Changes in frequency of occurrence of dry/wet years and its implications on the Spanish agro-food system sustainability

Alfredo Rodríguez [1], Margarita Ruiz-Ramos [2], Alberto Sanz-Cobena [2], Luis Lassaletta [2]

[1] Department of Economic Analysis and Finances, Universidad de Castilla-La Mancha, Toledo, Spain

[2] CEIGRAM, Universidad Politécnica de Madrid, Madrid, Spain

INTRODUCTION

Agrofood systems can be described by different compartments interconnected among them. These are cropland, grassland, livestock and people, and it is essential to understand each of them and their interrelation before any attempt of improving the system. The understanding of the system helps to identify potential hotspots of production and system leakages in pursuit of sustainability. It is also useful for measuring the degree of external dependency, which is interesting to be minimum for guarantee food security. Nitrogen (N) is essential for crops, livestock and people, part of life-essential molecules, but a potential pollutant if not embedded in food and feed. The relation of N and water (the main limiting factors of crop production) goes beyond production, where water availability significantly affects fertilizer use and nitrogen use efficiency of cropping systems. It also affects N deposition, N fixation and finally the net import/export of feed and food due to more demand or excess. Climate change affects precipitation patterns (IPCC, 2022) and the frequency of dry/wet years, even if this variable exhibit higher uncertainty in comparison to other atmospheric variables.

