Journal of Rural Studies xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Rural Studies

journal homepage: www.elsevier.com/locate/jrurstud

Automated pastures and the digital divide: How agricultural technologies are shaping labour and rural communities

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A B S T R A C T

A "digital revolution" in agriculture is underway. Advanced technologies like sensors, artificial intelligence, and robotics are increasingly being promoted as a means to increase food production efficiency while minimizing resource use. In the process, agricultural digitalization raises critical social questions about the implications for diverse agricultural labourers and rural spaces as digitalization evolves. In this paper, we use literature and field data to outline some key trends being observed at the nexus of agricultural production, technology, and labour in North America, with a particular focus on the Canadian context. Using the data, we highlight three key tensions observed: rising land costs and automation; the development of a high-skill/low-skilled bifurcated labour market; and issues around the control of digital data. With these tensions in mind, we use a social justice lens to consider the potential implications of digital agricultural technologies for farm labour and rural communities, which directs our attention to racial exploitation in agricultural labour specifically. In exploring these tensions, we argue that policy and research must further examine how to shift the trajectory of digitalization in ways that support food production *as well as* marginalized agricultural labourers, while pointing to key areas for future research—which is lacking to date. We emphasize that the current enthusiasm for digital agriculture should not blind us to the specific ways that new technologies intensify exploitation and deepen both labour and spatial marginalization.

1. Introduction

Digitalization, automation and AI are of increasing importance to farmers, scholars, and decision-makers in the field of food and agriculture. As social and environmental concerns, such as income inequity and climate change, intersect with mounting questions around the future of labour, work, and space in a digital age, significant gaps are apparent in agri-food research—some of which piqued initial discussions around the need for this paper. With critical gaps concerning the sociology of labour, rurality, and digitalization specifically, this paper investigates agricultural digitalization and automation and its potential impacts on labour and rural communities in industrial agri-food contexts like Canada. Throughout the paper, we consider the extent to which digitalization and automation[1] may disrupt, or further entrench, the 'productivist' paradigm (Burton, 2004)[2] and how this may impact the rural spaces and labour hierarchies that underpin it—with a focus on marginalized and racialized labourers.

In agri-food, digital technologies are being proposed by industry and decision-makers as a solution to growing social and environmental crises. For instance, the Canadian government is currently investing in 'climate smart' and 'precision' technologies that "will contribute to Canada's place as a world leader in agricultural clean technology, helping farmers to develop new and efficient uses of energy, while also protecting our environmental resources and mitigating climate change" (Agriculture and Agri-Food Canada, 2018). The argument by some is that combining digital tools (such as GPS, sensors and data modelling software) with automated technologies (such as smart tractors, drones and robots) will help farmers be more precise with inputs (i.e. seeds, water, fertilizers and pesticides) while enhancing their knowledge of agro-ecological conditions (including weather and landscape interactions and soil and plant health). Some researchers, policy makers, and commentators suggest that the combination of these technologies will

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[1] When we refer to digitalization of agriculture, we are referring to a number of high tech tools that gather data to help farmers make more site-specific and informed management decisions. Automation, or mechanization, on the other hand, has been an ongoing trend in agriculture and other industries for decades (Friedmann, 1978; Wolf and Buttel, 1996). The novel aspects of the current developments in automations are the increased use of robotics for jobs that were previously only capable by human hands, such as milking a cow or picking sensitive fruits like strawberries.

[2] Productivist agriculture is defined by Burton (2004) as a model "whereby emphasis was placed on maximising food production through the application of intensive production approaches and increasing biochemical application" (p 195).

https://doi.org/10.1016/j.jrurstud.2019.01.023
Received 29 June 2018; Received in revised form 18 January 2019; Accepted 20 January 2019

increase profits, improve the livelihoods of farmers, enhance the health and wellbeing of livestock, and reduce environmental impacts (Eastwood et al., 2012; Gebbers and Adamchuk, 2010; Wolfert et al., 2017).

