Production Factors impacts on agriculture in Brazil and France

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Abstract

World Bank datasets were used to evaluate which production factors had larger impacts or were mostly impacted by evolution on agriculture (cereals and livestock), as well as how they correlate between each other. We selected two countries (Brazil and France) and 8 indicators as variables (Cereal Production, and Livestock Index, as agriculture outputs; Agricultural Land and Forest Area as factors of land; Fertilizer Consumption, Cereal Yield and Number of Tractors, as factors of capital and Employment in Agriculture as factor of labor) and applied to the data stardadization and correlation. It was found that while brazilian agriculture output had a great impact from/on most variables, France had little change on its agriculture outputs related to those factors. In both countries, Forest Area is strictly related to agriculture production factors.

Motivation

Agriculture intensification has been pointed as one of the main causes of Climate Change. Countries with a long tradition in agriculture, like France, resorted to intensification in the past, to reach high levels of productivity and tackle food insecurity. Others, like Brazil, have been building their vocation for agriculture through intensification in more recent decades.

By having a better understading of how each country performed agriculture intensification and their strategies, we can antecipate potential problems and predict what are going to be like the impacts in the future, in terms of social, environmental and economic aspects.

Dataset(s)

The datasets used were:

The World Bank Indicators (WBI) dataset and the World Bank Fertilizer Consumption dataset.

The reason for using a specific dataset for the Fertilizer Consumption indicator is that in the regular WBI dataset, the time span covered is signifcantly shorter than the specific dataset, starting in 2002 (against 1961, from the specific dataset), which would make its analysis unfeaseble.

For all the other variables, it was used the regular WBI daaset.

Data Preparation and Cleaning

Regular actions were necessary, such as:

- Dropping null values and not usefull rows and columns
- Filtering the selected countries and indicators
- Transposing rows x columns (for the Fertilizer Consumption dataset)
- Merging several dataframes into only one

More complex actions needed include:

- Updating indexes and columns to make it easier to read and merge
- Changing columns dtypes
- Scaling (stardardization) to perform statistical analysis

Research Question(s)

How agriculture production factors impacted and were impacted from agriculture evolution, and how do these factors correlate to each other? Is there any difference in those impacts between different countries?

Methods

Standardization allows us to compare data on a same scale. Different variables have different measure units. It is hard to compare 'million tons' of a product with 'employment rate'. Standardization makes it possible to have a clearer view on how they compare and relate. It is not essential for checking correlation, though. Standardization were performed by using sk-learn '*preprocessing*' package and '*StardandScaler*' function.

Correlation: is used to describe the Size and Direction of a relationship between two or more variables *(source: abs.gov.au)*. In this work, it allows us to verify how agriculture variables (factors, production and others) behave according to their peers. Graphical view have been provided and will be shown on next slides.

An overview of the data may clarify why standardization were necessary and how they were implemented. Take for instance the 'final_data' table for Brazil. Notice the difference between variable units

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In [145]: final_data
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Out[145]:

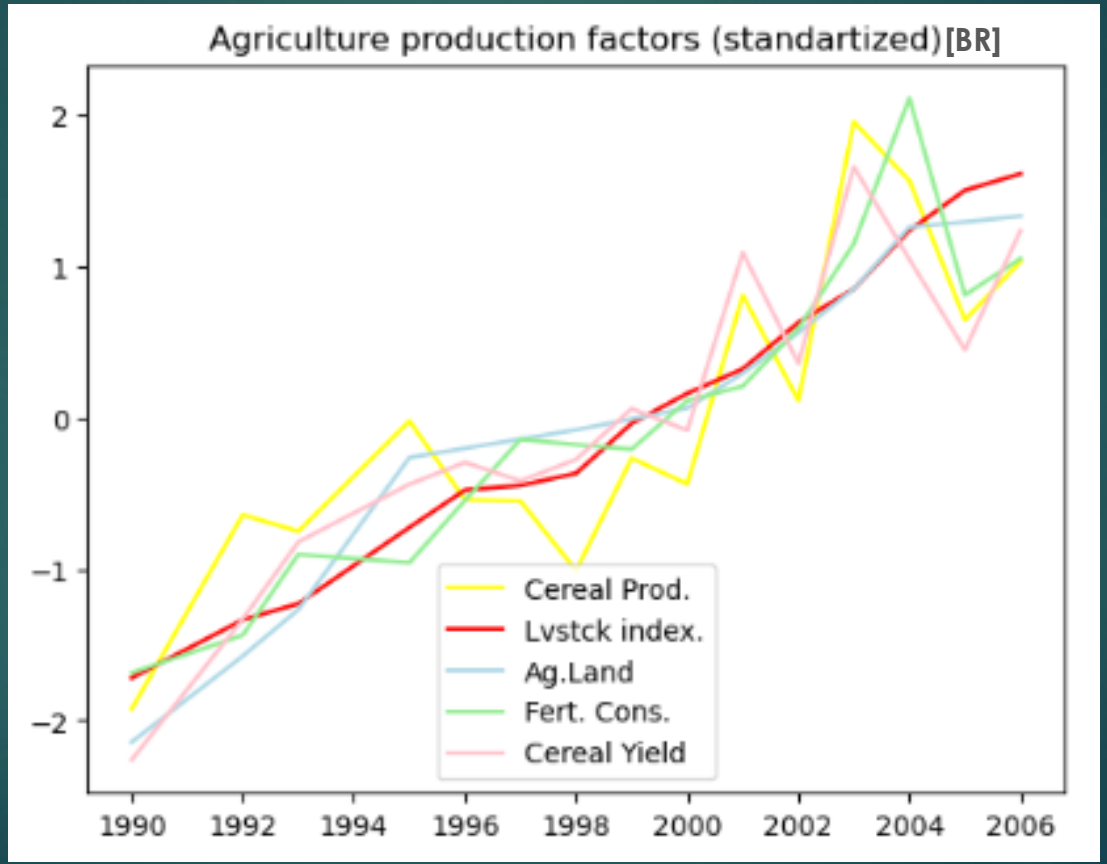
	Cereal production (million metric tons)	Livestock Index (%, /2005)	Agricultural Land (% of land)	Fertilizer consumption (kg/ha)	Cereal yield (kg/ha)	Number of Tractors	Employment in Agriculture (%)	Forest area (% of land area)
1990	3.249039	44.91	28.906910	67.760879	1755.061	728779.0	22.799999	65.409888
1992	4.405800	51.59	29.517213	78.370758	2142.471	753766.0	28.299999	64.801355
1993	4.307346	53.44	29.846712	101.138662	2354.545	766260.0	27.400000	64.497089
1995	4.964182	62.20	30.924584	98.815873	2513.151	791248.0	26.100000	63.888557
1996	4.495717	66.49	30.990029	116.365322	2573.147	803742.0	24.400000	63.584290
1997	4.487128	67.01	31.055474	133.584189	2522.079	802173.0	24.200001	63.280024
1998	4.073418	68.41	31.120800	132.096898	2581.250	800604.0	23.400000	62.975758
1999	4.742895	74.14	31.198209	130.814379	2720.950	799035.0	24.200001	62.671492
2000	4.589336	77.58	31.275619	144.516810	2661.353	797466.0	18.500000	62.367225
2001	5.712461	80.39	31.521965	148.571429	3149.603	795898.0	20.600000	62.019301
2002	5.087888	85.71	31.809470	164.911296	2846.024	794329.0	20.600000	61.671377
2003	6.746822	89.58	32.120663	188.763343	3385.302	792760.0	20.700001	61.323452
2004	6.396363	96.30	32.558919	229.819282	3131.450	791191.0	21.000000	60.975528
2005	5.566863	100.90	32.594884	174.313395	2882.592	789622.0	20.500000	60.627604
2006	5.914897	102.80	32.636926	184.578011	3210.503	788053.0	19.299999	60.429569

