THE FUTURE OF FARMING

FROM DATA GIANTS TO FARMER POWER

Friends of the Earth Europe

Friends of the Earth Europe campaigns for environmentally sustainable and socially just societies, unites more than 30 national organisations with thousands of local groups, and is part of the world's largest grassroots environmental network, Friends of the Earth International.

Researched and written by: Chris Chancellor

Contributions and edits: Adrian Bebb, Stanka Becheva, Laura Hieber and Mute Schimpf

Design: Noble Studio

Friends of the Earth Europe
Rue d' Edimbourg 26
1050 Brussels, Belgium

+32 2 893 1000
info@foeeurope.org
www.foeeurope.org
twitter.com/foeeurope
Facebook.com/foeeurope

This publication has been funded with support from the European Commission. The publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

INTRODUCTION

Farming has always been a dynamic sector under constant evolution. However, over the past century European agriculture has undergone an unprecedented process of industrialisation, fuelled by successive technological innovations designed to maximise the efficiency of production. The development of heavy machinery has significantly reduced labour requirements, and the promotion of chemical fertilisers, synthetic pesticides and seed technologies saw an initial surge in yields of a few commodity crops[1]. A similar story of intensification in the livestock sector has enabled the mass production of meat and dairy products.

The logic behind these technological advances has always been that by maximising agricultural outputs, farmers' profits are increased whilst more food can be produced to feed a growing world population. Yet this narrow logic ignores the wider consequences of the industrial farming system and fails to capture the inherent complexities of food security. Reliance on these technologies has encouraged heavy agrochemical and energy use as well as monoculture production, driving soil degradation, polluting water systems, damaging biodiversity, creating pest and disease resistance and impacting public health and nutrition[2]. The concentration of control over land[3] as well as input and downstream markets[4] has squeezed farmers' profit margins, forcing smaller producers to scale up or disappear from the sector altogether, contributing to the wider trend of rural-urban migration. All of this threatens the future of agriculture itself, leading to a growing consensus that a substantial transformation is necessary[5,6,7].

One of the most prominent solutions being put forward in policy and agribusiness circles is that of digital farming. This is being presented as a suite of innovations that serve as a panacea for the current sustainability crisis facing the food and farming sector. The initial proposals for the ongoing reform of the European Union's (EU) Common Agricultural Policy (CAP), for example, feature a cross-cutting objective on modernising European agriculture through knowledge sharing, innovation and digitalisation[8].

However, innovation is not necessarily desirable in its own right[9], and little critical attention has been paid to the economic interests behind digital farming solutions, or whether they are actually appropriate for the contemporary challenges we face. Whilst the technologies themselves are new and complex, there is a danger that the style of innovation actually still reflects 'operational optimisation', with the old-fashioned focus on technology-based efficiency gains[10]. The presentation of digital farming technologies as a silver bullet also deflects attention from the root causes behind the current crises. In addition, it overlooks alternative innovation pathways such as agroecology, which would drive wider systemic transformations towards inclusive food systems that protect the climate and nurture biodiversity.

This report outlines what digital agriculture is, details how it is being promoted under the CAP and explores the opportunities and concerns this throws up, before making the case that agroecology represents a viable alternative pathway. It will then provide examples of alternative forms of appropriate innovation and give recommendations on how they can be supported by EU policy.

DIGITAL FARMING: WHAT IS IT?

Digital farming involves utilising digital technology to observe, monitor and manage farming activities and other parts of the supply chain in an integrated manner[11,12], with mass data collection, storage and analysis forming a fundamental component.

Multiple terms exist to refer to parts of the same broad concept, including precision agriculture or farming, digital or smart agriculture and 'agriculture 4.0'[13]. This section will lay out what digital farming encompasses, and some of the potential benefits and concerns of its emergence in European agriculture.

KEY COMPONENTS

PRECISION:

one key trait is the use of geo-location services and machine learning for precise sensing, identification, prediction and action[14]. For example, sensors in a field or attached to machinery, including drones, could track soil moisture or nutrient levels in specific parts of the field. Producers can then use this information to irrigate or fertilise accordingly, in theory enabling them to reduce water use or chemical input application through greater efficiency. Digital technology can also be used to track livestock health and growth.

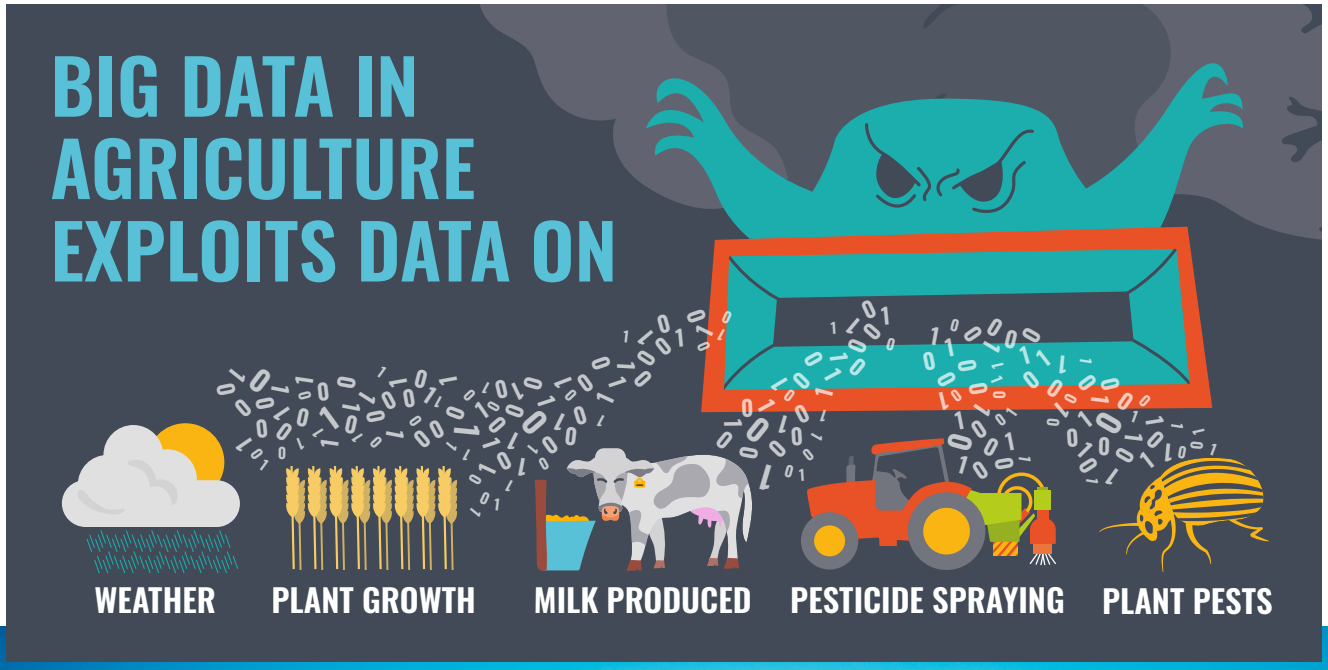
INTEGRATION & AUTOMATION:

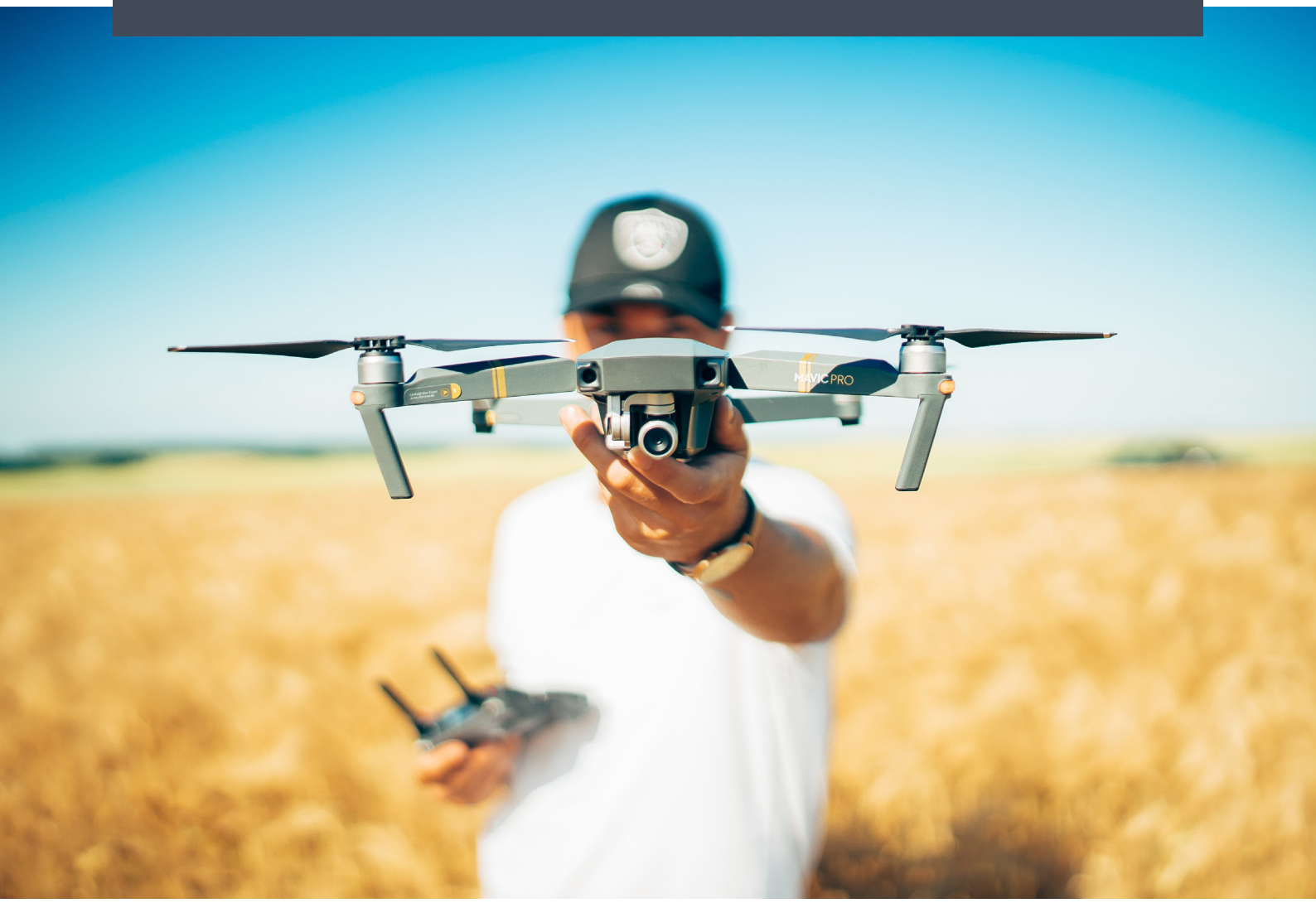
another key development relates to what is known as Internet of Things (IoT) technology. Here data collection, analysis and mechanised action are connected in one system, in which the whole process can be automated[15]. Feeding and milking in dairy production can be automated, for example, or temperature in greenhouses can be adjusted automatically in line with real time analysis of soil moisture, plant health and atmospheric data. Producers can track progress and even take action remotely, potentially reducing labour costs significantly.

However, digitalisation extends beyond the production phase itself[16], with sensor or blockchain technology also potentially enabling products to be tracked along the supply chain[17].

DATA AGGREGATION & ALGORITHMS:

the mass of data that can be collected within digital farming systems facilitates the rise of 'big data' in agriculture. This refers to the aggregation of data from many producers into large digital datasets, which can then be analysed by computer algorithms[18]. These data platforms are typically owned and controlled by large corporations, or potentially governments. Value is generated from the sale of this data and related analysis or advisory services, as well as the sale of IoT devices that are compatible with these databases and their algorithms. Farmers pay for access to software platforms providing advice based on data collected on their farm; this is sometimes already included with hardware they have purchased. These could potentially promote seed and agrochemical packages sold by the platform owners or their partners.


BIG DATA IN AGRICULTURE EXPLOITS DATA ON
WEATHER
PLANT GROWTH
MILK PRODUCED
PESTICIDE SPRAYING
PLANT PESTS


MAVIC PRO

MODERNISING THE CAP

The CAP is the overarching agricultural policy framework for the EU, and is divided into two pillars: 1) mainly direct income support for producers; and 2) the rural development fund. It is renewed periodically and is currently undergoing its latest reform, with the European Commission having published its initial proposal in 2018. This places a strong emphasis on modernisation, and in particular digitalisation of agriculture and rural areas[19].

National Strategic Plans: a big part of the proposals is the introduction of national CAP strategic plans. This involves individual Member States creating their own funding allocation proposals, which will have to demonstrate how they align with the new CAP specific objectives, outlined below[20]:

CAP SPECIFIC OBJECTIVES[21]

(a) support viable farm income and resilience across the Union to enhance food security;

(b) enhance market orientation and increase competitiveness, including greater focus on research, technology and digitalisation;

(c) improve the farmers' position in the value chain;

(d) contribute to climate change mitigation and adaptation, as well as sustainable energy;

(e) foster sustainable development and efficient management of natural resources such as water, soil and air;

(f) contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes;

(g) attract young farmers and facilitate business development in rural areas;

(h) promote employment, growth, social inclusion and local development in rural areas, including bio-economy and sustainable forestry;

(i) improve the response of EU agriculture to societal demands on food and health, including safe, nutritious and sustainable food, food waste, as well as animal welfare.

AKIS & Farm Advisory Services: These plans will involve strategies for developing digital technologies in agriculture and rural areas, including building agricultural knowledge and innovation systems (AKIS)[22]. Member States must also provide farm advisory services that cover digital technologies[23].

