LINEAR REGRESSION ON AIR POLLUTANTS VS CROP PRODUCTION

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STA302

RESEARCH QUESTIONS

1. DO AIR POLLUTANTS AFFECT CROP PRODUCTION?
2. WHICH POLLUTANTS HAVE THE INFLUENCE ON THE CROP YIELD?

Production of crop is associated with **food**, **animal feed**, **fiber**, **fuel** and so one.

=> Learning about the impacts of pollutants is important to protect **food safety**, **public health**, **maintain** and **promote sustainable agriculture.**

LITERATURE REVIEW

1.

Review | Published: 12 September 2022

Crops' response to the emergent air pollutants

Ram Kumar Shrestha, Dan Shi, Hikmatullah Obaid, Nader Saad Elsayed, Deti Xie, Jiupai Ni & Chengsheng Ni

ACTION

Reviewing findings of previous research on the morphological, physiological and biochemical changes in important crops which is exposed to high level of air pollutants.

RESULT

Suggesting that the air pollutants appear to be harmful to crop yields and quality because air pollutants interfere with the photosynthesis process.

DATA AND METHODS

Literature review on major findings of crop's reaction to soil moisture, light, temperature, humidity, rain and interaction with sulfur dioxide, ozone, carbon dioxide, nitrogen oxide.

2.

Published: 18 April 2020

Decoupling the climatic and carbon dioxide emission influence to maize crop production in Pakistan

Abdul Rehman, Hengyun Ma & Ilhan Ozturk

ACTION

Studying the carbon dioxide's influence on the maize crop in Pakistan from 1988 to 2017.

RESULT

Maize production has positive coefficient with carbon dioxide emission (*p* value 0.0395).

DATA AND METHODS

ARDL approach and Granger causality test to check the dynamic linkage between carbon dioxide emission, maize crop production, area under maize crop, water availability, rainfall and temperature with the evidence of long-run and short-run.

$$\mathrm{CO_2}e_t = f\left(\mathrm{MCP}_t, \mathrm{AMC}_t, \mathrm{WA}_t, \mathrm{RF}_t, \mathrm{TM}_t\right) = \zeta_0 + \zeta_1 \mathrm{MCP}_t + \zeta_2 \mathrm{AMC}_t + \zeta_3 \mathrm{WA}_t + \zeta_4 \mathrm{RF}_t + \zeta_5 \mathrm{TM}_t + \varepsilon_t$$

3.

Journal of Scientific Research
Banaras Hindu University, Varanasi

Vol. 55, 2011 : 77-102
ISSN : 0447-9483

GASEOUS AIR POLLUTANTS : A REVIEW ON CURRENT AND FUTURE TRENDS OF EMISSIONS AND IMPACT ON AGRICULTURE

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ACTION

Studying the impact of air pollutants, including nitrogen oxides, sulfur dioxide, ozone, and particulate matter on crops and the overall affect on the economy.

RESULT

Air pollutants cause deleterious effects on physiology and metabolism of plants.

DATA AND METHODS

Literature review on major findings of sulfur dioxide, ozone, carbon dioxide, nitrogen oxide impact on crop growth.

DATASET #1

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

OECD.Stat

Sulphur Oxides
- Sulphur Oxides
- Nitrogen Oxides
- Particulates (PM10)
- Particulates (PM2.5)
- Carbon Monoxide
- Non-methane Volatile Organic Compounds

Total man-made emissions
- Total Mobile Sources
  - Road Transport
  - Other Mobile Sources
- Total Stationary Sources
  - Power stations
  - Combustion
    - Industrial combustion
    - Other combustion
  - Industrial processes and product use
  - Agriculture
  - Waste
  - Miscellaneous
- Total emission intensities
  - Total emissions per capita
  - Total emissions per unit of GDP, Kg per 1000 USD
- Total emissions, Index 2000 = 100
- Total emissions, Index 1990 = 100

Emissions of air pollutants

Customise | Export | My Queries

Pollutant	Sulphur Oxides
Variable	Total man-made emissions
Unit	Tonnes, Thousands

Country	Year 1990	1991	1992	1993	1994
Australia	1 585.19	1 569.96	1 652.02	1 742.30	1 764.29
Austria	73.64	70.66	54.13	52.75	47.11
Belgium	363.59	364.71	355.93	330.92	289.27
Canada	3 010.73	2 793.20	2 670.82	2 582.74	2 371.14
Chile	..	..	..	..	..
Colombia	..	..	..	..	..
Costa Rica	1.40	1.59	2.05	1.76	2.31
Czech Republic	1 754.56	1 650.33	1 381.95	1 302.86	1 159.39
Denmark	178.01	238.68	184.13	149.17	151.44
Estonia	277.00	250.98	191.63	155.53	150.64

DATASET #2

Crop production

Wheat / Rice / Maize / Soybean, Tonnes/hectare, 2018 – 2030

Source: OECD-FAO Agricultural Outlook (Edition 2021)

Show: Chart | Map | Table

fullscreen | share | download | My pinboard

Wheat

Location	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	20
Argentina	3.094	2.862	2.567	2.941	2.970	3.008	3.035	3.059	3.090	3.123	3.155	3.188	3.2
Australia	1.692	1.485	2.400	2.021	2.049	2.081	2.108	2.135	2.163	2.193	2.222	2.251	2.2
Brazil	2.660	2.204	2.717	2.527	2.557	2.590	2.618	2.646	2.675	2.706	2.737	2.767	2.7
BRICS	3.715	3.762	3.803	3.755	3.782	3.808	3.834	3.858	3.885	3.911	3.938	3.965	3.9
Canada	3.274	3.384	3.512	3.390	3.492	3.529	3.563	3.597	3.633	3.670	3.707	3.745	3.7
Chile	6.286	6.004	5.980	6.010	6.039	6.077	6.105	6.129	6.160	6.193	6.225	6.258	6.2
China (People's Republic of)	5.417	5.631	5.742	5.597	5.619	5.646	5.665	5.688	5.710	5.733	5.756	5.779	5.8
Colombia	2.200	1.000	1.667	1.600	1.618	1.641	1.666	1.690	1.718	1.744	1.771	1.798	1.8
Egypt	6.296	6.383	6.316	6.466	6.545	6.644	6.747	6.849	6.961	7.071	7.182	7.295	7.4