1-10 range

%

Hundreds of thousands

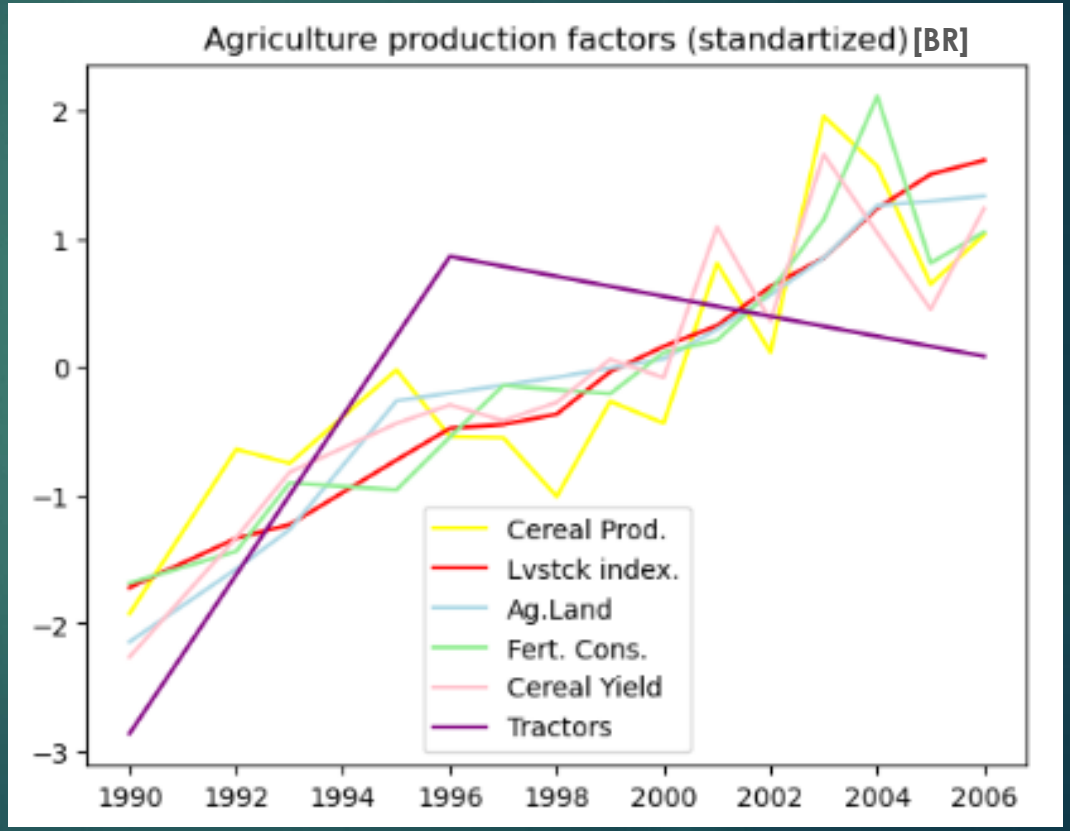
Some variables clearly have similar behavior. It seems plausible to check for correlation.



Findings

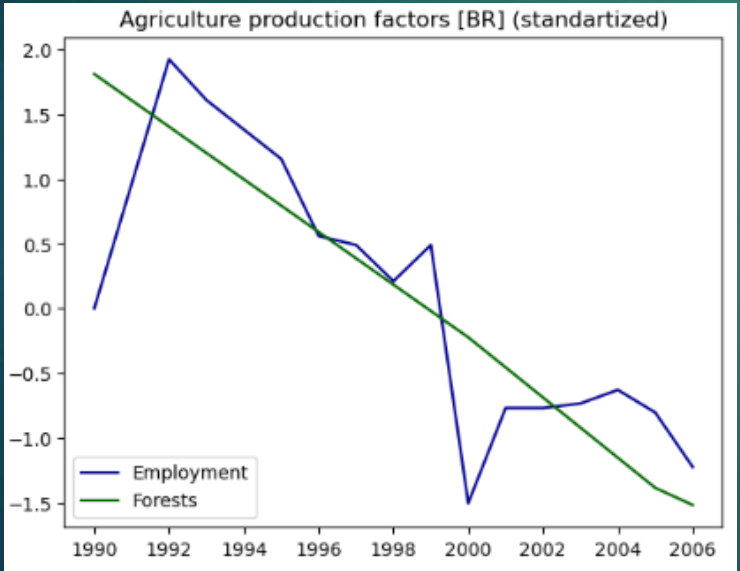
For brazilian agriculture, traditional production factors, such as **Land** (i.e: increasing agriculture land) and **Fertilizers** have been continously applied in the period evaluated.

