



How do coffee farmers engage with digital technologies? A capabilities perspective

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Abstract

A reality-design gap in the conceptualization and practice of digital agriculture has been systematically reported in the literature. This condition is favored by the lack of understanding and inclusion of local worldviews around digital technologies. Informed by Amartya Sen's capabilities approach, this study looks to bring stories of local appropriation to the spotlight. Based on a qualitative approach that included data collected through interviews with 73 households, the authors explored the way in which two selected communities of Colombian coffee growers are engaged in the use of digital technologies in material and symbolic ways. Three emergent themes—a relational way of farming, (dis)connected machines, and nurtured families and communities – articulate multiple interactions between farmers, farms, institutional programs, and technologies, that originate local forms of digitalization (and non-digitalization). This study points out the relevant role of situated ideas of development in positioning technologies in or out of the farm, and broader digitalization agendas in or out of farmers' life projects. At the same time, it presents a critique of notions of universality that drive unquestioned quests for technification. In contrast, building on a relational perspective, this study calls for embracing a perspective of multiplicity within notions of development and innovation.

Keywords Digitalization · Capabilities approach · Coffee · Relational agriculture

Introduction

A gap between the perspective of developers and proponents of digital technologies (electronic tools that generate, store, process, transmit, display and use data) and the reality of farming communities has been systematically reported in the social literature on digital agriculture and on Information and Communication Technologies for Development (ICT4D) (Prost et al. 2012; Heeks 2002; Dodson et al. 2013; Contreras-Medina et al. 2020; Rose et al. 2018; Eastwood et al. 2019). Some argue that a common practice in digitalization in agriculture is to embrace a dominant development paradigm that fails to recognize the existence of multiple interpretations of the world, notions of development, and ideas of a desirable future (Beguin et al. 2012; Zheng 2009). Critical views argue that digital agriculture is dominated by a productivist and technocentric perspective of development (Bronson 2018; Bronson and Knezevic 2016; Kuch et al. 2020; Lajoie-O'Malley et al. 2020; Rotz et al. 2019a; Wolf and Wood 1997). This dominance not only contributes to originating practices of scientific inquiry, industrial production, and policy design, that continue the reality-design gaps

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(Rose et al. 2018; Macmillan 2018), it also prevents the recognition of users' preexisting knowledge (Coggins et al. 2022). In fact, on ground digitalization trajectories seldom match mainstream discourses and agendas that are becoming dominant in research, practice, and policy (Forney and Dwiartama 2023).

Even the research under the scope of responsible innovation (see Bronson 2019; Hellström 2003; Owen et al. 2013; Stilgoe et al. 2013), which advocates for a more inclusive approach in the design of digital technologies, tends to narrow down the possibilities to understand alternative perspectives of development, as it is often mainly concerned with identifying the mechanisms to promote the uptake of digital technologies, without much reflecting on what uptake really means for the communities, or whether it is actually their desired development pathway (Kleine et al. 2012; Zheng 2009). In the process of appropriation, the decision to reject a technology is as meaningful as the decision to use it. This conception challenges general assumptions associated with techno-centric perspectives of development. While from a techno-centric perspective, a lack of 'adoption' tends to be interpreted as a problem of access and digital literacy, in practice, the issue is much more complex.

To present an agency-centered perspective on digitalization, the aim of this study is to explore the current ways in which two selected coffee growers' communities nestled in the mountains of Colombia are engaged in the use of digital technologies in material and symbolic ways. Namely, the position that these technologies have in their imaginary. The study particularly aims to understand how these technologies are integrated into the farming practices and life strategies of these communities. It recognizes local perspectives of development as powerful drivers of technological appropriation. By doing this, we look to move local stories of digitalization from the fringe to the center in critical debates around digital agriculture.

The relevance of this lies in an existing gap in the way the analysis of rural digitalization has been approached. In contrast with "spotlight digitalization" (Forney and Dwiartama 2023), and the diffusion of technologies (particularly from a linear perspective), the forms in which local communities are already engaged in the use of these technologies in their own terms are continuously neglected (Rose et al. 2018, 2016; van Delden et al. 2011; Rose and Chilvers 2018). For this reason, the examination of unfolding local interactions with digital technologies outside the frame of particular developmental interventions or deployments of specific digital tools remains a blind spot (Rose and Chilvers 2018; Rose et al. 2018). This paper looks to contribute to the literature by analyzing one of these highly contextual processes of digitalization and linking it with broader narratives of digitalization. We look to provide evidence on the way local processes of digitalization unfold in unique

forms, potentially divergent from these broader narratives and digitalization agendas. This is conducted through the articulation of the different ideas of development that farmers and proponents of digital agriculture can hold, pointing out the negotiations and tensions that occur in the space of interaction.

Emerging social research that examines processes of cultural appropriation and perceptions towards digital technologies in agriculture has predominantly centered around the Global North (Klerkx and Rose 2010; Rose et al. 2018), and in industrial farming contexts (Bronson 2019). For this reason, there is a pressing need to overcome geographical and cultural bias in research about digital presences in rural spaces (Cieslik et al. 2018; Mann 2018; Sulaiman et al. 2012; Ash et al. 2018). Building on emerging contributions such as Dwiartama's work in Indonesia (Forney and Dwiartama 2023), and Abdulai's work in Sub-Saharan Africa (Abdulai 2022), we look to contribute to the body of literature centered in the Global South with a local analysis of digitalization in the smallholder family-type farms setting in Colombia.

For the analysis, we adopted a human-centered approach based on Sens' capabilities framework (1999). Under this framework, resources only become assets when they can be used by individuals to accomplish the life they value. This idea opens the possibility to explore multiple development perspectives. Through this conceptualization, we focused our analysis on the opportunity for people to use technologies to achieve their own particular goals, rather than on how technologies fulfill aspirations of dogmatic notions of development (those that compare development with economic growth or modernization). Thus, we were concerned to first understand what elements configure a valuable life for these communities, and next, how they use digital technologies to support the accomplishment of this life. Following a relational perspective (Higgins 2006; Darnhofer 2020; Forney and Dwiartama 2023), we conceive that farmer's agency in this process of appropriation is shaped by occurring interactions between knowledge, value systems, social institutions, and the agency of non-humans (land, plants, animals, technologies), in the search for integrating technologies into the life they find valuable.

The paper is structured as follows. The section below reviews the capabilities approach and its application in explorations of the appropriation of digital technologies. Subsequently the research methods adopted for this study are presented. The next section describes the findings of the study, which are organized around three themes that emerged from the data: a relational way of farming; (dis) connected machines; nurtured families and communities. These themes articulate the different social and material interactions that shape local engagement with digital technologies. Local values that underpin this process are also

contrasted with those expressed in dominant narratives of digital agriculture. Thereafter, the findings are discussed in relation to existing literature on rural local ontologies and the appropriation of digital technologies for agriculture. We conclude by summarizing the main findings, and suggesting relevant epistemological considerations to study the role of digital technologies in the lives of farmers, their families, and their communities, highlighting the evidence that shows that rurality is a world of many worlds.

