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Efficient Carbon, Nitrogen and Phosphorus cycling in the European Agri-food System and related up- and down-stream processes to mitigate emissions

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D6.7 Policy Note

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Circular Agronomics

POLICY NOTE

TOWARDS A CIRCULAR EU AGRI-FOOD SYSTEM

Summary

Agriculture, and in particular livestock, uses nutrients inefficiently, contributing to water and air pollution and global warming. One of the objectives of the Green Deal of the European Commission (EC), through the Farm to Fork strategy, is the reduction of nutrient losses by at least 50% while ensuring the soil fertility. The EC expects that this will reduce the use of fertilisers by at least 20% by 2030. Integrated nutrient management plans will be developed by Member States with the objective of reducing and preventing further pollution from excessive use of fertilisers, while encouraging nutrient recycling from organic waste as fertilisers. At the same time, the EC encourages increasing information to consumers through harmonised labelling and establishes targets to reduce food waste.

Circular Agronomics aims to convert agriculture into a more circular and sustainable sector through short- and long-term measures from practical innovations to costumer awareness and facilitating legislation. With many of the developed innovative solutions a significant reduction of nitrogen emissions, in particular ammonia (NH_3), was achieved. Besides, the harmful greenhouse gas (GHG) nitrous oxide (N_2O, almost 300 times the Global Warming Potential as carbon dioxide over 100 years) was reduced significantly (e.g. >75 % due to fertiliser reduction in the trials with N efficient genotypes of winter wheat). Results are very promising for a transition to an environment- and climate-friendly agriculture, when farmers are able to invest in such innovations and build up the necessary knowledge. At the same time, consumers need transparent product labelling to make the right decision based on their norms.

Introduction

Nutrients and carbon maintain fertile and healthy soils, and allow adequate plant growth. Both nutrients and carbon are crucial in agriculture, but poorly managed so far. While most of the nitrogen and phosphorus entering our agricultural system comes from non-renewable sources, only one ton of every five tons of nitrogen entering the European Union's (EU) agri-food chain is actually converted into food for human consumption.
The story is similar for phosphorus and potassium[1]. Agricultural soils suffer carbon depletion and valuable nutrients are lost, leading to environmental pollution and contributing to GHG emissions. Globally, surpluses of nitrogen and phosphorus exceed safe limits for the environment. In Europe, livestock production is responsible for 81% of the contribution of agricultural nitrogen to aquatic systems.

According to the European Environment Agency (EEA), the EU exceeds the nitrogen leak limit by 3.3 times and the phosphorus leak limit by twice (Directive 91/676/CEE, 2021). Animal based emissions represent half of the GHG emissions from agriculture. Feed digestion accounts for 78% of the GHG emissions in livestock[2].
Low nutrient use efficiency (NUE), poor soil management and exploitative agricultural practices reduces agricultural productivity on a long term. In addition, diets rich in animal products and high amounts of food waste put our food security and sustainability of the European agri-food chain at further risk. Hence, improved nutrient management needs to be coupled with measures at the consumer end to build sustainable nutrient cycles guaranteeing high NUE and nutrient recovery.

[1] Buckwell, A. Nadeu, E. 2016. Nutrient Recovery and Reuse (NRR) in European agriculture. A review of the issues,opportunities, and actions. RISE Foundation, Brussels.

[2] European Court of Auditors, Common agricultural policy and climate: half of EU climate spending but farm emissions are not decreasing. Special report No 16, 2021. Publications Office, 2021, https://data.europa.eu/doi/10.2865/285879

The solutions of Circular Agronomics

The solutions of Circular Agronomics addresse the challenge of sustainable circular management of Carbon (C), Nitrogen (N) and Phosphorus (P) by analysing flows, stocks, and emissions from different European agricultural, livestock and food processing practices. The proposed innovations aim to mitigate emissions and eutrophication by increasing circularity and NUE while reducing mineral fertiliser use. Some of the solutions focus on the producer end while others focus on the consumer end. Sustainable and circular use of nutrients and carbon can be achieved only by addressing both.

Innovations to reduce environmental impact

Table 1: The unique selling points of the Circular Agronomic innovations (further information are on our website: www.circularagronomics.eu)

Circular Agronomics innovations	unique selling points (incl. potential reduction of N emissions compared to conventional scenarios)
N efficient genotypes of winter wheat	significant reduction of N fertilization rates & of N emissions per kg wheat **(up to 50% NOx, up to 78% N2O (GHG), up to 99% NH3)**
N efficient slurry application techniques	flexible application possible to reduce climate/weather impacts & reduction of emissions **(up to 22% N2O, up to 44% NO3)**
Conservation tillage	comparable yields with lower energy (fuel) consumption & reduced emission **(>10% NH3 and NOx)**
Solar-dried digestate in crop rotations	combined calorific and solar power, production of organic biofertiliser with NPK (according to European legislation), no residual streams & significant emission reductions **(up to 46% N2O, up to 89% NH3)**
Fertigation with microfiltered digestate	Increased Nutrient Use Efficiency, replacing mineral fertiliser, low maintenance, reduced water and energy consumption, significant emission reduction **(up to: 79% NH3, 24% N2O)**
Precision feeding & fertilization strategies	optimized use of dietary N and reduced emission **(up to 33% NH3, 33% N20 and 33% NOx)**
extensive management in less favourable area	closed production cycle, farms produce food and provide environmental services **(up to 65% NH3 & 64% NO3)**
N recovery through digestate degasification	> 80 % removal of inorganic N achievable, production of mineral fertiliser & N depleted manure/digestate (decoupling N and manure facilitates compliance with EU Nitrates Directive)
P and K recovery in the form of struvite	80-90 % P recovery possible, production of precision fertiliser with, high Nutrient Use Efficiency
Acid whey treatment with novel membranes	high potential of valorisation because of high amounts in Europe (further research needed)



