

POSITION PAPER

# Digital innovations for the agroecological transition: A user innovation and commons-based approach

Vasileios D. Gkisakis<sup>1</sup> and Konstantinos Damianakis<sup>2</sup>

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Vasileios D. Gkisakis



Konstantinos Damianakis

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Agroecology is currently an emerging concept for the transition towards sustainable and resilient food systems, with a significant body of literature on how to accomplish such a transit following a systemic and holistic approach (Pimbert, 2015; Altieri et al., 2017). Most transition analyses are based on what MacRae et al. (1990) presented to be a linear step-wise process of increased efficiency of the use of agricultural inputs, followed by their substitution, and eventually the whole system redesign, focusing equally at the farm and the greater territorial level (Gliessman, 2015). Such a process is meant to be knowledge-intensive, where employment of several innovative frameworks, tools, and technologies, re-directed towards sustainability principles, could potentially be used (Rains et al., 2011; Caron et al., 2014). Indeed, quite a few agricultural technologies are widely described as being aligned with this path of transition, while most recent mainstream narratives of agricultural innovation propose a variety of “disruptive” technological fixes for increasing the efficiency of the food system (Gkisakis et al., 2017).

Digitalisation in agriculture (DiA) is top-placed among these technological propositions as a term that collectively describes the multitude of concepts and forms of digital technologies applied in agriculture, also known as ‘smart farming’, ‘precision agriculture’, or ‘digital agriculture’. DiA is defined as the socio-technical process of applying digital innovations in

agricultural production systems and value chains (Klerkx et al., 2019). It comprises “technocentric” approaches of gradual to extreme mechanisation of farm management, supported by data-driven procedures and sophisticated tools and technologies, such as information and communication technology platforms, big data, the Internet of things, drones, robotics, sensors, or artificial intelligence. DiA approaches are often regarded as highly prestigious solution-providers that increase yields, reduce costs, and, notably, promote agricultural sustainability (Barilla CFN, 2017). They have also become a prioritised trend in the EU and global rural development policies and supported applied research topics in order to facilitate the creation of a market players’ ecosystem, including manufacturers, researchers, and infrastructure providers, and ensure the rise of a novel economic sector (European Commission, 2019).

Despite the technological optimism, warnings are often expressed about how the ultimate objective of systemic redesign could be compromised by adopting approaches that simply focus on input-substitution and efficiency increase, eventually containing the risk of “conventionalisation” of the agroecological transition process (Darnhofer et al., 2010; Caron et al., 2014; Duru et al., 2015). This argument has rather advanced the discussion among stakeholders on the differentiation of agroecology from other approaches regarded

<sup>1</sup> Hellenic Mediterranean University (HMU), School of Agricultural Sciences, Heraklion, Greece

<sup>2</sup> Agroecologiki SP, Agricultural Research & Development, Crete, Greece

as likewise sustainable (e.g. climate-smart agriculture or sustainable intensification), in order to avoid possible co-optation by the mainstream agricultural trends (Pimbert, 2015; Altieri et al., 2017). However, a conclusive consensus has not been reached with regards to the potential role of DiA in the agroecological transition towards truly sustainable and resilient food systems.

For almost a decade, the application of digital technologies has been related to the so-called “weak” form of ecological modernisation, which promotes an interventionist and “therapeutic” strategy, in continuity with production-oriented approaches that still rely on external chemical inputs (Horlings and Marsden, 2011; Rains et al., 2011). Contrariwise, the “strong” form of ecological modernisation, also described as “biodiversity-based agriculture”, is featured to support agroecology (Duru et al., 2015), by enhancing the provision of agroecosystem services mainly through practices and farming systems that are based on biodiversity attributes. Furthermore, DiA has been shown to only partially improve the efficiency of inputs and resource use or decrease production costs (Duru et al., 2015). This is accompanied by high costs of farm management mechanisation that require large initial investments in time and capital (Van Meensel et al., 2012) and consequently exclude small scale farmers that may not take advantage of the new technologies (Osipov and Bogoviz, 2017).

DiA approaches have also been described as valuing mostly the big data and technology transfer models, rather than promoting an experience-based exchange of knowledge and long-term observation of ecological processes (Carolan, 2017; Higgins et al., 2017; Gkisakis et al., 2017). In fact, mainstream agricultural digitalisation appears to be more aligned to a top-down paradigm, centred on and driven by technology developers. Under this approach, users are considered as a mere market (Kshetri, 2014; Seppala, 2014), which eventually generates a considerable gap between innovation development and the context, needs, assets, and emerging constraints faced by farmers (Bellon and Ollivier, 2018). Thus, it is stressed by several authors that DiA tends to ignore any resulting economic and cognitive dependencies of farmers, especially small ones, to technology providers, which may lock both food producers as well as citizens into asymmetrical power relationships and lead to the loss of autonomy (Gkisakis et al., 2017; Higgins et al., 2017; Carolan, 2018).

