Strawberry chemicals EDA

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Input cleaned data

```
straw_ca <- read.csv("survey_ca_chem.csv")
straw_flo <- read.csv("survey_flo_chem.csv")
```

After the data cleaning, compare to the data in California which contain 1238 observations, there are only 207 observations in Florida. This unbalanced dataset may be caused by some reasons such as Agricultural Scale Differences, Sampling Differences, and Data Availability or Reporting.

Descriptive statistics

```
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```r
library(knitr)
library(kableExtra)
```

```
Attaching package: 'kableExtra'

The following object is masked from 'package:dplyr':

    group_rows
```

```r
straw_ca_lb <- straw_ca %>%
  filter(measure == "MEASURED IN LB") %>%
  filter(mkt == "BEARING - APPLICATIONS")
straw_ca_lb %>%
  pull(Value) %>%
  summary()
```

```
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max. 
     100     1300     3400   313658    10800 15611900 
```

```r
straw_flo_lb <- straw_flo %>%
  filter(measure == "MEASURED IN LB") %>%
    filter(mkt == "BEARING - APPLICATIONS")
straw_flo_lb %>%
  pull(Value) %>%
  summary()
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
    100     600    5100   45149   54800  303200 
```

```r
chemicals_ca <- unique(straw_ca$Name)
num_cols <- 5
num_rows <- ceiling(length(chemicals_ca) / num_cols)
chemicals_ca_padded <- c(chemicals_ca,
                         rep(NA, (num_rows * num_cols) -
                               length(chemicals_ca)))
chemicals_ca_matrix <- matrix(chemicals_ca_padded, ncol = num_cols,
                              byrow = TRUE)
kable(chemicals_ca_matrix, col.names = rep("Names", num_cols),
      caption = "California Chemicals") %>%
  kable_styling(font_size = 8)
```

Table 1: California Chemicals

Names	Names	Names	Names	Names
AZOXYSTROBIN	NA	BOSCALID	CAPTAN	CYPRODINIL
FENHEXAMID	FLUDIOXONIL	FLUOPYRAM	FLUXAPYROXAD	MEFENOXAM
MYCLOBUTANIL	PENTHIOPYRAD	PROPICONAZOLE	PYRACLOSTROBIN	PYRIMETHANIL
QUINOLINE	SULFUR	TETRACONAZOLE	THIRAM	TRIFLOXYSTROBIN
FLUMIOXAZIN	PENDIMETHALIN	ABAMECTIN	ACEQUINOCYL	ACETAMIPRID
AZADIRACHTIN	BIFENAZATE	BIFENTHRIN	CHLORANTRANILIPROLE	CYANTRANILIPROLE
CYFLUMETOFEN	FENPROPATHRIN	FLONICAMID	FLUPYRADIFURONE	HEXYTHIAZOX
IMIDACLOPRID	MALATHION	METHOXYFENOZIDE	NOVALURON	SPINETORAM
SPINOSAD	THIAMETHOXAM	CHLOROPICRIN	DICHLOROPROPENE	FLUTRIAFOL
CYFLUFENAMID	TRIFLUMIZOLE	OXYFLUORFEN	FENPYROXIMATE	NALED
PYRETHRINS	SPIROMESIFEN	BLAD	DIFENOCONAZOLE	ETOXAZOLE
PYRIPROXYFEN	SULFOXAFLOR	NA	NA	NA

```
chemicals_flo <- unique(straw_flo$Name)
kable(data.frame(chemicals_flo), col.names = "Florida Chemicals",
      caption = "Florida Chemicals") %>%
   kable_styling(font_size = 10)
```

Table 2: Florida Chemicals

Florida Chemicals
AZOXYSTROBIN
CAPTAN
CYPRODINIL
FLUDIOXONIL
THIRAM
NA
ABAMECTIN
ACETAMIPRID
BIFENTHRIN
CHLORANTRANILIPROLE
NOVALURON
THIAMETHOXAM
SPINETORAM
BIFENAZATE

```
chemicals_ca <- unique(straw_ca$Name)
chemicals_flo <- unique(straw_flo$Name)
chemicals_only_in_ca <- setdiff(chemicals_ca, chemicals_flo)
chemicals_table <- data.frame(Chemicals_Only_In_CA = chemicals_only_in_ca)
```

```
chemicals_table_split <- matrix(chemicals_table$Chemicals_Only_In_CA,
                                ncol = 4, byrow = TRUE)
kable(chemicals_table_split, col.names = rep("Chemical Name", 4),
      caption = "Chemicals Found in California but not in Florida") %>%
   kable_styling(font_size = 10)
```