Machinery (Tractors) had an important role up to the last 5 years of the last century, but its adoption saw a direction shift by the turn of the millennium.

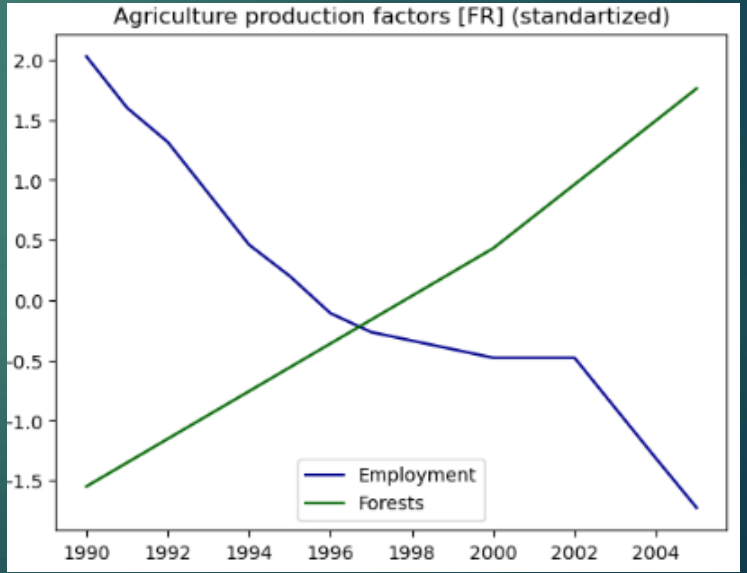


Findings

Forest area and labor had sharp decrease, in Brazil over the 17 Years analysed...

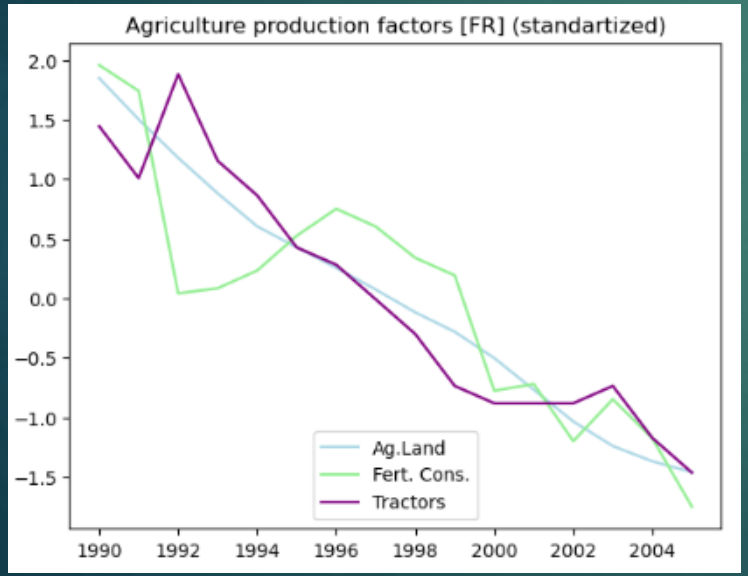


For France, while labor repeated the Brazilian falling pattern, forest area have significantly increased

