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Davide Rizzo
Fatma Fourati-Jamoussi
Lucian Ceapraz
Mariia Ostapchuk
Hanitra Randrianasolo
Anne Combaud
Michel J.-F. Dubois

Identifying the stakeholders' interactions within an agricultural innovation system towards sustainability

The case of a French cluster for agritech innovation

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Abstract

The paper explores novel connections between human and technology-driven innovation in a French agritech cluster. It focuses on the whole system innovation and addresses specifically the impact of digitalisation related to precision agriculture deployment. The cluster under investigation has been settled by the Beauvaisis municipalities' agglomeration. It comprises interactions between local authorities, firms and knowledge institutions. The analysis covers various perspectives of the stakeholders' interactions and the role of intermediary actors and introduces the concept of the floating prescriber. The early results and the following analyses will contribute to highlighting the way an ecosystem (a cluster) is developed around the issue of digital technologies and sustainable agriculture.

Outline

1 - Introduction

Agricultural machinery and digital technologies, the main components of the “agritech” sector, play a crucial role in farming innovation and its transitions towards sustainability, for instance, to operationalize agroecology [1,2]. The agritech sector involves a heterogeneous set of stakeholders operating at multiple levels. Structural recent evolutions of agriculture – such as the expectation of increased production and better environmental performances from a decreasing number of farmers, digitalization allowing for deeper understanding, control and automatization of practices, etc. – are requiring the agritech stakeholders to redefine their interactions. In France, a joint report of the agricultural equipment stakeholders called for a clarification of the innovation ecosystem, especially through regional initiatives [3]. On the one hand, regional characteristics and location factors remain fundamental determinants of a place-based activity like agriculture. On the other hand, digitalization and technology development could weaken or lose the linkage with local activities. Indeed, important innovations (e.g., GPS, Internet of Things, artificial intelligence, telemetry, robots) are currently and for the most exogenous, thus potentially opaque, to the agricultural sector. Research is therefore required to grasp the new economic-environment linkages in agritech innovation [4,5]. In this regard, the adoption of an agricultural innovation system (AIS) approach can help to clarify the existing and emerging interactions [6], as well as to evaluate their relevance to stimulating the transition towards sustainable agriculture [7].

In this paper, we aim at identifying the stakeholders' interactions within an agricultural innovation system and their relevance for the transition towards sustainability. We focus on a French agricultural cluster ("pôle territorial" in French) for agritech innovation and digital farming, recently launched in the Hauts-the-France region (northern France). The cluster and our scientific observation are planned to last several years, so we conclude by drawing the major challenges ahead.

2 - Agritech for sustainable farming

Agriculture is challenged to feed a growing world population. Yet, further expansion of cropland would encroach land devoted to fundamental ecosystem services [8]. As so, farming is expected to increase productivity by improving resource use efficiency [9]. Insofar, two major approaches emerge to support the transition towards sustainable agricultural production: (a) resource efficiency/substitution and (b) biodiversity-based agriculture [7]. The former aims at providing the optimal environment for crop and animal husbandry, to maximize the achievement of potential yields and growth. The latter addresses instead the environment structure, processes and services to improve the fitting of crop and animal husbandry accordingly through context-wise management [10,11].

The so-called "precision agriculture" fosters the accuracy of farming operations promising the right dose at the right place and time. Accordingly, it seems to operationalize the context-wise approach, even though it is first expected to provide more efficient use of resources. Historically, precision agriculture can be dated back to some traditional practices focused on individual plant or animal management. We can include in such a perspective the knowledge-intensive practices that designed terraced and other cultural landscapes before the availability of mechanized equipment [12] or some three hundred years old native American seed management practices [13].

In recent times, precision agriculture is dated back to the deployment of global positioning system technologies, which first allowed the place-based description and understanding of cropland management [14].

Following, further sensors were made available and adopted, steadily improving the capability to collect and process an increasing number of physical variables. The availability of cheaper and more efficient sensors further enhances the development of connectivity between pieces of equipment (the "internet of things") and with the cloud computing facilities through various types of networks, such as internet, smartphone, Lora, etc. [15].

