**Title Slide**: both

**Metadata: KENDRA**

* Found data from FAO: Food & Agriculture Organization of the United Nations
* FAOSTAT: free access to food and agriculture statistics for over 245 countries – we focused on the USA
* Interested in manure management and green house gas emissions created by livestock, including methane, nitrous oxide and carbon dioxide
* “Livestock are responsible for up to 14% of all GHG emissions from human activities” ; “manure collection ponds generate about 1/10th of US methane emissions (EPA)”
* NADIA
* Within the data there is information on 13 different livestock categories in the USA: includes cattle, chickens, turkeys, sheep, asses, ducks, and swine.
* Focused on 1980 to 2018. Also included projected data for 2030 and 2050, which we may come back to for final report

**Question 1: Have methane emissions changed over time? NADIA**

* Decided to focus on methane because:
  + “Methane is 25 times more potent at trapping heats than carbon dioxide, making it one of the worse greenhouse gases (GHG)”
  + Methane gas is produced by anaerobic decomposition of manure stored or treated

**Methane Emissions Over Time Plot KENDRA**

* Conducted overall time series on total methane production for all livestock.
* We were not able to decompose time series because there was no seasonality, but the Mann-Kendall test confirmed there was a significant trend (p-value < 0.05)
* There is an overall positive trend that methane is increasing.

**Methane Emissions by Animals Plot NADIA**

* Wanted to see if methane emissions changed over time by animal?
* Noticed that dairy cattle and market swine consistently had the highest amount of methane emissions over time

**Time Series plots for Dairy Cattle and Market Swine NADIA**

* Performed time series analysis on both the dairy cattle and market swine. The MK test also confirmed they were significant trends.
* Notice the methane for dairy cattle is decreasing and the methane for market swine is increasing

**Question 2: Does the average methane emissions rate differ between each animal category?: KENDRA**

* When visualizing the different methane emissions by animal, we suspected that there might be statistical differences since for, example: dairy cattle and market swine had higher rates than others
* Conducted a one-way ANOVA to evaluate whether the different animals, on average, have different emission rates
* Also performed a Shapiro-Wilks test for normality – of the 13 livestock, only ducks, breeding swine, and market swine were normal.
* Viewing a Q-Q plot, data does not follow a normal distribution.
* Lastly, the Bartlett test showed the variances were not equal.
* So – all tests for normality failed, but we continued on anyway!
* The ANOVA test showed us that there was a significant difference in mean emissions among animals (p<0.05)
* Decided to perform a Tukeys HSD test to determine which animals had statistically different emission rates
  + Extracted groupings for pair-wise relationships – letters represent the different groupings
  + As we can see from this graph – asses, ducks, goats, mules, and sheep all had statistically similar emission rates
  + Most of the other animals, such as market swine and dairy cattle, have their own grouping

**End: NADIA**

* Methane produced by ruminants (such as cows and sheep) come from 3% of the vast numbers of microbes that live in rumen.
* Potential of diet change can lead to reductions in methane production – diet CHANGES can lead to about 20-25% reduction in methane
  + More fiber can lead to more methane
* Innovations to reduce methane: include burp backpacks
  + Device that can be attached to a cow’s nose ring or rumen to convert exhaled methane to the less potent carbon dioxide

Sources:

<https://www.dailykos.com/stories/2020/2/4/1873983/-Renewable-Tuesday-Deniers-Have-a-Cow-Fart>