

How agriculture performs urbanity: connecting urbanization and socio-practical shifts in farming cultures

ERNST MICHAEL PREININGER



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Agriculture and farming practices are often at the center of idealized imaginaries and characterizations of rurality. At the same time, agriculture is in flux, undergoing rapid change through globalized economic restructuring and new globalized cultural paradigms. Agriculture is thus a venue where farmers put into practice the latest technological advances to remain competitive economically, a process which simultaneously challenges farmers' (self-)perceptions and the characterizations of rural communities. Scholars of urbanization theory propose exploring rural transformations through the everyday, as performed through practices and reflected in the habitus. Building on such scholarship, this article connects insights from urbanization studies with a qualitative assessment of practice shifts in farming by situating digitally-assisted farming practices as indicators of rural transformation. Using the participatory visual method of photovoice, the article follows how farmers from south-eastern Austria outline contexts in which digitization has led to transforming their farming practices. The conceptual framework of *habitual urbanity* (Dirksmeier 2006, 2007, 2009) is used to analyze the resulting material. The main qualitative results highlight how digital technologies led to the reordering, reassessment, and at times, discontinuation, of everyday farm tasks. These disruptions potentially lead to a growing variety of business modes and at the same time, mark cornerstones of rural transformation in thought and behavior.

Keywords: digital transformations, rural transformations, smart farming technologies, visual methodologies, habitual urbanity, rural-urban divide

Ernst Michael Preininger (<https://orcid.org/0000-0002-1897-8125>), Department of Geography and Regional Science, University of Graz, Austria. E-mail: ernst.preininger@uni-graz.at

Introduction

Contemporary perspectives on 'the rural' in Human Geography and Sociology literatures emphasize a plurality of discursive approaches to the concept (cf. Marszalek *et al.* 2017). Symbolically-charged, romanticized imaginations of 'rurality' and 'country life' are still prevalent and reflected in the lucrative market for country-themed magazines, especially among mainly urban citizens in Western countries (Baumann 2014, 2018). These magazines feature iconic representations of 'the countryside', showing lifestyles often inspired by simplicity, nature, and agrarian practice. Such characterizations may also be found in media, tourism, and entertainment industries (Baumann 2014). These representations are often perpetuated intentionally to sell a certain image of 'country life' on aesthetic and emotional levels (Horton 2008, Woods 2011). Reduced to a commodity, the rural representations fulfil economic roles (cf. Woods 2005; Cloke 2014) and may, deliberately or not, contribute to forming identity (Sackmann & Schubert 2018). Development policies such as the European Union's 'common agricultural policy' (CAP) (European Commission 2023) and the 'Rural Pact' (cf. European Commission 2022), suggest that agricultural practices and 'the rural' still are very much intertwined on political, spatial and socio-practical levels (cf. Friedland 2002).

Considering the limited economic opportunities in remote areas, these correlations between rurality and agriculture might not be especially surprising. Contemporary 'Western' agriculture, however, is at the forefront of developing and applying complex technological solutions linked to globalized industries and finance (Sippel & Dolinga 2023), a configuration which increasingly reshapes the look and routines of farming. Societal digitization (cf. Stalder 2016) has brought forth digitally enhanced production systems, often referred to as 'Smart Farming' or 'Agriculture 4.0' technologies with regard to Industry 4.0 (Liu *et al.* 2020) and the Internet of Things (Lasi *et al.* 2014). In contrast to these systems, romanticized, simplified imaginations of agricultural practices and farm life appear to be relatively oblivious to the actual dimension in which socio-material transformations in agri-food production are taking place.

Due to the complexity and range of technologies, there are several ways to approach the definition of digital farming. For the purpose of this article, *digital farming* is understood as the use of interconnected digital tools, management, and precision agriculture resources for different stages of food production, including agricultural machinery and in combination with robotics, Big Data analysis, and artificial intelligence (following Balafoutis *et al.* 2017; Zambon *et al.* 2019). Specific examples of these applications, for instance, as represented to a broader public through Austrian media (Preininger 2023) include (fleets of) drones, autonomous harvesting and weeding machines or tractors, sensory equipment used in and on animals' bodies, or multi-functional farm control software (for a more detailed listing of applications in the focus of this paper, see the study context section).

Many scholars have recently pointed to the concerning implications of digital farm technologies regarding socio-ethical aspects of food systems, relevant not only in industrialized regions but potentially affecting all kinds of enterprises and contexts of global agri-food production (for an overview, cf. Eastwood *et al.* 2019). Some scholars have emphasized problematic impacts for rural communities and labor markets, as these technologies potentially increase exploitation of the most vulnerable (Rotz 2019; Carolan 2020). Others raise concerns over technologies' impacts on governance, through increased neo-liberalization as an effect of Big Data companies (Carolan 2017). Some see digital farm technologies as a threat to the democratization of knowledge since value created by digitization in agriculture tends to be unevenly distributed between tech providers and farmers (Lioutas & Charatsari 2022). Others have pointed to disruptive consequences for structural and organizational aspects of farm life (Klerkx *et al.* 2019) as well as for family structures, cultural and gender-related (self-)attributions of involved actors, animal-human relations, and responsibility (cf. Bear & Holloway 2015; Jakku *et al.* 2022). Technological changes in farming may push actors to modify or abandon their farming practices related to a variety of situations. It is, thus, relevant to explore the political significance of digital farm technologies, understood by the farmers themselves, as inscribed in day-to-day tasks on the farm. This research sheds light on the spectrum of potential opportunities and challenges that powerful new technologies bring forth (cf. Lioutas & Charatsari 2022).

