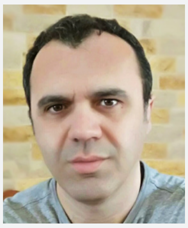
POSITION PAPER

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

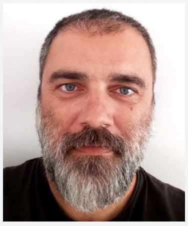
Vasileios D. Gkisakis[1] and Konstantinos Damianakis[2]

Received: February 19, 2020
Revised: April 7, 2020
Accepted: May 6, 2020



© private

Vasileios D. Gkisakis



© private

Konstantinos Damianakis

KEYWORDS **agroecology, digitalisation, innovation, transition, commons**

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 stepwise 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

[1] Hellenic Mediterranean University (HMU), School of Agricultural Sciences, Heraklion, Greece
[2] Agroecologiki SP, Agricultural Research & Development, Crete, Greece
CONTACT: gkisakis@hmu.gr

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 Rohracher, 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.

REFERENCES

Altieri M, Nicholls CI, Montalba R (2017) Technological approaches to sustainable agriculture at a crossroads: an agroecological perspective. Sustainability 9(3):349, doi:10.3390/su9030349

Barilla CFN, Barilla Center for Food and Nutrition (2017) Smart farming: the new "green revolution" [online]. Retrieved from <https://www.barillacfn.com/en/magazine/food-and-sustainability/smart-farming-the-new-green-revolution-/> [at 1 Sept 2017]

Bauwens M (2014) Commons based peer production: an introduction [online]. Retrieved from <https://www.boell.de/en/2014/07/08/commons-based-peer-production-introduction> [at 8 July 2014]

Bauwens M, Pantazis A (2018) The ecosystem of commons-based peer production and its transformative dynamics. Sociol Rev 66(2):302–319, doi:10.1177/0038026118758532

Bellon S, Ollivier G (2018) Institutionalizing agroecology in France: social circulation changes the meaning of an idea. Sustainability 10(5):1380, doi:10.3390/su10051380

Benkler Y, Nissenbaum H (2006) Commons-based peer production and virtue. J Polit Philos 14(1):394–419, doi:10.1111/j.1467-9760.2006.00235.x

Carolan M (2017) Publicising food: big data, precision agriculture, and co-experimental techniques of addition. Sociol Ruralis 57(2):135–154, doi:10.1111/soru.12120

Carolan M (2018) 'Smart' farming techniques as political ontology: Access, sovereignty and the performance of neoliberal and not-so-neoliberal worlds. Sociol Ruralis 58(4):745–764, doi:10.1111/soru.12202

Caron P, Biénabe E, Hainzelin E (2014) Making transition towards ecological intensification of agriculture a reality: the gaps in and the role of scientific knowledge. Curr Opin Environ Sustain 8:44–52, doi:10.1016/j.cosust.2014.08.004

Cerf M, Jeuffroy MH, Prost L, Meynard JM (2012) Participatory design of agricultural decision support tools: taking account of the use situations. Agron Sustain Dev 32:899–910, doi:10.1007/s13593-012-0091-z

Darnhofer I, Fairweather J, Moller H (2010) Assessing a farm's sustainability: insights from resilience thinking. Int J Agr Sustain 8(3):186–198, doi:10.3763/ijas.2010.0480

Douthwaite MB (2002) Enabling innovation: A practical guide to understanding and fostering technological change. London, New York: Zed Books, 266 p

Duru M, Therond O, Fares M (2015) Designing agroecological transitions; a review. Agron Sustain Dev 35:1237–1257, doi:10.1007/s13593-015-0318-x

European Commission (2019) Building a European Data policy [online]. Retrieved from <https://ec.europa.eu/digital-single-market/en/policies/building-european-data-economy> [at 7 Febr 2020]

Gambardella A, Raasch C, von Hippel E (2017) The user innovation paradigm: Impacts on markets and welfare. Manag Sci 63(5):1450–1468, doi:10.1287/mnsc.2015.2393

Gkisakis V, Lazzaro M, Ortolani L, Sinoir N (2017) Digital revolution in agriculture: fitting in the agroecological approach? [online] Agroecology Greece. Retrieved from <www.agroecology.gr/ictagroecologyEN.html> [at 20 Dec 2017]

Gliessman SR (2015) Agroecology: The ecology of sustainable food systems, 3rd Edition. New York: CRC Press/Taylor & Francis, 406 p

Higgins V, Bryant M, Howell A, Battersby J (2017) Ordering adoption: materiality, knowledge and farmer engagement with precision agriculture technologies. J Rural Stud 55:193–202, doi:10.1016/j.jrurstud.2017.08.011

