Communities of Practice in Crop Diversity Management: From Data to Collaborative Governance

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Abstract Establishing linkage among data of diverse domains (e.g. biological, environmental, socio-economical, and geographical) is critical to address complex multidimensional issues such as food security or sustainable agriculture. The complexity of this challenge increases with the level of heterogeneity of the data but also with the social context of production of datasets, a dimension usually less considered. Building on the experience of a transdisciplinary project on the diversity of crop diversity management systems in West Africa (CoEx), this chapter reflects on the importance to better account for agency for more meaningful, responsible and

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efficient plant data linkage. The chapter addresses sequentially the cognitive and political challenges related to data work and the way they could be addressed simultaneously within the same social unit. To do this, we rely on the concept of community of practice (CoP) which gained enormous popularity in relation to data and knowledge management. More than simply a social mechanism for community knowledge management, we show in this contribution that CoP needs to be approached as a social experiment and a terrain of collective situated learning in order to address each challenge and their linkages with respect to data work.

1 Introduction

Establishing linkage among data from diverse domains (e.g. biological, environmental, socio-economical, and geographical) is critical to address complex multidimensional issues such as food security or sustainable agriculture. As illustrated by Rawlings and Davey (among others) in this volume, many technical solutions exist to link heterogeneous datasets. However, the complexity of these technical solutions increases with the level of heterogeneity of the data. It also increases with the social context of production of datasets, a dimension less frequently considered.

Dataset production may be carried out by scientists only. In this case, the difficulty for establishing data linkages would increase with the level of heterogeneity of disciplines and conceptual frameworks involved. The problem becomes even more acute in transdisciplinary contexts in which dataset production is carried out not only by scientists, but also by farmers themselves, or by other stakeholders. In such a complex social context of production of datasets, people may not necessarily share the same background and cognitive references, and they may not necessarily follow the same normative orientations about the way to produce, access, exchange and use plant data.

The diversity of people involved in dataset production implies a diversity of practices. The way people interact and value the knowledge they produce, as well as the rules they adopt about how this knowledge can be used by other people, directly relate to the ethical and political dimensions of data work. Data, datasets and databases do not exist only as a material, numerical or technical product, but also as a result of social processes at work before, during, and after the data production. In addition, different levels of responsibility are engaged before, during, and after the data production: why collect new data? To what extent are the diversity of actors and

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practices considered in data work? Are these actors able to interpret the data they contribute to producing or collecting? Are data production processes and modalities for using and exchanging the knowledge produced collectively defined?

Unfortunately, the technical aspect of data production often tends to quickly take precedence over these social, political and ethical dimensions (Boeckhout et al., 2018). Diversity of practice in data work, and different levels of responsibility, are too often overlooked in discussions about plant data linkage. This chapter asks, to what extent does enhanced understanding and recognition of the practice of data work and the people involved help to make plant data linkage more meaningful, responsible and efficient?

Building on the experience of a transdisciplinary project on the diversity of crop diversity management systems in West Africa, this chapter reflects on the importance of better accounting for agency to achieve more meaningful, responsible and efficient plant data linkage. We argue that this cannot be done in isolation from the technical challenges or – even worse – only once the technical challenges are solved, as their resolution has a direct impact on data quality (metadata) and their actual and legitimate linkages.

This chapter distinguishes between the cognitive and political challenges related to data work. The cognitive challenge refers to how data is produced and interpreted. From a technical point of view, this challenge consists in developing standards for metadata (data about data) and data annotation that are meaningful and computer-readable (Arnaud et al., 2020). Such efforts aim to enhance epistemic accuracy through the production and linkage of multidisciplinary data, which spans genetics, environment, agroecology, biology, and socioeconomics (Arnaud et al., 2020). If such an approach certainly enriches plant knowledge representation, it leaves aside the difficult issue of collective data-making in multi-stakeholder contexts characterized by a great heterogeneity of actors with diverse backgrounds and cognitive references, beyond academic disciplines. Responding to this socio-cognitive challenge obliges us to move away from a vision of the epistemic activity of data production as a passive contemplation of the 'world out there' (Popa et al., 2015) in which each discipline brings additional descriptors to enrich what is implicitly defined as the same entity. We show in this chapter that the concept of community of practice (CoP), by contrast, can help by considering the creation of meaning as a collective production process, negotiated through participation and social interactions. Attention in this paper is paid to the way objects (here seeds) get their meaning and reality in the course of practical activity that involves the relations amongst humans and between humans and non-human entities. In this context, ontologies are no longer about modes of knowing pre-existing entities, but the way objects are enacted in practice (Woolgar & Lezaun, 2013).