Capabilities approach, agency, and farmers' interactions with technologies

Sen (1999) defines development as the freedom that people have, to live the lives that they value. In contrast to more orthodox notions that make development a convention comparable to economic growth, this perspective focuses on the expansion of people's agency to pursue their own goals in life as the basis for human development (Kleine et al. 2012; Zheng et al. 2018; Jiménez and Zheng 2018; Poveda and Roberts 2018). Development goals, consequently, are not fixed but contextual and multifaceted. Financial resources and production can be inputs to build development as much as the protection of freedom, political participation, socio-cultural practices, norms and traditions, or the provision of public goods (Crocker and Robeyns 2012).

Central to Sen's conceptualization of development are the concepts of functionings and capabilities (Kleine et al. 2012). Functionings refers to the various things a person can value doing or being in life, while capabilities are the functionings that a person can actually achieve (Sen 1999). According to this approach, the ends of well-being and development should be assessed in terms of people's capabilities and choice, that is, their effective opportunities to be who they want to be, and the possibility to choose from these opportunities, the options they value most (Crocker and Robeyns 2012). In the process of articulating his capabilities approach, Sen (1985) described that the freedom to undertake the actions and engage in the activities that lead to a state of existence associated with well-being is what makes life valuable. Following the work of Sen, Carolan (2018) expressed that goods, services, and rights have no intrinsic value; it is the possibility of using these resources to produce valued outcomes that transforms them into assets.

Building on this perspective, technologies can be considered assets if they can be used to obtain meaningful goals in life, if chosen to do so, resulting in the expansion of human capabilities. The idea that technologies can be perceived as "enablers to the pre-existing capabilities of human beings" (Banerjee 2013 p. 79) aligns with this value of technologies as a tool for the expansion of human-development. A consequence of this idea is the transition from a technological to a

human-centered perspective in technology studies (Madon 2004). Following the capabilities approach, in this work we place farmer's agency at the center, rather than the technical possibilities of the technologies. This approach requires paying special attention to the motivations that drive a person's actions, and their adaptive preferences (Peter 2003). It also involves understanding technological appropriation as an active process of selecting, rejecting, and adapting, in the search of living a valuable life. Agency can be exercised individually and collectively, and does not always mean pursuing one's own self-regarding goals. It can also involve helping other's to achieve their goals or forming associations to pursue common goals (Crocker and Robeyns 2012). This idea of technological appropriation highlights the agency of farmers in constructing technologies, echoing Sen's proposition that individuals and groups themselves should shape their own destiny, and be active participants in change, rather than passive recipients of assistance (Sen 1999). This understanding links the capabilities approach with the idea that technologies are socially constructed (Bijker 1995; Hughes 1987; Orlikowski 1992).

Farmers are rarely passive participants in farm innovation (adopters), but rather transformation agents through resistance and negotiation with other human (e.g. peers, developers, promoters, practitioners) and non-human agents (e.g. plants, animals, machines, computer programs). Simultaneously, technologies contribute to reshaping the social context within the farms. Cash et al. (2006) argue that "new technologies are not adopted as if they were ready-to-wear fashion but rather sewn, in bits and pieces, into the fabric of the users' social setting and existing practices" (p. 474). Accordingly, the meaning of a technical artifact is not only the result of design, but is also given through the process of interaction with the technology (Pirnejad and Bal 2011). Thus, the meaning and performative role of technologies can not only change over time but can also be different for different actors (Sterne 2003).

Capabilities and personal agency, however, are not solely the result of the intrinsic capacities of the individual (Crocker 2008), but rather are entitlements made possible or constrained "by the social, political and economic opportunities available to us" (Sen 1999 p. xi-xii). The set of these opportunities is described by Alsop and Heinsohn (2005) as the 'opportunity structure', which is the constellation of "psychological, informational, organizational, material, social, financial and human assets" (p. 8) that a person has at hand to make meaningful choices. The opportunity structure is determined by both formal and informal institutions, such as laws, social norms and customs, which ultimately result in varying levels of empowerment (Kleine et al. 2012). Social structures, including policy-making, industry, markets, and scientific production, the assemblages of these structures, along with the institutions that they generate, play a crucial

role in driving socio-technical pathways – both those that are allowed and those that are not (Klerkx and Rose 2020; Pigford et al. 2018), through the technical projects and the imaginary supporting those projects (Gidley 2017). On the other hand, technology itself is an important component of the opportunity structure. First, it influences people's behavior and has the capacity to shape political systems and social relations that distribute power and authority (Winner 1980). Second, as previously described, technologies can be used as assets to achieve a valuable life.

The agency of farmers is not absolute, as it is constantly shaped by material relationships established with technological and biophysical entities and contexts. It is well known that farmers continuously have to 'negotiate' with and work around uncontrollable weather, unruly plants, diseases, breakable machines, and financial constraints (Darnhofer 2020). Complex biophysical settings, for example, have been recognized as challenging scenarios for processes of industrial transformation of agriculture (Goodman et al. 1987), a relationship that favored processes of agricultural homogenization for the sake of industrialization. On the other hand, agricultural landscapes are also a product of cultural forces. Therefore, biophysical arrangements are also shaped by farmers' values and goals, and their quest for a valuable life. The concept of 'tinkering' as it is used by Higgins et al. (2017), is useful to understand the operation of agency in technological appropriation on farms. They describe tinkering as a process of 'negotiation, work, and work around' technologies in response to technical and biophysical constraints. However, it is also about using the affordances of these technologies to care for their farms. We argue that this process is heavily influenced by cultural relations, given that tinkering is an interpretation and adaptation (physical and symbolic) of technologies by farmers, to align with local farming practices and identities.

Technical attributes of technologies have a significant impact in the possibilities they afford to farmers, how they are used, and the operational requirements. Therefore, these attributes also shape the agency of farmers. In the context of digitalization, asymmetrical access to connectivity, energy sources, equipment and devices, and information, which has strong rural dimensions (Pfeizer et al. 2020), favor processes of hierarchization and exclusion, commonly referred to as the 'digital gap'. This refers the gap between the technological haves and have nots (Rama and Wilkinson 2023). On the other hand, interactions with non-human agents also shape farmer's agency and their interactions with technologies (Higgins 2006). Relational approaches in rural sociology call for understanding farms as entities with agency and affectivity (Darnhofer 2020). These attributes influence the way farmers engage with technologies responding to the agency of the farm. Recognizing these properties in the farm and its different elements allows the understanding

that agricultural technologies, when interacting with plants, animals, and the land (which they permanently do), are not simply 'governing' passive entities, but establishing relationships with agents with affective and decision capacity. Moreover, the process of digitalization is reframing notions of agency in rural studies. Algorithms, smart devices, and automated machines, act in material and regulative ways in the cyber, physical, and social spheres, affecting the agency of human and other non-human agents (Lioutas et al. 2019; Rijswijk et al. 2021).