The deployment of precision agriculture is leading the transition towards the digitalization of farming activities. In this sense, digital is compared to analogue, the former implying the use of numbers, the latter being instead a simple model of reality [16,17]. In particular, the shift from an analogue to digital agriculture is expected to increase the accuracy of operations [18], where accuracy is meant as conformity to truth or a standard or model [19].

Altogether, digital agriculture allows drawing crop and animal husbandry on a better understanding of the field and herd truth. This data and information framework finally enriches the description and management of the farming system components (soil, crops, herds, machinery, etc.). As so, it might be a practical way to operationalize the biodiversity-based approach mentioned here above [10]. Though, as stated by Kritikos in a thematic report for the European Parliament: "precision agriculture (also referred to as precision farming, smart farming, site-specific crop management or satellite farming) is a data-based management approach that is characterized by the collection and use of field-specific data" [20]. Hence, precision agriculture, while enabling the technologies for sustainable innovation of agricultural systems, is boosting the shift towards digital agriculture and, in the end, the collection and use of data. In this way, it empowers the exploitation and integration of complementary data sources, thus enriching the data value for information and knowledge creation.

The data-intensive agriculture based upon the precision agriculture deployment is reducing the uncertainties through a transition from heuristic to fact-based and data-intensive agriculture. The digitalization of farmers' practices and expertise will be a game changer in the primary sector. Similar dynamics can be observed in other economic sectors (e.g., industry 4.0 and e-). Yet, agricultural digital (r)evolution is characterized by the strong and unavoidable environmental exposure that increases the complexity of the operational development of such a fusion

of the physical-virtual worlds [21]. In such conditions, precision is more in the decision than in the localisation.
According to the European machinery industry, 70 to 80% of new farming equipment currently on the market embarks some form of precision agriculture component technology [22]. However, the real use of the various data-related technologies is still low compared to the potential. The main reasons for that include the following:

1. the lack of adequate training of farmers, agricultural operators and intermediary actors (e.g., extension services, dealers) [23,24];
2. the vague legislative framework about non-personal data usage rights and protection, especially aggregated and analysed data [20];
3. the technical accessibility and affordability, with rural areas still suffering of weak connectivity, while the average age of legacy tractors and equipment continue to increase [29].

In this perspective, the European Agricultural Machinery Association called for the recognition of the intrinsic link between agriculture and the farm machinery industry, namely through the promotion of the agritech [26].
Agritech encompasses the most advanced technologies that support the agri-food value chain. This includes a vast array of solutions ranging from mechanization equipment and robots to management software, data-capturing devices, decision support software and big data analytics [27]. Further improvements will be achievable by promoting cross-industry interactions and technologies application. Nevertheless, this adds complexity and radically changes the agricultural industry organization.

3 - Agritech stakeholders' interactions

The paper builds upon available scientific concepts and approaches for the description and evaluation of system innovation. In particular, we focused on the geography of innovation and proximity measures [28] to investigate the role of prescribers and boundary actors and elements [29].

To understand and describe the stakeholders' interactions, we started from the industrial and rural "district" framework, as defined by Italian legislation. This framework acknowledges the status of "district" to those areas having: (i) a high concentration of enterprises, mostly of small and medium size; (ii) a specific internal organization of the production system; (iii) a production specialization [30]. Hence, we hypothesise that geography plays a role in the context of technology transfer and development. Starting from the industry-university-industry (U-I) interface, three further dimensions can be added to the simple geographical proximity: (i) cognitive proximity, concerning the way of perceiving, analysing and understanding research; (ii) organizational proximity, measures of similarity in regulations, representations, and beliefs; (iii) social proximity, related to the degree of common (generally personal) relationships between actors [31]. In this line, a study by Huang and Chen [32] identified three factors to improve the innovation performance of universities in U-I interactions: (i) the definition of formal management mechanisms; (ii) the actual implementation of regulated U-I collaborations; (iii) the inherent innovation environment in the university. In the case of agritech stakeholders, we can further add the notion of technology proximity [33], which can be compensated by institutional proximity when there is a need for a partnership between firms. In this regard, institutional differences can become an obstacle to interactions, for instance in the collaboration between firms and universities [33].