The political challenge classically refers to both normative and procedural issues. By normative issues, we understand the underlying conflicting logics, values and assumptions that arise among heterogeneous actors with regard to data content. The procedural issue refers to the various ways in which power and participation are constructed and enacted in data practices (Couldry & Powell, 2014). Plant science crystallizes a significant number of issues related to divergent visions about

marketing, quality and certification of seed, intellectual property and access and benefit sharing legislations, and risk management, among others. These legislations impact many actors (farmers and their organizations, NGOs, breeders in the public or private sectors, researchers, genebank managers, policy makers, etc.). The complex landscape of rights and responsibilities and associated institutional frameworks generates tensions among these stakeholder groups, which in turn affect plant data exchange and use practices. Hence, addressing both normative and procedural political challenges requires a critical stance towards the understandings, values and assumptions of the various stakeholders as well as towards the institutional and power structures that shape the current organization of data work.

This chapter addresses sequentially these two challenges related to responsibility and agency in plant data linkage, but is also interested by the way they could be addressed simultaneously within the same social unit. To do this, we rely on the concept of community of practice. CoP has gained enormous popularity in relation to data and knowledge management as a way to cultivate expertise and foster learning. However, more than simply a tool and social mechanism for community knowledge management, we show in this contribution that CoP need to be approached as a social experiment and a terrain of collective situated learning in order to address each challenge and their linkages with respect to data work. We argue that responsible data production and linkages require not only consideration of the diversity of knowledge systems and practices (socio-cognitive challenge) but also the need to enhance the ability of various stakeholders to contribute to meaning production in a context of strong heterogeneity among actors (political/normative challenge). More importantly, we argue that responsible data production and linkages cannot be fully achieved if the political/procedural challenge is not addressed simultaneously with the two others to translate the recognition of the socio-cognitive and political/normative challenges into concrete changes in everyday practices and organization of data work. Addressing this last challenge, which is too often overlooked or reduced to its managerial dimension, requires enhancing our understanding of the way the community of practice acts on itself to manage collective data work.

The paper is broken down into four sections. In the first section, we present the case study of the CoEx project and the way data work has been organized and conducted within this project. We then present the versatile concept of CoP and describe how it could apply to the collaborative context of the CoEx project. The following sections describe how CoEx has addressed respectively the three challenges. We conclude by discussing the relationship between these three challenges and the extent to which they offer a way to combine in a fruitful way both the managerial and situated learning dimensions of CoP.

2 The CoEx Project

CoEx is a 4-year collaborative (2016–2020) project funded by Agropolis Foundation and constructed as a collective and multi-actor inquiry on crop diversity management systems in West Africa. This collective gathered researchers from various

disciplines as well as farmers' organizations and NGOs in Burkina Faso, Canada, France, Mali, Niger and Senegal with the overall objective of providing a more accurate picture of actual practices surrounding seed acquisition, uses and exchange, beyond the usual "formal" and "informal" binary division that still predominates international and national legal and policy frameworks.

The so-called formal system is based on breeding programs and is organized around the release of genetically uniform certified seeds in a market in which farmers are end users. The so-called informal system covers genetically heterogeneous seeds selected, produced and distributed by farmers and their organizations, generally in a subsistence economy (Almekinders et al., 1994).

The reality of farming practices regarding seed management is not so clear-cut, with interactions and a continuum between these two systems (Louwaars, 2007). Faced with the diversity of farmers' and consumers' demands, the diversity of production contexts and the diversity of crop types, the diversification of seed supply sources is an essential strategy for food security and sustainable agriculture. Indeed, by promoting the diversity of plants and cultivated varieties, the diversification of supply sources also favors the resilience of agricultural systems through stabilization of yields over time, nutritional improvement or adaptation to climate change (Labeyrie et al., 2021). Hence, reconciling the legal and policy frameworks surrounding crop diversity management systems with the diversity of actors, rules, standards and practices is a key challenge for sustainable agriculture.

However, abandoning the binary vision in order to characterize the plurality of crop diversity management practices with a more refined approach represents a definite methodological challenge: How to characterise the most diverse situations throughout the world while being as faithful as possible to what farmers are experiencing, without falling into analyses that are too context-specific?