Table 3: Chemicals Found in California but not in Florida

Chemical Name	Chemical Name	Chemical Name	Chemical Name
BOSCALID	FENHEXAMID	FLUOPYRAM	FLUXAPYROXAD
MEFENOXAM	MYCLOBUTANIL	PENTHIOPYRAD	PROPICONAZOLE
PYRACLOSTROBIN	PYRIMETHANIL	QUINOLINE	SULFUR
TETRACONAZOLE	TRIFLOXYSTROBIN	FLUMIOXAZIN	PENDIMETHALIN
ACEQUINOCYL	AZADIRACHTIN	CYANTRANILIPROLE	CYFLUMETOFEN
FENPROPATHRIN	FLONICAMID	FLUPYRADIFURONE	HEXYTHIAZOX
IMIDACLOPRID	MALATHION	METHOXYFENOZIDE	SPINOSAD
CHLOROPICRIN	DICHLOROPROPENE	FLUTRIAFOL	CYFLUFENAMID
TRIFLUMIZOLE	OXYFLUORFEN	FENPYROXIMATE	NALED
PYRETHRINS	SPIROMESIFEN	BLAD	DIFENOCONAZOLE
ETOXAZOLE	PYRIPROXYFEN	SULFOXAFLOR	BOSCALID

```
chemicals_ca_lb <- unique(straw_ca_lb$Name)
chemicals_flo_lb <- unique(straw_flo_lb$Name)
common_chemicals <- intersect(chemicals_ca_lb, chemicals_flo_lb)
num_rows <- ceiling(length(common_chemicals) / 2)
common_chemicals_matrix <- matrix(c(common_chemicals,
  rep(NA, (num_rows * 2) - length(common_chemicals))),
  ncol = 2, byrow = TRUE)
kable(common_chemicals_matrix,
      col.names = c("Common Chemicals ", "Common Chemicals"),
      caption = "Common Chemicals in California and Florida (LB)") %>%
  kable_styling(font_size = 10)
```

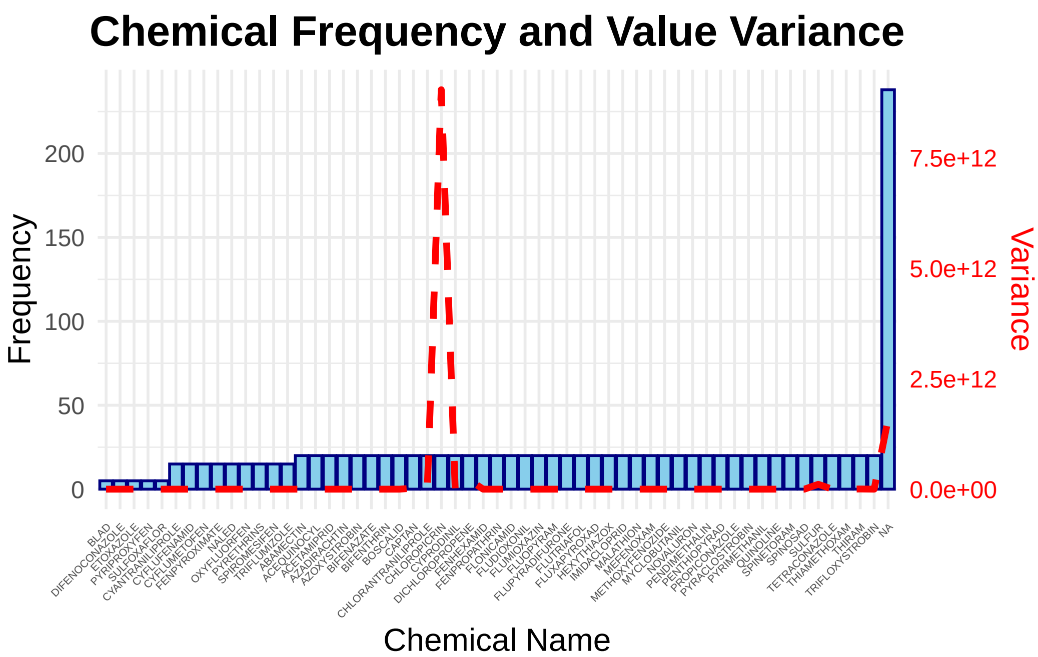
Table 4: Common Chemicals in California and Florida (LB)