Governance may play a role to catalyse synergies and to deploy the potential of the geographical proximity between stakeholders of a given sector, in particular when other proximity dimensions are not yet developed. In this regard, national and regional authorities can operate in two different ways: through promotion and facilitation or with goal-oriented efforts [34]. On the one hand, the institutions rely on their organic role as providers of infrastructures, to be populated and exploited through incentives and regulatory flexibility. On the other hand, a visionary goal might instead be identified to channel synergies and help to attract and coordinate partners. The latter appears to be preferred to support the agritech sector development.

4 - Case study: a French cluster in agritech innovation

The European Union aims to play a role as a world leader in agritech innovation. Precision agriculture and related technologies were identified as major game changers in the agricultural sector [22] and are expected to significantly impact the life of European citizens [35,36]. In this context, France is fostering a relevant place, namely in the development of agricultural robotics and farming digitalization [37]. This ambition draws upon a list of nine recommendations formulated by relevant stakeholders to be addressed for the future of the agricultural equipment sector [3].

We focus here on a recent French cluster for agritech innovation to investigate the stakeholders' role as system builders. First, we describe the stakeholders' missions and their previous interactions. Then, we characterize the upcoming collaborations as fostered by the new organizational framework, finally introducing the concept of the floating prescriber.

4.1 - Involved stakeholders and previous collaborations

The study case is composed of four main stakeholders of the agricultural equipment and agritech sector that are located in northern France, namely in the Beauvaisis agglomeration community (53 municipalities in the Hauts-de-France region).

The cluster draws around the Beauvais campus of the Polytechnic Institute UniLaSalle that proposes high-education courses and degrees in agriculture, geology and food and health (www.unilasalle.fr). In its earlier form, it dates back to 1865 as a section in the local school for teachers. Since the first years, the founders addressed the synergies between the agricultural and the industry sectors as the main engines of national development. Accordingly, the educational program included the purchase of a farm and the creation of an experimental station. Throughout its history, two societies of software development stemmed out: ESCORT, based on a study office created in 1969, and ISAGRI, created as a spin-off in 1983.

More recently, UniLaSalle further strengthen its involvement in the agritech sector through the creation of two new bodies. First, it hosts and backs the chair in agricultural machinery and new technologies, with the patronage of AGCO and the Michelin Corporate Foundation, as well as funding by the Region Hauts-de-France and the EFDR European program. The chair fosters the design and development of research, education and training in agricultural equipment and new technologies to support the transition towards sustainable agroecosystems [38] by acting at the interface between students, the industry sector and farmers and their organizations (e.g., CUMA, cooperatives, and technical institutes). Second, AgriLab® (2018), co-financed by the Beauvaisis agglomeration, the Oise Department and the Region Hauts-de-France, as an open innovation platform participating in the sustainable development program of UniLaSalle. It is inspired by the Fab Lab model and initiatives such as Open Ecology and Atelier Paysan. Its novelty is to be completely oriented and equipped to support innovation by and for farmers and other stakeholders of the agrifood sector.

The Beauvaisis agglomeration identified the UniLaSalle campus as a pivot in its territorial development strategy on the agritech sector. Accordingly, it branded the area nearby the campus to attract the establishment of agrifood sector enterprises in a so-called technology park.

ISAGRI is a European leader in the development of computer-based tools for farm management. Jean-Marie Savalle, the current CEO, and a few teachers of the Agricultural Engineer School of Beauvais (currently UniLaSalle), created it. In 1995, they left the school buildings where the spin-off was born, yet remained in the neighbour area to keep the proximity and ease the students' recruitment.
Massey-Ferguson, currently part of the AGCO group, built its most important European tractor production plant in Beauvais in 1960. Its current vice president & managing director for Europe and the Middle East is Thierry Lhotte, a former student of the Agricultural Engineer School of Beauvais. The group continues to strengthen the plant and the territorial anchorage through the construction of a 2nd and a 3rd production plant in the same area. In addition, in 1994, AGCO-Massey Ferguson created, in a joint venture with Renault agriculture (then become CLAAS tractor), GIMA to develop and produce transaxles systems for agricultural application.