To this end, a conceptual framework general enough to accommodate a diversity of knowledge systems and specific enough to provide relevant applicable knowledge for various stakeholders (Popa et al., 2015) was established. This framework was based on the concept of social-ecological systems (SES) that accounts for the intertwined social and biological dimensions of resource management (Berkes & Folke, 1998; Anderies et al., 2004; Ostrom, 2009; Young et al., 2006; Folke et al., 2005). The social-ecological seed system focuses on the relationships and interplay between resources (seed, crops), actors (farmers, sellers, community seed bank managers, researchers, breeders, etc.) and institutions (understood as the rules, accepted norms, standard procedures according to which individuals and organizations think and act) within a specific environment defined as a socio-ecological context (Labeyrie et al., 2021). All kinds of relationships between resource systems, resource units, users and governance systems, acting at multiple levels within the same system, were considered without any established hierarchy. For example, in a classical unidirectional human/ecological interaction model, communities establish rules to (sustainably) manage resources but this framework also allows accounting for the other way around, i.e. the way resources (in this case, seeds) 'create' a community with specific types of attachments and relationships.

Three major farmer-crop relationships were considered within CoEx: seed access, crop choice and use of the harvest. Data work to characterise these relationships involved collecting quantitative and qualitative information and covered different disciplines and protocols, some of them co-constructed with farmers' organizations. Moreover, specific attention was paid within CoEx to agreeing on data sharing and management practices as part of a collaborative governance approach of the project and in which any output was considered as a commons.

3 Community of Practice in the Context of CoEx

Communities of practice have gained enormous popularity in relation to knowledge management. They have emerged as a powerful governance mechanism to address complex problems by fostering spaces for collaboration and opportunities across wide areas of expertise, geographies and actors. Building on information and communication tools and coupled with the movement of big data, they are today presented as a way to facilitate connectivity and leverage maximum impact from data by accelerating linkages (see https://bigdata.cgiar.org/communities-of-practice/ and Bertin et al., this volume). Tracing the genealogy and providing a critical review of the notion of CoP are out of the scope of this paper. We rather build upon existing reviews of this concept (see in particular Bolisani & Scarso, 2014; Cox, 2005; Gherardi, 2009; Handley et al., 2006; Li et al., 2009) to point to issues of relevance to the CoEx project.

Community of practice has become an "umbrella term" since its inception by Lave and Wenger (1991). This notion was initially coined to reflect on the collective and socially situated dimension of learning in opposition to the dominant cognitive and individual approach of learning. The active, experimental and collective character of knowledge building departs from a conception of learning as a matter of individual construction and acquisition. As Stahl noted (2003: 523, quoted in Allert, 2004: 6), "*meaning making is not understood as a psychological process which takes place in individuals' minds but as an 'essentially social activity that is conducted jointly – collaboratively – by a community, rather than by individuals who happen to be co-located'*". The focus shifts from outcomes and products such as 'knowledge' or 'data' to activities such as "knowing" as a process of participation in shared learning activities and social processes of knowledge construction (Allert, 2004).

Over time, the CoP concept has been taken up in management literature and the focus shifted rapidly from CoP as a terrain of social learning to CoP as an organisational tool to manage knowledge teams in a more effective way (Li et al., 2009). In this stream of literature, CoPs are approached as a mechanism through which knowledge is held, transferred and created (Gherardi, 2009). Expertise is seen as the most crucial resource in CoPs and skills and knowledge interdependencies need to be effectively managed through technology-mediated tools, standards and protocols (Gherardi, 2009). The prevailing notion among knowledge management

scholars is the one that considers a CoP as an entity in itself that requires managerial efforts to initiate, develop or cultivate. Wenger himself departed from his initial view and further reinforced this 'managerial turn' in his book published with colleagues in 2001 (Wenger et al., 2001), which formalised the three main elements of community of practices (Bolisani & Scarso, 2014): the domain (i.e., the area of knowledge that brings the community together); the community (i.e., the group of people for whom the domain is relevant, the relationships among them and the boundaries); and the practice (i.e., the body of knowledge, methods, tools, stories, documents which members share and develop together).

The original meaning, in which CoP is a way to consider learning and knowing as situated in social practices, is much more relevant to describe how concretely knowledge building and data work has been conducted within CoEx. In effect, in our willingness to producing new data and knowledge about seed systems that move away from pre-conceived categories and truly reflect what actors on the ground were experiencing, 'practice' rather than 'community' is what mattered most. As previously described, the SES framework focuses on the relationship between human and non-human entities rather than on representation of fixed entities. This allowed us to describe how entities such as seeds are enacted in practice, i.e. get their particular reality in a specific context. Such an approach gives more importance to the diversity of practices producing knowledge about seeds and recognizes the dynamic relationship between what can be deduced from the object itself on one hand and collectively constructed in social situations to give its meaning to the knowledge and data produced on the other hand.