Farm Sustainability Tool for Nutrients (FaST): Another element expected to encourage digital uptake is the Farm Sustainability Tool for Nutrients (FaST). If implemented digitally, this tool will integrate information from existing EU databases with data inputted by the farmer in order to generate a nutrient management plan. This plan will be aligned with the various nutrient-related legal obligations that farmers must adhere to[24]. The use of FaST has been proposed as a conditionality standard for receiving direct payments[25]; Member States must establish a system to provide the tool for income support beneficiaries, and may obtain EC support for its design as well as data storage and processing services. The initial premise of FaST is to prevent over- or under-fertilisation[26], although another explicit goal is to create a foundation for future public or market-based digital service provision[27]. This would pave the way for the widespread digitalisation of EU agriculture.

DIGITAL DISRUPTION: A POSITIVE FORCE OR CAUSE FOR CONCERN?

New technologies can be described as disruptive because of their ability to drastically alter how things are done in a given sector; this can have both positive and negative consequences28,29. With digitalisation central to the EU Commission's vision for a modern CAP, this section will examine the relevant opportunities and concerns.

EFFICIENCY IS KEY

The argument for a digital farming revolution is built around the idea of efficiency. It is often constructed as follows: in the context of increased resource scarcity, a growing population requires drastic increases in food production without much scope for expanding the cultivated area[30,31,32]. The only solution, therefore, is to drastically increase yields whilst minimising inputs; something digital farming can supposedly deliver[33,34].

Producer profits: reduced costs for labour, water, artificial fertiliser and pesticide inputs, along with improved yields, are touted to secure greater incomes for farmers. However, returns to investment are not assured, with high start-up costs requiring debt finance[35,36]. Most digital farming tools are designed for large-scale production, and will exclude many small- and medium-scale producers, or force them to scale-up their operations in order to make such investments viable. Together with increased automation, there are fears that this could further erode the autonomy of peasants and small-scale producers.

Furthermore, the costs of maintaining new technologies have rarely been discussed, such as connectivity, access to paid data platforms, or for repair. Technologies are often designed to obstruct self-repair, leading to higher costs[37].

Reduced environmental harm: more efficient input use is also claimed to be able to reduce the burden on the environment, for example through lowering water footprints or through precise and timely spraying of fertiliser or pesticides[38]. Mechanical weeding robots are also being developed as a way to reduce herbicide applications. In addition, supposed yield increases are presented as a land-sparing mechanism, allowing more land to be dedicated to environmental conservation.

However, high-tech solutions incentivise scaling-up and uniformity of production[39], a trend which has already contributed to declining biodiversity across Europe and the world[40]. There are also concerns that the ownership of big data platforms by agrochemical companies could undermine the potential benefits of these technologies. The energy and raw material input required to run these various devices as well as the digital platforms themselves is also something that has not entered the conversation.

INTERCONNECTEDNESS & INTEGRATION

Simplification: big data is attractive for the administration of the CAP because it could allow for a far simpler monitoring system. Using existing EU satellite services, such as Copernicus and Galileo, Member States could monitor farmers' compliance with income support conditions remotely[41,42]. This could save both auditors and producers considerable time and expense. Standardising and integrating data platforms would also reduce the administrative burden on farmers[43]. It does, however, raise the issue of privacy, with farmers understandably not wanting to feel like they are being spied upon.

Safety & security: This leads into another key issue; such large-scale pooling of data brings up the issue of cybersecurity. If farming systems become dependent on these datasets, then vulnerability to cyber-attacks or black-outs adds a whole new dimension to food security[44]. Automated algorithm-based operations also bring about safety fears, especially if digital platforms malfunction or are hacked.

Risk management: this also has implications for another focal point of the CAP reform proposals: risk management. Digitisation brings new forms of risk which create new markets for insurers, whilst simultaneously giving them intimate access to previously disconnected farmers and their data. This could allow private insurers to further profit from CAP subsidies[45].

***The 2014-2020 CAP framework** saw 2.2 billion of public expenditure allocated to covering insurance premiums[46].*

It has been suggested that insurance companies will come to play a bigger role in farm decision-making, **leaving** farmers with less power to make their own choices[47].

Data ownership and control: because the aggregation of data allows it to be transformed into a valuable commodity, agribusinesses, IT companies and financial institutions all find the emergence of big data in agriculture an attractive prospect. Big data services are being set up so that farmers lose ownership rights over their data once it is aggregated, allowing corporations alone to reap the profits[48]. This has left many farmers sceptical about the benefits they can gain by signing up to such platforms[49,50]. Once data is privatised in this way, it is known as proprietary data or data exploitation.

In an input-based food and agricultural system that relies on digitally held data, those who own and control datasets are likely to wield significant power, especially if they are also active in other relevant input sectors.

Transparency: on the other hand, digital technologies such as Blockchain possess the potential to increase supply chain transparency, which could be used to expose unfair trading practices, for example. However, relevant EU legislation would have to be in place to ensure this, as the technological potential for greater transparency has already existed for a while without being appropriately utilised.

Increased traceability of agricultural products could also cater for increasing citizen demands for more localised food systems, and strengthen local direct marketing models.

SOCIAL IMPACT

Disposing of labour: one of the main input cost reductions explicitly promised by proponents of digital farming is that of labour. Yet agriculture is a strong source of rural labour absorption, meaning displacement of agricultural jobs is likely to have a profound societal impact. The idea that digitalisation will bring in new jobs masks the fact that these will primarily be off-site and involve high-tech knowledge.

Food security: one of the main arguments for ushering in digital farming practices is that world food supply must increase in order to feed a growing population. However, the idea that increased supply solves food security follows remarkably narrow reasoning that has long been discredited. We already produce enough food globally to feed the projected population by 2050[51]; the persistence of global hunger and malnutrition has much more to do with distribution, access and control imbalances than it does with lack of supply. The displacement of rural labour, for example, could create the conditions for food insecurity to proliferate regardless of increased yields.

CONCENTRATED CORPORATE CONTROL

The central theme running through all of the above is that of control, which is largely ignored in the techno-centric debate. In reality, power plays a huge role in shaping the rules of the game and who is able to secure the benefits[52].

All the major markets in the EU food and farming supply chain are highly concentrated, a situation exacerbated by recent mega-mergers[53]. The market for farm machinery is dominated by 5 major players: CNH Industrial (UK/Netherlands), Claas (Germany), Deere & Co (USA), AGCO (USA) and Kubota (Japan)[54]. As expected, all are active proponents of digital farming in Europe and use their market power to lobby for EU support[55,56]. They are also all active in the European Agriculture Machinery Association (CEMA), with many of their staff heading boards or internal committees[57,58,59]. CEMA has called for direct CAP support measures and wider EU research funding for digital and precision technologies, as well as investments in rural broadband and digital training for farmers and advisors[60,61].