Perspectives

Wheat, Rice, Maize, Soybean (4/4)

Compare variables

Tonnes/hectare

Countries

Highlighted Countries (0)

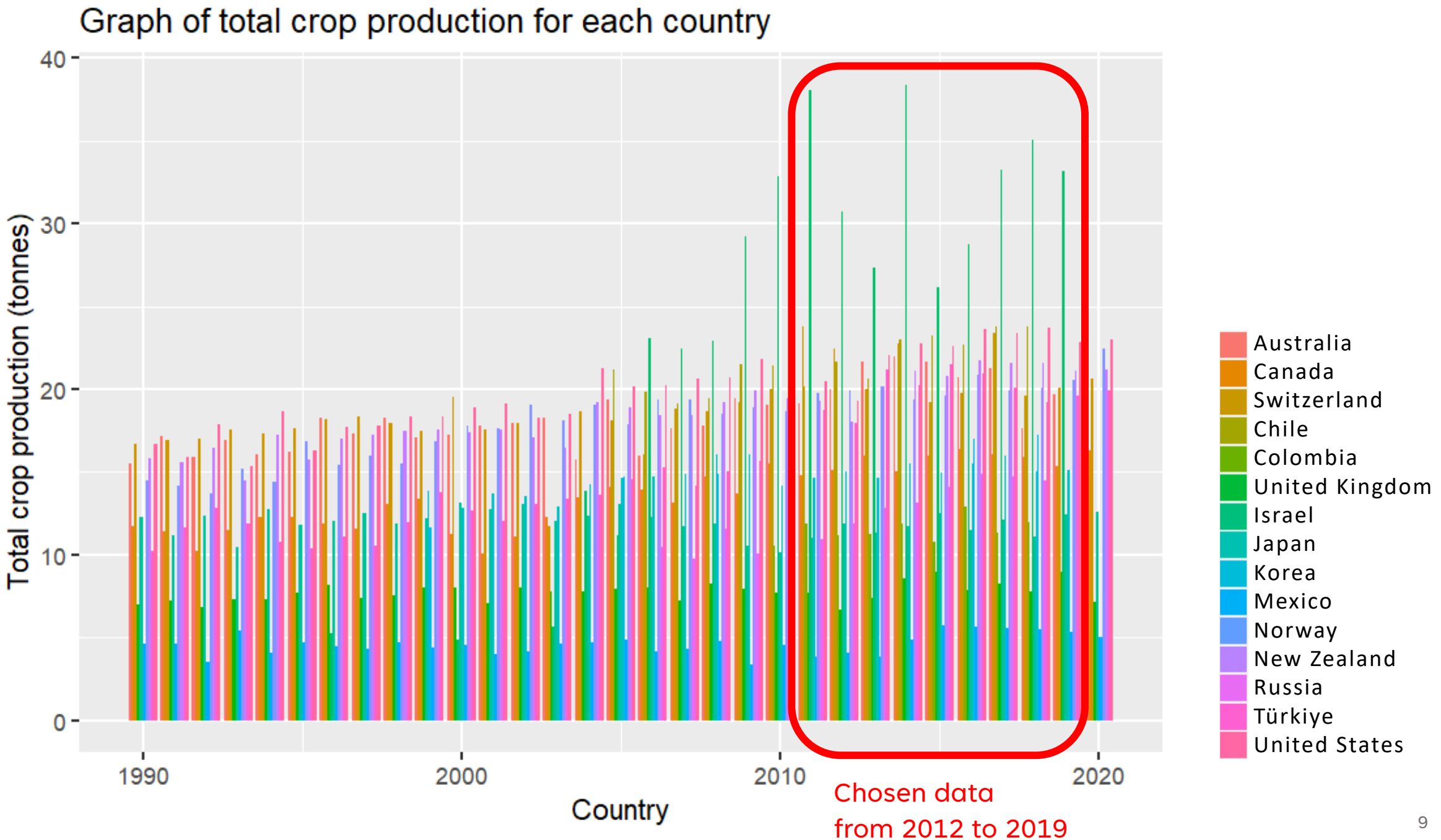
Time

yearly | quarterly | monthly

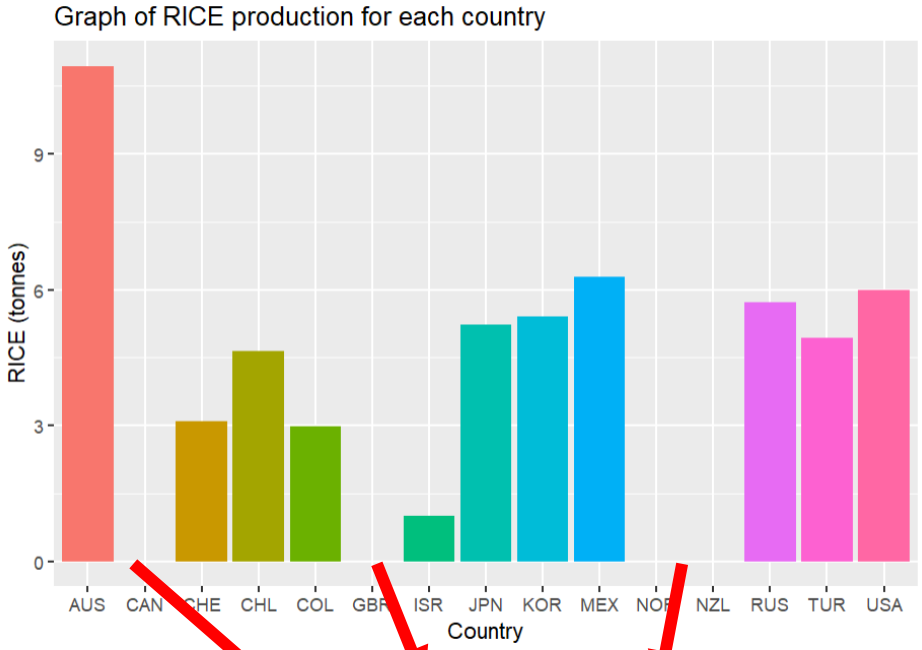
latest data available

8

2018 – 2030


Graph of total crop production for each country
Total crop production (tonnes)
40
30
20
10
0
1990
2000
2010
2020
Country
Chosen data
from 2012 to 2019
Australia
Canada
Switzerland
Chile
Colombia
United Kingdom
Israel
Japan
Korea
Mexico
Norway
New Zealand
Russia
Türkiye
United States