To summarize, we argue that using the capabilities approach to explore social interactions with digital technologies presents the next conceptual implications in our analysis. First, through the concept of 'functionings', it is recognized the coexistence of multiple ideas of personal and collective development, and correspondingly, multiple development pathways. Second, this approach integrates the idea that technologies are socially constructed, acknowledging the active role of farmers in innovation through processes of selection, adaptation, appropriation, and rejection in their quest to live the life they value. Third, the concept of 'opportunity structure' allows to explore the ways in which social structures and the institutions they do or do not engender, and material relationships between humans and non-humans, enable, constrain, and mold farmers' interaction with digital technologies. In other words, the notion of 'opportunity structure' implies that agency is co-constructed.

Methods

Context of the study

This study examines the relationship between digital technologies and two coffee-growing communities in Colombia, analyzing their current material and symbolic interactions. For this examination, we followed a human-centered approach, informed by Sen's capabilities approach.

The first community is located in the northern part of Colombia, in the Sierra Nevada de Santa Marta mountain range, which is the highest coastal mountain range in the world. It is also one of the geographical indications (GI) for Colombian coffee (national system), and was awarded the Protected Designation of Origin (POD)¹ in 2017 (European

¹ Geographical indications (GIs) are names given to products that present unique qualities associated with their area of origin. The Protected Designation of Origin (PDO) is a form of regulation that certifies that i) a product is originated in a defined area, ii) that its qualities are defined by the geographical environment with its inherent natural and human factors, and iii) that the production and processing take place in the defined geographical area (European Commission 1992).

Fig. 1 Location of the areas of study

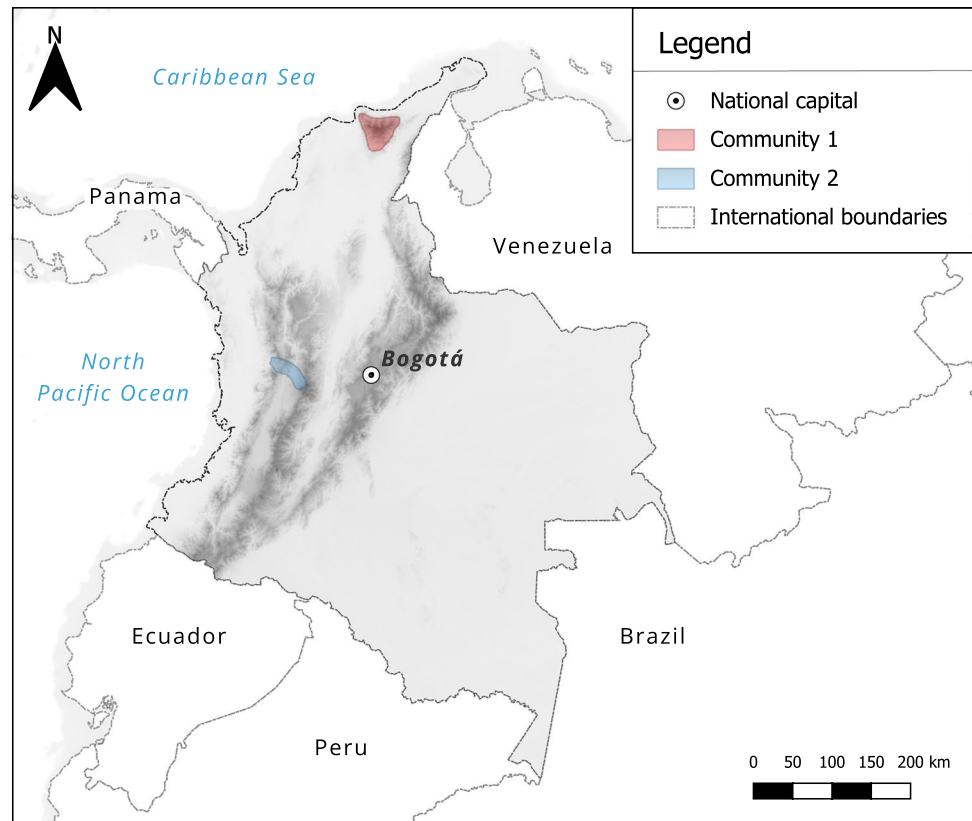


Table 1 Geographical and agricultural characteristics of the sample included in this study

Community	Region	Municipalities	Production model	Average farm area (Ha)	Hired labor	Altitude above sea level
Sierra Nevada de Santa Marta	Caribbean	Santa Marta Aracataca	Organic	5	Yes	1300—1900
Cetral-Western Andes	Andean	Santa Rosa de Cabal Concordia Betulia	Conventional	16	Yes	

system). The second community is located in the central-western region of the Colombian Andes, in one of the regions with the greatest tradition of coffee production in the country (Fig. 1). Both communities share characteristics of the UNESCO World Heritage site named the 'Coffee Cultural Landscape' (Muñiz 2016), a designation that encompasses a combination of agroecological conditions, socio-economic processes and cultural identity, all built around coffee production. Some of the representative elements of this cultural landscape present in the communities of this study, as well as in other coffee-growing communities in Colombia, are characterized by the dominance of Arabica coffee plantations in a mountainous terrain. The production is dispersed and carried out predominantly by smallholder growers living in isolated areas with limited infrastructure.

The two communities also have a long farming tradition, a wealth of experiential knowledge, and a strong shared cultural identity. While there is high participation in farmer's cooperatives, the family acts as the central unit of social organization, around which, life strategies and decisions are coordinated. Table 1 presents some geographical and agricultural characteristics of the sample included in this study.