Yet even this underplays the true picture of corporate power at play; formal and informal agreements between firms within and across sectors, as well as the hidden practice of horizontal shareholding, creates an interest group of unprecedented power[62,63].

***Yara** is the dominant player in the EU fertiliser market. They have invested significantly in digital farming devices, and are now teaming up with ICT giant IBM to develop a digital farming platform[64]. In 2017, they also acquired Adapt-N, a precision software fully integrated with John Deere equipment[65].*

Asset management firms, financial institutions, commodity traders, and seed and agrochemical giants, as well as new players such as Google[66] and Microsoft[67], are all keen to cash in on what is essentially a new revenue stream[68]. They thus play a key role in pushing the big data-driven digital farming agenda in Europe. They are also pushing for deregulation of the sector, claiming that regulatory costs are a significant barrier to providing cheaper technologies[69].

***The precautionary principle** is an EU consumer protection measure that allows decision-makers to adopt precautionary measures on issues of environmental or human health, when the scientific evidence is uncertain[70]. This is now being undermined by a term created by industrial lobbyists and reportedly gaining traction in Brussels: the innovation principle[71]. This advocates special consideration for products that represent a significant scientific advance, potentially allowing firms to bypass environmental and public health regulations in bringing their products to the market.*

The danger is that with such unprecedented market power, firms can collaborate to set the parameters of algorithms and promote dependency on the inputs that they themselves offer, leaving producers with weak bargaining power and severely curtailed decision-making autonomy. This serves to further entrench a techno-centric model and divert attention from viable sustainable alternatives[72].


4 FIRMS NOW CONTROL 60%
OF THE GLOBAL SEED MARKET
CORTEVA
BAYER
MONSANTO
BASF
CHEMCHINA
syngenta

AGROECOLOGY: AN ALTERNATIVE INNOVATION PATHWAY

Whilst it is clear that digital technologies offer some exciting possibilities for the future of food and farming, the envisioned role of digital farming in the EU seems to be one of damage limitation: reducing the intensity of isolated harmful components of the industrial farming model. This only encourages a further lock-in of industrial farming system, albeit a streamlined version. In addition, given that the development of big data goes hand in hand with concentrated networks of control[73], the modernisation of the CAP has got to look beyond rolling out digital technology as an end in itself[74].

If the new CAP is to achieve the specific objectives it proposes, the overarching aim must be to promote farming systems that actively protect and restore ecosystems and social wellbeing in a holistic manner[75]. Agroecology presents a viable pathway through which to achieve this[76].

> ***Agroecology** is 'a holistic set of ecological, social and political principles that aims to embed food production within healthy and diverse agroecosystems and social networks, in a manner that minimises external inputs, provides secure livelihoods for producers, and delivers nutritious food for consumers. Agroecology cannot be reduced to a set of replicable technologies or practices, as it will take different forms depending on the ecological and cultural context of the local area'[77].*

Small-scale producers are explicitly placed at the centre, recognising that they already form the backbone of our food systems: together they are the main or sole providers of food to 70% of the global population[78], and in the EU, two-thirds of total farm holdings are smaller than 5 hectares[79].

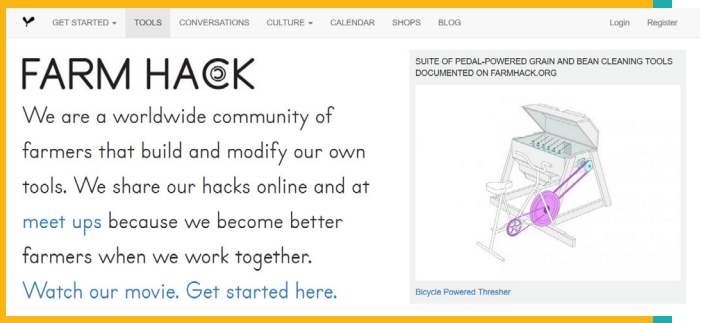
There is now a growing scientific consensus that an agroecological transition could provide sufficient healthy and nutritious food[80], nurture healthy soils, address declining biodiversity, shift agriculture away from fossil fuel dependent practices and serve as an effective climate change mitigation and adaptation strategy[81,82,83]. In addition, it can do so whilst providing economic benefits for farmers and promoting employment and empowerment in rural areas[84,85].

In terms of innovation, the key here is that agroecology provides a principled framework, and various solutions can be developed to assist the diverse array of ecologically, socially and culturally-specific contexts in which producers operate[86], rather than technology defining how food is produced and distributed in a top-down manner. It should be emphasised that innovation does not have to be digital to make it modern, effective solutions to contemporary problems can also be simple and low-tech. The holistic nature of agroecology also brings attention to alternative yet equally important forms of innovation, such as social and organisational innovation[87], which are crucial in addressing the root causes of the current challenges faced.

Techno-centric innovations have commanded large public and private resources, and very little has been allocated to the development and dissemination of innovations targeting small-scale agroecological producers. Despite this, examples of appropriate innovation, both digital and otherwise, do exist in Europe and around the world and are beginning to spread. They show that small-scale food producers and their families are active, critical actors, with transformative capacity, and not passive recipients of external knowledge. They also break the belief in the hegemony of knowledge and demonstrate models of democratic governance and decentralized knowledge exchange such as: "di**á**logos de saberes" (dialogue of knowledges), horizontal participative processes, and farmer to farmer exchanges. The case studies presented below represent the sorts of innovations, digital and otherwise, that the CAP could and should be looking to support.

FARM HACK *USA/GLOBAL*

Farm Hack is a global farmer-led community of innovators that collaborate in developing and sharing open-source agricultural tools for use in resilient agricultural systems, and advocate for the right of farmers to repair their own machinery.

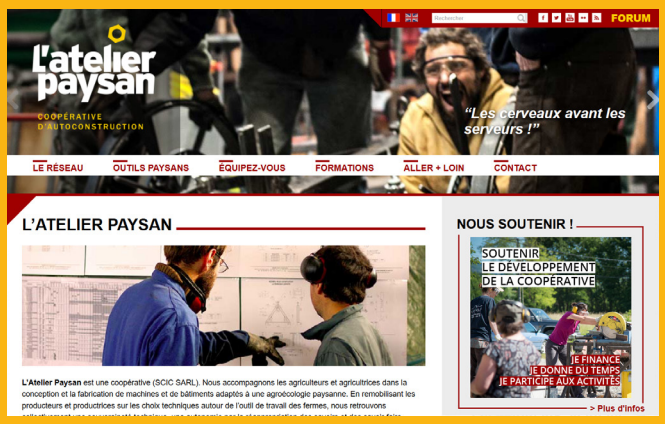


How does it work? Farm Hack functions as a platform that is comprised of farmers and a range of interested actors with technical expertise[88]. Together they co-develop a library of open-source farm technology, ranging from hand tools to management software[89]. Products or their blueprints are made available under Creative Commons licenses, meaning they are accessible to all.