Despite the above, other authors (Maurel and Huyghe, 2017) emphasise the positive aspects of digital technologies and include DiA among the broad technological possibilities that will help meet the challenges of agroecological transition; as such, DiA is expected to make a multi-level contribution to farming efficiency that would help farmers close the loop of biochemical flows or take advantage of biodiversity. Ingrand (2018) also states that the combination of agroecology and DiA would minimise the risks of failure for both, in comparison to a model of separate development. For agroecology, this would mean a reduction of the risk of having limited capacity to motivate different actors due to its low-tech nature; for digital sciences and other new technologies, this would mean avoiding the risk of social rejection

due to the mechanisation tendencies associated with several technological actors while excluding farmers. Other recent related reports (Rudram et al., 2016; HPLE, 2019; Kipling and Becoña, 2019) aptly stress that digital tools and technologies, like mobile phones and Internet, provide opportunities for improved information exchange, knowledge-sharing, and co-production. Therefore, they potentially facilitate farmer-to-farmer exchanges in various countries, including low-income ones, as well as increase the ability to establish shorter food chains and build trust among farmers and consumers.

To move beyond such conflicting dissensions and in order to provide a pragmatic, transdisciplinary approach, we argue that digital technologies could play a potential complementary role in the agroecological transition, only when certain prerequisites, previously described by data science and socio-economic disciplines, are met:

i) A user innovation (UI) process should be applied, emphasising the end-user's involvement (in our case – the farmers) in digital tool and technology development. UI is regarded to be fundamentally different from the traditional, manufacturer-centric model, where products and services are developed by manufacturers in an exclusive way (von Hippel, 2005). Instead, it stresses the end-users' ability to either innovate for themselves in a do-it-yourself manner that goes beyond a simple participatory approach or co-innovate by benefiting from freely open-shared innovations, consequently organising participation at multiple levels and take advantage from collective intelligence and organisational structure in a non-exclusive manner (Ornetzeder and Rohrer, 2006). Therefore, UI has been regarded as representing the democratisation of innovation development, where users possess the unique local knowledge of their needs and the technical capacity to create follow-on innovations to meet these needs (Douthwaite, 2002). Examples of agricultural technologies, including digital ones, developed by or co-developed with users are already abundant, and an essential next step proposed would be their scaling up and scaling out (Cerf et al., 2012; Van Meensel et al., 2012; Lindblom et al., 2017).

ii) A peer-to-peer (P2P) process of sharing innovation should be followed, incorporating its diffusion to non-innovators (Gambardella et al., 2017) within a commons-based peer production (CBPP) model, as described by Benkler and Nissenbaum (2006). P2P represents a relational dynamic of human interaction requiring a decentralised and non-hierarchical network organisation with the aim of communicating, collaborating, creating, and exchanging value (Bauwens and Pantazis, 2018), such as, in the case of DiA, the value generated by technology and data use. Within CBPP, the P2P process is further advanced, leading to a mutual contribution by stakeholders and creating a common pool of either innovative knowledge, tools or design, through participatory governance open to further contributions (Bauwens, 2014). CBPP is already exemplified in cases related to DiA, including open source agricultural technology initiatives, such as Farm Hack (USA), collaborative projects for the creation of technology solutions and innovation by farmers (L'atelier

paysan, France), or even research projects like CAPSELLA of EU's H2020 programme (Gkisakis et al., 2017). Importantly, such approaches, characterised by impartiality, provision of advice and information, and independence from private-sector sources, have been reported as being highly appreciated by the farming community (Knierim et al., 2018).

To conclude, a broad consensus on the role of digital innovations in agroecology has not been reached as many stakeholders strongly argue that DiA is not expected to be one of the main drivers for the agroecological transition, at least not like other core-features, such as the enhancement of agroecosystems and biodiversity management. Nevertheless, digitalisation could potentially comply with agroecological principles when a combination of user innovation processes and a commons-based peer production model is applied. This would redirect the development and application of the emerging digital technologies towards an approach that contains the immediate farmers' involvement and a horizontal transfer of innovative knowledge among stakeholders, as part of a holistic management strategy for sustainably redesigning the food system.

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