Not only in the study areas but throughout the country, the institutional framework for technological transfer in the coffee sector is represented by the Federación Nacional de Cafeteros (FNC). This federated organization is the central authority involved in policy making, research, extension, and trade in the Colombian coffee sector. It has even been delegated by the national government to regulate the industry. Historically the FNC has played a key role in processes of

Table 2 Number of interviews conducted in each selected community

Community	Role	Number	Average age	Average experience with coffee (years)
Sierra Nevada de Santa Marta	Farmer (F)	22	52	30
	Partner (P)	-	-	
	Children (C)	3	22	
Cetral-Western Andes	Farmer (F)	36	50	35
	Partner (P)	8	57	
	Children (C)	4	19	

innovation. For example, it has set technical guidelines for agricultural practices (De La Hoz Montes et al. 2019; Guerrero et al. 2017), implemented the national genetic program to develop new coffee varieties (Alvarado-Alvarado et al. 2005), promoted technological packages related to industrialized production (monocultures with synthetic inputs) (Camargo and Espitia 2016), mechanization and technification of production and processing and more recently encouraged a shift towards production oriented to specialized markets linked to quality and sustainability standards (Dietz et al. 2019). On occasions, pushing these transformations by exerting its influential position over farmers (Sanabria-Gómez and Caro-Moreno 2020). The FNC has also ventured into the field of digitalization, with initiatives such as a smart card for the identification of coffee growers and for monetary transfers (Marín-Torres 2008) and delivering tablets to access digital content related to coffee production (Zapata and Marín 2015). According to Zapata and Marín (2015), in 2010, 700 of these tablets were delivered in the same region where community 2 is located; however, during this study there was no evidence of their use or that this program was known by the farmers.

Data collection and analysis

The data collection took place between December 2021 and January 2022. Two of the authors had previous access to the coffee grower communities. One of the authors already had research experience with one of the communities (See Quiñones-Ruiz 2021). The research plan was presented to representatives of both communities who expressed their interest and consent to participate in the research.

Data were collected through semi-structured interviews. The interviews were conducted at the household level, meaning that, in addition to farmers themselves (F), other family members, such as the farmers' partners (P), and the children (C), voluntarily participated in the interviews. We made this decision paying attention to the central role of family in the coffee farms and following the idea that decision making on the farm is a process of deliberation between various family members (Darnhofer 2020). In total 73 household interviews were conducted (Table 2). All participants were informed of

privacy and ethics practices, and their informed consent to participate in the research was secured.

Access to the interviewees was obtained through three different strategies. The first strategy consisted of conducting interviews directly on the farms. The second strategy involved conducting interviews in meetings organized by the coffee producers' organizations. A total of three such meetings were attended in the Sierra Nevada de Santa Marta area. No meetings took place while the researchers were in the community of the Andes. The third strategy involved interviewing farmers on the spot when they went to sell their dry parchment coffee to the buying points. A total of five of these sessions were carried out (three in the community of the Andes, two in the community of the Sierra Nevada de Santa Marta). The interviews lasted between 35 and 90 min each time and covered the current use and perceptions of everyday digital technologies such as mobile phones, smartphones, computers, tablets, and other technologies closely associated with digital agriculture such as drones and robots. The questions focused on the role of these technologies in everyday practices, the main goals, aspirations and challenges of the household, and how the role of these technologies is understood in relation to these aspects- They also covered general attitudes towards these technologies, including elements of trust in the devices and the information, and perceived benefits and risks derived from their use.

Interviews were digitally voice recorded and subsequently transcribed in the original language (Spanish). Manifest and latent content analysis of the interview transcripts were conducted using inductive coding (Charmaz 2006) to identify emerging themes. These themes helped to uncover patterns of use, underlying perceptions, and the association of technologies with the life interviewees value. The themes emerged from the reported uses and perceptions addressed in the interviews.

Results

From the interviews three different themes emerged that articulate the uses and perceptions of digital technologies by these communities of coffee farmers. These themes will

be identified here as *a relational way of farming, (dis)connected machines, and nurtured families and communities.*

A relational way of farming

Respondents' descriptions of work and life on the farms largely speak about the practice of a relational way of farming. Labor is described as a process of reciprocal, non-hierarchical, relationships with the different elements of the farm, such as soil, water, plants, and animals. The relational way of farming, as described by the interviewees, also highlight the importance of social relationships with family, workers, and peers, which is further explored in the third theme. According to the respondents, the reciprocal relationship with the farm is what allows them to learn from direct experience with the land and achieve their goals through processes of dialogue and 'negotiation'. This is reflected in the way they describe their experience of farming.

The land has taught me a lot, when you are in the plot, walking through the trees, talking to the trees, looking at the tree, you begin to merge with it, and then we become friends (F5).

This farm is an example of sustainability, she² remains beautiful in good times in bad times, you have to keep her in good shape because she must respond with production (F6).

It is described that direct experience with the land is essential for being a 'good' farmer and an important component to build a sense of identity and pride. Some interviewees expressed that digital technologies do not occupy a relevant place in farming practice; on the contrary, they are generally perceived as sources of interference with the direct relationships that underpin and signify the experience of being a farmer. Technologies with which they are familiar, such as cellphones, smartphones, computers, and tablets, are perceived to belong to a different sphere than farming practice, incompatible and non-applicable in the fieldwork. Consequently, they are not perceived as relevant components of their opportunity structure for farming. The interaction with these technologies is downgraded, while "hands-on" work occupies a central position. Experiential knowledge and the associated ability to interpret the components of the farm themselves and make decisions autonomously are essential functionalities, being relevant sources of self-confidence and pride.

Here (showing a cell phone) I look for calls and make calls. It's just that I haven't started to explore it either. It

is that I am very ignorant, although, for example, what do you (referring to the interviewer) know about cultivation? One was born in this (the plantation), one knows from sowing the seed to make it to produce (F21).

My job is not on the computer, my job is simply field manager, and the field is not managed with a computer (F27).

Technical attributes of smartphones, computers, and tablets, also play a role in the way the interviewees position these technologies on the farm. In general, they are perceived as fragile devices, not compatible with harsh and uncontrollable fieldwork conditions. Farmer 17 describes this perception in the following way:

A smartphone is very good, but is very fragile, and you are very dedicated to the work, smeared with so many things. What is one going to do with it? So, one doesn't use it, one working cannot use that (F17)

An antagonistic relationship is not only described in terms of the device's inability to withstand common farming conditions, such as water, dirt and falls.³ It is also associated with the idea that, farmers themselves, precisely because of being exposed to those harsh working conditions during their life, do not fit with the operation of these 'fragile' devices. In other words, farmers are 'made' for work in the field; digital technologies are not.

What happens is that I am very manual at work. I keep my hands very stiff due to rustic and manual work, so the digitization is not so fast for me, I am trained for something else, I have very heavy hands (F6).

Contact with the land is also a fundamental component of rural identity, providing a sense of enjoyment in working and living on the farm. "Feel good," "like," and "enjoy" are expressions that appeared recurrently when interviewees narrate their work and life on the farm, expressing a correspondence with their functionalities. This does not mean that rural work and life is considered free of difficulties, but it reflects the existence of fundamental values and benefits (more often intangible) in this life. As expressed by Partner 2: "Despite the difficulties we like it, we like the farm, we like the coffee. From the farm, one gets what one needs."