Following from these debates, this paper contributes original empirical analysis to the ongoing (re) characterization of agricultural methods caused by novel digital farm technologies. The paper raises the question of how digital farming technologies, based on the case of rural Southeast Austria, are part of greater transformation processes in rural areas (cf. Dirksmeier 2006). For this paper, the visual and participatory method of 'photovoice' and data analysis according to the framework of 'habitual urbanity' (Dirksmeier 2006, 2007, 2009, see subsequent section) were used to understand shifts in farming practices as perceived by farmers.

The article builds upon two key questions: a) Which kinds of disruptions of agricultural practices do digital farm technologies lead to? b) In which ways can socio-practical transformations of 'rural' agriculture be conceptualized through 'urban' notions of habitus? The conceptual framework used in the analysis will first be introduced. Thereafter, the study context and photovoice method will be presented, followed by the combined results and discussion section, situating the empirical findings in relevant literature. The paper finishes with a summary and conclusion of the findings.

The 'rural' and the 'urban' reflected in practices

Contemporary rural geographies, concerned with the conceptualization and practices of rural areas (Woods 2009a), have adopted new conceptual approaches like non-essentialist and more-than-human worldviews in their scholarship (Whatmore 2006), as well as deconstructing conventional views of 'rural' areas, for example, through the concept of 'postproductivism' (Hoogendoorn & Visser 2011; Argent 2020). Theoretical influences like actor-network-theory (Latour 1999), and assemblage thinking (McFarlane & Anderson 2011) enriched debates about what constitutes 'the rural' by moving beyond the rural-urban dichotomy (Schmidt-Lauber & Wolfmayr 2020). Building from such approaches, new cultural geography offers new insights on the (re)production of meaning and power relations inherent in cultural practices (Price & Lewis 1993; Castree & Nash 2006), understandings upon which this article is theoretically grounded.

Inevitably, categories like 'rurality' and 'urbanity' are discursive assemblages often referring to socially negotiated, spatial semantics (Clope & Johnson 2005; Redepenning 2015, 2019). Whether or not they serve as containers of spatial attributions, are built on relations and scale, are defined by cultural categorization (Jones 1995; Jones 2009; Woods 2009a, 2009b), or seen as 'performed' (Woods 2010), any categorization of 'the urban' or 'the rural' contributes to the social construction of space and may be reflected in practices (cf. Woods 2009a; 2010). British Rural Geographer Halfacree noted:

[A] central reason for acknowledging the popular resilience of rurality is that it has very real material, geographical and socio-political consequences. In short, people act on or through their understandings of rurality in their everyday lives and the rural world is partly produced thus. (Halfacree 2009, 451)

To explore the emergence of potential 'new rural subjectivities', Bear and Holloway (2015) addressed the correlations of rural farm life and the use of agricultural technologies, a focus also at the center of this paper. Based on their conclusion, technologies may be conceptualized as 'performed' and embodied by human and non-human living beings, who, through practices and different scenarios of being affected, become part of technology (cf. Law & Singleton 2000). Examples from their insights include farmers who, on the basis of a newly emerging set of practices, (re)define their identity, and farm animals, which have been genetically modified out of market-related objectives (Bear & Holloway 2015).

In contrast to the resilience of the concept of the 'rural' lies the hypothesis of an urban society that sprawls across all territorial entities and scales, Wirth (1938) as well as Lefebvre (1970, 2003) inspired scholarship on the performative 'planetary urbanization' thesis (cf. Robinson 2005; Merrifield 2018), tracking the 'urban' in dimensions of lifestyle. Similarly, and in reference to Monte-Mór (2005), Brenner and Schmid (2011, 13) postulated "the end of wilderness [...] increasingly interconnected with the rhythms of planetary urbanization at every geographical scale, from the local to the global". It is essential for the understanding of both concepts that *urbanization* is not built on the materiality of the *city* but on a "[...] processual, place-transcending urbanism" (Wilson & Jonas 2018, 1577). In a comparable fashion, Amin and Thrift (2002) conceptualize the urban as expanding network of social

relations and flows of information, from which there is no escape – a fabric of which all socio-spatial conditions are made of (cf. Brenner & Schmid 2015). Scholars of urban theory (e.g. Amin & Thrift 2002; Brenner *et al.* 2012; Merrifield 2018) have long argued that behavioral patterns and living conditions formerly understood as distinct urban, today affect society as a whole and cast doubt on the utility of an urban-rural dualism.