As agricultural technologies rapidly advance, predictions over the future of labour and rurality diverge. For instance, other scholars, activists, and farmers argue that agricultural technologies entrench land degradation, capital accumulation, and the exploitation of marginalized and racialized labourers by land owners, governments and corporations (CBAN, 2015; McMichael, 2013; Weis, 2010). In turn, several social questions arise concerning how digital agricultural technologies will impact labour dynamics and rural communities in the future. Scholars are asking how digital agriculture and the concomitant development of new productivity-increasing technologies fit into a suite of processes that are dramatically changing food-producing landscapes and the communities that support them. This question sits amidst a backdrop of literature that has highlighted how a digital divide, i.e. unequal geographic access to information and communication technologies (ICT), has led to uneven socioeconomic development outcomes (Roberts et al., 2017; Salemink et al., 2017). Within this context, some scholars conclude that agricultural digitalization and automation will inevitably reinforce social, economic, and racial inequities in labour, skills development, and rural spatiality (Bronson and Knezevic, 2016a, 2016b), just as many digital technologies already reflect existing social divides (Basu and Chakraborty, 2011).

Others argue that, if done well, digitalization can positively contribute to growth in rural communities by creating new workplace opportunities (Ivus and Boland, 2015; Pant and Hambly Odame, 2016). Recent labour and workforce reports argue that Canada's agri-food industry is growing rapidly and is creating a surplus of well-paid jobs; meanwhile, many such jobs are unfilled, highlighting a disjuncture between skills and labour availability (Advisory Council on Economic Growth, 2017; Ontario Agricultural College, 2017). A study by the Ontario Agricultural College (OAC) indicates that there are currently four jobs for every graduate entering Ontario's food and agricultural sector, and that this labour gap is expected to grow (Ontario Agricultural College, 2017). The Canadian government argues that these jobs can help build a more inclusive workforce if sufficient investments are made in life-long training, education, and skills development for currently marginalized groups (e.g. low-income workers, new immigrants, Indigenous peoples, women, and persons with disabilities) (Advisory Council on Economic Growth, 2017). While this is a notable goal, given what we know about uneven digital development and marginalization, key questions become: 1) How might these technologies restructure labour in agriculture, for better or worse, and reshape rural communities in North America, and 2) How could policy and research help support more equitable development for currently marginalized groups in agri-food?

To explore these questions, this paper draws from literature shaping this debate alongside research with scholars, farmers, and practitioners on the topic of digital agriculture and automation. We begin by providing an overview of the historical trajectory of labour and rural communities in North American agriculture. Next, we outline the current context and future projections for labour and rurality as agricultural technologies evolve. We then outline our methodological approach to the paper, then move to our findings, which are divided into three themes surrounding digital agricultural technologies and its implications for labour. We highlight three key tensions: rising land costs and automation; the development of a high-skill/low-skilled bifurcated labour market; and issues around the control of digital data. From there, we discuss the sociopolitical landscape through which agricultural digitalization is evolving, and consider its implications for marginalized labour and spatiality specifically. We close by considering potential research and policy directions that will help to build a more socially just agri-food sector as digital ag-tech forges ahead. More empirical research on this issue is necessary, in turn, we highlight areas that would particularly benefit from additional research. The main goal of this approach, and the paper more broadly, is to open up discussion for future work within a currently under-researched topic.

2. Background

2.1. Historical contexts shaping current realities

Prior to the 1940s, North American agricultural production depended primarily on farm families. A distinguishing feature of these settler farm families[3] was their ability to self-exploit and self-reproduce via 'free' family labour in a climate of expanding world markets and mass production (Friedmann, 1978). Since the 1940s, however, the proportion of family labour to wage labour has declined significantly due to increased urban employment opportunities and increasing pressures for farm commercialization and consolidation (Basok, 2002; Kandel, 2008; Wall, 1994). The rising cost of farm inputs, alongside buyer-driven supply chains and the liberalization of trade in international markets, has created a 'cost-price squeeze' for many producers, who either abandon farming or increase the scale of their operation by investing in more land and/or farm implements (Basok, 2002). Between 1950 and 2002 the average farm size in the U.S. more than doubled from 216 to 444 acres, while the total number of farms declined from 5.5 to 2.1 million (Hoppe and Korb, 2005). Similarly, average farm size in Canada grew from around 250 acres in 1950 to 820 acres in 2016 while the total number of farms fell from around 700,000 to under 195,000 (Statistics Canada, 2016). The concentration of land and capital into fewer producers, combined with advances in agricultural technology, has led to an overall decrease in farm labour and a growing reliance on a nonfamily workforce to satisfy outstanding labour demands (Basok, 2002; Kandel, 2008; Wall, 1994). In order to expand, farmers must minimize their input and/or their labour costs. Given the rising cost of on-farm inputs, to remain economically viable, labour intensive farm operations rely on the exploitation of cheap labour.