4 Socio-Cognitive Challenges in Crop Diversity Management Characterisation

Two classifications coexist within the scientific biological community interested in crop diversity. The Linnaean (botanical) system of classification creates fixed categories based on agreed (though arbitrary) criteria based on morphological traits and biological characteristics to which all scientists subscribe: Class, Order, Family, Genus, Species, Sub-Species. Genetic information is increasingly used to classify or to update previous classification.

In addition to this botanical classification, researchers working on crop diversity use different categories to describe species and sub-species: wild relatives of crop plants; local varieties and primitive cultivars; obsolete ancient cultivars; advanced breeding lines, mutations and other products of plant breeding programs; and high-yield elite modern cultivars (Wilkes, 1988; National Research Council, 1993). This whole set of categories constitutes what is called genetic resources (or germplasm) in a generic way, which implicitly refers to the breeding (use) value. In effect, it describes a spectrum that holds a vision of genetic progress in which modern cultivars constitute the end goal and become a variety that is meant to be certified

and sold in the market for production purposes (Bonneuil, 2019; Fenzi & Bonneuil, 2016). Unlike the botanical Linnaean system, this categorisation is not based on agreed criteria and thus, this information could be reported in various way by researchers.

In parallel to this biological classification systems, ethnobotanists and anthropologists have described a diversity of autochthonous classification systems used by farmers around the world to describe crop diversity, using vernacular name based on morphological, origin or symbolic characteristics.

CoEx discussed and investigated to what extent these existing categories and descriptors were able to accurately reflect existing seed acquisition, use and exchange practices with the overall objective to move away from the linear vision of genetic progress underpinning the binary formal/informal vision that predominates the characterisation of crop diversity management systems.

To this end, specific efforts were made to focus on the way seeds were being enacted in practice. Within the CoEx's community of practice, our object of inquiry was the coming into existence of entities (here seed "varieties") in the course of a practical activity rather than the modes of knowing of given entities. For example, during the field research carried out in one village of the Thiès Province in Senegal, we were able to observe, as notably and already described in other contexts (Leclerc et al., 2014; Labeyrie et al., 2019), a lack of consensus among farmers from the same village regarding the history and names of certain seed varieties, a fact presumably linked to their different life trajectories. This diversity of classification systems within the same village is made even more complex if we introduce a temporal perspective. In effect, our observations show that the categories used to designate the status of seed varieties used by farmers rapidly evolve over time. This semantic shift in our Lissar case study was particularly noticeable when seed lots move from the farmers' individual stores to the community 'seed bank' (a collective crop storage and conservation place). Through this movement of seeds that took place, we observed a change of the status of a given variety, from improved variety to collective variety. This suggests an ontological reconfiguration in the perception of farmers towards their plant material during these physical flows of seed lots in the village. Besides, lots designated as "farmers' varieties" or "local varieties" covered many varied origins and genetic compositions. This dynamic character, associated with the unstable character of variety qualifiers, underlined not only the diversity and combinatorial nature of variety perception and seed management by farmers, but also challenged the unquestioned use of these denominations for data collection and research purposes (see Fullilove, this volume).

This also brought into question the very notion of variety from a practice-oriented view. In our attempt to characterize seed acquisition strategies, we were interested in documenting whether privileged forms of acquisition were associated with varietal status, something that required aggregating data collected by seed lots at the scale of varietal status. However, such a task proved to be difficult since these categories, as noted above, were dynamic and not fixed over time and among farmers. Repositioning the analysis at the level of the physical entity managed by the farmer, i.e. the seed lot he/she sows or harvests in his/her field, was perceived as a promising

way to avoid this caveat. This was especially the case when the description of seed lots mobilized several different descriptors known and used by farmers including seed variety name, varietal status and also other morphological or agronomic characteristics. Using an unweighted multi-dimensional description of the seed lot offered the possibility of diluting the impact of the heterogeneity of perceptions on all the descriptors when clustering methods are applied to aggregate the different seed lots.