This perspective inspired the development of novel research agendas on rural transformations and led to the conceptual framework of *habitual urbanity* (Dirksmeier 2006, 2007, 2009). It was developed to trace and uncover ‘placeless’ urbanity encountered on emotional, affective or everyday levels (Siebel 1999). Dirksmeier (2006, 221) bases his theory of the “incorporation of the conditions in the city” on Bourdieu’s social theory (Bourdieu 1976). With the ‘habitus’ term, Bourdieu conceptualized practice patterns resulting from individual prerequisites, consisting of beliefs, values, perspectives *et cetera* (Costa & Murphy 2015). *Habitual urbanity*, thus, interprets urbanity as an intrusive force – a type of human ‘capital’ (after Bourdieu’s terminology describing specific resources) which interferes with perception, thinking and action. Dirksmeier argues that, apart from the territorial expansion of urbanization, also:

The habitus can be seen as a medium for the expansion of urbanity. [...] Taking a closer look at the urbanity that has become part of the habitus of the actors opens up new, hitherto unnoticed perspectives on transformation processes in rural areas. (Dirksmeier 2006, 229)¹

Dirksmeier (2006, 2009) identifies three constructive categories for conceptualizing the urban through the habitus: *strangeness*, *individualization*, and *contingency*. These categorial stages build upon each other and are to be understood as *urbanisms*, constituting habitual attributes.

Strangeness refers to an urban setting where strangers coexist in close proximity to each other, as an alternative to existing in a “tribe or clan [...], traditional social formats in which it is inherent that their members know each other” (Dirksmeier 2009, 44). Further developing this line of thought, Dirksmeier postulates that *strangeness* promotes the “individuation” of the individual, insofar as “[...] structural strangeness, [...] serves the purpose of self-identification” (Dirksmeier 2009, 58). The second category which constitutes the incorporation of urban habitus is therefore *individualization*. Dirksmeier argues that *strangeness* and *individualization* promote a third category, *contingency*. German sociologist Luhmann (1984), in his Systems theory, used the term *contingency* to describe something that is neither necessary nor impossible, a state in which perceptions, thoughts, or experiences are just as well differently possible. In the context of habitual urbanity, the term refers to habitual indeterminacy (Dirksmeier 2006). Innovations emerging from the era of industrialized agriculture have continuously and significantly modified labor and work routines of single farm businesses. However, digitally enhanced agri-food production – in the form of socio-technical assemblages which draw on global markets and trends – could mean disruptions for whole rural communities and their socio-ethical realities in which they operate. This paper’s central aim is to investigate how characteristics of the ‘habitual urbanity’ framework resonate with farmers’ experiences of rural agricultural transformation through digital farming technologies.

Diversified produce and areas of application in a small scaled study region

The study region in the southeast of Austria’s department of Styria was selected as part of a research project² on digitization of agriculture. The small scaled region is situated along the south-eastern foothills of the Alpine ridge and features a moderate climate, low altitude and fertile soils. Farming has a long tradition in the region. The only significant urban setting near the study area is Austria’s second city and the county’s capital Graz with almost 300.000 residents (Stadt Graz 2023). Statistically, the degree of urbanization is low throughout the whole study area. To classify the extent of urbanization throughout the country, the Austrian statistical authority (Statistik Austria 2022) used a threefold typology developed by the European Commission (Eurostat 2018). According to this typology, all locations in the study area were classified as ‘thinly populated (rural area)’, except one, which lies within a defined ‘intermediate density area (towns, suburbs)’. Topographical conditions vary greatly

locally, composing an agrarian structure which is diversified in types of produce and size, but in general, does not allow large-scale operations.

The author grew up in this area and – because of family ties to agricultural production – drew on diverse background experience and knowledge from his early childhood. Interviews for the article were conducted in German and all excerpts were translated to English by the author. The limitations to the study's results encompass the fact that they refer to an economically and culturally relatively homogeneous region in Austria, whereas experiences and individual meanings attributed to technologies might vary in other cultural, regional, and economic contexts. Also, the size and type of the qualitative study design limits its transferability.

To recruit study participants (local farmers with experience in applying tools and machinery from the range of so-called digital farm technologies), persons from immediate environment of the author were contacted initially. Subsequently, the snowball-sampling method (Noy 2008; Etikan *et al.* 2016) proved to be effective. According to the methodical principles of the sampling procedure and the selection criteria, eight farmers were recruited between May 2020 and January 2021. Two out of the eight farmers selected were excluded from the main data collection part of the study, as they were not using most of the above-mentioned farm technologies. They were, however, interviewed and included in the sampling process to provide names of further participants. Some of their interview responses were integrated in the discursive analysis. The range of produce from the farms that were included in the survey varied to a great extent. On two farms, a diversity of grain such as wheat, spelt and oats was cultivated, whereas the other business specialized, for example, in fruits such as apples and pears, berries and field vegetables, wine, or cattle breeding.

The digital technologies of interest on these farms include a) data acquisition technologies (sensory equipment for measuring soil humidity, weather conditions, real-time camera-controlled weeding, precision application systems for seeding and fertilization, chip implants and sensors in cow stomachs for tracking behavior and bodily function parameters), b) guidance systems (GPS modules on tractors and other machinery for tracking pathways, real time kinematic steering assistance), c) precision application systems (site-specific fertilization or seeding devices). In addition, d) different types of office software or mobile phone apps, which draw on internet resources, were used (farm management software for the integration and further utilization of various farm data, time recording and logging systems for workload monitoring, weather apps, plant recognition software, early warning services for plant disease infestation and management software for the fulfilment of legal obligations). The following section outlines the methodological approach used in the study.