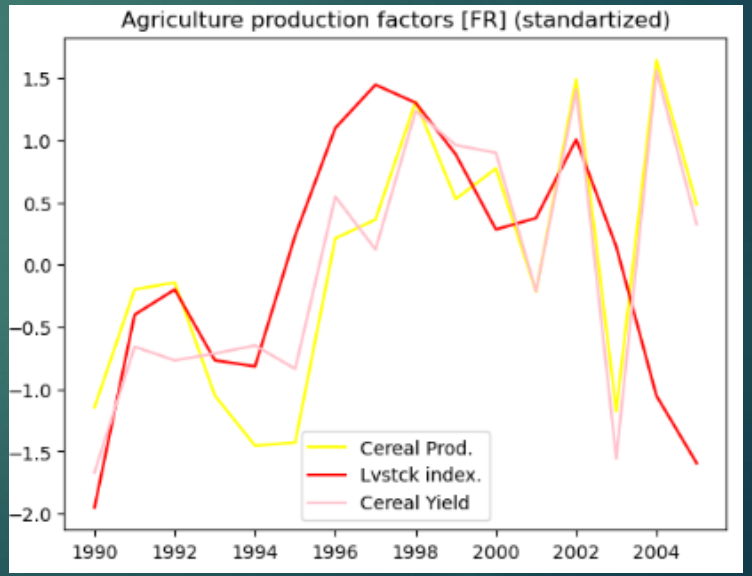


Findings

Agricultural Land, Fertilizer Consumption and Number of Tractors dropped in France.



Farms outputs and productivity followed an irregular pattern in France, during this period, having had sharp increases followed by sharp falls.