In order to circumvent the difficulty of producing data without referring to pre-existing categories and better reflecting those categories experienced by the different actors involved, some CoEx members have also explored the specific attachments of farmers to their seeds (Lewicka, 2011). This was done through mixed quantitative and qualitative methods based on farmers' surveys to clarify the dimensions involved in the characterisation of seeds from the farmers' point of view. Such a relational approach to seed characterisation offers a way to grasp what really matters for farmers besides the instrumental values and the plurality of status and values associated with seeds within each community. This includes in particular emotional dimensions (such as pride, hope, collective, emancipation) and moral values (such as faithfulness, loyalty, reliability, solidarity), two aspects seldom explored despite their critical importance to the perception of fairness and equity in the management of crop diversity (Jankowski et al., 2020). Such an approach has underlined the way in which any characterisation is embedded and defined through the social relations that engage the farmers to their seeds.

By focusing on how entities such as seeds get their particular reality in a specific context and in the course of a relationship between human and non-human entities, rather than on representation of fixed entities, the CoEx's CoP addressed the socio-cognitive challenge of producing data on objects/dimensions that better reflect the diversity of actual practices in the field and are usually left out in existing knowledge systems and database about seed and seed systems. However, producing equitable and responsible data not only means taking into account the plurality of ways of knowing about seed but also tackling the political challenges related to the background values and assumptions guiding research, and to the socio-institutional structures supporting particular norms and practices.

5 Political Challenges in Crop Diversity Management Characterisation

In the context of CoEx, learning did not only occur in regard to the ontological and semantic status of a particular entity (seed). It also took place by encouraging various processes of critical assessment and social learning in regard to the different values and assumptions as well as the institutional and power structures that shape the current organization of research. Such learning is deemed essential to overcome the fact that knowledge and data production and sharing take place within a political

context of strong inequalities among actors in their ability to contribute to meaning production (Bezuidenhout, 2020; Godrie et al., 2020; Fricker, 2007).

Knowledge actors rarely share complementary or compatible motivations and objectives. Various institutional logics usually coexist within a CoP without necessarily being made explicit or transparent to others in the course of knowledge production. In the specific context of plant science and breeding, strong divergence of views and power differentials among actors requires paying particular attention to collective meaning production.

The situated learning approach of CoP, as approached within CoEx, helps address the political challenge in both normative and procedural ways.

5.1 The Political Challenges from a Normative Point of View

As previously noted, seeds, genetic resources and associated knowledge crystallize a significant number of issues related to the divergent views about their legal status (see Manzella et al., this volume). Seeds are critical to the conventional paradigm of industrialization of agriculture, while at the same time they are at the core of the food sovereignty movement as part of farmers' autonomy and diversification and adaptation strategies in a rapidly changing environment. Recognizing and accounting for the diversity of normative orientations of the different stakeholders within CoEx involved paying careful attention to strengthening the capacity of partners to engage in the research design and to contribute to the meaning of the data collectively produced.

In this regard, CoEx established a research process that tried to ensure that all partners could benefit from the data produced in the course of the research. This was achieved by promoting the appropriation of scientific methods by and sharing results with farmers' organizations' members and rural communities. Besides simply sharing intermediary findings, such a process also permitted the project to integrate multiple legitimate perspectives into the scientific analysis and to ensure better linkages between scientific and societal problems.

One CoEx task was particularly amenable to this approach. Cognizant about the 'local trap' that accompanies collecting comprehensive data in one specific location, to provide as accurate a picture as possible about the so-called informal seed systems, CoEx proposed to characterize the diversity of seed systems at a larger scale. The project did this by enabling the collection of data over a large geographical area. In order to obtain an overview of the diversity of seed systems, a spatial uniform distribution was used as sampling strategy to describe – without any geographical *a priori* – the diversity of crops (species and varieties via their morphological traits), the variety of their uses, and the different modalities of seed acquisition. Surveys were carried out in 144 villages, spread over four countries in the 1.5 million square kilometres of the Sahelian strip, from Senegal to Niger, passing through Mali and Burkina Faso moving from West to East.

The surveys documented the presence or absence of 32 crop species, with a particular focus on pearl millet, cowpea, sorghum, gumbo, groundnut and maize to further characterize varieties, seed acquisition patterns and uses at multiple spatial – farm, local, regional, national, and multi-country – and temporal scales. These crops are the staple food of the population, i.e. reaching about 330 million people.

In order to reconcile the scientific robustness and objectivity of the surveys on the one hand, and the social relevance of the knowledge produced on the other hand, an approach covering all stages of the collaborative research process was developed, ranging from the co-construction of research questions and data collection protocols to the joint analysis of results.