Visual photovoice method and framework analysis

As an alternative to textually based data, visual methodologies, for ethnographic and geographic research in social sciences, have been addressed in a broad range of literature in the last decades (Pink *et al.* 2004; Dirksmeier 2013; Mitchell 2013; Rose 2016; Mitchell, de Lange & Moletsane 2017). Bourdieu's research practice partly built upon visual forms of sociological knowledge generation introduced by photographic-semiotic image analysis (*cf.*, Bourdieu *et al.* 1981; Dirksmeier 2007; Schultheis *et al.* 2021). For this article, the everyday-practical dimension is the central source of data, following Dirksmeier's (2009) recommendation for scholars to engage in reflexive photography to address the levels of habitus. He argues that reflexive photography makes experiences and practices accessible to research processes (Dirksmeier 2013).

For this paper, the participatory visual method of 'photovoice' was chosen. As a method originally developed to illuminate realities of rather underrepresented groups, it aims to decipher contextually rich, culturally, and socially coded knowledge of individuals who are embedded in a community (Wang & Burris 1997; McIntyre 2003; Sutton-Brown 2014), but remains an underrepresented approach within the evaluation of farm technologies. One of the method's most significant aims is highlighting moments of agency within uneven power dynamics (Sutton-Brown 2014) through introspection and reflection. The implicit nature of knowledge produced this way, emerging from reflecting everyday

practices, thus, often points at political dimensions. For the research focus of this case study, photovoice therefore was highly suitable.

The method involves three phases. First, the thematic context or problem was identified, which here is the representation of rural transformation through contemporary digital farm technology application, affecting everyday routines and tasks. Second, participants were asked to take 10–20 photographs with their smart phones to capture their daily farm work, in response to the prompt: *which areas of your day-to-day tasks are increasingly affected or transformed by digitization?* Third, participants reflected on visual material, as personal images were the basis for follow-up semi-structured in-depth interviews of roughly two hours each.

At the beginning of the interviews, participants were shown their images printed out on paper in a random order and asked to form clusters based on thematic context they identified like work alleviation on the field, automation, visual surveillance, weather forecast interpretation, indoor livestock keeping, farm management, office management and administrative duties, marketing *et cetera*. These clusters and the associated images were discussed in detail regarding the semantic content and personal relevance. For a better illustration, Figure 1 shows four images that were taken before the interviews by different participants who, through them, referred to the following topics: the collection of data with digital sensory equipment to gain information otherwise invisible for human senses, higher accuracy in plant cultivation through automation, and animal welfare.



Fig. 1. Images taken by farmers as part of the Photovoice method, exemplary (a).

With other photographs, participants pointed to topics such as administrative obligations, animal surveillance, generational conflicts, saving time for the most relevant tasks, new ways of dealing with demanding topographical and ecological conditions (Figure 2 and 3).



Fig. 2. Images taken by farmers as part of the Photovoice method, exemplary (b).



Fig. 3. Images taken by farmers as part of the Photovoice method, exemplary (c).

These topics laid the ground for structuring the interviews and, through them, lead to the qualitative data. The resulting data set was analyzed according to guidelines of 'Framework analysis' (cf. Richie & Spencer 2002; Gale *et al.* 2013; Kiernan & Hill 2018) with MAXQDA qualitative data analysis software. The process encompassed two major phases. The initial phase sought to reach a rough understanding of the topics and meanings conveyed through the interviews, but also considering aspects unspoken, such as emotional undertones. Subsequently, in phase two, the framework of *habitual urbanity* was applied to the data set to systematically code the results. After that, the three categories were split up in further, more detailed sub-groups in reference to the content of the interview excerpts. Table 1 shows the resulting categorization.

Tab. 1. Resulting framework after applying the Habitual Urbanity concept (Dirksmeier 2006) to the data (own design).

STRANGENESS	INDIVIDUALIZATION	CONTINGENCY
Structural disengagements Structural changes (operational), local / regional adaptations, indifference to surroundings	Release from ties/ independence Dissolution of traditional or family ties or expectations, overcoming dependencies	Flexibility and choice of production spectrum, business structure, customer relations, communication, quality, scale
Anonymization Receding into background, automation, outsourcing, loss of personal significance	Rationalization Efficiency increase, financial optimization, streamlining of operational processes	
Productive indeterminacy Openness of developments, increased options for action, increased external contacts	Knowledge increase Increase of codified, specific knowledge with techno-sensory mediation	
	Specialization Reduction of production spectrum, professionalization of sub-areas	

The following section presents the main results of the study in a structured manner based on statements of farmers, according to the categorization of strangeness, individualization, and contingency. In parallel, each section connects empirical data to critical assessment from the relevant literature, illustrating the data's relevance for broader theoretical debates.

Effects of digital farm technologies: strangeness

Structural disengagements

The first of three subcategories to the initial stage of urbanisms, *strangeness*, is defined by structural reconfigurations that farmers have been observing in response to the implementation of digital technologies. Contemporary digital farm tools are powerful working aids which involve functions and modes of operation that often require adjustments of farms on material and organizational levels. Statements of study participants suggest that the public often hardly realizes the level of structural

disentanglements the agricultural sector faces and in which digital agricultural technologies play a significant role. One farmer explains the situation she finds herself in.

