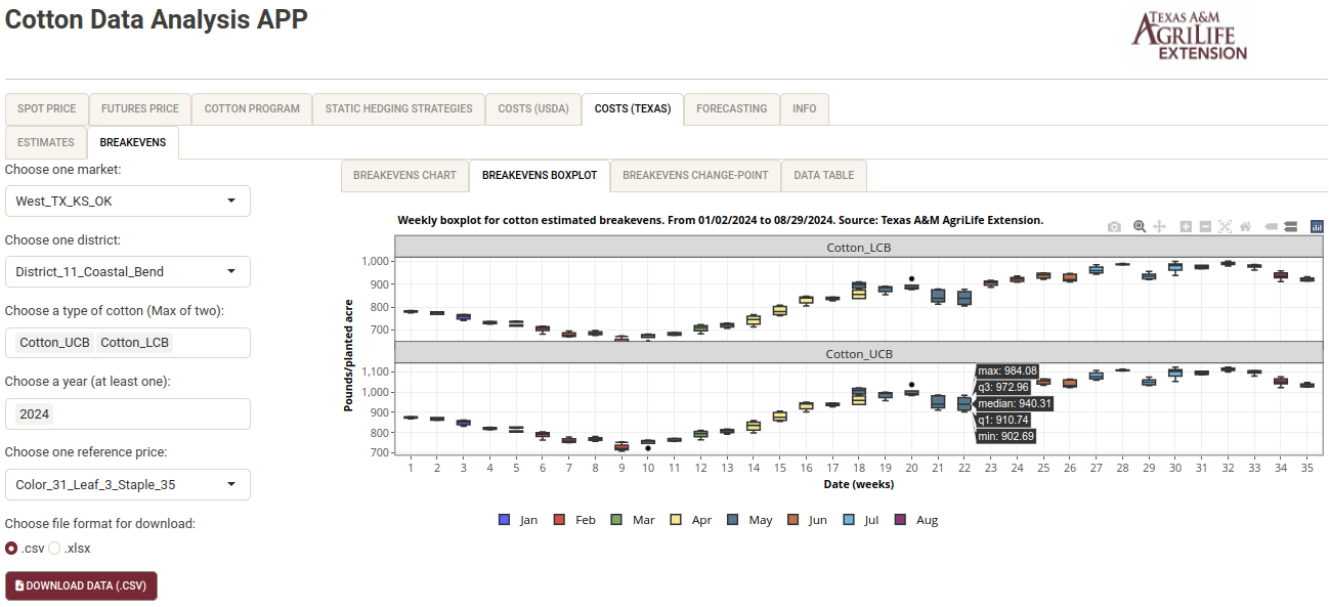
The breakevens chart chart **allows you to**:

- observe the trend evolution of the daily breakevens;
- compare whether annual production, when available, exceeded or fell short of the estimated breakeven points.

7.2.2. Breakevens Boxplot

In the breakevens boxplot subtab (Figure 29), the query result is an interactive boxplot chart showing data for the maximum of two available cotton types in a selected district. A boxplot is a standardized way of displaying a dataset using five summary numbers: the minimum, maximum, sample median, and the first and third quartiles.

Figure 29. The Breakevens boxplot subtab.



The breakevens boxplot **allows you to**:

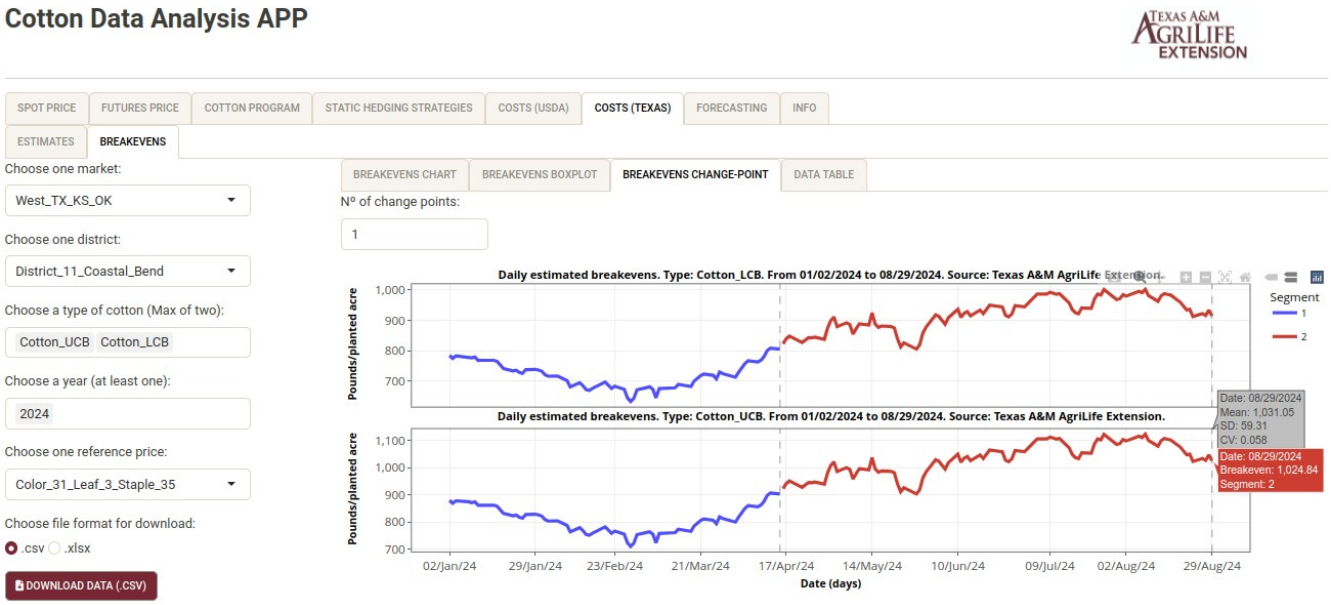
- observe the weekly variation in breakevens, grouped by month;
- observe the trend evolution of weekly breakevens, grouped by month.

7.2.3. Breakevens Change-point

The breakevens change-point subtab (Figure 30) displays, for the two available cotton types in a selected market, an interactive line chart that shows the change points marked by vertical dashed lines in gray.

Change point detection refers to identifying the point at which the statistical properties (such as mean and variance) of a sequence of observations (like a time series) change. This App uses the binary segmentation algorithm (Killick & Eckley, 2014)to detect up to nine change points in the cotton time series.

Figure 30. The Breakevens Change-point subtab.

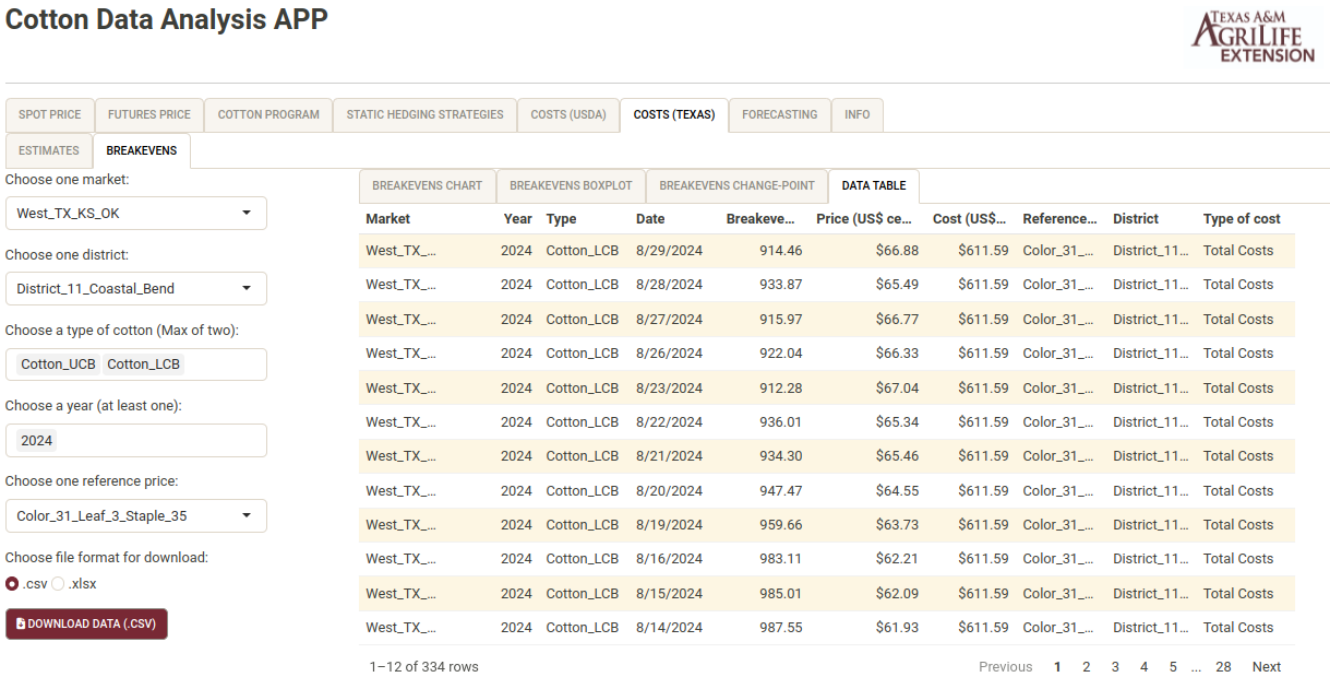


The breakeven change-point **allows you to**, for each gray dashed vertical line:

- observe the date the change point occurred;
- obtain the mean, standard deviation, and coefficient of variation of the breakeven time series before the change point.

7.2.4. Data Table

Figure 31. The Data Table subtab.



The data table subtab (Figure 31) displays the data utilized in subsections 7.2.1. to 7.2.4. At the bottom of the table, in the left corner, you'll find the total number of observations generated from the query. In the right corner, there is a data paging menu.

The data table subtab **allows you to**:

- retrieve data relating to market, year, type, date, breakeven (pounds/planted acre), price (US$ cents/pound), cost (US$ dollars/planted acre), reference price, district, and type of cost.

8. Forecasting Tab

The forecasting tab lets you predict spot and futures prices, basis, and breakeven (USDA and Texas), shown in Figure 32.

Figure 32. The Forecasting tab. The Spot Price subtab. The Forecast chart subtab.

Each option has its control panel, which is displayed on the left-hand side of their respective subtabs:

- **Spot price and Breakevens (USDA):** you can select a market, the year to predict, the years to build the model (minimum of three), the number of cores for parallel processing (maximum of two cores if needed) and the type of prediction (monthly, quarterly, semi-annual, yearly);
- **Futures price**: you can select a maturity, one contract, and the number of cores for parallel processing (maximum of two cores if needed). It only performs monthly predictions;
- **Basis**: you can select one maturity, one contract, a market, and the number of cores for parallel processing (maximum of two cores if needed). It only performs monthly predictions;
- **Breakevens (Texas)**: you can select one market, one district, one type of cotton, the year to predict, the years to build the model (minimum of three), the number of cores

for parallel processing (maximum of two cores if needed) and the type of prediction (monthly, quarterly, semi-annual, yearly);

Please keep in mind the following information: for spot price and breakevens (USDA and Texas), it is important to note that all types of predictions are available only for the current year. For previous years, the App only calculates yearly predictions. Additionally, we recommend selecting only two cores if the calculation time exceeds one minute.

After setting up your preferences, simply click the "forecast!" button. The results will be displayed in three subtabs on the right-hand side: forecast chart, forecast metrics, and console. These three subtabs are available for all forecast options. The explanation of each subtab is provided in the following sub-sections.

8.1. Forecast Chart

Figure 32 also displays the forecast chart subtab. It presents the current value (dark blue – ACTUAL), the value to predict (cyan – TARGET), the predicted value, and the prediction range (red – MODEL). You can hover over each point to get detailed information.

The forecast chart subtab **allows you to**:

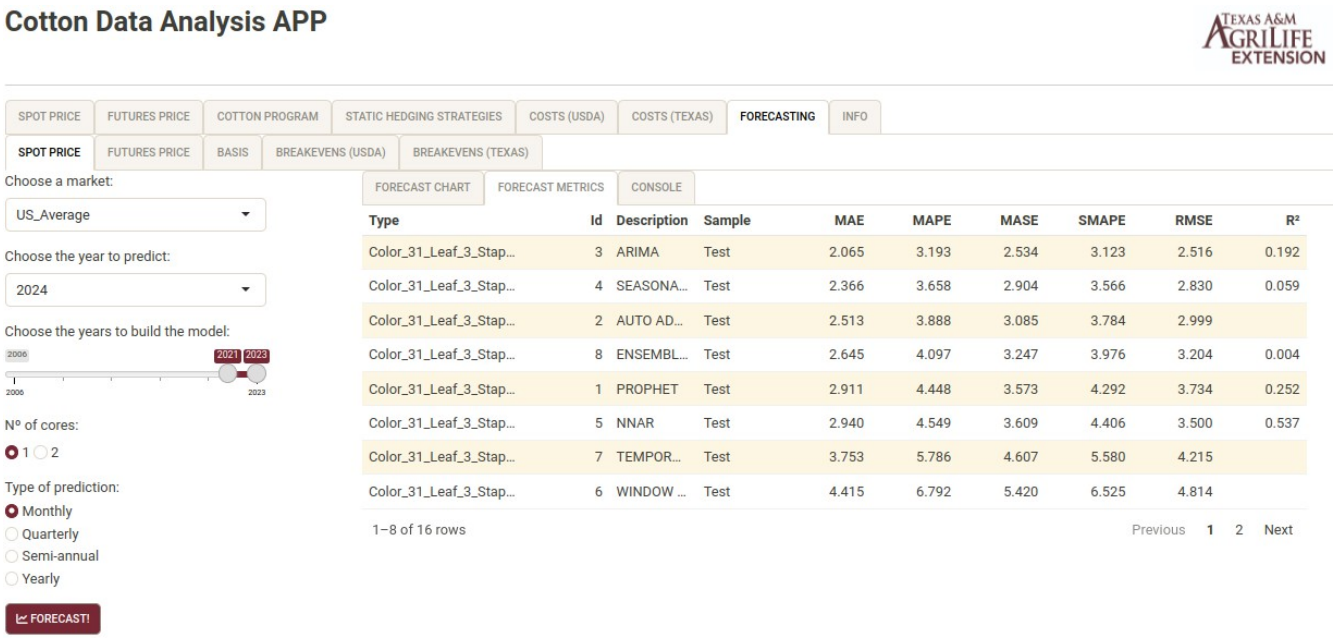
- Forecast time series values for spot and futures prices, basis, and breakeven points (USDA and Texas) on a monthly, quarterly, semiannual, and annual basis;
- Visually inspect whether the predicted values are within the estimated prediction range.

8.2. Forecast Metrics

Figure 33 illustrates the forecasting metrics. The application evaluates eight types of forecasting models and selects the model with the lowest Mean Absolute Scaled Error (MASE). The App also shows the following metrics: Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Symmetric Mean Absolute Percentage Error (SMAPE), Root Mean Squared Error (RMSE), and Coefficient of determination (R^2).

The models tested are ARIMA, Seasonal Decomposition, NNAR, Window Function (Dancho, 2024a; Hyndman & Athanasopoulos, 2021), Prophet (Taylor & Letham, 2021), Auto ADAM (Svetunkov, 2024), Hierarchical Temporal Forecasting (Athanasopoulos et al., 2017), and Ensemble [Median] (Dancho, 2024b).

Figure 33. The Forecast metrics subtab.



The forecast metrics subtab **allows you to**:

- retrieve data relating to type, id, description, sample, MAE, MAPE, MASE, SMAPE, RMSE, and R^2.

8.3. Console

Figure 34. The Console subtab.

The console subtab (Figure 34) displays the results of the processing to obtain the forecast models. It provides details on the time spent calculating and selecting the best model for forecasting the specific time series.

The console subtab **allows you to**:

- retrieve information about which models have been enabled to perform time series forecasting;
- get the processing time of the models and the time to select the best forecasting model for the time series;
- obtain additional information about the parameterization of the best-chosen model.

References

Athanasopoulos, G., Hyndman, R. J., Kourentzes, N., & Petropoulos, F. (2017). Forecasting with temporal hierarchies. *European Journal of Operational Research*, *262*(1), 60–74. https://doi.org/10.1016/j.ejor.2017.02.046

Dancho, M. (2024a). *modeltime: The Tidymodels Extension for Time Series Modeling* (R package version 1.3.0). https://business-science.github.io/modeltime/

Dancho, M. (2024b). *modeltime.ensemble: Ensemble Algorithms for Time Series Forecasting with Modeltime* (R package version 1.0.4). https://business-science.github.io/modeltime.ensemble/

Hyndman, R. J., & Athanasopoulos, G. (2021). *Forecasting: principles and practice* (3rd ed.). OTexts. https://otexts.com/fpp3/

Killick, R., & Eckley, I. A. (2014). changepoint : An R Package for Changepoint Analysis. *Journal of Statistical Software*, *58*(3). https://doi.org/10.18637/jss.v058.i03

Lee, J., Chang, J.-R., Kao, L.-J., & Lee, C.-F. (2023). *Essentials of Excel VBA, Python, and R. Volume II: Financial Derivatives, Risk Management and Machine Learning*. Springer International Publishing. https://doi.org/10.1007/978-3-031-14283-3

Svetunkov, I. (2024). *smooth: Forecasting Using State Space Models* (R package version 4.0.2). https://openforecast.org/adam/

Taylor, S., & Letham, B. (2021). *prophet: Automatic Forecasting Procedure* (R package version 1.0). https://github.com/facebook/prophet