A first workshop entitled 'common research protocol' took place in Ouagadougou (Burkina-Faso) for 1 week, bringing together partners from five universities and five farmers' organizations from Niger, Mali, Burkina Faso, Senegal and France. The survey protocol and questions were discussed in order to agree on what data and information will specifically be collected. The participants also considered ways to address cultural difference between languages and countries, and the associated diversity of crop management practices. All participants collectively ran a testing phase of the survey in the field to ensure a higher level of common understanding despite these specificities.

The survey was implemented simultaneously in the four countries with a total of eight field survey teams. Each team used a touch screen tablet with Kobo Tools software. Touch screen tablets allowed the teams to conduct data entry directly in-field. Data was uploaded each day in a server, which was common to all partners. This offered the possibility for each survey team to see the progress of other teams in real-time, on a map with dots representing villages that were already surveyed in different countries. Each team had access to the results obtained by the others. This form of data management and access has made "shared data" a common and central value among the partners.

A second workshop entitled 'collective results interpretation' took place in Montpellier (France) for 1 week. Questions to be analysed first were formulated before the meeting by each partner, according to their priority. During the meeting, results were analysed first separately by country, and then transversally across country. The interpretation of the results was based on the local knowledge and practices of each partner. Thus, a given observation was considered of broader significance when different (and independently formulated) interpretations from different teams converged. This form of collective interpretation contributed to enhanced appropriation of the results by the partners.

Moreover, the formation along the way of a CoP built as a group of partners sharing a common research frame of reference made it possible to forge a common understanding about the value of the knowledge being produced. The whole challenge of the approach consisted in ensuring that the facts observed by researchers in the different countries during the surveys were collective facts, not only shared in materiality (via the computer tools used) but also in meaning (via co-constructed protocols and collective analysis). By simultaneously asking the questions "what do we do" and "how do we do it" and by conceiving the production of knowledge as

process of co-participation and social interactions, the CoEx's CoP made it possible to produce collective meaning from the huge amount of data collectively collected.

This allowed overcoming the opposition often presented as irreconcilable between the criteria of scientific robustness on the one hand and those of social relevance and legitimacy on the other hand (see Leonelli and Williamson, this volume). Not only did the mobilization of farmers' organizations make it possible to carry out a large number of surveys, but they also provided valuable elements of understanding of the context. This allowed an informed interpretation of the results complementary to those of the researchers (particularly in statistics) that made it possible to compare the different situations and give them a general scope.

With this knowledge, farmers, researchers and public decision-makers have valuable information to better valorise the solutions experimented with locally to adjust to their environment. The partnering farmers' organizations are now in a position to build a discourse based on scientific evidence they contributed to generate, and even to participate in gaining better recognition of farmers' right to cultivate their seeds and, more generally, of their role in the management of agrobiodiversity. This could also be made possible by the opening of new public space for enhanced interactions between the various stakeholders and policy makers (Nlend Nkott & Temple, 2021).

5.2 The Political Challenges from a Procedural Point of View

Our approach to participation within CoEx was not only limited to the data production and interpretation process. It also included participation in decision-making processes about the use of this (collectively produced) data. This decision-making process has not only been approached from a managerial perspective, but rather as a knowledge area in itself that became part of the collective inquiry process. CoEx has indeed been conceived as a collective experiment that has taken up the question of the conditions of its own collaboration and defined its own modus operandi, objectives and means according to the specific problems to be solved in the course of the project.

To do this, and in line with the situated learning approach, CoEx established the two following activities: a collective analysis of past research collaborations experienced by members; and a reflexive process in regard to the CoEx conditions of collaboration as the research continues to develop.

The first activity consisted of collecting agreements made in past multi-stakeholder research collaboration and surveying farmers' organization members and researchers about their perceptions and perspectives about what worked or not in these agreements. Two workshops were organized in 2017 and 2018 to collectively organize this work and analyse the findings. A third workshop in 2019 lead to the drafting of a manual on multi-stakeholder research collaboration that listed different points to be considered and monitored within such complex collaborative contexts

and options to address them. This learning process enhanced the collaborative capacity of the participants in multi-stakeholder contexts.