Impact: resilient producers gain access to the types of technologies suitable to their needs, as opposed to having to change their models to accommodate top-down technologies offered on the market. They are free to repair and modify both the hardware and software elements of their equipment, allowing for creative adaptation and reducing costs.

Support & admin: the platform is governed in line with co-created community principles published on the website[90]. The Farm Hack community has generated its own design principles. These include 'design for disassembly', replicability and affordability, as well as promoting solutions based on biological systems and a holistic approach[91].

L'ATELIER PAYSAN *FRANCE*



The l'Atelier Paysan network comprises of farmers, employees and agricultural development organisations, and aims to guide and promote the development of farmer-driven technologies for small-scale agriculture.

How does it work? The cooperative provides support and advisory services in the field of farmer-led research and development. Together with small-scale farmers, they develop working groups to co-design technologies adapted to the particular needs and context of the farmers, with final designs made available under a Creative Commons license[92].

Impact: products developed reflect the specific needs expressed by farmers. Creative Commons licenses and skills training allow them to further modify tools or duplicate them without proprietary constraints, reducing costs, and increasing efficiency in an autonomous manner.

Support & admin: L'Atelier Paysan is run under a cooperative legal structure, similar to a Community Interest Company. It is more than 60% self-financed, which comes from a mix of participatory financing, such as user contributions and crowdfunding, and income generated from training courses or sales of materials and accessories that farmers use to build tools featured in their self-build guides[93,94].Their innovation model is founded upon the involvement of users, who also play a role in defining the general direction of the cooperative and participate in broader coalitions advocating for radical changes in public farming policies.

DEEP MULCH *HUNGARY*

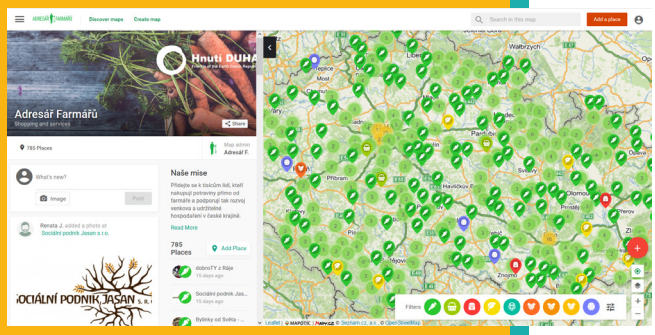
Deep mulching is a cultivation technique developed by Iván Gyulai in Hungary, imitating nature to build healthy soils for gardeners and small-scale farmers.

How does it work? Soil is prepared in autumn by applying a 50-60cm thick surface cover of organic waste, which contains the optimum carbon-nitrogen ratio for composting. In spring the composting process begins; when the soil is ready crops can be seeded or transplanted directly into the mulch[95].

Impact: Tillage is not necessary, reducing weed pressure and fossil energy inputs, saving time and expense throughout the growing season and protecting soil ecology. Permanent coverage protects against soil erosion and nutrient leaching, helps to lock carbon in the soil, and retains moisture, reducing water use and irrigation costs and mitigating extreme weather conditions. The composting process warms soil in early spring, leading to more vigorous crop growth, and develops fertile top soils; 25-30cm has been created since 2002 on Iván Gyulai's original plot[96]. This technique also lends itself to social innovation, creating opportunities for effective use of organic waste.

Support & admin: efforts are being made to spread knowledge on deep mulching, including a short film as well as TV and journal coverage. In addition, the Ecological Institute for Sustainable Development has started to organise training courses to disseminate the practice.

ADRESÁŘ FARMÁŘŮ *CZECH REPUBLIC*



Adresář farmářů is a free mobile and web application created by Hnutí DUHA (Friends of the Earth Czech Republic) and the platform Mapotic, which displays sources of fresh and local food for consumers.

How does it work? The map-based app allows farmers to upload the location of their farm and the products that they offer, including education programs, to the platform's directory[97]. Links and contact details are provided so that consumers can contact farmers directly[98].

Impact: More than 25,000 people entered the registry in 2019 to search for farmers in their area, whilst 783 locations are currently registered across the country[99]. Registered users can leave feedback on services or products provided, promoting transparency and high quality food.

Support & admin: Participating farmers must adhere to a set of rules, including not using synthetic agrochemicals, practicing crop rotation, maintaining animal welfare and returning greenery to the landscape.

LOCAL FOOD NODES *SWEDEN/GLOBAL*

Local Food Nodes is an open digital tool designed to facilitate direct marketing in new and existing local food supply chains[100].

How does it work? The tool functions like an online marketplace for local food producers and consumers in a given locality. Orders can be picked up from multiple producers at the same time at a dedicated pick-up point, known as a 'node'.

Impact: producers can connect directly to customers in their area, who can choose from a variety of local products in the same location. Producers are able to set their own prices and quantities offered, and harvests can be customised in line with demand, reducing waste, reflecting seasonal availability, and facilitating diverse mixed farming systems. In addition, nodes help to reinforce existing or build new social relations around food and can serve as a site of community education. There are currently 159 local nodes operating across the world, primarily in Europe.

Support & admin: the tool is funded by a combination of membership fees, crowdsourcing and other incomes[101], with all financial transactions published on the website for transparency[102]. Each individual node has the freedom to implement their own administration and governance structures, using this tool to serve their contextual needs and preferences.

FOSTERING A FAIR FUTURE FOR ALL: THE ROLE OF THE CAP AND BEYOND

60 years of Common Agricultural Policy has gone hand in hand with increasing numbers of farmers giving up their farms, rising emissions from the food and farming sector that are contributing to the global climate crisis, and further loss of ecosystems across Europe.

The digital age offers new opportunities to overcome the challenges faced, but must be steered appropriately in order to achieve genuinely sustainable outcomes. Techno-centric solutions that fail to challenge wider systemic issues of corporate control and export-orientation simply cannot be sustained.

1

BUILDING A TRULY SUSTAINABLE FOOD & FARMING POLICY

Reforms of the CAP must fit into a coherent long-term vision for our food system, leading to a radical transformation towards agroecology. Diverse, climate resilient and low input production and distribution models must be promoted, which prioritise the protection and restoration of ecosystems, soils and the climate, as well as fair incomes and working conditions for producers and labourers across the supply chain. Friends of the Earth Europe calls for the de-monopolisation of digital agriculture, sector specific rules and EU wide laws to counteract unbalanced bargaining power in the agricultural sector. Corporate control of the food system must be addressed, whilst the development of short food supply chains should be encouraged. More detailed suggestions for policy measures to achieve this within the CAP have already been put forward elsewhere[103,104].