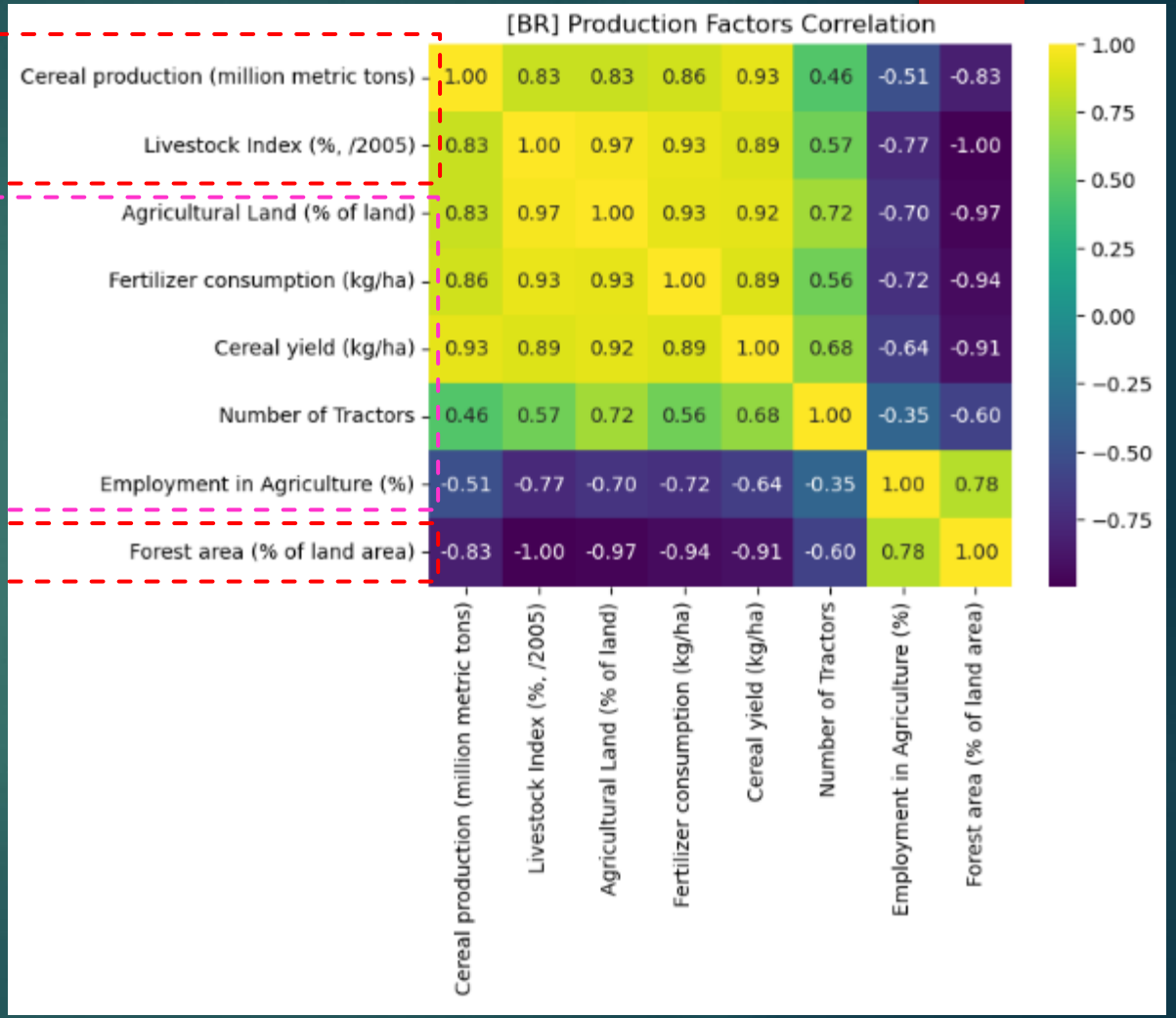
Correlation

Agriculture **output** indicators

Production Factors: Land, Labor and capital (technology)

Forest Area (related to Land use)

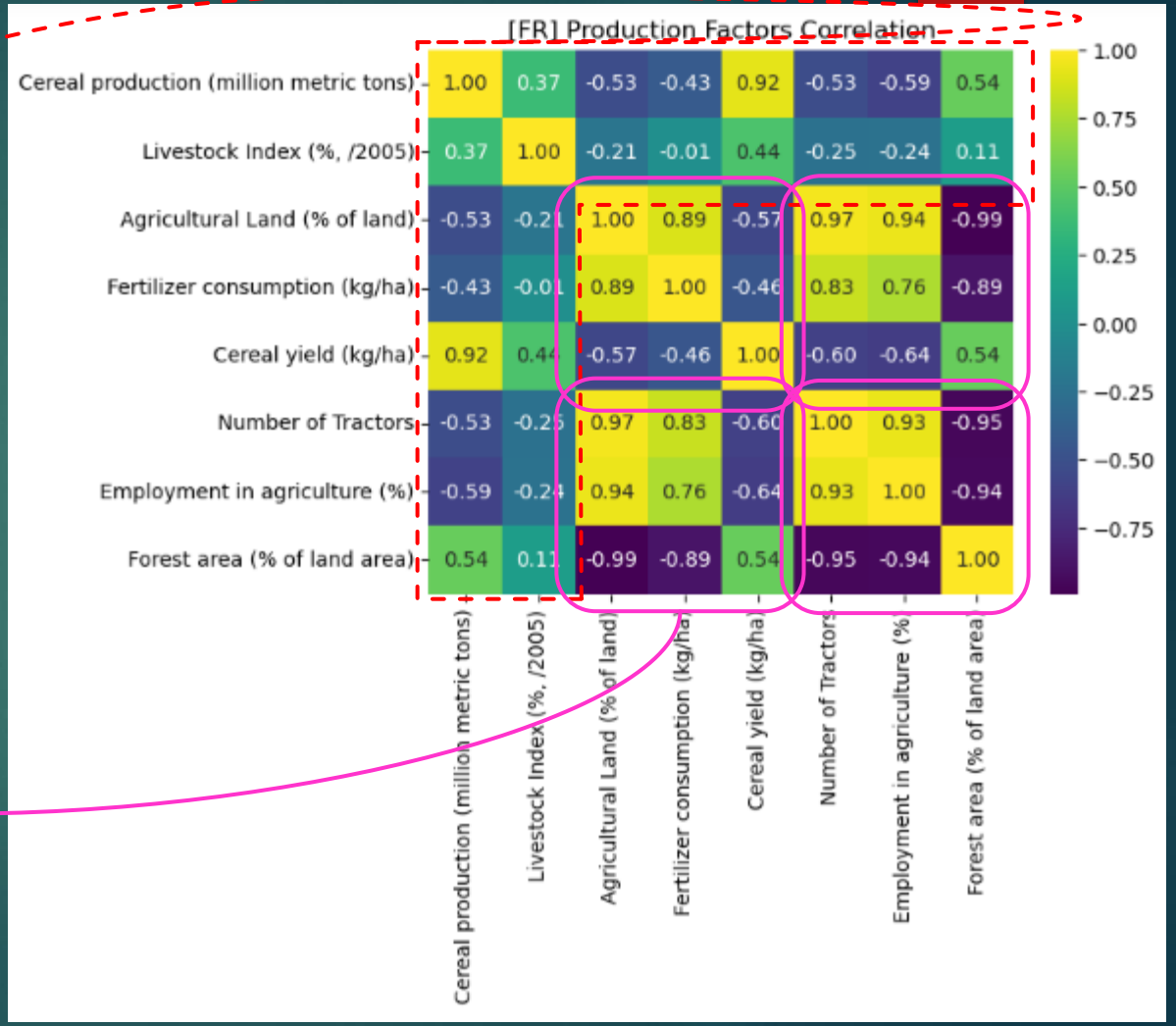
For **Brazil,** 'Number ofTractors' is the only parameter that is not strongly correlated to agriculture outputs. 'Employment' and 'Forest Area' have Strong Negative correlation, while the others have Strong Positive correlation.