The second activity consisted in establishing a project governance structure that reflected the multi-stakeholder nature of the collaboration process and examined specific collaborative issues as they occurred in the context of the project implementation. Rather than relying on existing resources and administrative routines to the research organization in charge of the coordination of the project (the French CIRAD, in this case), this reflexive process increased the involvement of the community in its own collective functioning. In relation to data work, three topics were specifically covered: one related to the ethical aspects of collecting survey data from farming communities; one related to data management and the status of data and results within collaborative projects; one on the type and status of knowledge made available by project participants, in particular concerning the practices and know-how disclosed by producer members of farmers' organisations participating in the project. To address this issue, CoEx recognized that all partners have equal rights over the data, dataset and data analysis jointly produced, considering these outputs as a commons. This was materialized by the recognition of the right to participate in any decision regarding publication, utilization for various purposes, transfer to third party, or application of any intellectual property right. One concrete experience during the project that offered an opportunity to test these ideas related to the willingness of one researcher to engage in a new collaboration with a US university that would use data collected in farmers' surveys on seed acquisition practices and sources,. A 'Data Provision agreement' was prepared and negotiated between CIRAD and the US university. This involved many back and forth exchanges between CIRAD and the CoEx members on the one hand, and CIRAD and the US university on the other hand, as many clauses proposed to protect the integrity of the (social) context in which such data had been collected, as well as the collective validation process of data use in publications through the CoEX multi-stakeholder steering committee, were perceived at odds with established practices in inter-academic collaborative practices. The partners also undertook to treat with the utmost vigilance, and in accordance with the various national legislations, any local or traditional knowledge associated with seed and genetic resources that may be transmitted to them by farmers in the course of the surveys, in order to prevent any kind of misappropriation.

6 Conclusion

In considering the notion of community of practice in its initial conceptualisation, which involves blurring the distinction between knowledge and practice and between production and use of knowledge, this paper revisited both socio-cognitive and political challenges related to data production and responsible data linkages. The concrete combination within the same project of these three dimensions offers a perspective on CoPs quite different from the managerial angle through which most

of the discussions on data work have apprehend them. This in turn has consequences for the way to approach the agency issue in plant data production and linkages.

Regarding the socio-cognitive challenge, beyond accounting for the plurality of ontologies or knowledge systems (often reduced to a diversity of classificatory modes), we have shown that producing data that "make sense" to the different members requires also to get a better understanding of their respective epistemologies or ways of knowing. More specifically, we showed that the dynamic character of seed circulation and the social relations that engage farmers with their seeds ultimately impact their characterization.

The recognition of the various ways of knowing is also crucial to address political/normative challenges in interpreting the data and creating collective meaning and learning. The establishment of a group of partners sharing a common research frame of reference and the mobilization of the different set of available interpretative resources provided by the different actors made it possible to forge a common understanding of the value of the knowledge being produced. Through the collectively produced knowledge, the partnering farmers' organizations are now in a better position to build a discourse based on scientific evidence that they contributed to generating, and even to participate in gaining better recognition of their rights.

Beyond this collective learning process on the (technical) topic of research, the establishment of modalities for collective organization and decision-making itself was also part of the learning process. Very often reduced to its managerial aspect, this governance dimension is crucial to ensure full participation in addressing the socio-cognitive and political/normative challenges in the first place, and to manage as best as possible the differences in power between groups in the use of data and knowledge jointly produced.

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References

Allert, H. (2004). Coherent social systems for learning: An approach for contextualized and community-centred metadata. *Journal of Interactive Media in Education 1*(2004), 2004(2).

Almekinders, C. J., Louwaars, N. P., & De Bruijn, G. H. (1994). Local seed systems and their importance for an improved seed supply in developing countries. *Euphytica, 78*(3), 207–216.

Anderies, J. M., Janssen, M. A., & Ostrom, E. (2004). A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society, 9*(1), 18.

Arnaud, E., Laporte, M. A., Kim, S., Aubert, C., Leonelli, S., Miro, B., et al. (2020). The ontologies community of practice: A CGIAR initiative for big data in agrifood systems. *Patterns, 1*(7), 100105.

Berkes, F., & Folke, C. (Eds.). (1998). *Linking social andecological systems: Management practices and social mechanisms for building resilience*. Cambridge University Press.

Bezuidenhout, L. (2020). Being fair about the design of FAIR data standards. *Digital Government: Research and Practice, 1*(3), 1–7.

Boeckhout, M., Zielhuis, G. A., & Bredenoord, A. L. (2018). The FAIR guiding principles for data stewardship: Fair enough? *European Journal of Human Genetics, 26*(7), 931–936.

Bolisani, E., & Scarso, E. (2014). The place of communities of practice in knowledge management studies: A critical review. *Journal of Knowledge Management, 18*(2), 366.

Bonneuil, C. (2019). Seeing nature as a 'universal store of genes': How biological diversity became 'genetic resources', 1890–1940. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences, 75*, 1–14.

