IMPACT OF PESTICIDES ON YIELD FROM 1990 TO 2019

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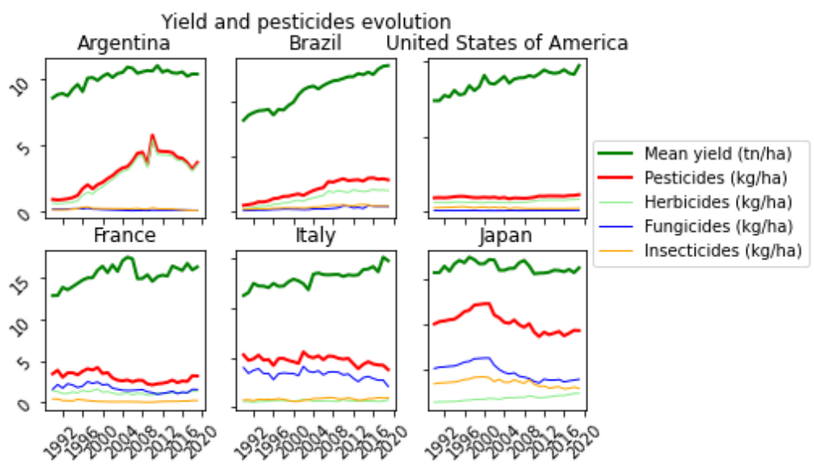
INTRODUCTION

*In this study, we will show the evolution of **pesticide** use and **yield** (Source: FAO). For this, we chose to take into account six of the ten countries that use more inputs of this type, between **1990 and 2019**. After a first step of data cleaning and preprocessing, we analyzed the correlation between the variables: pesticides (**herbicides**, **fungicides** and **insecticides**, expressed in kg/ha) and yield (average of all crops, expressed in tn/ha).*

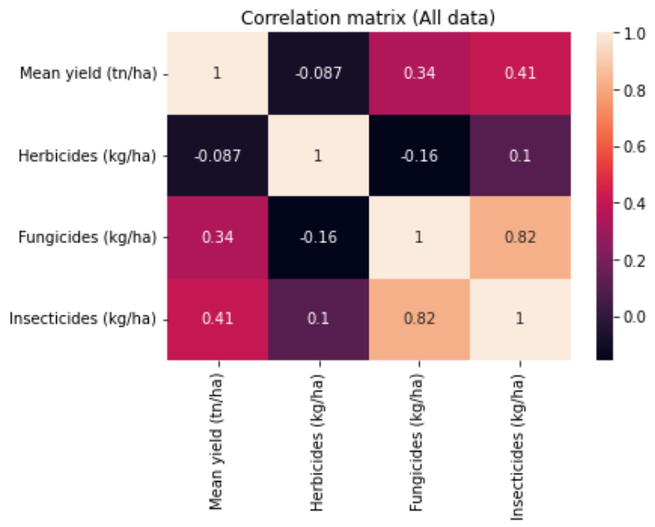


*As we can see in the graph, countries such as Argentina or Brazil, where commodities are the most produced goods in terms of volume, the use of pesticides in general has been **increasing**, and partly also the yield. The latter also increased in USA, although no significant changes in pesticides were observed. On the other hand, in countries such as France, Italy or Japan, pesticide use had a **negative trend**.*

*Second, we can also observe that for the top three countries, **herbicides** are the main component of pesticides, while in the bottom three countries it is more evenly distributed, with a slight advantage for **fungicides**.*

STATISTICAL ANALYSIS

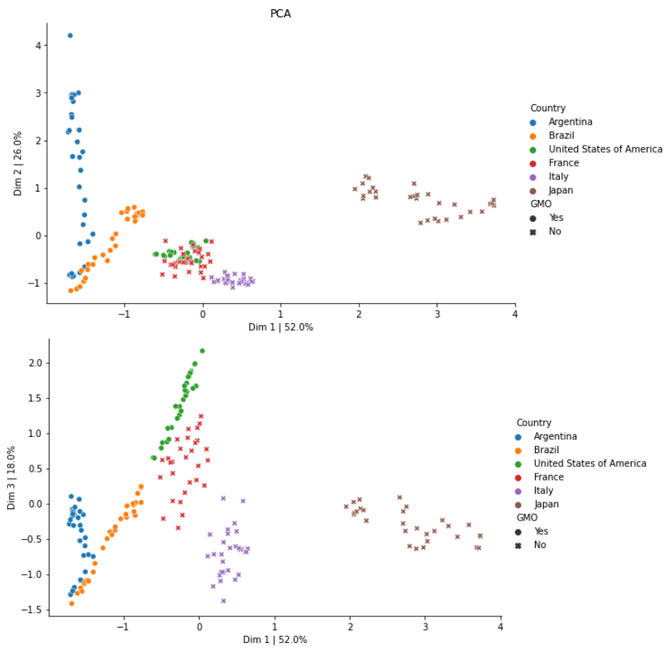
*In order to understand the link between the 4 variables studied and its evolution through time we plotted a correlation matrix. We can see that the use of fungicides and insecticides is **strongly correlated**, while the case is different for herbicides, where a strong correlation with the rest of the variables is not observed. On the other hand, yield is **positively correlated** with the use of insecticides and fungicides, while with herbicides it is close to zero.*