Common Chemicals	Common Chemicals
AZOXYSTROBIN	NA
CAPTAN	CYPRODINIL
FLUDIOXONIL	THIRAM
ABAMECTIN	ACETAMIPRID
BIFENAZATE	BIFENTHRIN

CHLORANTRANILIPROLE	NOVALURON
SPINETORAM	THIAMETHOXAM

In this report, we focus on the BEARING - APPLICATIONS group, since it contain larger data. It is obvious that the weight usage of chemicals in pounds (LB) differs between the two states. In total, the average of chemicals weight measured in lb in California (313,658) is larger than that in Florida(45,149). In addition, there are 57 kinds of chemicals are used in California, but only 14 kinds in Florida. ## Distribution of chemicals in two State

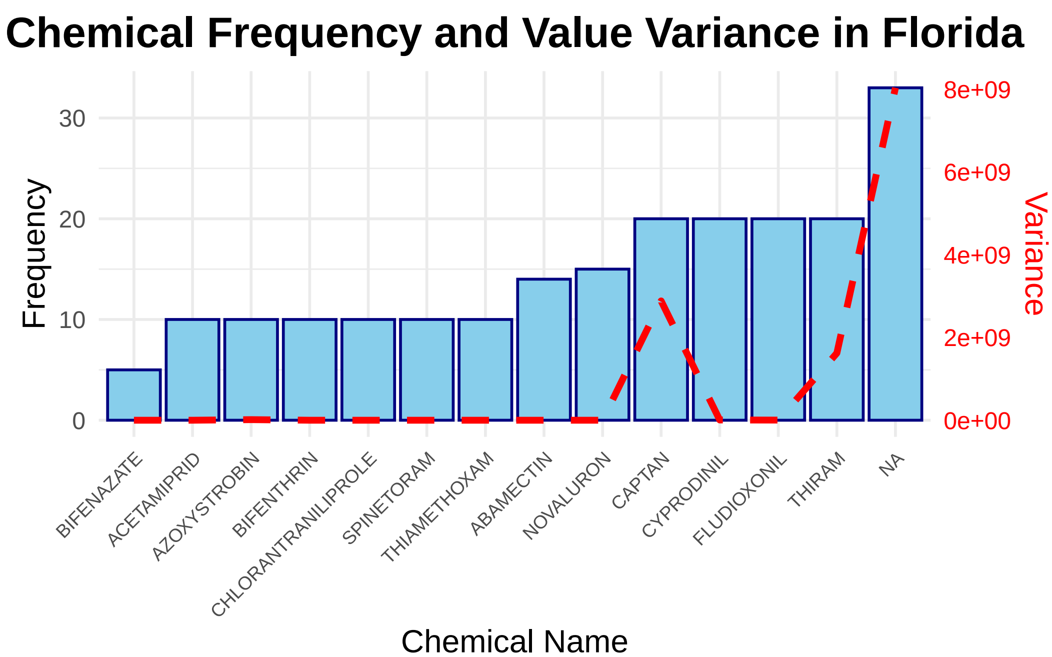
```
library(dplyr)
library(ggplot2)
chemical_summary <- straw_ca %>%
  group_by(Name) %>%
  summarise(
    Frequency = n(),
    Variance = var(Value)
  )
max_frequency <- max(chemical_summary$Frequency)
max_variance <- max(chemical_summary$Variance)
ggplot(chemical_summary, aes(x = reorder(Name, Frequency), y = Frequency)) +
  geom_bar(stat = "identity", fill = "skyblue", color = "navy") +
  geom_line(aes(y = Variance * max_frequency / max_variance),
            color = "red", linetype = "dashed", group = 1, linewidth = 1.2) +
  labs(
    title = "Chemical Frequency and Value Variance",
    x = "Chemical Name",
    y = "Frequency"
  ) +
  scale_y_continuous(
    sec.axis = sec_axis(~ . * max_variance / max_frequency,
                        name = "Variance")
  ) +
  theme_minimal() +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1, size = 4),
    axis.title.y = element_text(size = 12),
    axis.title.x = element_text(size = 12),
    plot.title = element_text(hjust = 0.5, size = 16, face = "bold"),
    axis.text.y.right = element_text(color = "red"),
    axis.title.y.right = element_text(color = "red", size = 12)
  )
```