2

INNOVATION FOR THE PUBLIC GOOD

Support for agricultural innovation must therefore fit within this wider vision. In order to establish a just and sustainable food system, EU agricultural and food policy, and in particular the CAP, must:

- Be used to promote this transition, and any support for digital farming must be geared towards achieving these wider goals.
- Provide funding possibilities for participatory processes like farmer-led innovation platforms and farmer-to-farmer knowledge exchange at the local and regional level.
- Ensure that farmers transitioning towards agroecology are supported under national advisory services, with advisors trained in agroecology and relevant innovations.
- Encourage replicability and the right to repair, and incentivise open-source licensing.
- Strengthen and empower small-scale family farmers innovation.
- Ensure that marginal groups, such as small-scale farmers, breeders and local food processors are protected from the potential exclusionary effects of new technologies.

3

LEADING THE WAY

- Ensure that public funding for research in digital farming is only available for projects focussing on holistic solutions to the environmental, climate and hunger crises, as well as socio-economic inequalities.
- Introduce measures to protect farmers' ownership and control over data produced on their farms, including once it has become aggregated, to ensure farmer autonomy. Legislation is also required to limit corporate agribusiness control over digital farming and promote publically owned data.

Food and farming policies will need to be complemented by wider cross-sectoral reforms on competition law and data ownership to prevent the formation of oligopolies across the supply chain, and place power in the hands of farmers themselves.

It is now up to the EU to live up to its own billing as a global leader in the field of agriculture. Beyond food production itself, agriculture can serve as a vessel for positive change, from rural livelihood provision, community cohesion and human health, to landscape management, ecosystem stewardship and climate resilience.

In order to capture this potential and support a food system that protects ecosystems and the climate, enhances farmers' incomes and rural livelihoods, and upholds social justice, EU policy makers will need to focus on creating an enabling policy environment based on agroecology. This should support community and farmer-led knowledge sharing and innovation, both digital and otherwise, and place those that produce, distribute and consume food at the heart of their own food systems.

The modernisation of the CAP needs to be about reacting to the contemporary challenges facing European agriculture in order to provide a food and farming system that works for all.

REFERENCES

1 IPES Food (2016). From University to Diversity: A paradigm shift from industrial agriculture to diversified agroecological systems. [Online]. Available at: http://www.ipes-food.org/_img/upload/files/UniformityToDiversity_ExecSummary.pdf

2 Nyéléni Europe & Central Asia (2019). More farmers, better food: Why and how to put small-scale producers at the core of the new CAP. [Online]. Available at: https://www.eurovia.org/wp-content/uploads/2019/03/Nyeleni-ECA-More-farmers-better-food_compressed.pdf

3 Kay, S., Peuch, J. and Franco, J. (2015). Extent of farmland grabbing in the EU. Brussels: European Parliament.

4 IPES Food (2017). Too big to feed: Exploring the impacts of mega-mergers, consolidation and concentration of power in the agrifood sector. [Online]. Available at: http://www.ipes-food.org/_img/upload/files/Concentration_FullReport.pdf

5 IAASTD (2009). Agriculture at a Crossroads: Global Report. Washington, DC: Island Press.

6 IPCC (2019). Climate Change and Land. [Online]. Available at: https://www.ipcc.ch/report/srccl/

7 IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. [Online]. Available at: https://www.ipbes.net/sites/default/files/downloads/spm_unedited_advance_for_posting_htn.pdf

8 European Commission (2018). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL: establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council. Brussels: European Commission.

9 BEUC (2019). When innovation means progress: BEUC's view on innovation in the EU. [Online]. Available at: https://www.beuc.eu/publications/beuc-x-2019-073_when_innovation_means_progress-view_on_innovation_in_the_eu.pdf

10 Voshgimir, Novakovic, Wildenberg, & Rammel (2020). Blockchain, Web3 & the SDGs. ADA project report.

11 EU Parliament (2017). Precision agriculture in Europe: Legal, social and ethical considerations. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603207/EPRS_STU(2017)603207_EN.pdf

12 Friends of the Earth Europe (forthcoming). FoEE position paper on digital farming.

13 Klerkx, L., Jakku, E. and 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 – Wageningen Journal of Life Sciences, 90-91.

14 Mckinsey Digital (2016). How big data will revolutionize the global food chain. [Online]. Available at: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/how-big-data-will-revolutionize-the-global-food-chain

15 Business Insider (2016). Why IoT, big data & smart farming are the future of agriculture. [Online]. Available at: https://www.businessinsider.com/internet-of-things-smart-agriculture-2016-10?r=US&IR=T

16 Wolfert, S., Ge, L., Verdouw, C and Bogaardt, M. (2017). Big data in smart farming – A review. Agricultural Systems, 153, pp. 69-80.

17 ETC Group (2018). Blocking the chain: Industrial food chain concentration, Big Data platforms and food sovereignty solutions. [Online]. Available at: https://www.etcgroup.org/sites/www.etcgroup.org/files/files/blockingthechain_english_web.pdf

18 EU Parliament (2017). Precision agriculture in Europe: Legal, social and ethical considerations. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603207/EPRS_STU(2017)603207_EN.pdf

19 European Commission (2018). CAP Specific Objectives... explained. Increasing competitiveness: The role of productivity. [Online]. Available at: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/cap-briefs-2-productivity_en.pdf

20 European Parliamentary Research Service (2018). CAP strategic plans. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/630324/EPRS_BRI(2018)630324_EN.pdf

21 European Commission (2018). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL: establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council. Brussels: European Commission. (Article 6).

22 EU SCAR AKIS (2019). Preparing for Future AKIS in Europe. Brussels: European Commission., p15. (Referred to in Article 102b of the EC proposals).

23 (Referred to in Article 13-4f of the EC proposals)

24 Campos Rodriguez, I. (2019). Common Agricultural Policy post-2020: Farm Sustainability Tool for Nutrients (FaST). [Online]. Available at: https://www.slideshare.net/EU_GNSS/farm-sustainability-tool-for-nutrients-by-isidro-campos-ec

25 European Commission (2019). New technologies and digitisation in agriculture: a crucial aspect to deliver on CAP's objectives. [Online]. Available at: https://ec.europa.eu/info/news/new-technologies-and-digitisation-agriculture-crucial-aspect-deliver-caps-objectives-2019-may-24_en (Referred to in Article 12 of the EC proposals)

26 European Commission (2019). A new tool to increase the sustainable use of nutrients across the EU. [Online]. Available at: https://ec.europa.eu/info/news/new-tool-increase-sustainable-use-nutrients-across-eu-2019-feb-19_en

27 Farm Sustainability Platform (2019). Farm Sustainability Tool. [Online]. Available at: https://embedded.fast.sobloo.io/static/farmer_mobile_app/embedded.html

28 European Parliament (2017). Current and emerging trends in disruptive technologies: Implications for the present and future of EU's trade policy. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603845/EXPO_STU(2017)603845_EN.pdf

29 Trendov, N. M., Varas, S. & Zeng, M. 2019. Digital technologies in agriculture and rural areas – Status report. Rome: FAO. Licence: cc by-nc-sa 3.0 igo.

