Transition towards a more carbon and nutrient efficient agriculture in Europe

F. Corona[1,2], D.Hidalgo[1,2], J.M. Martín-Marroquín [1,2]

[1]CARTIF Centro Tecnológico, Boecillo, Valladolid, 47151, Spain
[2]ITAP Institute, University of Valladolid, Valladolid, 47010, Spain
Keywords: nutrient recovery, phosphorous, nitrogen, carbon, biofertiliser.
Presenting author email: fraenc@cartif.es

Intensified European agriculture is crucial for the EU food supply and self-sufficiency, but it also generates environmental challenges related to GHG emissions and nutrient related pressure (eutrophication). In addition, European agriculture is under economic pressure due to its high dependency on import of primary nutrients and energy. Nitrogen (N) has been highlighted as one of the three "planetary boundaries" that have been exceeded beyond supportable levels alongside climate change and biodiversity loss (Steffen et al, 2015). For example, one of the most potent greenhouse gases is nitrous oxide (N_2O) whose concentrations have increased in the past 50 years from 270 to 330 ppb (IPCC, 2014). This is significant taking into account that N_2O has a global warming potential which is 300x that of CO_2 and for which agriculture is responsible for 60% of its emission. In addition, ineffective management of manure and other fertilizing products results in eutrophication of water bodies with nitrates as well as elevated volatile ammonia emissions threatening biodiversity adjacent to agricultural activities. Phosphorus (P) has been highlighted and was placed on the "Critical Raw Material" list by the European Commission, considering the European continent is dependent on import (currently EU28 is 92% dependent (P-REX Policy Brief)) to secure its own agricultural production (and hence food security). Carbon has been insufficiently investigated and even overlooked in past nutrient oriented research, yet N-, P- and C-cycles are intertwined and need to be examined within a single methodological framework. Carbon is of primary importance as (effective) carbon in organic matter returned to soils, which plays a vital role in abatement of soil degradation and maintaining soil fertility. In Europe, 45 % of soils are thought to have a low or very low organic content matter (0-2 % organic carbon). These soils are located primarily in southern Europe but also in areas of France, the UK and Germany (EC, 2016). In addition, closing the carbon cycle is highly relevant from the perspective of renewable energy potential from agro residues (e.g. biogas) and reduction of GHG emissions from agricultural practices (e.g. CH_4 losses from animal husbandry).

NUTRI2CYCLE addresses the current gaps in the N, P and C cycles of different European agricultural systems and the related environmental problems by implementing optimized management systems whilst having a positive trade–off with productivity, quality and environmental impact. NUTRI2CYCLE is a partnership which includes applied practice oriented research institutes and universities, agro-businesses and non-profit stakeholder associations. The NUTRI2CYCLE consortium and central research views find their origin in the EIP-AGRI Focus Group on "Nutrient Recycling" which ran from 2016-2017 with the final concluding report and associated technical papers currently pending to be published (see also: https://ec.europa.eu/eip/agriculture/en/focus-groups/nutrient-recycling).

The end-report of the EIP-AGRI Focus Group (Meers, 2017) put forward the central notion that to improve nutrient and carbon cycles within agricultural systems, a third pillar of agricultural activity is required: agro-processing (see Fig 1).

The basic understanding is that plant production and animal husbandry have each intensified independently from one another over the last century, resulting in disjunctions on nutrient and organic carbon flows between both these conventional pillars of agriculture.

To obtain the highest possible productivity and economic efficiency, plant production has increasingly required nutrients in directly available form as mineral fertilisers whereas animal production has been characterized by upscaling and increased animal concentrations. NUTRI2CYCLE starts from this central three-way interaction in modern agriculture and investigates optimizations within cropping systems, within animal husbandry and between plant-animal production via optimized management and technologies as well as via the agro-processing intermediaries.

NUTRI2CYCLE starts from existing N-P-C flows and farm management systems and will propose, test and implement more mature and sustainable farm prototypes including innovative technologies to better close the loops. These prototypes will serve as an innovation engine to further extrapolate the farm level impact to regional and European level impact. NUTRI2CYCLE brings together the extensive expertise of leading experts in the field of nutrient cycling. This collaboration finds its basis in the EIP-Focus Group on Nutrient Recycling, in a joint effort to bring the combined knowledge to practice, closely interacting with the EIP Operational Groups in the individual EU member states.