Economic restructuring in high-income Western countries intensifies structural demands for cheap agricultural labour, demands that are increasingly met by migrant labour (Basok, 2002; Kandel, 2008; Labour Task Force, 2013; Leach and Winson, 1995). Urban economic expansion has cut rural unemployment rates, while better-paying industrial and service sector job opportunities—coupled with a generally unfavourable attitude towards farm employment opportunities—have drained rural communities of a permanent and stable local agricultural wage labour pool. Social barriers to rural immigration, alongside rural exodus and aging population significantly impacts rural communities, and manifests in a declining local tax base, weakened public services, and depressed economic activity (Desmarais and Wittman, 2014). In turn, while workplace diversification is growing in rural communities, this is not necessarily being reflected in rural community settlement (Leach and Winson, 2002; Reimer, 2007).

In the absence of a readily exploitable domestic wage labour pool, North American agriculture has been characterized by a growing demand for temporary migrant wage labour (Basok, 2002; Bélanger and Candiz, 2014; Guthman, 2004; Kandel, 2008; Labour Task Force, 2013; Martin, 2002, 2003; Preibisch, 2012). The exploitation of migrant and racialized workers in Canada through federal programming and immigration policies highlights the state's role in harnessing an exploitable labour pool for capital accumulation in agriculture. The Canadian government established the first temporary migrant labour program in 1966 with the temporary admission of Caribbean seasonal agricultural workers. This did not solve the labour shortage, so the

[3] Settlers are broadly defined as those who occupy Indigenous lands. This term also intersects with racism to shape the social, economic, political and cultural privileges that white settlers have gained specifically, in contrast to people of colour (Byrd, 2011; Kepkiewicz and Dale, 2018; Thobani, 2007).

government introduced the Seasonal Agricultural Workers Program (SAWP) in 1974. By 2015, agricultural worker programs accounted for over 50,000 migrant workers in Canada (Weiler, 2018).

While the SAWP is the primary form of institutionalized labour exploitation in Canadian agriculture at present (Weiler et al., 2017), there is also a long history of both migrant and Indigenous labour exploitation (Friedmann, 1978; Laliberte, 2006). For instance, through the 'grab-a-hoe Indian' program, sugar beet farmers filled labour shortages by working alongside the federal government to force thousands of Indigenous peoples onto beet farms under grueling working and living conditions with poor access to food and water and very little pay (Carreiro, 2017; Laliberte, 2006; Laliberte and Satzewich, 1998). The industry operated across western Canada from the 1940s until the 1980s, allowing sugar beet farmers, and the industry as a whole, to accumulate significant capital.

Indigenous farm labour was augmented through—and later overtaken by—the migrant worker program to support farmers in exploiting labour for capital accumulation amidst the push by governments and corporations for farmers to 'get big or get out'. Notably, while the migrant worker program has expanded, no concurrent programming was developed to support marginalized peoples in Canada to access fair and socially just employment. For instance, while Indigenous communities have called on the Canadian government to fund comprehensive Indigenous labour and employment programming, this has yet to happen.

Racialized labour continues to be a necessary condition for the expansion and flexibility of agricultural industries in North America (Alkon and Agyeman, 2011). Agricultural employers harness a compliant, low-wage labour force according to seasonal labour input demands through temporary migrant labour programs in Canada and undocumented immigrants in the U.S. (Guthman, 2004; Kandel, 2008; Preibisch, 2010). These workers are crucial to the development of intensive horticultural and livestock industries (e.g., Boyd and Watts, 1997; Friedland et al., 1981); in 2008, hired farmworkers made up one-third of the estimated three million people employed in U.S. agriculture and over half are estimated to be 'unauthorized' immigrants (Kandel, 2008; Haspel, 2017). In Canada, primary agricultural occupations make up nearly 60 percent of all temporary foreign work positions (Employment and Social Development Canada, 2017). The remainder of the agricultural workforce is composed of (1) self-employed farmers, their unpaid family members, and year-round employees (Kandel, 2008; Statistics Canada, 2012), and (2) interns, apprentices, and volunteers, who are an important source of nonpaid labour for small-scale and alternative ecologically-oriented farming operations in particular (Ekers et al., 2015).