30 Tech Republic (2018). How self-driving tractors, AI, and precision agriculture will save us from the impending food crisis. [Online]. Available at: https://www.techrepublic.com/article/how-self-driving-tractors-ai-and-precision-agriculture-will-save-us-from-the-impending-food-crisis/

31 Bayer (2019). Digital farming: Enabling farmers to get the most out of their fields while using less land and fewer inputs. [Online]. Available at: https://www.cropscience.bayer.com/innovations/data-science/digital-farming

32 Goldman Sachs (2016). Precision farming: Cheating Malthus with digital agriculture. New York: Goldman Sachs.

33 PA Consulting (2018). Transforming agriculture with data-driven insights: How to prosper in the evolving market for digital agritech. [Online]. Available at: http://www2.paconsulting.com/rs/526-HZE-833/images/PA_Digital-Agriculture-Report.pdf

34 EY Global (2018). Digital agriculture: enough to feed a rapidly growing world? [Online]. Available at: https://www.ey.com/en_gl/digital/digital-agriculture-data-solutions

35 Rotz, S., Duncan, E., Small, M., Botschner, J., Dara, R., Mosby, I., Reed, M. & Fraser, D.G. (2019). The Politics of Digital Agricultural Technologies: A Preliminary Review. Sociologica Ruralis, 59 (2), pp. 203-229.

36 Barnes, A.P., Soto, I., Eory, V., Beck, B., Balafoutis, A.T. and Sanchez, B. et al. (2019). Influencing incentives for precision agricultural technologies within European arable farming systems. Environmental Science & Policy, 93, pp. 66-74.

37 New York Times (2019). It's your iPhone, why can't you fix it yourself? [Online]. Available at: https://www.nytimes.com/2019/04/06/opinion/sunday/right-to-repair-elizabeth-warren-antitrust.html

38 EU Parliament (2017). Precision agriculture in Europe: Legal, social and ethical considerations. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603207/EPRS_STU(2017)603207_EN.pdf

39 EU Parliament (2017). Precision agriculture in Europe: Legal, social and ethical considerations. [Online].

40 IPES Food (2016). From University to Diversity: A paradigm shift from industrial agriculture to diversified agroecological systems.

41 Alliance for Internet of Things Innovation (2019). IoT and digital technologies for monitoring of the new CAP. [Online]. Available at: https://aioti.eu/wp-content/uploads/2019/05/AIOTI-CAP-controls-and-ICT-technologies-May-2019.pdf

42 European Parliament (2019). Research for AGRI Committee - Impacts of the digital economy on the food chain and the CAP. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2019/629192/IPOL_STU(2019)629192_EN.pdf

43 European Commission (2018). CAP cross-cutting objective... explained. Simplification. [Online]. Available at: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/cap_briefs_10_simplification.pdf

44 US Department for Homeland Security (2018). Threats to precision agriculture. [Online]. Available at: https://www.dhs.gov/sites/default/files/publications/2018%20AEP_Threats_to_Precision_Agriculture.pdf

45 Accenture (2018). Agri-tech: the opportunities for insurers. [Online]. Available at: https://insuranceblog.accenture.com/agri-tech-the-opportunities-for-insurers

46 European Commission (2017). Risk management schemes in EU agriculture: dealing with risk and volatility. [Online]. Available at: https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/market-briefs/pdf/12_en.pdf

47 ETC Group (2018). Blocking the chain: Industrial food chain concentration, Big Data platforms and food sovereignty solutions.

48 European Parliament (2016). Precision agriculture and the future of farming in Europe. [Online]. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2016/581892/EPRS_STU(2016)581892_EN.pdf

49 Wiseman, L., Sanderson, J., Zhang, A. and Jakku, E. (2019). Farmers and their data: An examination of farmers' reluctance to share their data through the lens of the laws impacting smart farming. NJAS – Wageningen Journal of Life Sciences, 90-91.

50 European Commission (2019). EU agricultural outlook: For markets and income 2018-2030. Brussels: European Commission, DG Agriculture and Rural Development.

51 Holt-Jimenez, E., Shattuck, A., Altieri, M., Herren, H. and Gliessman, S. (2012). We already grow enough food for 10 billion people... and still can't end hunger. Journal of Sustainable Agriculture, 36 (6), pp.595-598.

52 Fielke, S.J., Garrard, R., Jakku, E., Fleming, A., Wiseman, L. and Taylor, B.M. (2019). Conceptualising the DAIS: Implications of the 'Digitalisation of Agricultural Innovation Systems' on technology and policy at multiple levels. NJAS – Wageningen Journal of Life Sciences, 90-91.

53 Nyéléni Europe & Central Asia (2019). More farmers, better food: Why and how to put small-scale producers at the core of the new CAP.

54 Mordor Intelligence (2019). Europe agricultural machinery market - growth, trends, and forecast (2019 - 2024). [Online]. Available at: https://www.mordorintelligence.com/industry-reports/europe-agricultural-machinery-market

55 Lobby Facts (2019). John Deere GmbH&Co.Kg (DE). [Online]. Available at: https://lobbyfacts.eu/representative/fdd449d04eb04da8919c3ff0995626d1/john-deere-gmbh-co-kg

56 Lobby Facts (2019). CNH Industrial. [Online]. Available at: https://lobbyfacts.eu/representative/229362faae164c99bb6c1f86bde6c749/cnh-industrial

57 CEMA (2019). Gilles Dryancour (John Deere) appointed Chairman of new CEMA Strategic Committee. [Online]. Available at: https://www.cema-agri.org/publication/press-releases/437-gilles-dryancour-john-deere-appointed-chairman-of-new-cema-strategic-committee

58 CEMA (2014). Michael Kohlem (CLAAS) elected new Chairman of the CEMA Technical Board. [Online]. Available at: https://www.cema-agri.org/publication/press-releases/161-michael-kohlem-claas-elected-new-chairman-of-the-cema-technical-board

59 CEMA (2016). Richard Markwell (AGCO) re-elected as CEMA President for another 2-year term. [Online]. Available at: https://www.cema-agri.org/publication/press-releases/197-richard-markwell-agco-re-elected-as-cema-president-for-another-2-year-term

60 CEMA (2019). CEMA priorities and key figures: Advancing agricultural machinery and solutions for sustainable farming. [Online]. Available at: https://www.cema-agri.org/images/publications/brochures/2019_CEMA_report_priorities_key_figures_web.pdf

61 CEMA (2016). Farming in the cloud: Europe needs to speed up on the path towards connected agriculture. [Online]. Available at: https://www.cema-agri.org/publication/press-releases/198-farming-in-the-cloud-europe-needs-to-speed-up-on-the-path-towards-connected-agriculture

62 ETC Group (2019). Plate tech-tonics: Mapping corporate power in Big Food. [Online]. Available at: https://etcgroup.org/sites/www.etcgroup.org/files/files/etc_platetechtonics_a4_nov2019_web.pdf