One of the main problems, I think, is advertisement. If everything is presented in a beautifully green way where flowers grow all over the place and farmers apparently make a living from just one single apple tree, then customers may also imagine it that way. They are totally overwhelmed seeing the machines we use, or all the electronic control elements. I frequently experience these situations when media representatives come to visit and they, for instance, ask me whether I had a nice wooden basket [they could use for photos], because therein I could arrange all the products more beautifully [than in the original context]. (G: 345)

To counter rising labor costs, and as the degree of effectiveness of autonomously operating machines (drones, tractors, harvesting machines, etc.) increases, investment in these machines is likely to become more common and will continue to contribute to the abstraction and alienation of formerly familiar work flows, the same farmer explained:

[...] autonomous harvesting robots are being advertised at fairs already [...] in order to technologize harvesting processes even more. When you, like me, still harvest by hand, you need a lot of employees. Every single berry is harvested by hand. Also with apples, [...] I see these harvesting robots coming up, especially for very large orchards. (G: 265)

The potential replacement of human work force with automated robotics to carry out the most intensive tasks is a remarkable step towards reducing labor burdens. However, one concerning side effect such advances of automation and robotics may have on labor, is that it would, ultimately, allow farmers to replace skilled workforce with untrained, easily replaceable and underpaid temporary workers carrying out work with minor responsibilities (Rotz *et al.* 2019). For Southeast Austria, this is especially relevant, because it is very common for farmers to employ workers from neighboring lower-wage countries of Slovenia and Hungary during the harvesting season.

Correlated with shifts concerning workflows and labor arrangements, the use of highly specialized technologies, based on economic factors, might require material re-configurations, including growing farms and businesses to bigger and bigger scale operations. One farmer, who had recently given up pig breeding, criticized business 'growth', facilitated by new technologies as a strategy to tackle economic difficulties and the outsourcing of labor to external companies:

Clearly, it's a vicious circle. Everything you can automatize you can upscale as you wish. You need one person to feed 100 pigs. [If you use] a computer [controlled system], you feed 100, 500 or 1000 [pigs], it doesn't matter. But the easier it is to scale numbers up with the new technologies, the faster the hamster wheel turns. (O: 252)

Everything is just a business today... You pay another farmer rent [for keeping your animals in his stable], he feeds the animals, and when they have been sold, employees of a Hungarian company show up to clean the barn. The liquid manure is [bought and] used by another external company. I only need a computer and a calculator, and I know from the beginning, what that all costs me. Of course, it all depends on the world market prices, but I know, the larger I go and the more office skills I have, the more revenue I can expect. Everything can be done by external operators, employees... especially people from abroad who, today, handle it. (O: 306)

Business development, in such competitive climate, could face difficulties when it is – like in parts of the study area – limited by topography in size, and affected farmers might thus not be able to reap benefits from the latest technologies, indicates another farmer: "You can see how all the technology is developing, and how difficult it often is [to harvest their value] in this small-scale structure." (H: 4).

To summarize, with the application of digitally enhanced farming methods, work sequences and their material and spatial contexts, are facing structural dissolutions and re-assemblance strongly connected to labor. Additionally, with dependence on external service providers (concerning work force but also software developers, agri-tech enterprises, and Internet companies), certain social bonds to local structures on the level of family, neighborhood, or village may lose their significance. Along with effects on socio-ethical foundations of the farming profession (see following sections and, for an overview, cf. Klerx *et al.* 2019), these reconfigurations potentially affect the (self-)perception of what makes a farmer today, leading to the subsequent section of *anonymization*. One farmer describes

that the nature of his work has changed insofar as he now holds a different position on the farm by keeping an eye on the 'big picture' rather than intimately engage in farming through physical work. However, this new role requires a new skill set:

The profession is changing, it is more about control, about observation and the adjustment and adaptation of the equipment. Compared to the past, where manual work or steering the tractor was at the center, it is now about integrating and using technology well to make the right decisions. (H: 78)

I may not need to be a programmer, but I must be able to deal with technologies, and I need to understand them a little bit. If I want to dig deeper, it's quite a big challenge to be competent on so many levels. (H: 50)

Anonymization

Relationships between humans and technologies may be conceptualized in different ways. For the purpose at hand, the relations are here understood as a systemic entanglement (Wolfert *et al.* 2017) which also encompasses the social dimension (cf. Latour 1999; Lioutas *et al.* 2019; Rijswijk *et al.* 2021). The agri-food-complex, through this lens, is constituted by quasi-social collaboration between human and non-human actors such as animals, technology, and also food. Through their materiality, these actors are granted agentic capacities and thus, represent political agents (cf. Huttunen *et al.* 2020). The concept remains part of a greater more-than-human geographical understanding (Whatmore 2006) and has been applied in Science and Technology Studies.

In the farming context, digital 'smartness' means that the systemic relationships in a network between conventional farm tools (tractors, harvesting machinery etc.), humans, and non-humans becomes enhanced by powerful decision making capacities based on the analysis of vast amounts of data and the use of artificial intelligence, implemented, for example on autonomous machinery. On this basis, farms could be perceived as a black box, controlled by Big Data analysis and opaque algorithms, while the agentic impact of the farmer loses significance. The fading farmer's authority appears, in many aspects, as the *anonymization* of the farming business.