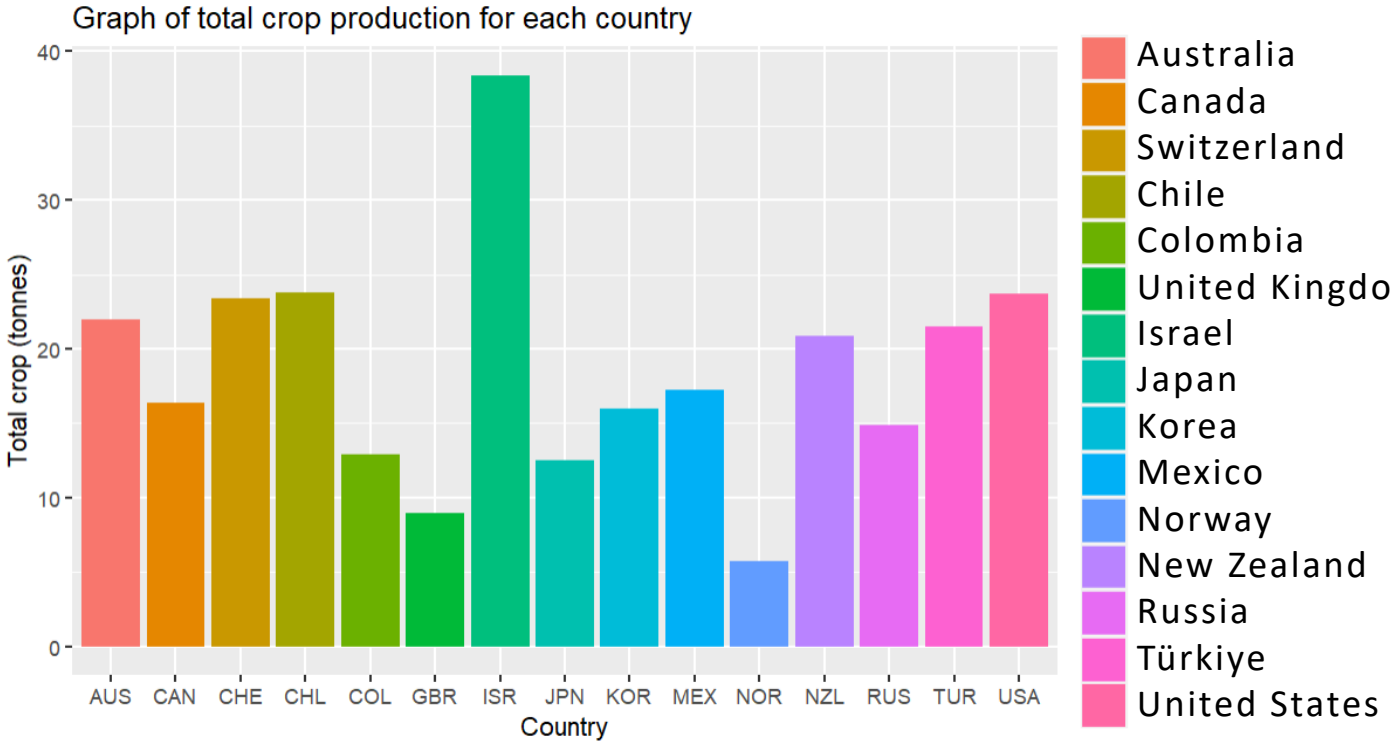
Crop Production Data

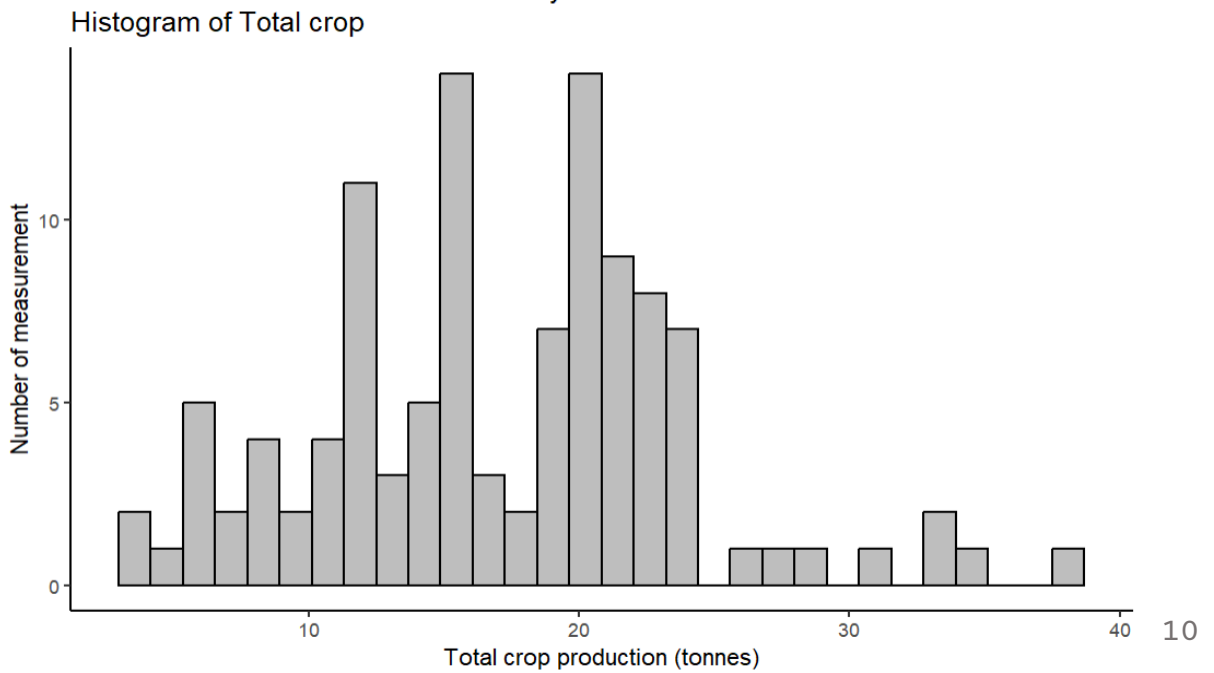


Do not have data

Total production =

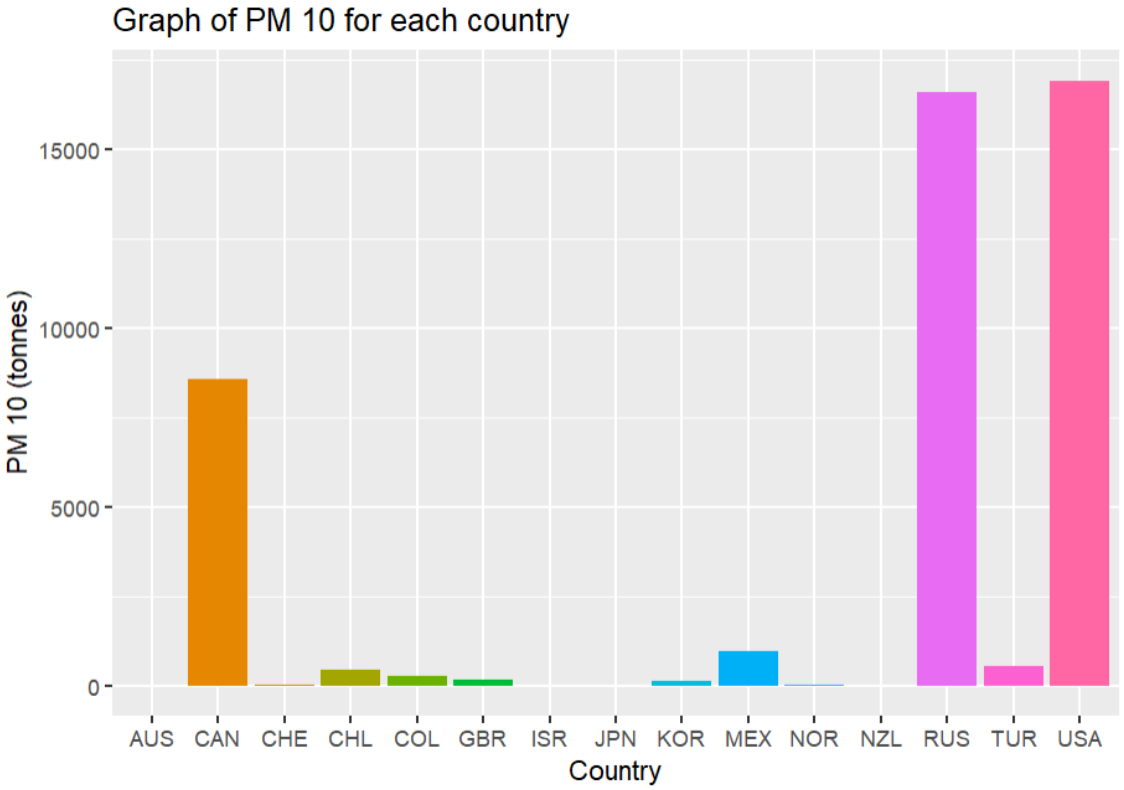