Interviewees continuously contrast values of rural life, such as freedom, tranquility, abundance, and more natural and healthier environment, with contrasting conditions of living in the cities, such as traffic, stress, insecurity, high living costs, or noise. This distinction helps to signify the value of living and working on the farm, linking this lifestyle with positive feelings. These conceptions have different

² Farm in Spanish language, the mother tongue of the interviewees, is female.

³ Mobile phones are considered more resistant and therefore more compatible with field work, at difference with smartphones, it is more common to bring these devices to the plots.

consequences on the way these communities perceive and use digital technologies. Occasionally, these technologies were associated with urban life and the loss of contact with nature. In the words of Partner 6: “In my time, we did not have internet, and well, I think that everything was better. We had the childhood of being up in trees picking mangoes.” For some other respondents, digital technologies can actually fit into the experience of living and having contact with the farm. These situations are prone to trigger engagement with technologies such as smartphones and tablets since the interviewees acknowledge an alignment between these technologies and elements of a valuable life. Farmer 7 described his experience with these technologies as follows: “I like having a good smartphone because of the pictures. I take videos and pictures; they are very beautiful.” When asked about the videos and pictures he takes, he proceeded to explain “everything, different pictures and videos, I can take a picture of a tree, a coffee plant, a machine, a person, myself, in the house, everything.” In this case, a smartphone, serves as a tool for documenting evoking both living and inanimate elements of the farm, as well as facilitating a meaningful connection with these elements. Thanks to this affordance, it becomes an integral part of their opportunity structure.

The capabilities approach contributed to identifying a set of values associated with working and living on farms. These are underpinned by a relational ontology. In turn, these values contribute to locating digital technologies both on and off the farm.

(Dis)connected machines

Interviewees were asked to describe their perceptions of emerging technologies such as drones and robots and were invited to reflect on the role of these technologies in agriculture. The intention was not to compare them to technologies like mobile phones, smartphones, tablets or computers, as they belong to different categories. Although the respondents had not physically interacted with these technologies, they all indicated having an idea about them, and symbolically positioned them in the farm, farming practice, and community. During the interviews, it became evident that two key elements influenced the interviewees’ conceptions of these technologies. First, elements of science fiction, especially the representations in cinema -where robots are predominantly portrayed as a threat to humanity-. Second, a pilot project for the mechanization of coffee harvest in Colombia, carried out by the FNC as part of their broader innovation program. These elements intertwined with the ontology of the relational way of farming, have resulted in particular perceptions and attitudes towards these technologies.

From “wonderful” to “scary,” the interviewees expressed different ideas about robots and their role in the practice of agriculture. Regarding the mentioned pilot implemented by the FNC, the proposed technology consisted of a handheld brushcutter-like machine that made the coffee fruits fall to the ground by means of vibration applied to the branches of the trees. Due to a lack of distinction between green and ripe fruits, and the steep slopes of the plots that caused the fruits to roll downhill, this technology did not produce the expected results. However, the project was widely disseminated, appearing in national news (Noticias Caracol 2018), and on the FNC's social networks (FNC 2020). The process constitutes a clear case of a reality-design gap, linking institutional, technical, and biophysical elements, and resulting in lasting consequences on the attitudes of these communities towards mechanization and automation. Most interviewees referred to this pilot and its lack of effectiveness when describing their own ideas about the opportunities of emerging technologies in coffee production. In this way, a process of innovation emerged from the institutionality contributed strongly to develop generalized distrust towards the ability of robots to work on the farms. On the other hand, some respondents expressed seeing robots as a promising opportunity. The following quotes illustrate these contrasting conceptions:

I kind of still don't believe in that, because the robot, well, it would be an important thing like in an office. They (the FNC) brought a harvesting machine here and that didn't work, that machine didn't work (F53). How nice it would be to place a fungicide can on a robot, and with that spray the coffee. If that existed to spray the coffee from the air, that would greatly help to avoid carrying the sprayer and having contact with the fungicide (F13).

From the interviews two orders of incompatibility between robots and coffee production surfaced. Contributing to raise the skepticism in these technologies. The first order is located within a symbolic-technical relation, expressed in a perceived mismatch between the skills needed to be a good coffee grower (harvester to be more precise) and the agentic (in)capacity of the robots. The second order can be described as a perceived incompatibility between machines and nature.

For most interviewees, producing coffee requires a particular 'know-how.' That is, particular skills, meticulousness, and sensitivity, even “passion” or “love” as some respondents expressed. It also requires the ability to adapt to different contexts and to act effectively in conditions of high complexity and variability. For the interviewees, these abilities cannot be developed by robots because they are associated with experiential knowledge obtained through several years of work, and some capacities inherent to the human condition such as empathy, instincts and sensitivity. It was

described how the value of coffee is given by the dedicated work of human beings, and attributes of the quality of coffee were associated with a handcraft process. It is perceived that the introduction of machines would affect the quality and in general would be against the philosophy behind producing a 'good' coffee; a component of the relational way of farming and driver of their functionings around working and living on the farm.

Coffee is so artisanal and it should be so artisanal. Obviously, you must create conditions for the work not to be so difficult, but I think that so much technology could really affect the coffee process, because if you know about coffee, you know that in such dedicated selection, in such dedicated washing, there is a good cup of coffee. So, it would really be a bit mechanized, doing it with robotics or so much technological tools, could lose that quality (C7).

An established interaction between the biophysical characteristics of the farm and the technical attributes of robots also contributed to attitudes of mistrust in the capacity of these machines. Interviewees stated it clearly: robots are not suitable for working on the mountainous terrain that characterizes the coffee plots.

It is a risk (that a harvesting robot) loses control in the coffee plot and damages it, or that it rolls over and falls on a person (F22).

The farm as a whole, along with its various biotic and abiotic elements, are endowed with sentient capacity by practitioners of relational farming. Fundamental elements of this conception, such as empathizing and caring, contribute, in turn, to defining certain positions towards robots and their place in the farm. For several respondents, the presence of robots can be detrimental to the farming experience by disturbing the natural environment where the practice of farming takes place. Some interviewees pointed out that robots and machines in general are not only incompatible with nature but can also do harm or reduce its well-being.

Mechanize the coffee system? No. Coffee is a domestic animal that requires love, and this can be in person only. I don't see it, because the plant is stressed and if the plant is mistreated, production and quality will drop. For example, machines produce noise, I believe that vegetable matter is incompatible with noise, the wild system is better. To add a strange element to live with them, such as mechanization, I don't think it's favorable. Let's look at the plants on the farm, I can show you an example, you cannot compare this banana plant with any other in the farm, and this is not because it has a special treatment, the same, but it has better foliage, better bunches. It was planted next

to my office, what can we observe? The plants that are participating in community life realize what it means to live in a community, and give a better response. So look, we're not telling lies, we're talking about facts. So one says, well, could it be that if we mechanize, we add noise, we mistreat the plants mechanizing them, will we have better quality or better well-being? No (F34).