2.1.1. Projections of agricultural labour in the rural economy under technological change

Despite state interventions to build labour supply, supply gaps are an ongoing issue for Canadian and U.S. agriculture. The Conference Board of Canada (2016) projects that low-skilled labour shortages will reach 113,000 people by 2025 as a result of an aging farm population, seasonal fluctuations of employment, the rural location of employment opportunities, and a negative cultural perception of farm work. With difficulties recruiting and retaining domestic workers, temporary migrant wage labour is projected to continue to increase over the coming years (Labour Task Force, 2013; The Conference Board of Canada, 2016).

Meanwhile, the continued and projected use of temporary migrant labour sits uneasily with principles of labour justice (Alkon and Agyeman, 2011; Allen, 2010). Temporary farmworkers are disadvantaged as they are less likely to speak English or French, or possess a legal work permit (Kandel, 2008). Moreover, unemployment rates for hired farm labourers are disproportionately high, while weekly earnings are nearly half those of other wage and salary workers. While temporary migrant labour is supported through government programs, workers are subject to precarious livelihood and working conditions (Horgan and Liinamaa, 2017; Walia, 2010; Robillard et al., 2018), including long shifts and hard labour, limited overtime compensation or holiday and vacation pay (Kandel, 2008; Paz, 2008). This can include hazardous working conditions, with extreme variability in health and safety provisions and training (Grez, 2006; Paz, 2008; Preibisch and Otero, 2014). In Canada, temporary workers are contracted to work on a single farm each season, with their return in subsequent years being contingent on receiving a positive evaluation from their employer. With restricted mobility and the threat of replacement, workers cannot effectively negotiate their working conditions or initiate any form of collective action against their employers, and therefore experience high levels of occupational insecurity (Horgan and Liinamaa, 2017; Preibisch, 2012; Reid-Musson, 2017).

Although wages from temporary migrant labour programs may allow workers to invest in inexpensive land, business, education, housing, clothing, medical treatments, or other amenities in their home communities (Basok, 2003), data suggest that workers have restricted "upward mobility" and that most employees in the unskilled labour streams are poor or jobless when they are "aged out" of work (Martin, 2002). Meanwhile, Canadian federal citizenship policies, which could improve work and livelihood prospects for migrant labourers (Preibisch and Otero, 2014), do not favour low-skilled labourers (The Conference Board of Canada, 2016). Critics of contemporary Canadian migrant labour policy note that the persistence of highly exploitative forms of migrant labour juxtaposed with restricted opportunities for permanent residency reflect a legacy of state racism and ongoing patterns and processes of colonization (Grez, 2006; Perry, 2012).

While progressive movements work to end exploitative labour arrangements, agricultural labour continues to be shaped by a persistent structural demand for low-wage seasonal labour to achieve further capitalization (American Farm Bureau, 2006; Kandel, 2008; Labour Task Force, 2013; The Conference Board of Canada, 2016). It is also important to note the susceptibility of North American horticultural sectors, where labour costs constitute nearly 40 percent of total farm operation costs (Kandel, 2008; Vineland Research and Innovation, 2013) and where fluctuations in factors affecting the labour supply, such as changes to immigration policies, would disproportionately disrupt their operations (as we are seeing under the current U.S. administration's crackdown on immigration) (Baertlein and Huffstutter, 2017; Shanker, 2018).

As we will explore in this paper, technology may disrupt these existing labour dynamics in agriculture. For instance, to curb high labour demand, some horticultural operators are beginning to invest in new automated labour-saving technologies in the areas of transplanting, pesticide application, and grading (Vineland Research and Innovation, 2013). Automation is projected to rise to 28 percent overall by 2030, while the 'projected potential' for automation could reach 52 percent[4] (Scott, 2017). Farm manual labour and pesticide applicators are projected to be most highly automated by 2030 (97%). Farmers, ranchers, and agricultural managers, on the other hand, are least likely to be automated (4.7%).