Such perceptions have repeatedly been referenced in the literature. Affected farmers have especially reported that they feel they have become employees or interns at their own farm, increasingly dependent on external decision makers (cf. Driessen & Heutinck 2015; Ayre *et al.* 2019). In this study, interviewed farmers reported similar experiences, for example that their responsibility in the farming process was declining or that their role continues to be reversed with some technologies they supposedly 'use'. One farmer, for instance, imagined that the constant increase of abilities among automated technologies will eventually lead to degrade humans to a status as mere assistants to the machine. Another farmer, in a humorous way, pointed out that humans in agriculture will lose the last shred of usefulness the moment when self-driving tractors displace them from the field.

If [...] you had two or three [drones] flying around on the plot, and they return completely autonomously to the loading and refuelling station, you would ultimately just be the one who presses the [start] button and [the one who] makes sure there is always enough resources for them to refuel [...]. And if one of them falls, you pick it up. (M: 142)

[...] when the tractor drives alone, the farmer is not even a tractor driver any longer. (K: 169)

Effects of digital farm technologies: individualization

Release from ties

The initial theme of the second stage of urbanisms, *individualization*, relates to a sense of detachment from ties or previously close attachments. Phenomena of singularization and individualization are, for some scholars of social theory, constitutive elements of modern societies (cf. Reckwitz & Rosa 2021). Individualization in the social environment of a city emerges from the "release from traditional ties",

according to Dirksmeier (2006, 223). Following on the previous section, some of the transformative potentials released by the expansion of the digital toolkit might contribute to the dissolution of a) practices 'traditionally' attributed to the farming profession and b) family-based labor structures because of the potential replacement of humans with robotic machines. Both dynamics, in agriculture, have a longer historical trajectory, as technology has long been part of adaptation processes to increasingly competitive economies. Digitization could contribute to intensifying these dynamics. When one farmer reflected on juggling several work tasks single-handedly, he regretted not to be able to fall back on supportive family ties anymore:

[...] today, your business needs to grow from five to 100 hectares. [...] In the past, [...] there were at least three people at home, who may have worked manually more, and it was difficult, sure. Today, one person manages what maybe three or four did in the past, you are now exposed to immense pressure. (O: 262)

As a contrast to this statement, an increase in efficiency and economic streamlining has been experienced by one farmer as a form of independence from barriers in family-based business structures; for him, digitization may help build up new alliances.

[Farmers] always complain, today's parameters are not suitable to keep up the work they'd like to do, which is not true. If I own a small business, I could team up wonderfully with my neighbors. Say, if we were five [farmers] and owned 150 hectares, we'd have five drivers. We could divide [work], we could even buy [and use] machines together. (H: 70)

Underlying this statement are efforts of business rationalization, which are also at the center of the subsequent section.

Rationalization

For economic survival in a competitive and complex business environment, efficiency has obviously played a major role in designing 'smart' tools that generate the highest possible value output of work (cf. Lioutas & Charatsari 2022). This is illustrated by four different statements taken out of interviews. The first addresses accuracy when applying plant protection measures:

There is GPS mapping involved in the cultivation on the field. [...] With that, you can avoid driving in those lanes again when you're spraying herbicide, or you work with hoeing equipment. (W: 40)

The second statement points at efforts to enhancing financial and ecological sustainability through robotization:

On a farm of 10 hectares, it would [already] pay off to do without a[nother] tractor, but instead using two robots. This would lead to [a very sustainable way of farming] and I could take care of other things in parallel, such as marketing. (M: 150)

The third statement describes reaching a higher level of work quality while at the same time having an easier job: "[With automated tools,] It's much easier, it gets the job done much better, and I think, if you don't take part [in the development], you're eventually going to fall behind." (H: 66). The fourth statement refers to evaluating work performance:

Working time has become less and less and is worth even more. And trying to decrease both work time and to increase know-how, in my opinion, calls for the implementation of performance-based payments. Then, everyone will start thinking about how they can be more productive. And that benefits the farmer, it benefits the employee, it benefits everyone. (W: 296)

Rationalization most likely results in larger sized spatial units and standardization (for instance of topography or in produce). In most future work scenarios of farming, as discussed in the interviews, however, the rationalization theme was negotiated through reducing physical human influence and reducing costs and error rates to potentially improve quality of produce. In the eyes of one interviewee, the outlooks of automation and reduction of human staff cast doubts about the usefulness of this approach. He pointed out that the human work contribution is only being shifted towards 'invisible' persons maintaining digital infrastructure in the background, a remark which connects to the previously discussed theme of anonymization:

I mean, rationalize humans away? Why do we want to keep people from working [on the field]? Because, ironically, there are people working behind the scenes to make digitization work. But the person who just does the work right away manually, that's what we seem to want to rationalize away. (P: 232)

Knowledge increase

Most of the technologies at the center of discussion rely on extensive digital data sets. Data-based correlations can enhance the understanding of biological and natural processes, exemplified by early detection and diagnosis of plants and animal disease symptoms, of weather conditions, or optimal harvesting times (Bronson & Knezevic 2016). However, knowledge emerging from this approach is only ready to use after data has been profoundly analyzed and contextualized (cf. Relf-Eckstein *et al.* 2019). Typically, this kind of knowledge is very specific, which, together with license agreements, limits the areas of application. One farmer pointed out that far more data is being collected than needed, and that, at the same time, a great deal of data is not being properly analyzed.