A relational way of farming creates connections with the land. However, more commonly, there are perceived disconnections with digital technologies. In these interactions, the technical attributes of mobile phones, smartphones, tablets, computers, drones, and robots, and their relationship with biophysical contexts and their agentic capacity shape these positions. This does not mean that these technologies cannot find a place within these agricultural communities. From a capabilities lens, when these technologies are paired with the elements that these communities consider valuable in life, perceptions and appropriation take a different form. This is represented in the third theme.

Nurtured families and communities

Exploring the elements that farmers find valuable in life revealed the centrality of family. The main goals are to ensure that the family remains together, promote collaboration between its members, progress and thrive, and take care of the home, including maintaining and improving the physical spaces where they live.

The small farm is the most solid, 2 to 3 hectares are solid because you involve your work, your time, part of the family labor, and you can generate a good standard of living because everyone works for the family group (F6).

Technologies such as mobile phones and smartphones have become important tools for communication and for maintaining connections between family members. These technologies are deeply integrated into people's routines and life strategies. Consequently, significant economic resources are allocated to access these devices and grant connectivity, despite the economic burden that this represents. Time is also invested in carrying out autonomous learning processes. If digital technologies do not have a material and symbolic place in the plots, they do occupy a relevant place on farms, within homes and in family life.

Well, to me, they are very good (digital technologies), it also depends on knowing how to use them, but it is very good, because if one realizes it, you are not with your family, but the way you communicate, it is as if you were with them (P4).

When I need something, I call. I found it difficult, complicated, as I tell you, one is not used to these kinds of devices, but the saying goes that nothing is difficult.

The children, one has the children to help them, what one wants is to have these technologies to have communication with them (F48).

A fundamental element behind the ideas of progress and thriving is facilitating children's access to education. Paradoxically, although the respondents recognize the values of rural life and the practice of agriculture, they simultaneously act in a permanent search to provide their children with education that will help them migrate and find work in the cities. Associated with this quest is the perception of an uncertain future of agriculture, the experience of burdensome working conditions, and high levels of economic vulnerability. Furthermore, the increased access to education in recent times, and the influence of Western ideals of modernity -which equate progress with professionalization, job acquisition, and leaving the countryside to live in the city- have also shaped the desire of different sets of functionings for their children.

She (the daughter) loves the countryside, but she also wants to improve herself, she thinks a lot about her daughter, she should look for the city, for the study that she deserves, where she can have training, and truly, if I find the way to set up a business for her in the city, I will try to set it up (F37).

Prevalent connectivity limitations and economic constraints strongly hinder the use of digital technologies on farms, affecting the opportunity structure of these communities and reflecting an important digital gap. However, households also showed strategies to access and use these technologies when the goal is the education of their children. This is evidence that when technologies align with people's valuable things in life (e.g. education for the children), these technologies acquire a special meaning. This situation promotes processes of technological appropriation. The following quote, shared by Farmer 42, exemplifies this relationship: "I want my daughters to progress, allow them to study, so that they can defend themselves. That's the best inheritance. Each one has a computer; I bought it for them." They also work around these constraints when using mobile phones and smartphones for communication: "Here the signal is very bad, my children have to walk up there to look for a signal (H2)."

The opportunities to work around the constraints are not available for everyone, which restricts the use of smartphones and computers on farms. There is a continuous struggle to overcome problems of connectivity and the cost of technologies; however, this cannot always be achieved. Moreover, interviewees showed a lack of motivation to work around these constraints if the use of these technologies is not prioritized in their life strategies.

We spent two, three days without a cellphone signal... internet, well no. If one is going to acquire it, it is at a very high cost (P1).

We need an antenna and on the other hand we have to think about something satellite, but it always generates costs, so sometimes other priority things that we have to choose one, but connectivity is always difficult here, for that reason one doesn't have a laptop (F49).

In the context of nurturing the family sphere, the interaction with digital technologies is not always perceived as a positive element. Some respondents expressed concerns about the excessive amount of time that people spend on the internet (especially, but not exclusively, younger generations), addictive conduct, and the way this process can erode family relationships. These elements of excessive use and addictive behavior that are commonly associated with urban life, also shape interactions with these technologies in rural households.⁴

Family things are coming to an end, because here, people who live in the town visit me and they are glued to the internet all the time, and we are at lunch and the young people do not pay attention. Even people, they are with the cell phone all the time. I think we are becoming very addicted to cell phones. I include myself. I have a lot of work, I feed workers and I use a wood stove, everything is more complicated, but the little time I have left, I am with the cell phone in my hand (P6).

Beyond the family sphere, households are immersed in the community, and maintaining this connection is another fundamental goal for the interviewees. Being part of the community and participating in the maintenance of the social fabric contributes to well-being and are important components of the life strategies to adapt and prosper in the rural ambit where the conditions of isolation, vulnerability, and the construction of social identity, define strong relationships of interdependence. This dynamic influences the way these communities use and perceive digital technologies. On the one hand, communication technologies are considered relevant tools for social cohesion and cooperation at the community level (collective functionings). On the other hand, robots as part of the process of agricultural mechanization and automation, are perceived as

⁴ Despite a clear separation between the rural and urban worlds, there is a continuous flow of materials, information, labor and capital between them. This exchange contributes to shaping cultural processes of transformation with elements of syncretism and the rescription of social values and conducts. According to Gibson et al. (2013), households are "permeable" to different sorts of influences through these different flows that occur through "porous boundaries."

a peril for labor relations and the regional economy. The following quotes portray these interactions:

I'm in a group of coffee growers on WhatsApp, associates are there, a large group. Any information, that a thief stole a chainsaw and that he is in such place, and there everyone seeks him, and locate him in less than nothing, that is a great advantage, or a meeting that is going to take place in such a day, then it's important. That group was created by us coffee growers (F37).

Well no, robots no. For me it shouldn't be, since coffee support too many families, and if there were that, totally, there would be more poor people, then for me it would not be a good idea, we would not use it on the farm (F38).

Interviewees perceive that robots have the potential for producing economic and social benefits. On occasions, robots were associated with higher productivity, reduced labor costs, and the simplification of farm management. However, generally, these benefits do not outweigh the social risks associated with the loss of rural jobs. For this reason, robots tend to elicit more serious concerns than optimism.

I would not like to have machines here replacing the workers because there are many people who depend on the work, robots can harvest more, but that robot does not receive a salary, so the people who live from this, what do we do with them, or what reaction will they take? For me it's not viable (F27).

If a robot comes here, there will be no work for the harvesters. It does not look good to me, I would not use it, even if the benefit for me was greater. For what I am going to pay 20 workers, perhaps one of those robots can make it, it would be better, but there are also people who are left without livelihood, is not good (F40).