Alongside these projections, there has been a global proliferation of financialization and venture capital investments related to emerging digital agricultural technologies. In 2017, for instance, agtech investment reached a new record of $1.5 billion and, since 2012, venture capital investment in agtech has grown by 80 percent annually (Kukutai and Maughan, 2018; Sparapani, 2017). The agtech investment landscape is now overflowing with start-ups promising to create, disrupt, and expand markets in the areas of gene editing and biotech; data analysis; AI and robotic design; as well as cloud-based technologies and marketplaces. Notably, many of these emerging start-ups are being

[4] This is based on an Oxford study using data from US labour markets (Benedikt Frey and Osborne, 2013).

rapidly acquired by agri-food and retail giants such as John Deere, Case IH, Bayer (which has now merged with Monsanto), Walmart and Nestlé (AgFunderNews, 2018).

Expected job growth in agricultural science, engineering, and other high-level positions presents a concern for rural agricultural employees in particular. Although it has been noted that digitalization, such as deployment of broadband, can bring service sector jobs to the rural economy (Ivus and Boland, 2015), it is unclear how jobs in primary agricultural production will be impacted. As Kristal and Cohen (2017) note, skill-biased technological change may contribute to wage inequality as demand for high-skilled, technological-savvy workers results in stagnant wages for less-skilled workers. These trends are complicated by the politics surrounding farmer debt and capitalization—as crop prices remain low, many farmers may find themselves unable to keep up with the capital-intensive investments necessary for digital farming technologies. In rural spaces characterized by persistent digital (Park, 2017; Warren, 2007) and labour (Binford, 2009; Reid-Musson, 2017; Weiler et al., 2017) inequities, a key question for scholars is, how might some actors exploit the opportunities afforded by emerging digital technologies, and how might others lose out? While further empirical observation is required to answer this question with certainty, the goal of this paper is to identify the current landscape of digitalization in agri-food, and consider the implications of this landscape for marginalized agricultural labourers and the rural communities that they work within.

3. Methodology

This paper emerges from an initial interdisciplinary workshop at the University of Guelph that brought together experts to identify and discuss key areas of emerging research priorities in rural and agricultural sectors. This workshop, with 20 scholars from diverse disciplines who are working across the fields of agri-food, digitalization and rurality (faculty, postdoctoral fellows, and graduate students) focused on discussions of trends and gaps in current analyses of these issues. Workshop participants were invited based on their research expertise; we aimed for interdisciplinarity because it is critical to understand these complex issues through diverse theoretical and analytical lenses. The workshop discussions were recorded and coded to identify themes.

Subsequent to the workshop, the lead researchers created a bibliography of peer-reviewed scholarly papers pertaining to the themes emergent from the workshop, including agriculture, digitalization, labour, and rural space. We used automation and labour-saving technologies as the main components of digital agriculture to organize the analysis, focusing on precision-tech, robotics, sensors, data software systems, drones, and mobile phones, as opposed to communication and transparency technologies like RFID chips or social media platforms.

In order to illustrate some of the key themes and questions that emerged from the workshop and the subsequent literature review, we also incorporated data from two studies undertaken by Rotz (2018) and Duncan (2018). Emily Duncan's study explored the adoption of digital agricultural technologies by crop and dairy farmers in Ontario. In 33 interviews with farmers who have adopted digital agricultural technologies and retailers selling them, it became clear that participants were concerned about how these technologies can address the nature of farm work and agricultural labour gaps. The second study conducted by Sarah Rotz (2018) considered race, settler colonialism, and the division of labour, focusing on Indigenous and migrant workers in southern Ontario. The relevant data from this study included five interviews with farmers who employ migrant labourers, as well as interview and focus group data with 20 food activists and representatives of labour and agri-food organizations. We have incorporated data from these two seemingly disparate studies in the analysis, because both studies demonstrated a larger question concerning the impact of digital agricultural technologies on marginalized and racialized labour and rural communities that requires urgent, and more in-depth scholarly attention.

4. Findings

Our analysis of the workshop, review, and field research data demonstrate three key, emerging issues that highlight tensions in the relationship between agricultural digitization and farm labour. Each of these have potential implications for marginalized and racialized labour specifically, which should help direct future research. First, rising land costs have put a squeeze on farmers, and some farmers are adopting automation as a way to reduce labour input costs. Second, while digital technologies are creating new high-skilled employment opportunities in agriculture, they are displacing some forms of low-skilled migrant labour. Third, labour is being impacted by the production of data itself and is shaped by new relations between players vis-à-vis access to and control over digital data.