Finally, Cetim is the French most important technical centre for the mechanical industry, established in 1965 to improve companies' competitiveness through mechanical engineering, transfer of innovations and advanced manufacturing solutions.

4.2 - The new organisational framework

Drawing upon the geographical proximity and the social and historical relations, the Beauvaisis agglomeration wanted to develop other proximity dimensions to facilitate innovation emergence and cross-industry technology development. They constituted a cluster to address agritech innovation, previously identified as the distinguishing feature of the local economy through national and international benchmarking.

By cluster we mean a form of geographic and sectoral agglomeration of enterprises or firms [39] which are interconnected with various institutions or public organizations (like universities, research institutes, knowledge-intensive business services and customers [40]) to stimulate innovation through different mechanisms or processes [41]. In this sense, an agricultural cluster is a sort of agricultural knowledge and information system where geographical proximity is maximised. By invoking the first law of geography [42], we focus on non-spatial dimensions of proximity, such as organizational, cognitive and social and on the role of boundary actors and objects that could bridge distances and increase proximity [31]. The underpinning hypothesis is that the various proximity dimensions between stakeholders have to be maximised to facilitate cross-sectoral and overall system innovation capabilities.

The studied cluster is composed of several stakeholders sharing the goal to ally agricultural machinery and digital technologies with farmer-oriented innovation. The cluster is materialized by a series of public-private investments and buildings for agritech innovation. On the one hand, the above-mentioned AgriLab®. On the other hand, Pim@tech, a high-technology test bench for machinery constructors being built on a mix private-public funding including the Beauvaisis agglomeration and Cetim, with the support by the Region Hauts-de-France, AGCO Massey-Ferguson and GIMA.

Such a heterogeneous panel of agritech stakeholders can consider the various sustainability components as either a constraint or a promoting factor for innovation. Their perspectives can sit anywhere in the range going from the conviction that technology alone can reduce the negative externalities of farming, to the call for a purely agronomy-driven change of farming systems. Hence, it becomes important to understand and describe the stakeholders' interactions in the absence of formal intermediate actors.

4.3 - Introducing the floating prescriber concept as an innovation broker

This paper attempts to clarify the relationship between different stakeholders within the French agriculture cluster on agritech innovation building on the concept of the prescriber. First, we will give a brief overview of the concept of the prescriber; second, we will compare the roles of prescribers with innovation brokers. Then, we will propose a definition of floating prescribers. This definition will help us to understand the different interactions that can be potentially considered within the cluster and define the role of each stakeholder.

In his seminal paper, Hatchuel [43] introduced the notion of "prescriber" [44].

This concept seems to be particularly useful in analysing the dynamics within the cluster (in comparison with innovation brokers). Prescribers not only perform the functions of innovation brokers (intermediaries) but are also involved in one way or another in the interaction between other parties [45]. Berghozi and Paris [46] analyse a prescription on the internet and the authors highlight that "prescribers are not simple intermediaries but third parties: they act alongside producers and consumers – not between them –to structure the product or service supply or to assume responsibility for some aspect of the consumer decision".

Initially, Hatchuel's study [43] discusses the role of the prescriber in the relationship between seller and buyer. We adapt this framework to interactions within agricultural innovation systems. Our study enhances the existing concept by introducing a new dimension, which deals with a duality of the roles of some stakeholders ("floating").

Intermediate or boundary players such as the prescribers can increase the proximity across multiple stakeholders. Literature provides multiple definitions of the prescriber, also known as innovation intermediaries or innovation brokers [47].

Innovation broker is defined as "an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, for bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations" (Howells (2006, p.720) as cited in [52].

Their role, defined by Klerkx and Leeuwis [47], is central between parties and they act as "facilitators of innovation", or even "sources" or "carriers of innovation". Neutrality is a particular feature as regards their position in the interactions between different actors. Indeed, the innovation intermediaries act neutrally as long as "their existence remains limited to the lifecycle of the issues they represent in societal debate" [49]. We refer here to the "neutrality or impartiality paradox" first used by Laschewski et al. [50]. These authors emphasize that intermediaries adopt a non-neutral position as they act with “a certain degree of steering”. Altogether, proximity remains mostly characterized by personal and individual relationships but where “intervention is connected with a degree of formalization of structures and goals” [50,51].