This graph represents how often each chemical used in California and the variance (red dashed line, right Y-axis) of the Value in pounds of usage, indicates how much the recorded values for each chemical fluctuate. The chemicals in the middle appear consistently across records but with lower frequencies. However there are 238 observations without chemical names. The chemical named CHLOROPICRIN has the biggest variance.

```
library(dplyr)
library(ggplot2)
chemical_summary_flo <- straw_flo %>%
  group_by(Name) %>%
  summarise(
    Frequency = n(),
    Variance = var(Value)
  )
max_frequency_flo <- max(chemical_summary_flo$Frequency)
max_variance_flo <- max(chemical_summary_flo$Variance)
ggplot(chemical_summary_flo, aes(x = reorder(Name, Frequency),
                                  y = Frequency)) +
  geom_bar(stat = "identity", fill = "skyblue", color = "navy") +
  geom_line(aes(y = Variance * max_frequency_flo / max_variance_flo),
            color = "red", linetype = "dashed", group = 1,
            linewidth = 1.2) +
  labs(
```

```
    title = "Chemical Frequency and Value Variance in Florida",
    x = "Chemical Name",
    y = "Frequency"
  ) +
  scale_y_continuous(
    sec.axis = sec_axis(~ . * max_variance_flo / max_frequency_flo,
                        name = "Variance")
  ) +
  theme_minimal() +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1, size = 7),
    axis.title.y = element_text(size = 12),
    axis.title.x = element_text(size = 12),
    plot.title = element_text(hjust = 0.5, size = 16, face = "bold"),
    axis.text.y.right = element_text(color = "red"),
    axis.title.y.right = element_text(color = "red", size = 12)
  )
```



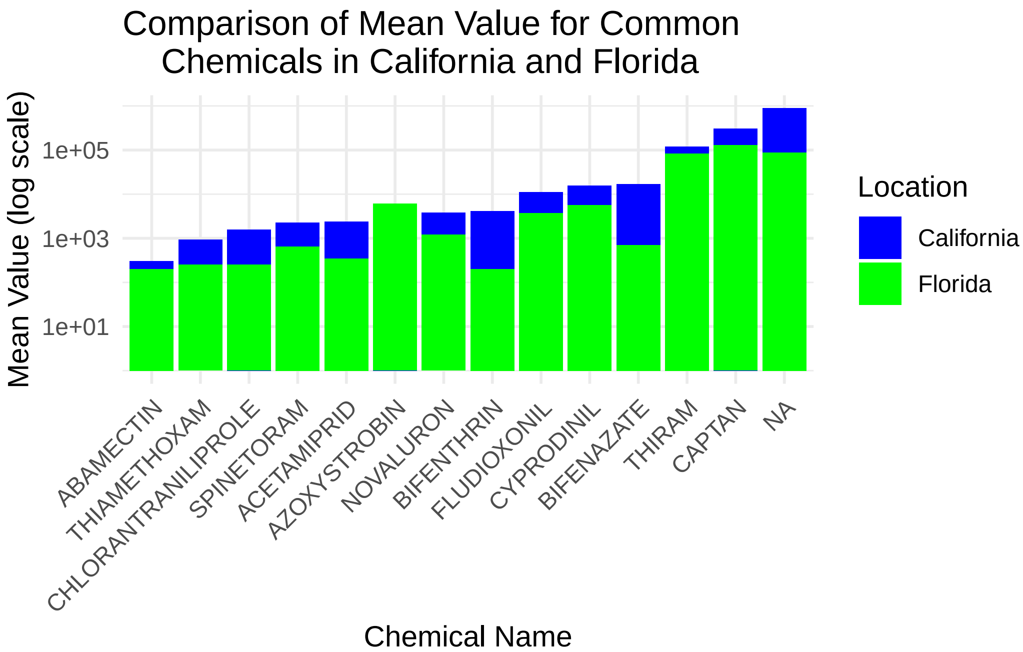
Similarly, here is the distribution of chemical usage in Florida. The BIFENAZATE is the least popular one used here, and as still most of chemicals are used without specific name.

```r
library(dplyr)
library(ggplot2)
common_chemicals <- intersect(chemicals_ca_lb, chemicals_flo_lb)
straw_ca_common <- straw_ca_lb %>%
  filter(Name %in% common_chemicals)
straw_flo_common <- straw_flo_lb %>%
  filter(Name %in% common_chemicals)

ca_mean_values <- straw_ca_common %>%
  group_by(Name) %>%
  summarise(Mean_Value_CA = mean(Value))
flo_mean_values <- straw_flo_common %>%
  group_by(Name) %>%
  summarise(Mean_Value_FLO = mean(Value))

mean_values_comparison <- merge(ca_mean_values,
                                flo_mean_values, by = "Name")

ggplot(mean_values_comparison, aes(x = reorder(Name, Mean_Value_CA))) +
  geom_bar(aes(y = Mean_Value_CA, fill = "California"), stat = "identity",
           position = "dodge") +
  geom_bar(aes(y = Mean_Value_FLO, fill = "Florida"), stat = "identity",
           position = "dodge") +
  labs(
    title = "Comparison of Mean Value for Common
    Chemicals in California and Florida",
    x = "Chemical Name",
    y = "Mean Value (log scale)"
  ) +
  scale_y_log10() +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  scale_fill_manual(name = "Location", values = c("California" = "blue",
                                                  "Florida" = "green"))
```