Some positive opinions, related to economic rationality, were also expressed, although to a much lesser extent. The next opinion from Farmer 1 exemplifies this: "Look, spraying with drones is coming. I wish I could afford to rent that or have one of those... I like it, because since one can save labor, costs drop." This heterogeneity within the communities adds another layer and scale to the notion of multiple coexisting views and the associated forms of socio-technical interaction. We found evidence of the diversity of elements that can be considered valuable by farmers and their families, and how different functionings coexist, opening opportunities for different forms of appropriation and opportunity structure configurations. What is apparent is that technologies such as robots and drones have not achieved a level of diffusion to spark discussions between supporters and detractors in the selected group of interviewees.

Discussion

The themes of *relational way of farming*, *(dis)connected machines*, and *nurtured families and communities* articulate the multiple situated social, technical, and biophysical relationships that shape material and symbolic interactions between the communities in the study and digital technologies. These interactions are highly contextual and rise local appropriation pathways that differ from dominant imaginaries and discourses surrounding digital agriculture and its different representations (Agriculture 4.0, smart agriculture, precision agriculture). Overlooking these local interactions and their outcomes is an important source of reality-design gaps in digitalization.

Broad imaginaries of digital agriculture are often framed outside of situated cultural and material contexts. In some cases, it emerges from non-existent rural worlds or non-rural worlds, and not necessarily informed by experience. This creates a fundamental difference from farming, and poses a challenge for integrating into development pathways of local communities, the socio-technical projects steered by these imaginaries. Farming, as described in the literature (Carolan 2016; Gosnell et al. 2019; Higgins et al. 2017; Layman and Civita 2022; Darnhofer 2020) and evidenced in this study, is a relational process. To exercise their agency, farmers continuously navigate throughout institutional, technical and biophysical contexts, entities, and the network of interactions between these elements. Everything in the quest for living the life they consider valuable. In this navigation, which can also be described as the negotiation between coalitions of different agencies (McFarlane 2011), technologies have different positions in farmers' opportunity structure, depending on the possibility and choice of using -or not using- them to achieve their functionings. Contrasting with the apparent stability that characterizes mainstream socio-technical projects (Forney and Dwiartama 2023), local interactions with technologies result from what Latour (2005) described as localized and short-lived associations of human and non-human actors. This nature of associations is established between farmers, farms, and machines, to build the form of digitalization evidenced in this study. It is the "everyday digitalization," which differs greatly from the big narratives or "spotlight digitalization" (Forney and Dwiartama 2023). We contend the co-occurrence of an 'everyday non-digitalization' resulting from the tension between these contrasting visions.

The functionings described by the communities in this study account for components that, at times complement, and in some cases challenge, rational-capitalist logics commonly associated with mainstream digitalization imaginaries and projects (Bronson 2019; Hütten

2019; Rotz et al. 2019b; Birch et al. 2020). For the communities in this study, capital and production are valued components of their functionings (it is not necessary to romanticize them). However, non-economic values such as autonomy, care for the land, and cohesive families and communities, largely contribute to a valuable life. Individualism and competency (common elements in capitalism), share the space with collective goals and a sense of interdependence (a nurtured family, a nurtured community). These values of individualism and competition are generally associated by those interviewed, with urban life. Highlighting that mainstream digital agriculture, when neglecting non-economic and intangible goals, could be designed to better represent urban-corporate imaginaries, or rational-capitalist forms of agriculture.

While visions of agriculture, strongly influenced by techno-centric and productivist perspectives, describe farms as places where people do not need and do not want to be (Baur and Iles 2023), the communities of coffee growers in this study conceive farms as places where they need and they want to be (what they wish for their children can differ). Moreover, responding to the ideas of 'good' farming—that include experience, instincts, and empathy—farms were recurrently imagined as places where technologies such as robots and harvesting machines cannot and should not be. Therefore, while influential agri-tech corporations tend to imagine peopleless landscapes populated by smart machines and artifacts that liberate farmers from the 'burden' of agricultural labor (Bronson 2018; Baur and Iles 2023), the respondents in this study are precisely afraid of this scenario. Similar perceptions have already been described in rural sociology. It has been reported that farmers are skeptical about robots having the capacity to interpret the elements of the farm as a good farmer can, to provide contextualized information, or the necessary ethics and “touch” to treat plants and animals properly (Kaler and Ruston 2019; Rose et al. 2018). Layman and Civita (2022), for example, reported feelings of guilt and empathy experienced by relational farmers, associated with the damage and pain caused to the land by using machinery.

The interviews depicted a relational way of farming not only associated with the relationship established between farmers and the land, but also associated with the value of social relationships that form the agricultural landscape. As has been expressed by Layman and Civita (2022), core to relational farming is the establishment of reciprocal relations with peers and the broader community. For Trivette (2017), relational farming has a lot to do with trust and caring for others. A comprehensive view of relational farming, derived from the application of a capabilities perspective, integrates the relationships between humans and non-humans and the network of social relations. This integrated perspective provided an informed understanding of the local forms of

interaction with digital technologies. The connection with the farm (a point where digital technologies are generally identified as disruptors), is complemented by the connection with other human beings (family and community). Here, digital technologies, as social communication tools, are identified as enablers, and important components in farmers' functionings and opportunity structure. This relationship contributed to locating digital technologies on or off coffee farms. It also points to the exercise of agency for collective goals, as has been recognized in conceptualizations of development from a capabilities perspective (Crocker and Robeyns 2012).

Structural determinants of technology appropriation, such as technological infrastructure, technical knowledge and support, biophysical contexts, innovation processes engendered by the institutionality, and the interaction between these different elements, configure the opportunity structure for using digital technologies at a local scale. Strongly driven by their functionings, and the important motivation they originate, the communities in this study employ different strategies to navigate throughout the multiple determinants of appropriation and work around the constraints. The centrality of social relations and the education of the children, for example, determine the willingness of farmers to work around connectivity problems, lack of digital skills, and costs of technologies. Cellphones are taken to the plots in case they are needed to make or receive a call, but smartphones are kept at home to protect them from damage. Farmers and family members walk, sometimes long distances, to find a signal for making or receiving calls, and these communities actively create WhatsApp groups to share information and coordinate collective action. However, not all farmers can work around the constraints, which are strongly linked to material and economic factors. More impoverished farmers find it more difficult to access connectivity and devices because of the costs, evidencing a prevalent digital gap with a strong economic dimension. This condition echoes propositions of digitalization as a space for broadening social inequities (Abdulai 2022; Fraser 2019; Pfeizer et al. 2020; Seyedsayamdost and Vanderwal 2020).