63 Corporate Europe Observatory (2019). Captured states: when EU governments are a channel for corporate interests. [Online]. Available at: https://corporateeurope.org/sites/default/files/ceo-captured-states-final_0.pdf

64 IBM (2019). Yara and IBM join forces to transform the future of farming. [Online]. Available at: https://newsroom.ibm.com/2019-04-26-Yara-and-IBM-join-forces-to-transform-the-future-of-farming

65 ETC Group (2019). Plate tech-tonics: Mapping corporate power in Big Food.

66 Fortune (2018). Alphabet Research Arm X Wants to Apply Artificial Intelligence to Farming. [Online]. Available at: https://fortune.com/2018/03/27/alphabet-google-ai-farmers/

67 Microsoft (2018). Feeding the world with AI-driven agriculture innovation. [Online]. Available at: https://cloudblogs.microsoft.com/2018/11/29/feeding-the-world-with-ai-driven-agriculture-innovation/

68 Bund (2019). Chancen und Risiken der Digitalisierung in der Landwirtschaft: Diskussionspapier des BAK Landwirtschaft. [Online]. Available at: https://www.bund.net/fileadmin/user_upload_bund/publikationen/landwirtschaft/bak_landwirtschaft_diskussionspapier_digitalisierung.pdf

69 EurActiv & CEMA (2016). Farming 4.0: The future of agriculture?

70 European Parliament (2015). The precautionary principle: Definitions, applications and governance. [Online]. Available at: https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_IDA(2015)573876

71 Politico (2018). Big business circles EU's consumer protections. [Online]. Available at: https://www.politico.eu/article/consumer-protections-europe-big-business-sharks-circle/

72 Vanloqueren, G. and Baret, P.V. (2009). How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations. Research Policy, 38 (6), pp. 971-983.

73 Bronson, K. and Knezevic, I. (2016). Big Data in food and agriculture. Big Data & Society, pp. 1-5.

74 Fraser, E.D.G. and Campbell, M. (2019). Agriculture 5.0: Reconciling production with planetary health. One Earth, 1 (3), pp. 278-280.

75 Pigford, A.E., Hickey, G.M., Klerkx, L. (2018). Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions. Agricultural Systems, 164, pp. 116-121.

76 El Bilali, H. (2019). Innovation-Sustainability Nexus in Agriculture Transition: Case of Agroecology. Open Agriculture, 4 (1), pp. 1-16.

77 Nyéléni Europe & Central Asia (2019). More farmers, better food: Why and how to put small-scale producers at the core of the new CAP. p10.

78 ETCC Group (2017). Who will feed us? The Industrial food chain vs the peasant food web. Val David: ETC Group.

79 Nyéléni Europe & Central Asia (2019). More farmers, better food: Why and how to put small-scale producers at the core of the new CAP.

80 Poux, X. and Aubert, P. (2018). An agroecological Europe in 2050:multifunctional agriculture for healthy eating. Paris: IDDRI.

81 Rodale Institute (2011). The Farming Systems Trial: Celebrating 30 Years. [Online]. Available at: https://rodaleinstitute.org/wp-content/uploads/fst-30-year-report.pdf

82 IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

83 IPCC (2019). Climate Change and Land.

84 van der Ploeg, J.D., Barjolle, D., Bruil, J., Brunori, Costa Madureira, L.M. and Dessein, J. (2019). The economic potential of agroecology: Empirical evidence from Europe. Journal of Rural Studies, 71, pp. 46-61.

85 FAO (2019). Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. [Online]. Available at: http://www.fao.org/3/ca5602en/ca5602en.pdf

86 Friends of the Earth International (2018). Agroecology: Innovating for sustainable agriculture & food systems. [Online]. Available at: https://www.foei.org/wp-content/uploads/2018/11/Agroecology-innovation-EN.pdf

87 IFOAM EU (2015). Feeding the people: The relevance of agroecology for nourishing the world and transforming the current global agri-food system. [Online]. Available at: https://read.ifoam-eu.org/publication/feeding-the-people/pdf/

88 Farm Hack (2016). Farm Hack Culture. [Online]. Available at: https://farmhack.org/wiki/farm-hack-culture

89 Farm Hack (2019). Tools. [Online]. Available at: https://farmhack.org/tools

90 Farm Hack (2014).Community principles for Farm Hack. [Online]. Available at: https://farmhack.org/wiki/community-principles-farm-hack

91 Farm Hack (2013). Farm Hack design principles. [Online]. Available at: https://farmhack.org/wiki/farm-hack-design-principles

92 l'Atelier Paysan (2019). Who we are. [Online]. Available at: https://www.latelierpaysan.org/Who-we-are

93 l'Atelier Paysan (2019). Our economic model. [Online]. Available at: https://latelierpaysan.org/Our-economic-model

94 L'Atelier Paysan (2020). Les catalogues outils. [Online]. Available at: https://www.latelierpaysan.org/Les-catalogues-outils

95 Okologiaiintezet (2015). Smart and Eco-friendly gardening - with subtitle. [Online]. Available at: https://www.youtube.com/watch?v=8EWz2FymKxM&feature=youtu.be

96 Gyulai, I. (2017). Deep mulching, a nature friendly method for gardening and farming. [Online]. Available at: http://www.ceeweb.org/wp-content/uploads/2017/12/deep-mulching_.pdf

97 Hnutí DUHA (2020). Adresář farmářů. [Online]. Available at: https://www.adresarfarmaru.cz/

98 Hnutí DUHA (2014). Dnes spuštěn nový interaktivní adresář místních farmářů s téměř 500 kontakty. [Online]. Available at: http://hnutiduha.cz/aktualne/dnes-spusten-novy-interaktivni-adresar-mistnich-farmaru-s-temer-500-kontakty

99 Hnutí DUHA (2020). Adresář farmářů: Place list. [Online]. Available at: https://www.adresarfarmaru.cz/places?lat=49.809631563563094&lng=15.413818359375002&zoom=6

100 Local Food Nodes (2019). Local Food Nodes: A healthier food system. [Online]. Available at: https://localfoodnodes.org/find-out-more

101 Local Food Nodes (2019). Co-create the future of food. [Online]. Available at: https://localfoodnodes.org/

102 Local Food Nodes (2019). Transcations. [Online]. Available at: https://localfoodnodes.org/economy/transactions

103 IPES Food (2019). Towards a Common Food Policy for the European Union: The policy reform and realignment that is required to build sustainable food systems in Europe. [Online]. Available at: http://www.ipesfood.org/_img/upload/files/CFP_FullReport.pdf

104 Nyéléni Europe & Central Asia (2019). More farmers, better food: Why and how to put small-scale producers at the core of the new CAP. p14-16.

Digitalisation is a key factor in the modernisation of European agriculture which the makers of the European Union's Common Agricultural Policy (CAP) are promising.

But is digital agriculture the one way forward?

Which innovations can effectively boost our farming system's capacity to protect and restore ecosystems and social wellbeing?

Friends of the Earth Europe