One of the key conclusions drawn from the literature is that rising land prices and input costs alongside stagnant commodity prices have driven farmers of all shapes and sizes to minimize labour costs by any means possible (Fine et al., 1994; Woodhouse, 2010).

In turn, where possible, human labour costs have been cut by automating manual labour tasks or by exploiting migrant labour. This conundrum is not new. It is what drove the perceived 'need' to establish the seasonal agricultural workers program in the first place. However, while farmers have increasingly turned to seasonal worker programs as a solution to the perennial cost-price squeeze, some are now seeking alternative solutions via automation technology.[5] What is less obvious, however, is how technologies may allow *some* farmers to move from more expensive skilled labour, to temporary migrant labour. In one example, a retailer of precision agricultural technologies noted how automated steering made it more conducive to hiring migrant workers who may not have relevant on-farm skills (i.e. tractor steering):

> (Automated) steering … basically, you have to have it [in order] to do the job of farming anymore. But, a lot of the vegetable growers bring in offshore labor, and basically, they sit on the tractor and the tractor does all the driving. And the job is consistent and accurate all the time. You don't have to save a specific duty for a specific person. The technology takes care of that.

Additionally, rising land and input prices are increasing the opportunity costs of non-productive land use, which may include habitat remediation and ecological biodiversity, wind breaks, or storage buildings and worker housing. In this case, it is the land needed for worker housing that can contribute to making migrant labour less feasible and attractive, particularly if rental markets are not viable alternatives. An apple farmer who employs SAWP labourers explained,

> Labour is less reliable. Rents are astronomical. If you don't have on-site housing, rents are astronomical for anybody up here, which is a really big problem. A lack of public transportation again is really bad if you're trying to hire workers and they don't have their own vehicle. [My husband] says, 'What about some of these Syrians', but I said, 'How are they going to get here? I'm not running to Owen Sound twice a day.'

Conversely, in agricultural industries that are less amenable to migrant labour—primarily because they are not seasonal—such as the dairy industry, automation is shifting labour demand and changing the

[5] Automation technologies include robots, drones, autonomous tractors, and artificial intelligence that replace human labour in manual farm tasks. To be fair, we note that not all farmers are turning to technology. To deal with the economic squeeze in agriculture, many are moving toward differentiated, value-added and niche markets, such as organic, biodynamic and specialty products.

work environment. As one retailer of robotic milking machines explains, “So let's say you have a hired man to milk 100 cows, well maybe you can milk your 100 cows now by yourself *if* you put in robots. So there is definitely some labour savings.” Certainly, for larger dairies, the labour component is still critical; yet the adoption of automated technologies changes the nature of employment for rural labourers. A dairy producer describes the shift in her employment strategy since the adoption of robotics, highlighting a nexus of working conditions, labour retention, and a shift toward higher skills,

> I think people assume that you can really cut down on your labour hours and that is something that they market a lot with the robots. I don't completely agree with that. So we had nine workers before, but you have to think about the fact that they were shift workers. They did 3–4-h shifts, so they were not nine full-timers, they were nine part-timers. Now what we have is five full-timers and one part-time employee. But also in that time – we had 330 cows when we started and now we have 500 milking, so we have to allow for that growth as well. Our labour may have decreased a little bit but … we didn't choose to do it to decrease our labour. We chose to do it to have better labour retention and a better work environment. So, you will decrease your labour slightly but I think the biggest benefit is that you can hire more dedicated, more skilled people. Part-timers, there is a lot of turn-over. Full-timers we are able to retain, and that was the biggest reason. I don't want to be hiring someone new all the time, and it is also hard when shifts were milking cows – it is just hard to make it sound appealing. We truly stand behind the fact that the work that we have is interesting and you can allow a person to take courses and to learn more on the job and to have varied tasks and to be more integrated and more responsible for certain aspects of the farm, and I think that is the way that we can retain our people.

