Remote sensing observations capture Winter crop rotation in Argentina.

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Background

A rational use of resources is essential to guarantee food security around the world. For this purpose, it is essential to identify relevant indicators that allow to track the adoption of sustainable practices in main productive areas.

Thanks to climate, OGM and soils characteristics in Argentina, sustainable practices such as no-till is widespread adopted. However, no-till as well as many other practices are possible only in crop rotation systems with a balanced planted area between oilseed and cereal crops.

Cereal crops provide large volume of stubble after its harvest and this stubble protects the soil from its degradation due to direct sun radiation or water and wind erosion. On the other hand, stubble helps to increase the amount of organic matter in the soil as well as its structure, improving different characteristics such as water infiltration and its retention.

In Argentina main cereal crops are corn, sorghum and winter cereals mainly represented by wheat and barley. Since 2000/01 season up to now, the percentage of winter grasses in crop rotation have significantly decreased due to the implementation of policies, extremely climate condition and also due to different market variables, affecting at the same time the sustainability of agroecosystems.

Crop rotation is also an important strategy in managing insects, diseases, and weeds, maximizing crop yield potential.

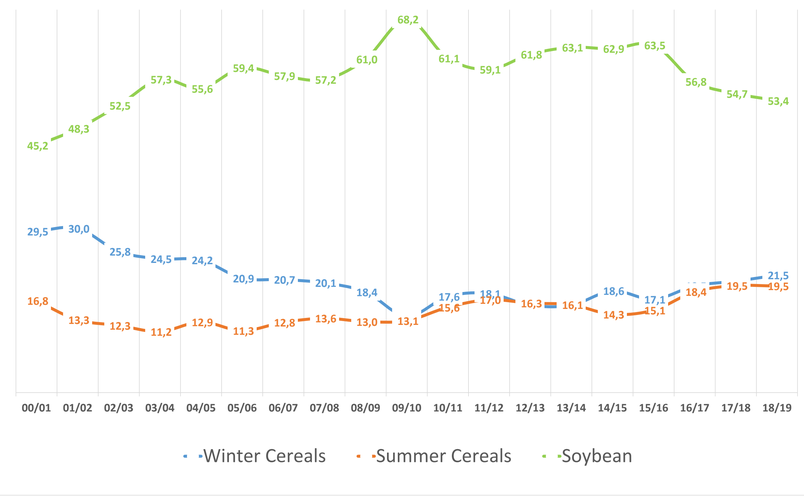
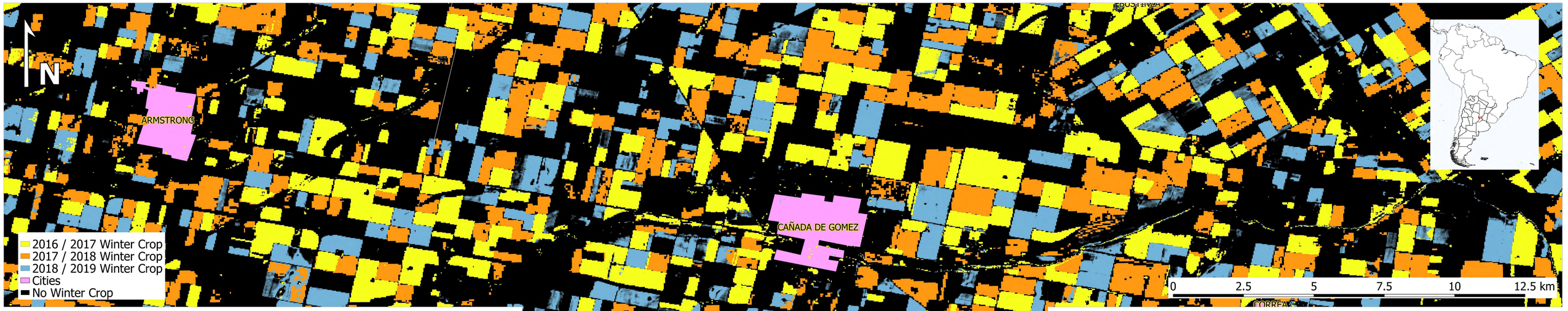


Figure 1: comparison among percentages of planted area of winter cereals, summer cereals and soybean during las nineteen years in Argentina. Values are calculated based on Buenos Aires Grains Exchanges planted area estimates.