WHEAT + RICE + MAIZE + SOYBEAN

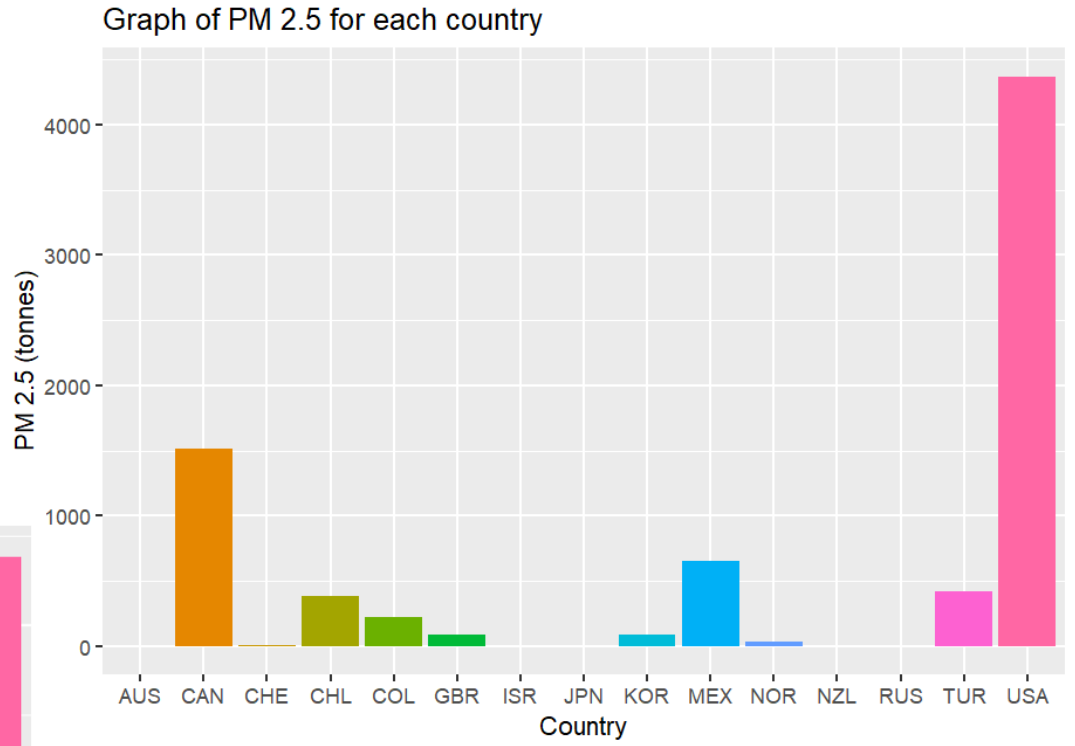




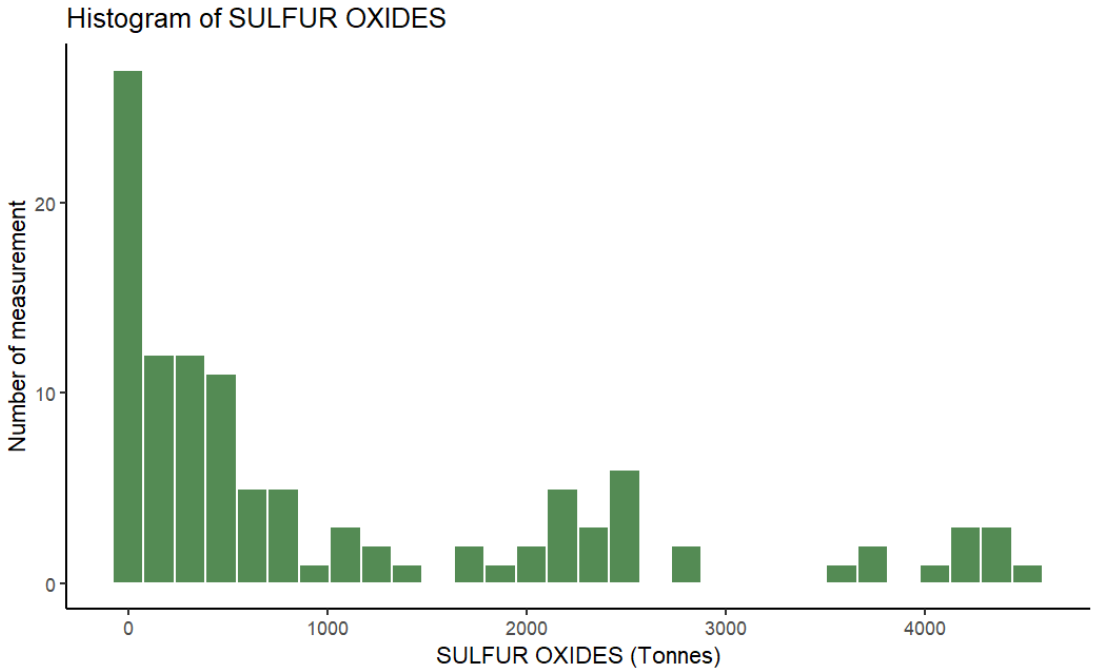
Air Pollutants Data

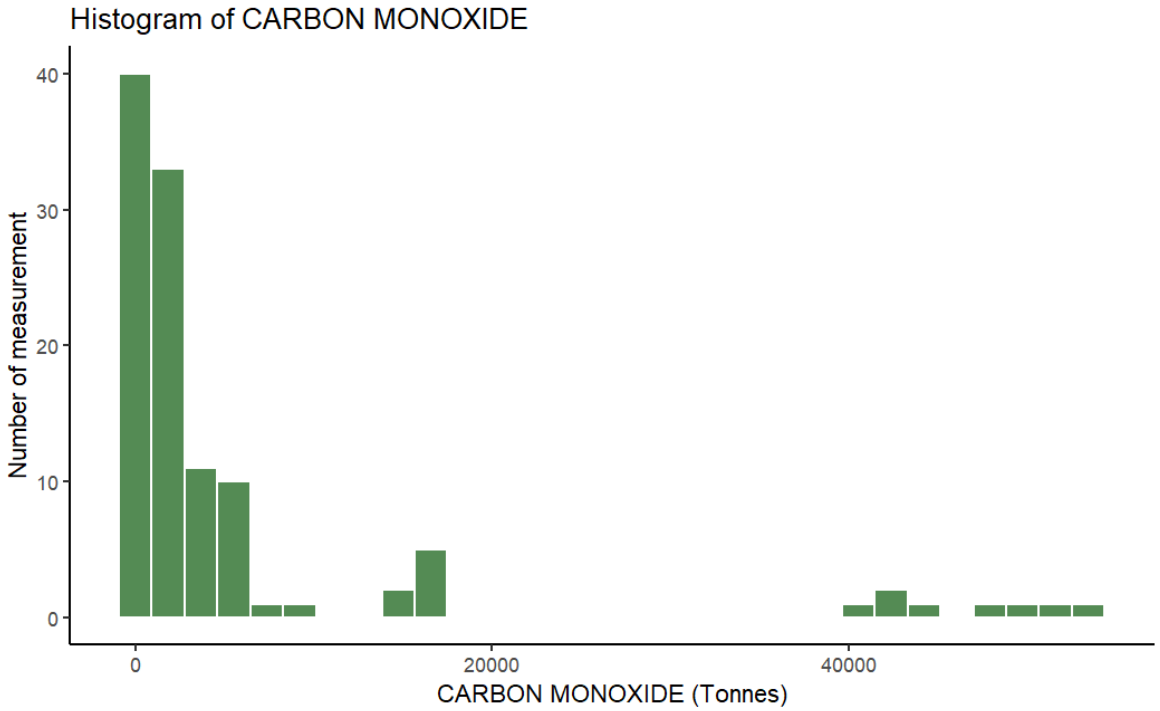
- Australia
- Canada
- Switzerland
- Chile
- Colombia
- United Kingdom
- Israel
- Japan
- Korea
- Mexico
- Norway
- New Zealand
- Russia
- Türkiye
- United States