Horlings LG, Marsden TK (2011) Towards the real green revolution? Exploring the conceptual dimensions of a new ecological modernisation of agriculture that could "feed the world". Global Environ Chang 21(2):441–452, doi:10.1016/j.gloenvcha.2011.01.004

HPLE, The High Level Panel of Experts on Food Security and Nutrition (2019) Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition [online]. Rome: FAO. HLPE 14. Retrieved from <http://www.fao.org/agroecology/database/detail/en/c/1242141/> [at 21 June 2019]

Ingrand S (2018) Opinion paper: 'monitoring *te salutant*:'combining digital sciences and agro-ecology to design multi-performant livestock farming systems. Animal 12(1):2–3, doi:10.1017/S1751731117001999

Kipling RP, Becoña G (2019) Applying a conceptual framework for effective implementation of on-farm greenhouse gas mitigation: Evaluation of knowledge exchange methods in Wales and Uruguay. Landbauforsch J Sustainable Organic Agric Syst 69(1):13–24, doi:10.3220/LBF1581687621000

Klerkx L, Jakku E, Labarthe P (2019) A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. NJAS-Wagen J Life Sc 90–91:100315, doi:10.1016/j.njas.2019.100315

Knierim A, Borges F, Kernecker M, Kraus T, Wurbs A (2018) What drives adoption of smart farming technologies? Evidence from a cross-country study [online]. In: Proceedings of the European International Farm Systems Association (IFSA) Symposium, Chania, Greece, 1–5 July 2018:1–14. Retrieved from <http://ifsa.boku.ac.at/cms/fileadmin/Proceeding2018/Theme4_Knierim.pdf> [at 14 July 2020]

Kshetri N, (2014) The emerging role of Big Data in key development issues: Opportunities, challenges, and concerns. Big Data Soc. 1(2)1–20; doi:10.1177/2053951714564227

Lindblom J, Lundström C, Ljung M, Jonsson A (2017) Promoting sustainable intensification in precision agriculture: review of decision support systems development and strategies. Precis Agric18:309-331, doi.org/10.1007/s11119-016-9491-4

MacRae RJ, Hill SB, Mehuys GR, Henning J (1990) Farm-scale agronomic and economic conversion from conventional to sustainable agriculture. Adv Agron 43:155–198), doi:10.1016/S0065-2113(08)60478-2

Maurel VB, Huyghe C (2017) Putting agricultural equipment and digital technologies at the cutting edge of agroecology. OCL 24(3):D307, doi:10.1051/ocl/2017028

Ornetzeder M, Rohracher H (2006) User-led innovations and participation processes: lessons from sustainable energy technologies. Energy policy 34(2),138–150, doi:10.1016/j.enpol.2004.08.037

Osipov VS, Bogoviz AV (2017) Transition to digital agriculture: background, roadmap and possible implications. Econ Agric Russ 10:11–15

Pimbert M (2015) Agroecology as an alternative vision to conventional development and climate-smart agriculture. Development 58(2–3):-286–298, doi:10.1057/s41301-016-0013-5

Rains GC, Olson DM, Lewis WJ (2011) Redirecting technology to support sustainable farm management practices. Agric Syst 104(4):365–370, doi:10.1016/j.agsy.2010.12.008

Rudram B, Faith B, Prieto Martín P, Ramalingam B (2016) The impact of digital technology on environmental sustainability and resilience: An evidence review [online]. Brighton: IDS, 61 p, Evidence Report No 209. Retrieved from <https://opendocs.ids.ac.uk/opendocs/bitstream/handle/

20.500.12413/12661/ER209_TheImpactofDigitalTechnologyonEnvironmentalSustainabilityandResilience.pdf?sequence=1> [at 15 July 2020]
Seppala TJ (2014) Monsanto pushes Big Data-driven planting but farmers are skeptical [online]. Retrieved from <https://www.engadget.com/2014/02/26/monsanto-prescriptive-farming/> [at 15 July 2020]
Van Meensel J, Lauwers L, Kempen I, Dessei J, Van Huylenbroeck G (2012) Effect of a participatory approach on the successful development of agricultural decision support systems: The case of Pigs2win. Decis Support Syst 54(1):164–172, doi:10.1016/j.dss.2012.05.002
Von Hippel E (2005) Democratizing innovation: The evolving phenomenon of user innovation. JFB 55:63–78, doi:10.1007/s11301-004-0002-8

OPEN ACCESS
This article is licensed under a Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/)
© The author(s) 2020