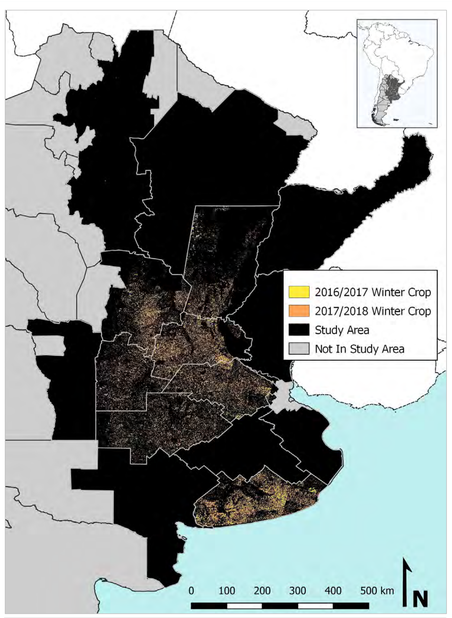
Methods Overview

- In order to map winter crop planted area, the first step is to study phenological stages development of wheat and barley during each season. Both crops share similar phenology development in a timeline and account for approximately 90% of winter crop area in Argentina.
  - The first date, T1, was selected during the seeding period, when NDVI values of wheat and barley are close to 0 due to the lack of vegetative coverage on its plots (fallow period following the previous harvest).
  - The second date, T2, was selected at the heading stage for both crops, when NDVI values reach their peak.
- Analysis of NDVI-images from Landsat-8 or Sentinel-2 scenes of both selected dates (T1, T2) was conducted. For ease of analysis, NDVI values were rescaled from the range [-1, 1] to [0, 2].
- The differences between the second and the first date (i.e. T2 – T1) were calculated to obtain two types of values:
  - Negatives values: due to vegetation that was detected in the first date and then disappeared in the second one.
  - Positive values (typically between 0 and 0.5): due to vegetation actively growing during the winter until the spring time, when the peak of NDVI is reached by winter crops (e.g. wheat and barley plots).
- After running this methodology in at least two seasons, winter crop masks are overlapped in order to study crop rotation in a time line.



Map 1: stack of winter crop masks from 2016/2017, 2017/2018 and 2018/19* seasons. The analyzed region is located at the center of the Santa Fe province, one of the most important agricultural regions in Argentina. * Preliminary analysis of 2018/19 season was included in this document in order to enrich the comparison among different crop seasons.

Objectives



Map 2: Argentina's agricultural regions where winter crop rotation between 2016/17 and 2017/18 seasons is analyzed at large scale.

- To map and analyze crop rotation along different season using satellite imagery approach (Map 1).
- Understand the geographic distribution of crop rotation at large scale along the entire agricultural region (Map 2).
- To integrate agronomical and remote sensed data into a political context analysis.
- Provide an objective measurement of crop rotation at regional scale in order to study the sustainable usage of arable lands.
- To contribute with new approaches to earth observation technologies that could be easily replicated at low-cost in others developing countries around the world.

Data

- Landsat-8 or Sentinel-2 images were selected to represent the early planting and peak vegetative stages of the winter crops based on known crop phenologies, for the area under study.
- NDVI [1] images were made from each Landsat-8 and Sentinel-2 scene.
- Ground data samples were taken during crop-tours in the reproductive stages of winter crops (wheat and barley).
- Winter crop masks from different seasons were stacked in order to understand its rotation between 2016/17 and 2018/19 seasons.

Conclusions

Earth observation technologies have become a powerful tool for improving our comprehension about food production at large scale and during learning process new research approaches have appeared. Preliminary studies aimed to quantifying winter crop planted area not only have reached high precision, but also paved the way for evaluating other variables strongly connected with sustainability of the Argentine's production systems. Since food security globally would be reached based on a sustainable agricultural production systems, this kind of approach is a fundamental tool for an holistic analysis.

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