Couldry, N., & Powell, A. (2014). Big data from the bottom up. *Big Data and Society, 1*(1), 1–5.

Cox, A. (2005). What are communities of practice? A comparative review of four seminal works. *Journal of Information Science, 31*(6), 527–540.

Fenzi, M., & Bonneuil, C. (2016). From "genetic resources" to "ecosystems services": A century of science and global policies for crop diversity conservation. *Culture, Agriculture, Food and Environment, 38*(2), 72–83.

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources, 30*, 441–473.

Fricker, M. (2007). *Epistemic injustice: Power and the ethics of knowing*. Oxford University Press.

Gherardi, S. (2009). Community of practice or practices of a community. In *The Sage handbook of management learning, education, and development* (pp. 514–530). SAGE.

Godrie, B., Boucher, M., Bissonnette, S., Chaput, P., Flores, J., Dupéré, S., et al. (2020). Epistemic injustices and participatory research: A research agenda at the crossroads of university and community. *Gateways: International Journal of Community Research and Engagement, 13*(1), 1–15.

Handley, K., Sturdy, A., Fincham, R., & Clark, T. (2006). Within and beyond communities of practice: Making sense of learning through participation, identity and practice. *Journal of Management Studies, 43*(3), 641–653.

Jankowski, F., Louafi, S., Kane, N. A., Diol, M., Camara, A. D., Pham, J. L., & Barnaud, A. (2020). From texts to enacting practices: Defining fair and equitable research principles for plant genetic resources in West Africa. *Agriculture and Human Values, 37*, 1083–1094.

Labeyrie, V., Kamau, J. I., Dubois, C., Perrier, X., & Leclerc, C. (2019). So close yet so different: Cultural differences among farmers in Central Kenya affect their knowledge of sorghum (Sorghum bicolor [L.] Moench) landrace identification. *Economic Botany, 73*(2), 265–280.

Labeyrie, V., Antona, M., Baudry, J., Bazile, D., Bodin, Ö., Caillon, S., Louafi, S., & Thomas, M. (2021). Networking agrobiodiversity management to foster biodiversity-based agriculture. A review. *Agronomy for Sustainable Development, 41*(1), 1–15.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Leclerc, C., Mwongera, C., Camberlin, P., & Moron, V. (2014). Cropping system dynamics, climate variability, and seed losses among East African smallholder farmers: A retrospective survey. *Weather, Climate, and Society, 6*(3), 354–370.

Lewicka, M. (2011). Place attachment: How far have we come in the last 40 years? *Journal of Environmental Psychology, 31*(3), 207–230.

Li, L. C., Grimshaw, J. M., Nielsen, C., Judd, M., Coyte, P. C., & Graham, I. D. (2009). Evolution of Wenger's concept of community of practice. *Implementation Science, 4*(1), 1–8.

Louwaars, N. P. (2007). *Seeds of confusion: The impact of policies on seed systems*. Wageningen University. ISBN 9789085047933 – 151.

National Research Council. (1993). *Managing global genetic resources, agricultural crop issues and policies*. National Academy Press.

Nkott, N., & Temple, L. (2021). Le secteur semencier céréalier au Burkina Faso: dépendance de sentier et trajectoires d'évolution depuis 1970. *Economie et institutions* (in press).

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science, 325*(5939), 419–422.

Popa, F., Guillermin, M., & Dedeurwaerdere, T. (2015). A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science. *Futures, 65*, 45–56. S0016328714000391. https://doi.org/10.1016/j.futures.2014.02.002

Stahl, G. (2003). Meaning and interpretation in collaboration. In *Designing for change in networked learning environments* (pp. 523–532). Springer.

Wenger, E., McDermott, R., & Snyder, W. (2001). *Cultivating communities of practice: A guide to managing knowledge*. Harvard Business School Press.

Wilkes, H. G. (1988). Plant genetic resources over ten thousand years: From handful of seed to the crop-specific mega-gene banks. In J. R. Kloppenburg (Ed.), *Seeds and sovereignty: The use and control of plant genetic resources*. Duke University Press.

Woolgar, S., & Lezaun, J. (2013). The wrong bin bag: A turn to ontology in science and technology studies? *Social Studies of Science, 43*(3), 321–340.

Young, O. R., Berkhout, F., Gallopin, G. C., Janssen, M. A., Ostrom, E., & Van der Leeuw, S. (2006). The globalization of socio-ecological systems: An agenda for scientific research. *Global Environmental Change, 16*(3), 304–316.