Dissemination of information, certainly, is still a very important point in digitization. Because right now it's just a lot of collecting and not producing much information. (W: 128)

As mentioned, techno-sensory perception enhances the recognition and visualization of relationships often inaccessible to human senses. This is especially relevant for livestock farming. With digital accessories, practices of knowledge generation on-farm methodically and epistemologically follow other rules than in pre-digital times and explore new spheres of possibilities, one farmer explained:

[With my sensory equipment] I get information that I might not easily get otherwise. You would have to test every cow's temperature [...] and have to be next to the cattle all the time, and I don't think any farmer does that. Especially one who owns [...] [say] 50 individuals [...]. (U: 216)

Generation of quantitative data, through digital technologies for animal husbandry, do not represent the practices which require implicit, tacit (embodied, experiential) knowledge. These are practices expressed through touch and non-verbal interaction between farmer and animal. Capabilities of digital technology are promising as a way to augment and intensify encounters between humans and animals (Webber *et al.* 2017), but emerging questions on ethical standards of implementation must remain in sight and be re-negotiated (Holloway *et al.* 2014).

In conclusion, the range of agricultural practices in knowledge generation and management has expanded, involving new fields such as programming and the management of algorithms based on vast amounts of specialized data. Accordingly, issues that deserve more attention include power distribution, data ownership, data security and datamining (Bronson 2018; Eastwood *et al.* 2019), governance and networking knowledge (Fielke *et al.* 2020) and monitoring growing dependencies on Big Data companies and the consequence of high investment costs (Bronson & Knezevic 2016; Klauser 2018). Discourses about the 'Smart City' and 'Smart Urbanism' are addressing similar concerns in detail (Crang & Graham 2007; Kitchin 2014; Albino *et al.* 2015; Bauriedl & Strüver 2018).

Specialization

Specialized, expensive farm gear (such as robotics, large farm machinery, or advanced sensor systems) for the generation and application of specialized data, is closely linked to larger, more industrialized businesses because of the investment burden (Fleming *et al.* 2018; Miles 2019; Rojo-Gimeno *et al.* 2019), a perspective also shared by a study participant:

I would say, [digital] technologies will not be adopted by small-scaled agriculture so quickly, because they are too expensive. Investments therefore rather can be expected in large cultivations which increase in number. (G: 417)

However, and rarely addressed in the literature, there seems to be a lot of unused potential of independently developing digital tools to support specialized business models – handcrafted technological aids combined with open-source software solutions and decentralized sharing of

relevant data and knowledge. These low-cost, personalized tools might promote managing a farm on a part-time basis, helping to scale *down* businesses instead of *up*. This could encompass occupying niches more successfully and render already existing farms more professional, as farmers pointed out: "Finding a niche certainly [is something to try] if you cannot compete with mass production." (M: 128).

If you want to practice this profession, you must find a niche — open a farm shop or specialize. It does not help to complain that today you can't make a living full-time with 10 or 15 hectares anymore. The times simply are changing, and one must move forward with the time. (H: 74)

Although not explicitly farm tools, it is worthwhile to mention digital media tools to support marketing aims. Some applications like social media significantly boost visibility of small-scale niche enterprises and again help specialize business strategies via developing a unique selling proposition (USP), emphasized through more direct customer relations or online based distribution. One farmer explains how Internet resources help him to find the right target group of customers and create new sets of practices:

Many of today's tasks [the way we do business] did not exist before. In a way, there is even more work to do than before. Because in the past I waited until someone came in [to the shop], now I just send them the wine. (W: 296)

[...] in the future we will have a wine presentation, just like we offer it here, only online. This is how you get to people that you just can't reach otherwise. [With these tools,] I can select my target group very precisely. We now also have sheep, and sheep meat is not the most popular meat in Austria, I would say. But there are a few who like it a lot [who we can reach directly]. (W: 270)

Effects of digital farm technologies: contingency

As evident in the empirical data and based on discussions in the previous sections, the application of some contemporary digital farm tools may have disruptive consequences on farming practices on very different levels (structural, material, labor, management, knowledge production etc.). Most consequences involve an increasingly undetermined and flexible business setup. In the habitual urbanity framework, the final of three stages is called contingency (see Luhmann 1984), and, in the framework understood as habitual indetermination. For the transformation of the agricultural sector, increasing contingency bears opportunities and challenges for business cornerstones such as product development and marketing, the evaluation and adjustment of quality standards, and the facilitation and configuration of internal communication or customer relations. Communication and networking skills, for the industry's sales and marketing efforts, still contains a lot of potential. To harvest the values generated using latest communication methods, one needs to develop a solid marketing model, one young farmer explained:

Many people have used it already, so we have been improving our online store over the last few years [...]. And now we have stepped up from 3 to 10% of annual sales in the online sector. That's already quite big. And for this, social media is the entry, but you really must pay attention to every single step. [...] You just have to think about what you want to show, how you want to be presented, what distinguishes you from others. (W: 220)

