

How can integrated farming production systems increase circularity and promote Sustainability in the context of climate change?

A tendency for more ecosystem-based and circular solutions...

One of the main features of modern agricultural systems has been to free themselves from the variability and restrictions of ecosystems and the environment by external inputs (e.g. fertilizers, pesticides, irrigation, mechanization), relying heavily on non-renewable energy, creating another form of dependence with non-desirable effects (e.g., climate change, water, soil and air contamination, biodiversity and natural resources depletion). In light of this reality, new agricultural models have emerged (e.g. agroecology, organic farming, ecological intensification, etc.) sharing a common idea; to be a more ecosystem-based activity, i.e. relying more on ecosystem mechanisms to ensure a sustainable supply of resources and services (figure 1).

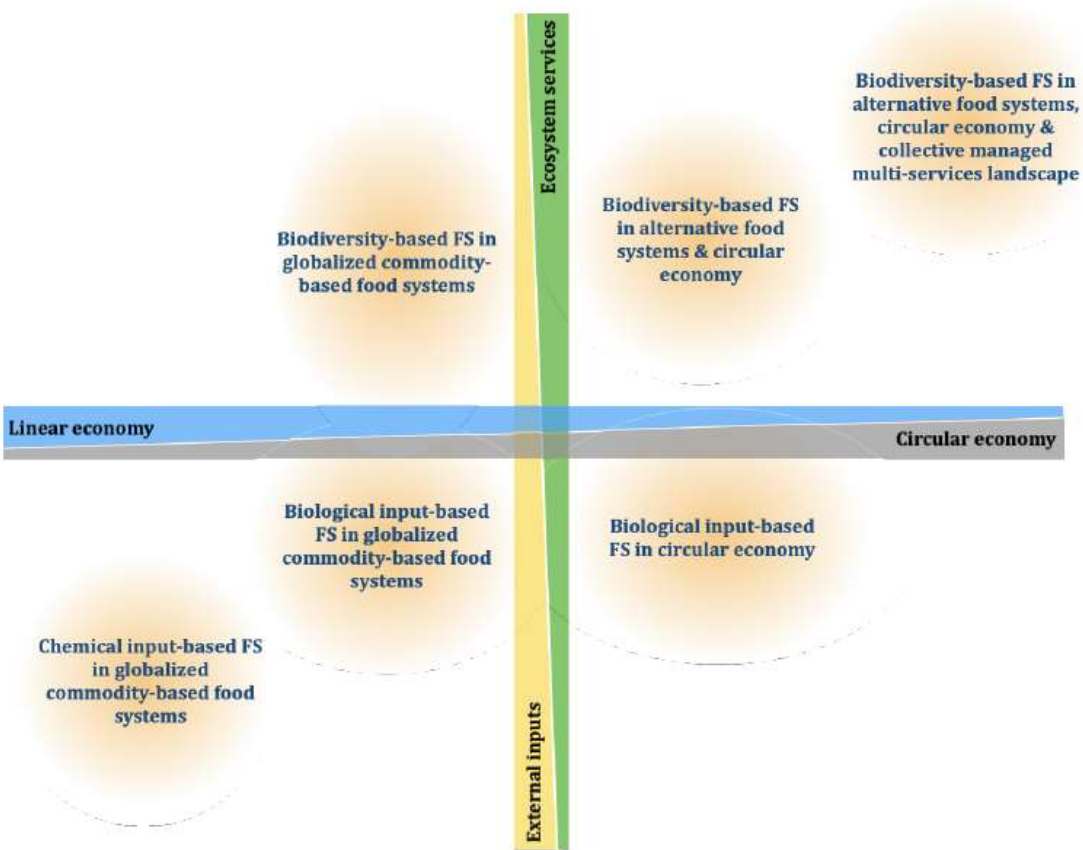


Figure 1: Six models of agriculture (FS: farming system) according to the gradient of inputs (ecosystem services vs. external inputs) and their relationship with socio-economic configurations (linear economy vs. circular economy) – adapted from Therond et al. (2017)

At the same time, integrated farming production systems (silvo-pastoralism, mix animal-crop farming system) are increasingly seen as an agroecosystem, that is, modified ecosystems to get natural resources for human society. Essential characteristics of ecosystems are the integration of components working in a synergetic and cooperative network, recycling and re-using flows of materials and nutrients. Those features are essential components that contribute to *Circularity* inside the agroecosystem. The farm system is also an economic activity that interacts with the agro-sector and other sectors and where circularity is also essential to the development of a synergetic network in resource use and developing industrial ecology strategies.

An integrated agricultural production system is an answer to a potential increment of Carbon and Nutrient Circularity. Mixed crop-ruminant livestock systems are farm systems already present all around the world that go in this direction. Different configurations and productive strategies should be developed to tackle the challenges that the agricultural sector needs to overcome on our planet, according to the climatic and social characteristics of each region.

The INTEGRITY Project

In this context, the project **INTEGRITY** (Integrated Crop-Ruminant Livestock Systems as a Strategy to Increase Nutrient Circularity and Promote Sustainability in the Context of Climate Change) aims to evaluate alternative management of mixed crop-ruminant livestock systems to increase Carbon and Nutrient Circularity in diverse agro-climatic regions worldwide. Nine countries from three continents (America, Europe, and Oceania) are involved in this proposal. Different degrees of integration between crops and livestock components of a system create scenarios revealing trade-offs among economic (productivity, efficiency), environmental (nutrient cycling, soil health, greenhouse gas (GHG) emissions), and social (work arduousness and organization, household networks) aspects.

To fully understand the mechanisms that reduce GHG emissions and/or increase soil C sequestration and nutrients (i.e. C, N) use efficiency in mixed production systems it is necessary to fill gaps in knowledge regarding the impacts of the integration; and which would be the impact of the proposed interventions with a broader and holistic perspective.

INTEGRITY looks to evaluate different management strategies on farms, quantifying their impact in a broad sense, addressing the circularity within the agricultural systems, and developing modelling tools. Standardized evaluation approaches and procedures across the different partners will allow direct comparison of the relative impact of new management alternatives. Stakeholders' involvement through the process will help us to focus on applicable new practices and facilitate their adoption by farmers.

For that, the project will:

- Investigate different management practices in diverse agricultural systems to enhance nutrient circularity, efficiency, and reduce carbon footprint
- Identify the potential improvement in reduction of carbon footprint by increasing the inclusion of by-products in ruminant diets
- Evaluate the management of carbon circularity and climate change mitigation and adaptation in mixed crop-ruminant livestock production, through system approach assessment and Information and Communication Technology
- Promote and develop Decision Support Tools models for circular and sustainable resource use management.

A particular characteristic of **INTEGRITY** is the range of diverse production systems with diverse agro-climatic and socio-cultural individualities allowing differential responses of enhanced resource use efficiency and optimize nutrient circularity.



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