Another dairy farmer raised similar perspectives, stating,

> Milking probably isn't the most exciting job if all you are doing is attaching milkers to cows for three hours straight. So, we were also looking for a lifestyle change where you wouldn't be tied to having to milk cows at set times. And milking robots basically take care of that. There is still all the other aspects of farming that you have to take care of, but at least the most labour intense, repetitive part – the robot does. Our goal with switching from the parlour to the robots was that we could hire more skilled people because they wouldn't just be milking, they would be in charge of more animal health and animal welfare. And we could offer a better working environment for them. We have completely changed the way we hire and train and the way we have our work schedules for our team.

The second theme that emerged as a key tension is that while technologies are creating new opportunities for the farming sector, a significant number of migrant labour positions will be displaced via automation or higher skilled jobs, which raises pertinent ethical questions. As the cost of technology declines, automation technology—such as fruit and vegetable pruners and harvesters—is becoming economically comparable to migrant farm labour. Moreover, replacing migrant labour with technology allows farmers to side-step the social and political complexities of migrant labour management. Although the institutional and policy structures of the migrant worker program have already removed most of the social and political accountability (e.g. for worker safety and security) from farmers, automating farm tasks absolves farmers of any further public pressure to improve opportunities and livelihoods for migrant farm workers (Paz, 2008). On one hand, reducing the structural need for highly-exploitable labour through automation may seem socially desirable. On the other hand, this raises questions about what kinds of obligations farmers – and nations – have to individuals whose labour has subsidized agriculture for decades. It also raises questions about broader social justice and livelihood issues globally. In 2012, SAWP remittances to Mexico alone totaled $174 million with workers remitting almost $10,000 per trip, upwards of 80% of their total seasonal income (Wells et al., 2014). In our workshop, the interdisciplinary scholars noted that Western neoliberal policies, such as NAFTA, have resulted in the extraction of resources and the creation of landless poverty in countries like Mexico, which has generated a surplus of exploitable migrant labour. Rather than increasing compensation and improving working conditions for migrant labourers, however, the capitalist fix incentivizes farmers to simply replace them with automation. From the perspectives of migrant workers and labour activists, robots and other automation technologies will replace their jobs, deepening precarious poverty and making life even harder for migrant workers.

As vulnerable forms of low-skilled migrant labour are being replaced by automation technologies, the literature also shows that a qualitative shift in farm labour is occurring where a larger number of high-skilled employment opportunities are becoming available for domestic post-secondary graduates (Ontario Agricultural College, 2017; RBC, 2018). As farming operations integrate sensors, robotics and decision support systems, farmers require support for programming digital systems and software, machine and hardware maintenance, as well as agronomic knowledge, and even potential assistance with accessing capital funding (e.g. writing grant applications). With the rise of digitalization, work in the ag-food sector now requires a much more technologically savvy skill-set, which is already creating a gap between labour needs and labour supply. As another dairy farmer who uses robotics notes:

> We have suggested it several times at our local community college to have a course on agricultural electronics … We need somebody who is trained on how these systems are put together … Even the robot, there are electronics on there that have never given us a whole lot of trouble, but there are sensors that do fail. Our principal dealer has had training on what sensors fail, and he knows exactly where to look. He is looking for a guy to help him and he hasn't found anybody yet. He basically has to train the right person himself.

Many farmers are looking to build and design equipment and sensor systems themselves through technologies like Raspberry Pi. A small organic hops farmer, who was engaged in this type of activity, predicted that,

> I'll probably work with one of the locals here who does software design and get a bunch of Raspberry Pi units so that we can take the information from the drying process. What I want is temperature, air flow and humidity on each of the different floor-levels, and in the conditioning space. I want to be able to control my entire system so that, while we're doing all of our harvest work, I can know with a certain degree of satisfaction and reliability that the system is also protecting my end-product so it reaches the highest quality parameters possible. It's so simple, it's binary: turn this off, turn that off, or downgrade the speed of something … That is the end game. All the on/off switches and gauges are simply right there so that all we need to do is throw in a few more controls. It could also be wifi'ed to my computer in the house, so everything gets sent over.

This farmer explained that if he can automate slightly and double his acreage to 20 acres, he could dramatically reduce the time and manual labour required for processing and handling his crop—which includes harvesting, pelletizing and bagging the hops. These technologies are reducing the need for short term, manual labour that performs the “heavy lifting” of agriculture by replacing these jobs with a reduced number of highly-skilled full-time positions.