Correlation

For **France**, Strong correlations (>0,8) were not found directly related to Agriculture outputs indicators, except the Cereal Yield x Cereal Production duo.

However, Production Factors correlate strongly between each other (positive correlation) and with Forest Area (negative correlation).



Limitations

- The time span assessed (17 Years) may not have been large enough for a fully trustful analysis. Although most of variables have a good time frame, they do not coincide in a large span.
- Other indicators that are related to the used ones could perform better in this analysis, like in the case for the 'livestock index', that refers to a ratio of a given year, instead of a gross production value.
- Many other production factors have strong impact on the agriculture outputs, but were not included in this study, such as some related to the technology application, weather, market aspects and so on.
- Causation is not predictable through the dataset provided and it would demand more complexes and context analysis to identify what is cause and what is effect on a set of variables.

Conclusions

Brazil has passed through a process of intensification of its agriculture in the period assessed. Therefore, it has seen a strong increase in its agriculture outputs and resources consumption, including land, fertilizers and machinery. Increase in agricultural land supposedly forced deforestation, while increasing technology (like fertilizers and tractors) reduced labor (employment) in agriculture.

France, for its turn, faced its agriculture intensification process several years before the assessed period of time and it is has recently faced a shift on its priorities, from seeking high production to environment preservation. In addition, farms outputs and productivity followed an irregular pattern, which indicates a dependance on other factors that are not counted in this study (weather and market, for example)

Further studies are necessary, however, to better understand the relation between these (and other) variables, and check for causation.

Acknowledgements & References

- World Bank Indicators website was checked in order to better understand the indicators selected.
- stackoverflow, pandas.pydata.org, matplotlib.org and other libraries websites were also consulted.
- *Australia Bureau of Statistics website was consulted for statistical definitions*
- No scientific paper or journalistic article were used in this work.
- Countries and indicators were selected according to the author previous knowledge and experience.
- Feedback from my family was given in order to improve the understanding of this work.

- I am also grateful for EDx and University of California San Diego for making it possible to me to take this course, which has been a 'watershed' in my Data Science trainning process.