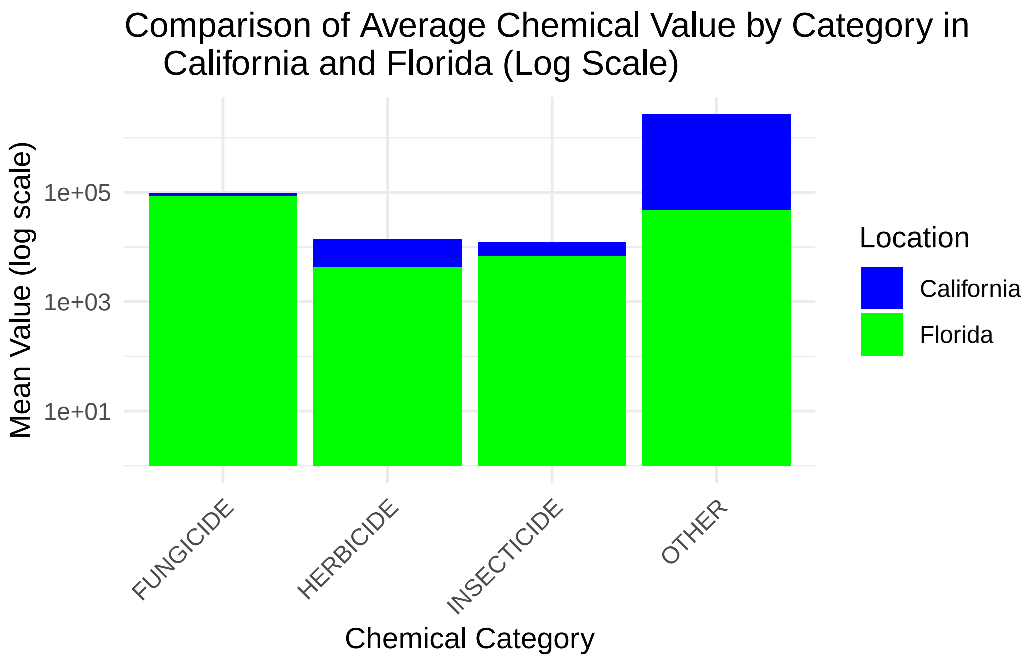


For the chemicals in common in two places, there is a graph about the comparison of their average usage in pounds (scaled by log). It shows that although there are more types of chemicals used in California, the usage in Florida is larger than that of California.

```r
library(dplyr)
library(ggplot2)
ca_category_value <- straw_ca_lb %>%
  group_by(col2) %>%
  summarise(Mean_Value_CA = mean(Value, na.rm = TRUE))
flo_category_value <- straw_flo_lb %>%
  group_by(col2) %>%
  summarise(Mean_Value_FLO = mean(Value, na.rm = TRUE))

category_value_comparison <- merge(ca_category_value, flo_category_value,
                                   by = "col2", all = TRUE)
ggplot(category_value_comparison, aes(x = col2)) +
  geom_bar(aes(y = Mean_Value_CA, fill = "California"), stat = "identity",
           position = "dodge") +
  geom_bar(aes(y = Mean_Value_FLO, fill = "Florida"), stat = "identity",
           position = "dodge") +
  labs(
    title = "Comparison of Average Chemical Value by Category in
    California and Florida (Log Scale)",
```

```