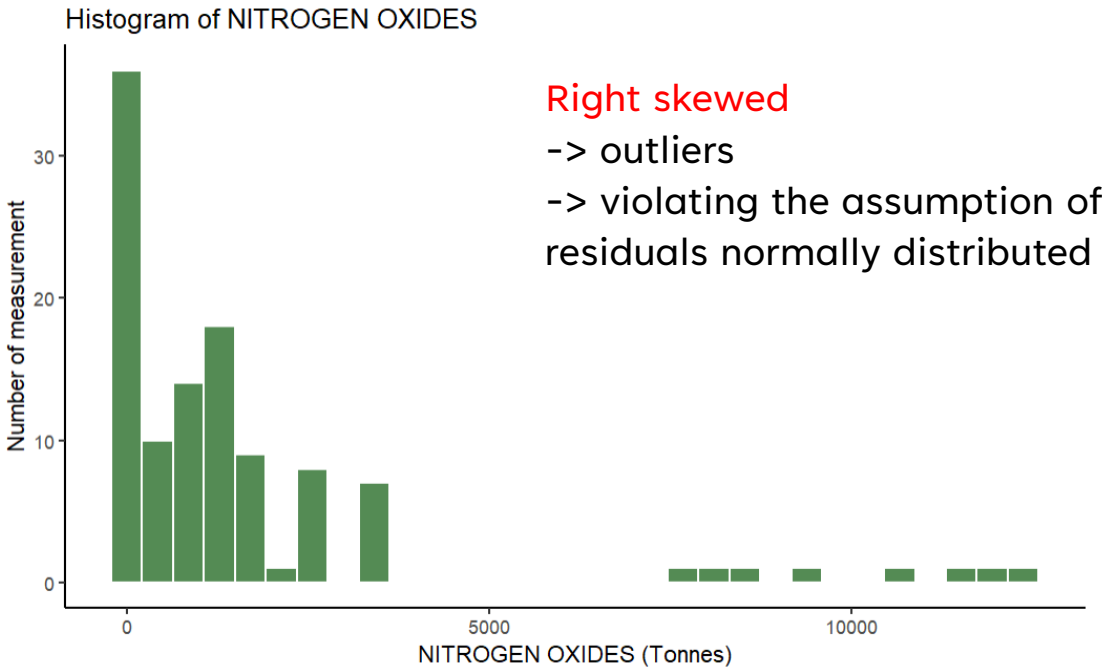




Lack of data on Particulates 10 and Particulates 2.5
-> do not consider



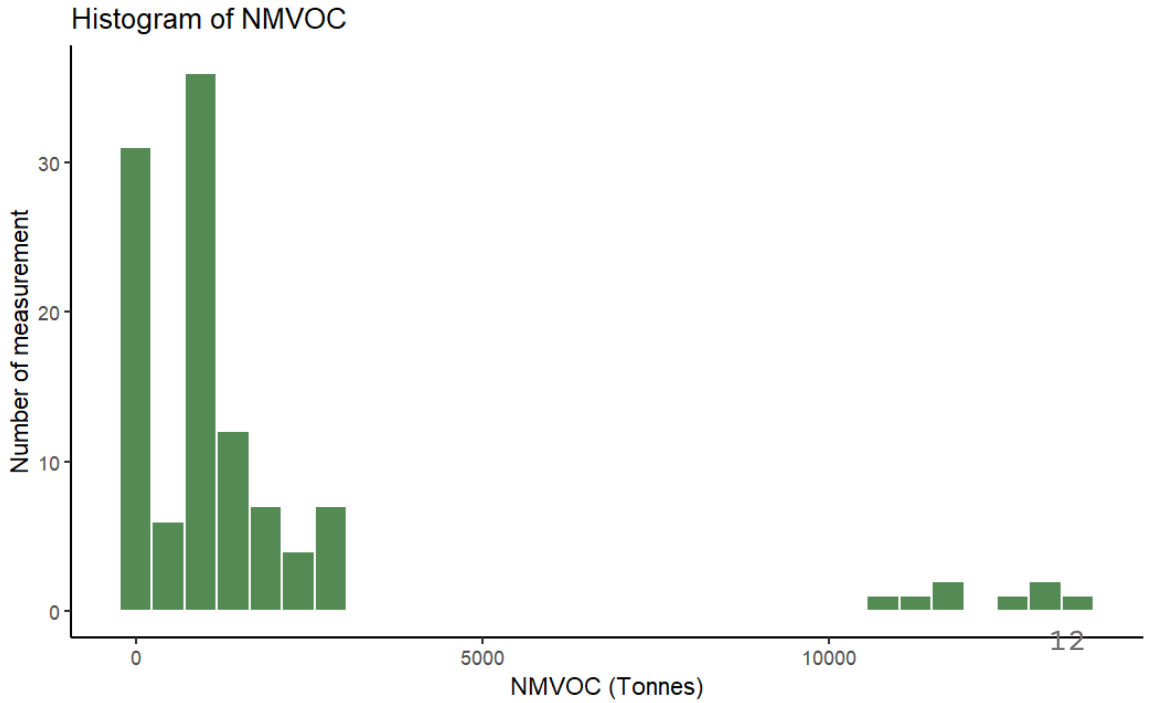




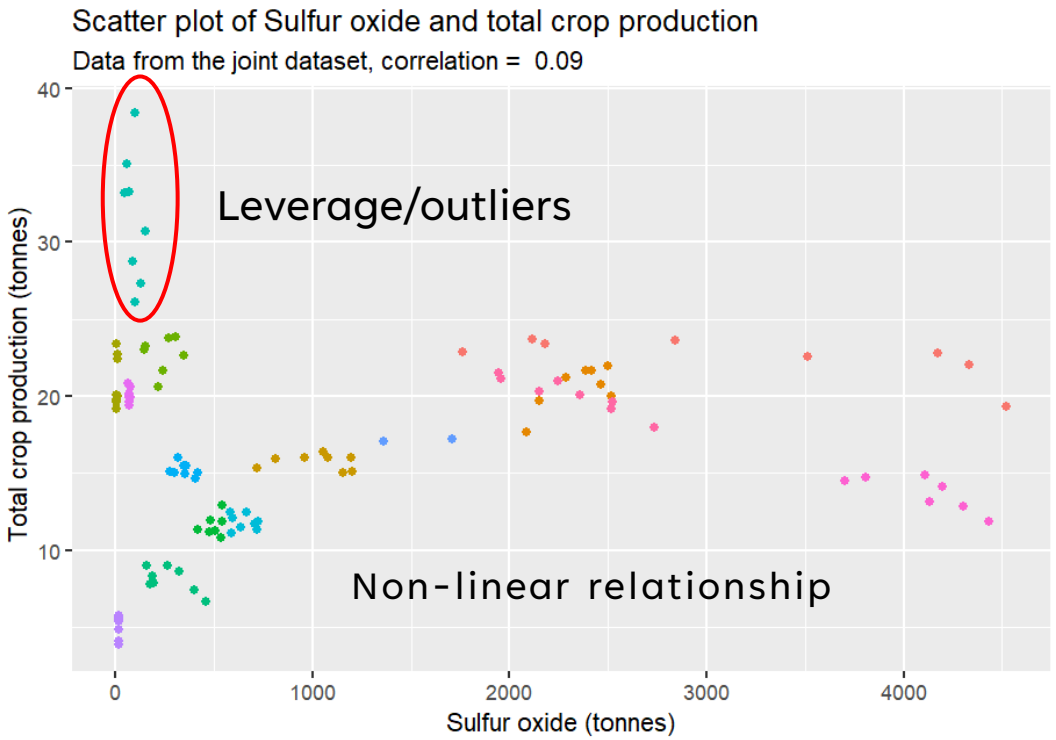
Right skewed

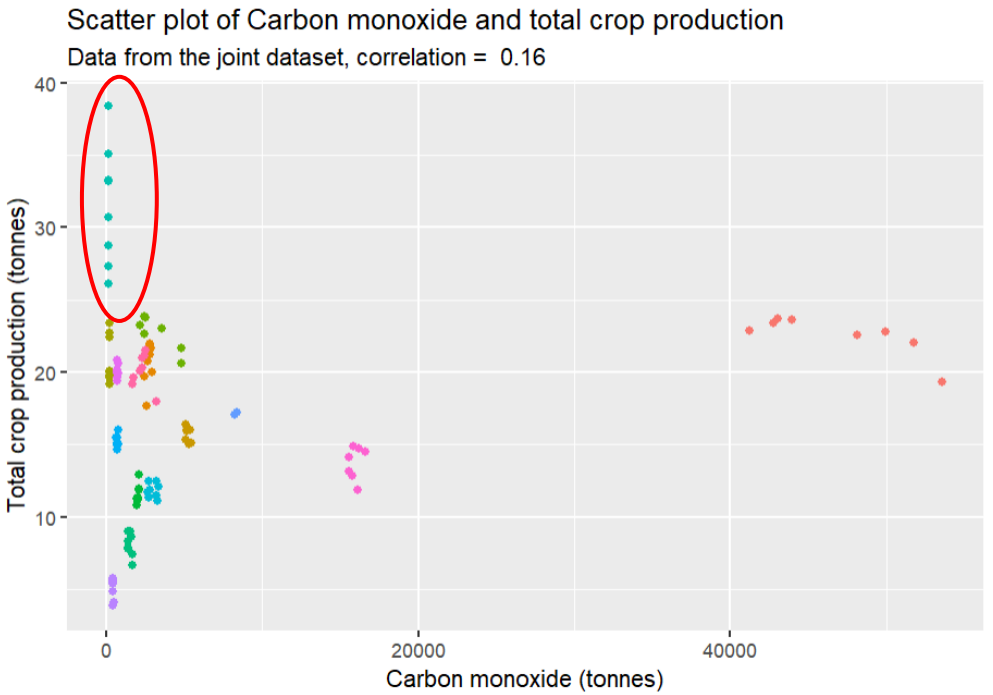
-> outliers

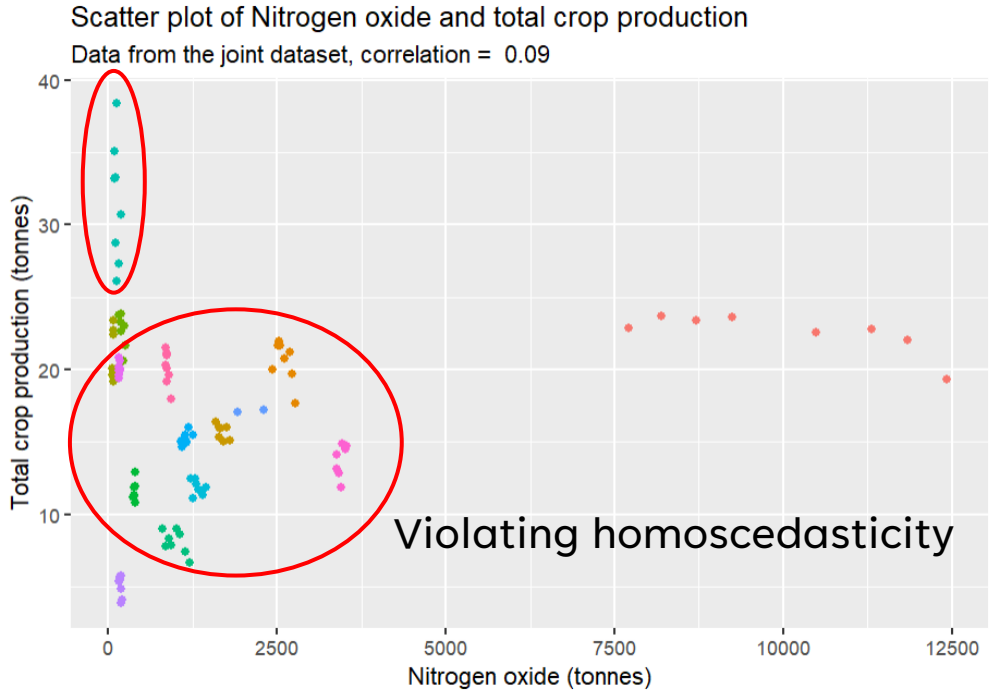
-> violating the assumption of residuals normally distributed



CORRELATION







PERFORMING MLR

Variable:

Xs : the air pollutants (NOX, CO, SOX, NMVOC)