A particular socio-technical interaction is illustrated by the use of WhatsApp. A process of appropriation originates from the connection with relevant values in users' lives, and from the opportunity to adapt the technologies to local practices and social expectations in terms of functionality, participation, and content. The case of the harvesting machine tells a different story, providing a perspective on how farmers also work around institutional programs. Better aligned with techno-centric perspectives and bypassing local cultural and biophysical contexts, the technology proposed by the FNC was ineffective and therefore rejected by farmers. The institutional project of technification tried to place a particular technology on the farm, but farmers placed

it outside of the farm and their opportunity structure. This reality-design gap case, in turn, contributed to building attitudes of distrust towards robots, a different technology but with similar functionality. This represents the critical view that farmers have regarding the applicability of technologies in their functionings, namely their contexts and plans. This is a process described as the reflexive capacity of individuals and collectives to critically assess their engagement with technologies and their proponents (Forney and Dwiartama 2023). Thanks to their situated knowledge, farmers found it easy to identify how the spatial complexity of the plots, and the requirements for an appropriate harvest, strongly hinder the applicability of these technologies, rendering them useless and excluded from their opportunity structure. Paradoxically, the central institution of the coffee sector in Colombia was unaware of this relation and misinterpreted the biophysical and social context.

In the context of this study, the binarity conventional/organic is not translated into rational/relational farming. Expressions describing a relational approach to farming (biophysical and social) were found in both communities. Consequently, these communities expressed similar concerns regarding the impact of mechanization and automation on the biophysical entities of farms, the social fabric, and 'good' farming. However, it was found that multiple perspectives regarding technologies coexist also within the same community. For some respondents, there is no relationship between technologies such as mobile phones, smartphones, or tablets, and non-human elements of the farm. For others, these technologies can be used as tools to document and evoke the relationships that farmers establish with these elements. These technologies are commonly considered important tools to nurture the family and the community, however, they also can promote addictive behaviors that undermine social cohesion. These descriptions speak about a complex engagement with digital technologies. Contrasting with a linear diffusion paradigm, the process unfolds in twisted and complex trajectories. Owen et al. (2013) described innovation as a dynamic, undulating path, sometimes with dead ends. Meanwhile, messy entanglements of day-to-day human and non-human interactions engender particular forms of digitalization (Forney and Dwiartama 2023). In conversation with these two ideas, we argue that from this messy entanglement, emerge equally messy material and symbolic engagements, with opportunity for fragmentation, contradiction, and ambiguity.

Disparate perspectives towards drones and robots were evident in the Andes community. For some, these machines are conceived as 'clumsy' workers and a threat to the social fabric of the community, while for others they are seen as potentially valuable aids in managing the farm. Following the perspective of multiplicity framed by proponents of farming as a relational process (Darnhofer 2020; Layman

and Civita 2022), we argue that multiple forms of interaction with digital technologies can coexist in the study areas, and that the outcome of the negotiations between different perspectives remains open. As evidenced with other technologies such as coffee varieties, pesticides, or renovation cycles, it is likely that the ordering of digital technologies will vary across coffee farms.

Conclusion

This paper makes two contributions to the critical literature on digital agriculture. Firstly, it applies a capabilities approach to highlight the relevant role of situated ideas of development in positioning technologies on or off the farms, as well as broader digitalization agendas, on or off farmer's life projects. Amartya Sen's capabilities approach presents a critique of the unquestioning pursuit of diffusing technologies across contexts based on a false sense of universality. Secondly, this study contributes to the emerging field of relational studies on local processes of digitalization in the Global South, by presenting a case of two communities of coffee growers in Colombia.

Through the integration of the concepts of functionings and opportunity structure, we were able to assemble the multiple negotiations between farmers' personal and collective goals, knowledge, institutional programs, and the agency of non-humans, that shape processes of digitalization. This study highlights that technological appropriation is a process of agency co-construction in the quest to integrate technologies with the life that people find valuable. The local outcome of this process, articulated through the themes of *a relational way of farming*, *(dis)connected machines*, and *nurtured families and communities*, is an emerging form of digitalization and non-digitalization. To explain this: in this study, digital technologies such as mobile phones, smartphones, tablets, computers, robots or drones, were described by respondents as incompatible (in material and symbolic ways) with the practice of farming; therefore, there does not seem to be much space for them in the coffee plots. The farm, on the other hand, as a space also composed of social relationships (a central component of a valuable life for these communities), provides room for digital technologies that work as communication tools (mobile phones, smartphones, digital social networks).

Centering the analysis around the underlying values in which farming practices and identity are rooted allowed us to identify important tensions between local practices and the broad digitalization agenda. The relational local ontology strongly contrasts with the techno-centric and productivist perspectives that seem to occupy most of the narratives and practices around digital agriculture, engendering opposing visions of a desirable future. By following

mainstream and top-down techno-centric perspectives and overlooking the local cultural and biophysical context, the main institution in the coffee sector in Colombia (FNC) failed to implement a mechanization project for harvesting coffee, contributing to rising local attitudes of distrust towards emerging technologies such as drones and robots. At the same time, it revealed the critical view of farmers regarding digitalization, automation, mechanization, and ideas of the 'good' farmer and the 'good' farming.

We consider that integrating in this study the perspectives of different family members (partners and children) provided a valuable understanding of the local interactions with digital technologies. The study shows that decisions at the farm level and perceptions regarding these technologies are shaped through dialogue between views, practices, and goals of different family members. We encourage social researchers to engage more often in household approaches when exploring local forms of appropriation. Considering the integration of smartphones and cellphones and WhatsApp in the routines of these communities of coffee growers, as well as the key role in facilitating collective communication and action, we consider that exploring dynamics such as imitation, the pressure to be excluded from these networks, and the need to conform to social practices, can provide valuable insights into understanding the not-so free choices in technological appropriation.

In the process of framing the mainstream picture of digitalization, it is possible that local stories of appropriation go unnoticed. If these stories are not better positioned in critical assessments of digital agriculture, there is a risk of over-focusing the discussion on non-existent rural worlds, using imagined scenarios. Meanwhile, a process of digitalization is unfolding through everyday localized cultural and material processes on farms. Drawing upon a relational perspective, we present evidence of the need to replace notions of immutability, universality and uniformity, with the recognition of multiple ideas of development and the role of technologies in personal and collective development. This is a process in which this paper contributes only a small part to the mosaic, and we make a call of reflecting on generalization impulses. Heterogeneity can even occur at local levels, opening the space for multiple co-existing innovation processes. Embracing these notions of multiplicity can make digital innovation a more inclusive and contextualized system, and thus contribute to reducing reality-design gaps. Digital agriculture is a multi-faceted process occurring at different scales and towards different trajectories. A commendable goal is to contribute to making it compatible with the life that farmers want to live. As we accounted, rural communities are actively involved in this process already; it is a matter of paying closer attention.

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