Farmer willingness to adopt our innovations

Circular Agronomics also aimed to understand farmers objectives and motivations. A large-scale survey showed that farmers are more willing to adopt these technologies if they are professional farmers with university training, if they are aware of environmental problems, or if they are located in a nitrate vulnerable area. However, the biggest challenges to implement technologies are economic. 84% of the farmers responded that government and public institutions should encourage the implementation of new technologies in agriculture through direct payments that support investments in emission reducing solutions and tax reduction schemes.

Understanding consumers preferences

According to the consumer survey of more than 5000 participants, the willingness to pay for specific products depends significantly on the variations of the country, the production system and the origin. Consumers are willing to pay an average of 120% more for a circular product than for a conventional one. The organic attribute is more preferred than the local one. Furthermore, many consumers across the EU have reported wasting food with fruit and veg the most commonly wasted.

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POLICY RECOMMENDATIONS - Closing the circle

Based on the findings, Circular Agronomics proposes the following recommendations:

Recommendation 1 :

EU support through the Common Agricultural Policy (CAP) to invest in emission mitigation practices and adoption of technologies

The CAP has been criticised for its low climate ambition (ECA 2021), in particular its first pillar. However, the current CAP framework allows for further uptake of measures through a more ambitious implementation and **greater use of the Agri-environment-climate Measures (AECM)** of the second pillar, water protection by reducing fertiliser or climate stewardship by reducing greenhouse gas emissions, among others.

According to the results from the farmer survey, the implementation of new technologies in agriculture should be significantly facilitated through **direct payments.** The intervention scheme should be designed to support farmers in their decision to adopt innovations through one-time structural grants for investments in sustainable innovations/technologies. Depending on the innovation, various measures might be also subsidised annually to compensate higher operating costs temporary. **Lower tax schemes** corresponding to lower GHG and nutrient emissions and an **expansion of the European Trade System (ETS)** covering also the agricultural sector is the future for a circular agri-food chain. In addition, **further development and research** for the very complex agricultural systems and their environmental and climate impacts are necessary to build up a more robust data base. This policy recommendation fits in with the current EU scheme on agri-environmental commitments towards manure management and investments in physical assets regarding manure storage and installation of anaerobic digesters.

Recommendation 2 :

Strengthen the processes of dissemination of innovations and capacity building for farmers.

To ensure effective policies that reduce GHG emissions and improve NUE at EU farms, the factors have to be considered that motivate farmers to adopt circular farming' innovations like farmers' characteristics, environmental attitudes and preferences for agribusiness. **The access to information and knowledge** promotes a greater willingness and capacity to adopt technological solutions of circular agriculture as has been evidenced by the research. **Experience and high level of training** increase the likelihood of adoption which is why that should be established readily accessible for all farmers. Furthermore, a **better dissemination of innovations** to national agricultural chambers and ministries is crucial. **Knowledge-sharing platforms and periodical sessions** with farmers and regulators to inform about project results should enhance a better understanding of policy-makers about a circular sustainable agriculture and about a facilitating regulatory framework.

The adoption of climate and environmental-friendly technologies and solutions is higher in Nitrate Vulnerable Zones (NVZ) within the EU. Therefore, the advisory systems and the access to information for farmers operating there, as well as the business cases and motivations should be also considered **best practice** elsewhere.

Recommendation 3

Rising awareness for the value of food and establish sustainable consumer choices based on transparent product labelling

Marketing campaigns to increase consumer demand and uptake of organic (and circular produced) food purchasing should consider attitudes, social norms and behavioural control rather than focus on the traditional demographic segmentation categories of age, gender etc. Changing norms using opinion leaders, role models, and community social marketing to assist in establishing new social and cultural norms may have the biggest impact on changing food purchase behaviour. Increasing sustainable purchasing behaviour in turn will help to form positive attitudes to sustainable foods. Attitudes could be targeted via **advertising campaigns** promoting the availability of sustainable products and education-oriented interventions. In any case, consumers need to have a sense of control over their purchasing behaviour. Hence, the availability of sustainable products in-store or at food markets should be promoted so that the products are readily available and recognizable to consumers. Developing a **sustainable food label** for lower environmental and climate impacts using a Circular Agronomics symbol, would enhance consumer usage and reward farmers for adopting technology. There is a need for **awareness campaigns and strategies for purchasing, using and storing** without food waste. Campaigns should focus on simple measures like meal planning and shopping lists, along with positive behaviours among peer groups and education on how to minimise food waste. The true cost of food including all resources (not just price) would highlight the full impact of food waste.

Conclusion

The most important measures identified in Circular Agronomics are the financial support of sustainable agricultural solutions for farmers, transparent information and awareness campaigns for both farmers and consumers. Circular economy, high nutrient efficiency and emission mitigation in agriculture aim to improve the agri-food chain at the start. Sustainable behaviour and responsible diets of consumers without wasting food targets at the end. Both ensures food security and environmental health on a long term.

Circular Agronomics

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