Undetermined business setups, together with more targeted communication, might be drawing newcomers to farming, said the same young farmer:

In the last years, I have had the impression, that people return to agriculture. There are a lot of newcomers, who just establish themselves with special cultures. [...] Also, people who [...] quit their office job in marketing [...] to go back to their roots with a small winery or something like that. Of course, they choose settings that are well marketable. It seems to me that more often, people see agriculture as a possible livelihood again [...], but they are also making high-end products. (W: 200)

In the history of farming, technology has often inspired imaginations of how future farms might look like. Some novel technologies, for instance, paved the way for indoor farming practices (Hati & Singh 2021), the 'vertical farm' (Despommier 2010) or multilocal businesses niches with hybrid, semi-

automated designs which integrate customers in the decision-making process (cf. Preininger & Hafner 2021). From various manifestations of specialized, customized business models to automated food systems that dispense with human labor, a greater variety of operating structures will become increasingly likely. Much of this development, for instance supporting sustainability efforts, should be cause for rejoicing, but at the same time should be an argument for consistent critical observation and evaluation, especially attentive to the related socio-ethical shifts. This concerns consequences that those 'rural' areas face, which historically have been characterized by agricultural economy and are affected fundamentally by transformations in agri-food production.

Reconfiguring the rural through altered agricultural practices

Public and scientific discourses indicate that rurality is 'performed' through cultural expressions which implicitly reflect local context (cf. Woods 2010; Dymitrow 2017). Media representations regularly connect rurality to simplicity, being close to nature, and backwardness or emphasize the idyll of 'traditional' rural settings. As an economic sector and way of life, agriculture is often attributed to such 'rurality', in opposition to 'urban' lifestyles. The ongoing embeddedness of the agricultural sector in global finance and large-scale policy strategies is driving latest digital farm technology development and affects the face of agri-food production, transforming farming cultures on structural and practical levels. This paper conceptualizes agriculture as an arena through which rural transformations may be explored. To this end, empirical data from conversations with farmers in Southeast Austria were analyzed using a theoretical lens which connects the habitus of farming practices with urbanization studies in peripheral areas.

The production, distribution and adoption of increasingly powerful digital technologies are the result of very competitive neoliberal global economic structures. Reflecting upon these technologies must consider that the survival of farming businesses depends on agility and flexibility, and the courage to allow major structural changes. This often entails unforeseeable consequences for social cornerstones of farm life via changing traditions, norms, autonomy, and paradigms, altering both farmer's identification with the profession (cf. Klerkx *et al.* 2019), our understanding of rural lifestyles, and the composition of rural communities.

Most of the so-called 'new' farm applications are advancements of technical equipment as used by previous generations, which, based on their advanced capabilities, potentially reorder or reshape daily practices. Other applications entail the creation of new tasks and work sequences. Examples involve the replacement of manual work with other patterns of machine use (for example in the encounter with automatable technologies), increase of screen and office time (for planning, control, record keeping etc.), and a general reduction of physical presence on the site (for example for the treatment of animals). The demarcation between these types of transformations is fluid, subject to constant reconfiguration by a multiplicity of influences such as societal trends, farmers' needs, strategic decisions of tech producers, political influence, and market relevance.

An indicator for the transformations is the shift from implicit, experiential knowledge to the growing importance of explicit, data-based knowledge. Algorithm-led decision support on top of functionalities of agricultural machinery mark a paradigm shift for both practices and the role of farming individuals. This significantly affects human-animal relationship, too. Since animal care increasingly draws on automation for monitoring health status based on data collected through multi-sensory equipment, practices related to controlling and adjusting software parameters increase at the expense of physical interaction with animals.

From a policy-wise perspective, closing the economic and infrastructural gap between agglomerations and their so-called rural surroundings often revolves around upgrading digital infrastructures. This also promotes technological upgrading of agricultural methods and visions of the future. The exploratory research in the study area, dealing with the impact of digital farm tech on agricultural practices, exposed a spectrum of ambivalent expectations of future developments of both agriculture and socio-economic 'rural' patterns. On the one hand, with the constantly expanding capabilities of farm technologies, proponents highlighted self-empowerment and increased agency for achieving their personal economic aspirations. On the other hand, the

increasing agentic influence of highly capable technologies raised concerns, mainly about the farmer's distinct role. Political stakeholders must keep in mind that a decrease of individual human influence on the farming system may marginalize the role of farmers, contribute to decreasing farm numbers, and thus, also potentially to the shrinking of rural regions, which calls for a more targeting local planning approach (cf. Hagen *et al.* 2022).

The results of this study point to the need for subsequent research on related dimensions. First, results show the importance of critically exploring the impact of technology on agricultural work dimensions, within the context of globalized economic structures and embedded in local social environments. Second, future critical research on rural transformations driven by technological change should draw from critical technology studies and social sciences, since different understandings of what encompasses the 'urban' and the 'rural' today entail different consequences for governing spatial justice (cf. Bäcklund 2019; Jones 2019). This also entails learning about societal and cultural understandings of environmental, aesthetic, or functional roles of territories.

Notes

¹ All citations of Peter Dirksmeier have been translated from German by the author.

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