Several authors have defined three main functions of brokers as demand articulation in the context of agritech innovations, linkages creation within an agriculture innovation system and “innovation process management” [52,53]. While intermediation and prescription are linked, the main functions of a prescriber are knowledge transfer and decision-making process support [46].
The phenomenon of prescription occurs in different fields and the interaction is not limited to product purchases. Public authorities, specialized magazines, a doctor, a theatre critic - these are all examples of prescribers. A client (buyer) with limited knowledge might need a prescription to ease a decision-making process related to a potential transaction. A prescriber can help a client get oriented by structuring the existing knowledge or suggesting substitutes that have not been perceived as such. For example, “white wine can be served as an aperitif”.

There are three types of prescriptions: factual, technical and judgment prescription. Prescriptions for buying a car can be considered factual prescriptions. These prescriptions demand a commitment to the truth [43,54]. Factual prescription is used by Hatchuel [43] to mean a prescription which allows clients to broaden their knowledge or to understand the benefits they get. Technical prescriptions refer to a way of doing something or a technique that a client might not have employed due to a lack of knowledge. A technical prescriber can indicate alternative suppliers or develop a new strategy. Doctors, architects and engineers fit into this category of prescribers. A “judgment prescription” deals with values and preferences. An act of consuming is not only about an acquisition of something but also about getting pleasure out of something. An art critic makes a judgment and provides a way to judge which helps a client to make a decision [43,54].

We propose a definition of “floating prescriber” in which one stakeholder plays several roles depending on the type of project and other parties involved in the interaction. The role can be shifted from one stakeholder to another.
Several characteristics of a prescriber – defined by Hatchuel [43] – and a floating prescriber are identical. Knowledge transfer occurs based on

mutual trust. A client and prescriber pursue the same interest: the interest of the client. A prescriber is committed to keeping the knowledge up to date and agrees not to join a competitor. A prescriber tries to be independent whether from the seller or a third party. As soon as a prescriber is identified, a seller might be interested in influencing the prescriber, taking advantage of the potential existence of asymmetric information. The prescriber-supplier relationship passes through knowledge transfer as the prescriber needs some information about other partners. A seller might challenge a prescriber and might want to maintain a direct relationship with a buyer or propose a new prescriber [43].

The concept of floating prescriber generates considerable interest in terms of shifting roles of stakeholders, which eases the transfer of knowledge from one stakeholder to another. Owning knowledge and criteria for judgment, any stakeholder within the cluster can be a potential floating prescriber.

5 - Conclusion

Agritech emerges as a game changer in the system innovation towards sustainable agriculture. We focused here on the genesis of a French cluster on agritech innovation and the involved stakeholders' interactions based on geographical and other proximity dimensions. Further analysis of the cluster should include the comparison of the innovation and sustainability strategies of each stakeholder, starting from a text analysis of their mission and official documents (e.g., fact sheet distributed at the inauguration of the cluster, stakeholder's website, and activity reports). This could enhance the understanding and description of the role of floating prescribers in the stakeholders' interactions.

Stakeholders' interactions imply an exchange of knowledge and expertise. This exchange helps to articulate demand, to forge links with "supporting services", and to manage the innovation selection process and other phases of the innovation management routine. As so, the specific role of the prescriber, in the interaction between other parties, is enabled only where knowledge, know-how and decision-making skills are established in a way to balance and limits mere "power relations". In perspective, our study could enhance the understanding of prescribers and advisory, through the test of a "floating prescriber" concept, addressing the dynamic role that each stakeholder can play in the operationalization of the transition towards sustainability.

Finally, the decrease in the number of farmers and the increase in their training level should empower their role within a new configuration of the agritech innovation system. They can help put agricultural system innovation as a boundary object to structure the agricultural information system dynamics and its transition towards sustainability [55,56]. In this regard, farmers can help to elicit the different agritech stakeholders' perspectives on sustainability, provided that they are trained for this new emerging role of mediators.

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