    x = "Chemical Category",
    y = "Mean Value (log scale)"
  ) +
  scale_y_log10() +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  scale_fill_manual(name = "Location", values = c("California" = "blue",
                                                    "Florida" = "green"))
```

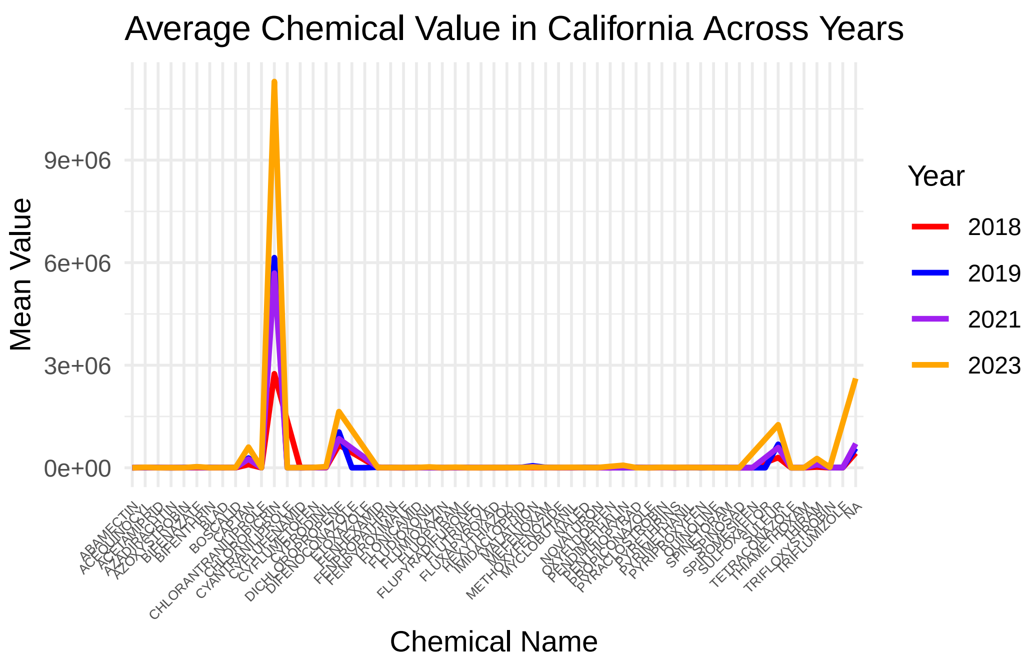


This bar chart compares the mean chemical values for different chemical types between California and Florida. The Y-axis represents the mean values on a logarithmic scale. In California, the mean value for fungicides is higher than in Florida. The difference between the two regions is small, but the logarithmic scale reveals that California has a slightly higher average fungicide usage than Florida. California appears to rely more heavily on chemicals classified as "OTHER" compared to Florida, which could indicate a different approach to managing crops or different environmental or regulatory needs. The relatively similar usage of fungicides and insecticides between the two states suggests some shared agricultural practices or similar pest management strategies.