y: total crop production

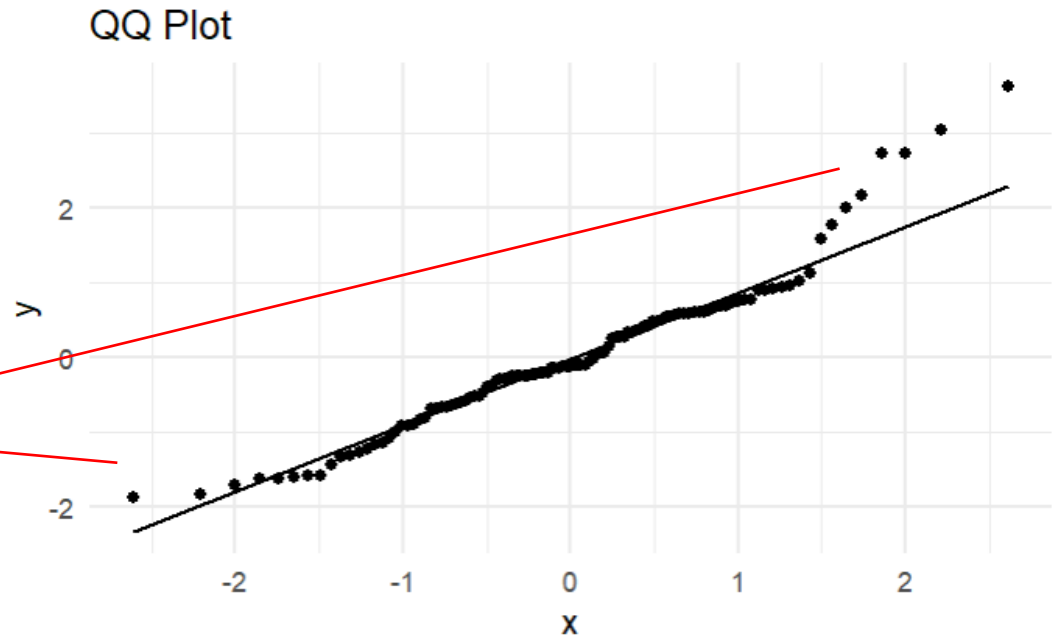
```
Residuals:
     Min       1Q   Median       3Q      Max
-12.1418  -4.0051  -0.7825   3.8246  22.5749

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 16.0388213  0.9797549  16.370   <2e-16 ***
SOX          0.0011450  0.0008785   1.303   0.1953
CO          -0.0003384  0.0003818  -0.886   0.3774
NOX         -0.0024522  0.0013038  -1.881   0.0627 .
NMVOC        0.0034063  0.0016193   2.104   0.0378 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.654 on 106 degrees of freedom
Multiple R-squared:  0.07405,   Adjusted R-squared:  0.03911
F-statistic: 2.119 on 4 and 106 DF,  p-value: 0.08346
```

Large residual

Large p value
-> multicollinearity



PLAN:

1. BOX-COX transformation
2. ANCOVA
3. Analyzing the correlation of the predictors
4. Making decisions regarding outliers
5. Adjust decisions on the dataset

THANK YOU

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