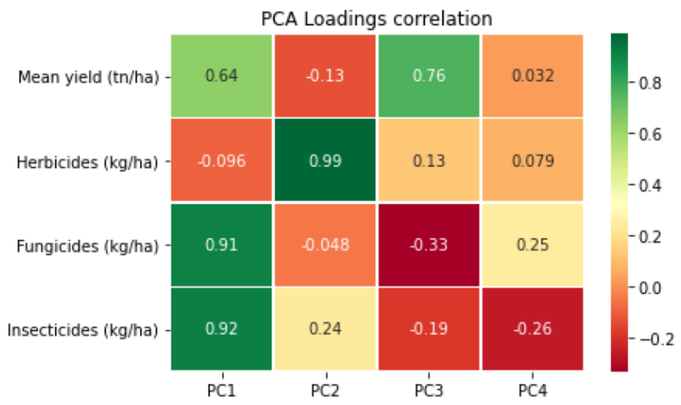


PRINCIPAL COMPONENT ANALYSIS

*To have more insights on the variables, we decided to perform a PCA. Based on the differential behavior of the pesticides (in particular, herbicides), we decided to add a new parameter to the analysis, Genetically modified organisms (**GMOs**), which indicates whether or not the country allows the use of this technology.*

- *Comparing **dimensions 1** and **2**, we see that most of the countries are quite well separated. To the left, we can find Argentina and Brazil, and to the right, Japan. The United States and France overlap on both axes, while Italy shifts a little to the right of both.*
- *This changes when we introduce **dimension 3**, which manages to separate these last three countries in a better way.*

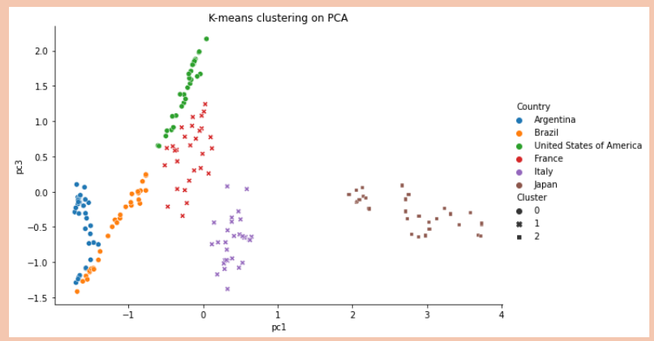




*A **PCA loadings** correlation matrix was added to show the importance of the variables in each principal component. We can see that PC1 is mostly dominated by **fungicides** and **insecticides** and PC2 separates by **herbicide** use. In the case of PC3, **yield** is the dominant variable.*

K-MEANS CLUSTERING

*Finally, we decided to test a **K-means** cluster, to try how the different countries are grouped according to this method. The results show that this method does a good job, grouping **GMO countries** on the left (Argentina, Brazil and USA), and **non-GMO countries** on the other (Italy and France), with the exception of **Japan** which, being very distant from all the others, possibly because of its unique management strategies, has an individual cluster.*



CONCLUSIONS

A statistical analysis was done on six different countries based on mean yield and pesticide use.

- ***Insecticide** use is the most correlated variable with yield.*
- ***Insecticides** and **Fungicides** share the most correlation between variables*
- *A **PCA** analysis using yield, herbicides, fungicides, and insecticides is sufficient to **separate** different countries into groups*
- *Principal component **1** is mostly dominated by **insecticides** and **fungicides**, this is expected as they are highly correlated*
- *Principal component **2** is mostly dominated by **herbicides***
- ***Yield** is predominant mostly on Principal component **3***
- ***GMO** use is a factor that influences the use of different pesticides and thus, we can observe clusters that tend to group GMO countries together*

REFERENCES

- *Jennifer Hsaio, 2015. GMOs and Pesticides: Helpful or Harmful?*
- *FAOSTAT database : Pesticides Use, Crops (Production)*
- *Scikit-learn, Machine Learning in Python*