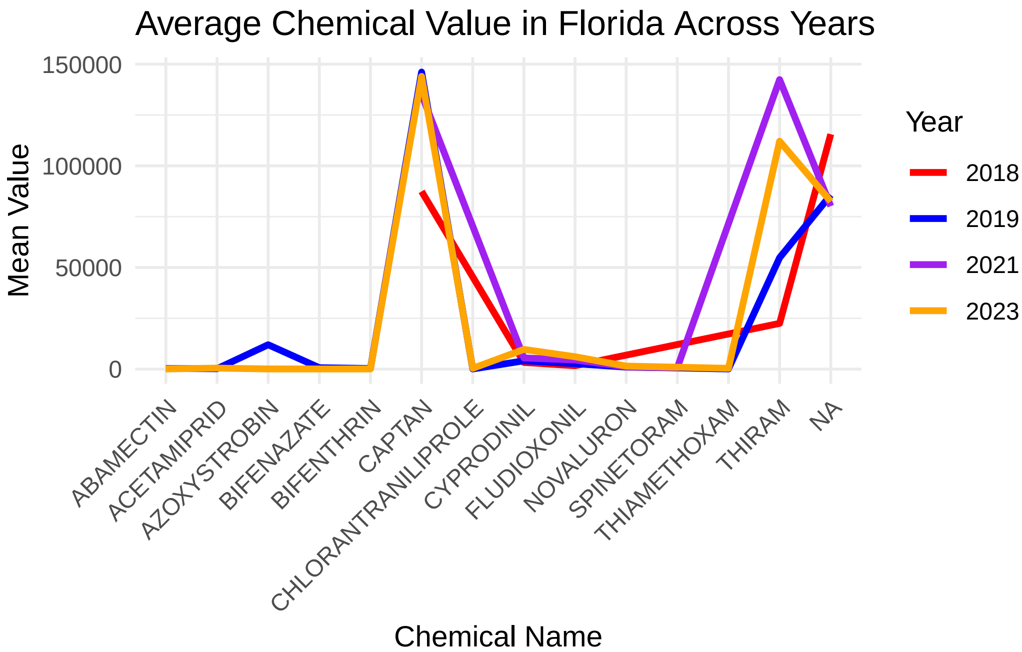
Comparisons of different years

```r
library(dplyr)
library(ggplot2)
ca_yearly_avg <- straw_ca_lb %>%
  group_by(Name, Year) %>%
  summarise(Mean_Value_CA = mean(Value))
flo_yearly_avg <- straw_flo_lb %>%
  group_by(Name, Year) %>%
  summarise(Mean_Value_FLO = mean(Value))

ggplot(ca_yearly_avg, aes(x = Name, y = Mean_Value_CA,
                          group = Year,
                          color = as.factor(Year))) +
  geom_line(size = 1.0) +
  labs(
    title = "Average Chemical Value in California Across Years",
    x = "Chemical Name",
    y = "Mean Value"
  ) +
  scale_color_manual(
    name = "Year",
    values = c("2018" = "red", "2019" = "blue", "2020" = "green",
               "2021" = "purple", "2023" = "orange")
  ) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, size = 5))
```




```r
ggplot(flo_yearly_avg, aes(x = Name,
                           y = Mean_Value_FLO,
                           group = Year,
                           color = as.factor(Year))) +
  geom_line(size = 1.2) +
  labs(
    title = "Average Chemical Value in Florida Across Years",
    x = "Chemical Name",
    y = "Mean Value"
  ) +
  scale_color_manual(
    name = "Year",
    values = c("2018" = "red", "2019" = "blue", "2020" = "green",
               "2021" = "purple", "2023" = "orange")
  ) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



These two graphs illustrate the average chemical values across different years (2018, 2019, 2021, and 2023) for various chemical names used in California and Florida. Both graphs provide insights into the changes in chemical usage over time in each state. For the graph of California, there is a significant spike in the average value in 2023 for some chemicals, particularly for chemicals labeled as "NA." This spike is much higher compared to other chemicals in the previous years. For most chemicals, the values in 2018, 2019, and 2021 are relatively stable, with slight variations. Apart from the "NA" spike in 2023, the average values for most chemicals are quite low, which suggests relatively consistent chemical usage with minimal fluctuations in most years. Unlike California, Florida shows more balanced fluctuations across the years. There are visible peaks and drops in different chemicals across all the years. Chemicals like "CAPTAN" and "THIRAM" show substantial changes in their average values over the years. And Florida demonstrates more year-to-year variability, with the chemical values having more pronounced changes compared to California. There are also some types of chemicals such as ABAMECTIN, ACETAMIPRID, AZOXYSTROBIN, BIFENAZATE and BIFENTHRIN are not used in Florida in 2018, but all types of chemicals are used in Clorida during all 4 years.