The main objectives of the NUTRI2CYCLE project are:

• Map and comprehensively present the current flows and gaps in C, N and P cycles in 8 investigated agro-typologies over three major agricultural pillars:

• Implement a toolbox with for stakeholders' comprehensible indicators to measure sustainability & evaluate trade-offs between the current practice and innovative, optimized farming systems for the investigated typologies.

• Innovation funnel:

o Assessment of 60 proposed optimized farming systems, aimed at closing nutrient loops and efficient mitigation measures (longlist).

o Shortlist top 24 innovations (3 per investigated agro-typology) from the acquired longlist, exhibiting most potential for reduced GHG emissions and nutrient losses, while enhancing or maintaining productivity and overall sustainability.

o Scrutinize and prioritize 1 to 2 innovations per agro-typology (12-16 in total) for further full scale demonstration and in-depth impact investigations.

• Further development and testing of minimal 1-2 prototype per farm typology taking into account the different agro-climatological and socio-economic aspects.

• Impact calculation at regional & EU level, extrapolating the potential GHG abatement and nutrient recycling/upcycling/re-use from farm-level (derived from the micro-economic assessments) to regional and European level.

• Evaluation on how agro-products obtained via more sustainable processes can aim for ecolabelling, and how this could affect consumer behaviour (willingness to pay), bridging the informational gap between producers and consumers, address consumer demand for quality assurance criteria, and ultimately create value for consumers and producers by assessing ecolabels.

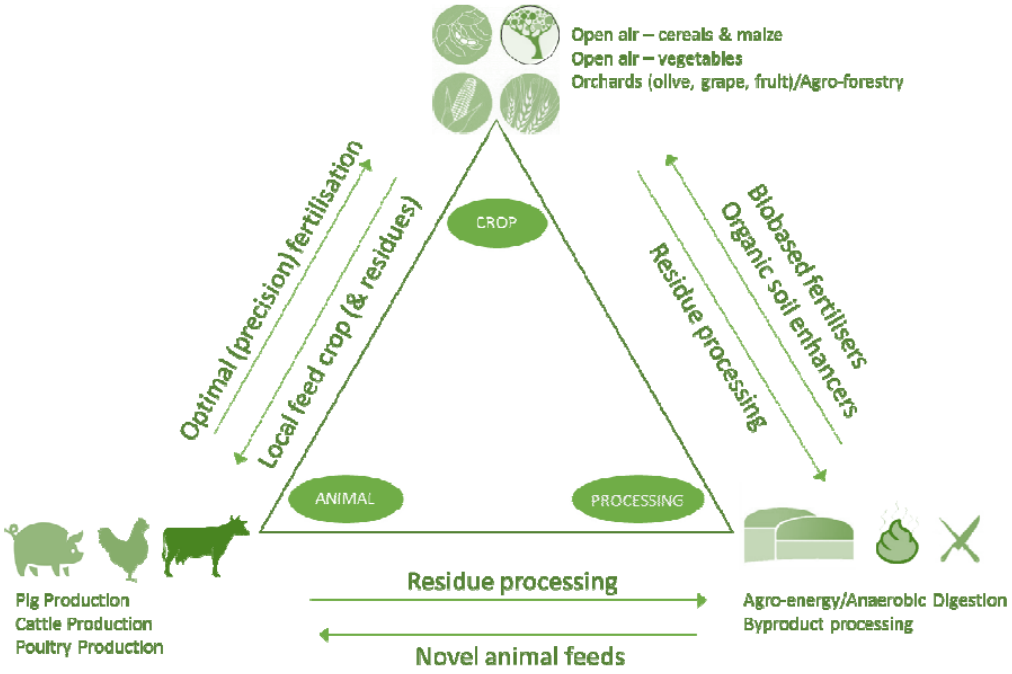

Fig 1. The three NUTRI2CYCLE pillars and the 8 key agro-typologies under investigation

References

European Commission, DG Environment, 2016. Resource efficiency in practice – Closing Mineral Cycle, pp 1-418

IPCC, 2014. Climate change 2014: synthesis report. Intergovernmental Panel on Climate Change, pp. 1-169.

Meers, E. (2017). EIP-AGRI Focus Group Nutrient Recycling – Final Report. In press.

Steffen et al. Planetary Boundaries: Guiding human development on a changing planet. Science 347, 2015

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773682 (NUTRI2CYCLE project)