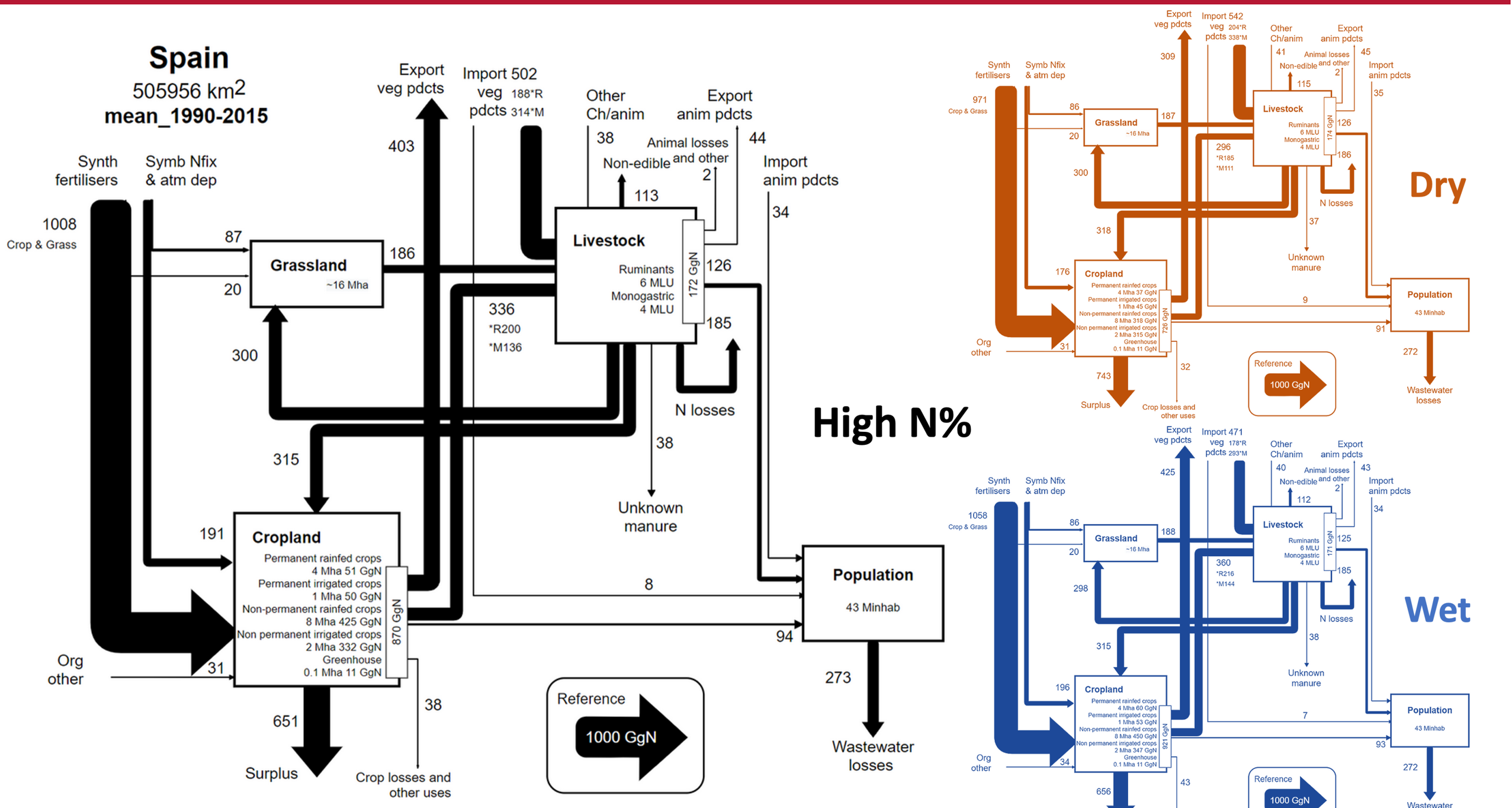

Fig 1. GRAFS of Spain using the %N upper limit for crops. Mean of the 1990-2015 period (left panel), mean of the dry years (top right panel) and mean of the wet years (bottom right panel)

MATERIAL AND METHODS

The GRAFS methodology (Le Noë et al., 2017) was used for representing in detail the N flows of the Spanish agrofood system for both provincial and national scale for the 1990-2015 period following a bottom-up approach. With that starting point from Rodríguez et al. (2022) and Rodríguez et al. (under review), the mean accumulated precipitation (PP) in Spain was calculated using E-OBS (Cornes et al., 2018) for the period, and dry (PP lower than 85% of mean PP) and wet (PP higher than 115% of mean PP) were identified, considering the hydrological year. In addition, and for describing the uncertainty related with the %N content considered for the crop production, ranges of %N were obtained from the literature, and new GRAFS were generated for the whole period for the low and high %N ranges, and for each N concentration, GRAFS for the dry and wet years were generated (for example Fig.1 shows a high %N for the whole period and also for the dry and wet years.

CONCLUSIONS SO FAR

- A relationship between N application, yields and wet/dry years was found, with dry years in general having a lower N inputs and lower y yields. For example, for the mean %N, synthetic N application for cropland was 950GgN for dry years and 1037GgN for wet years while crop production was 538GgN and 682GgN respectively.
- The uncertainty caused by the %N affected the N flows of the GRAFS including changes in the N imports and exports. For example, the feed import for the whole period varies from 502GgN from the upper N% case to 612GgN in the lower N% (mean %N being 550GgN, therefore with changes of around 10%). For crop exports the change is even bigger with a mean crop export of 240GgN changing to 152GgN for the lower %N and 403GgN for the upper %N, highlighting the importance of considering the associated uncertainty.

FURTHER WORK

The proportion of dry and wet years is being obtained from a climate ensemble from the CMIP6 project (Eyring et al. 2016) and the final proportion will be used for weighting the dry/wet GRAFS for obtaining a future projection in terms of impact on the agrofood system. Also, the work can be done also at provincial level where that information is also available.

ACKNOWLEDGEMENTS AND REFERENCES

Alfredo Rodríguez is grateful to the Department of Economic Analysis and Finances of the UCLM. Authors are grateful to the Spanish Ministry of Science, Innovation and Universities (AgroSceNA-UP, PID2019-107972RB-I00)

- Cornes, R.C., et al., 2018. Journal of Geophysical Research: Atmospheres, 123(17): 9391-9409.
- Eyring, V.,et al., 2016. Geosci. Model Dev., 9, 1937-1958
- IPCC, 2022. Climate Change 2022. Sixth Assessment. Cambridge University Press
- Le Noë, J. et al., 2017. Sci. Total Environ., 586: 42-55.
- Rodríguez et al., 2022. Proc. XXI International N Workshop. ISBN:978-84-122114-6-7