In this context, farmers had ongoing concerns about how shifts in skills – and skill demands – are impacting labour availability. In order to build in-depth knowledge and understanding of the specific farm context, many farmers need workers who are able to come back to the same farm year after year, but who do not expect year-round, on-farm employment. This is a significant driver for hiring migrant workers over domestic workers, as domestic workers are typically seeking long-term,

permanent full-time employment rather than seasonal employment. For domestic workers, farm employment is typically a temporary stop-gap rather than an annual commitment. Farmers thus noted that government policy and program support for migrant worker skill-building in the areas of digitalization and automation may be beneficial for farmers and workers alike.

However, without such shifts in policy, digitalization and automation will likely have adverse impacts on migrant worker employment. For instance, if seasonal agricultural worker policies seek to improve pay and working conditions for migrant farm workers without also attending to broader political issues (e.g. immigration reform, skills training and capital support), migrant labour displacement will be exacerbated by farmers replacing labour through automation. At the same time, social divides will likely emerge across the farm population concerning technological access—something we have already seen with older digital technologies. Pre-existing infrastructure access issues—-such as poor broadband internet availability—may be coupled with a lack of comfort with emerging technologies, technology trust issues, a perceived lack of use for farming, and disparities between technological availability and engagement to exacerbate inequities (Warren, 2004; Briggeman and Whitacre, 2010; Aubert et al., 2012; Hennessey, Lapple & Moran, 2016; Pant and Hambly Odame, 2016). As Basu and Chakraborty (2011) demonstrate, longstanding racial inequities, gender differences, and disparities in farm size affect access to technologies. We know, as a result of the 2016 Census of Agriculture in Canada, that larger, more capital intense farms are currently adopting digital ag tech at significantly higher rates (Duncan, 2018), even while some farmers continue without consistent access to basic broadband technologies (Duhatschek, 2018).[6] For example, in more marginal locales where migrant labour is not easily accessed, and where there are more significant farm labour shortages, digital technologies may not be a matter of displacing current labour per se, but rather about farmers without infrastructural resources to access, implement, and monitor new digital technologies. As such, this highlights other forms of agricultural marginality.

The third theme observed in the data is that digitalization is creating what we call a new 'sharecropping of agricultural data'. Data production technologies such as smart tractors require a system of data management to transform the data into useful outputs for farmers. Only then can data become an effective knowledge and decision-making tool. Many of these technologies are linked to specific data management platforms. The rise of these farm data management platforms such as Climate Field View mean that, while farmers still own the fields, they are effectively renting their data. In this sense, farmers and farm workers continue to carry the material risks and bear the livelihood impacts of agriculture while the capital gains of digitalization are, largely, extracted by data management companies. Indeed, agricultural data have significant use value because they are an essential tool for these companies' platform and predictive algorithm development. As with capitalist modes of banking, farmers deposit their data (money) into the system. These data are then used (reinvested) by the companies to make a profit.

In effect, some farmers are becoming 'digital labourers', while data management companies accumulate the economic benefits via the expansion of their knowledge systems—the new digital commodity. This is similar to the capital accumulation models of social media platforms such as Facebook and Google (Fuchs, 2018). Such user labour is yet another form of unpaid work under digital capitalism, raising the question of how this may allow corporations (and the web of digital agricultural support industries) to capture even more profits from the agri-food production chain (Clapp and Fuchs, 2009; Howard, 2016).

[6] Pant and Hambly Odame (2016), in their consideration of broadband in Eastern Ontario, note that in some farm contexts, digital technologies may provide local jobs while also reducing environmental costs.

One dairy farmer voices reluctance concerning the benefits of their data production for farmers:

> Everything is connected to the internet, I don't think you have any control over it anymore. That is a tricky one right, because like I said they [data management companies] have access to everything, yet we still get the bills all the time. So when do we get to issue a bill and get a little bit of a kick-back for the information that we are generating on a daily basis? Because, the supplier companies are like 'we need to find our R&D programs, to make it better for you guys'. But every time you make a new investment then the price of your equipment just went up because now it is the newest, latest, greatest, so you figure you [the company] can charge another 10% or another 5% or whatever amount it might be. So, you [the company] took all my information to do that.

Meanwhile, larger farmers in particular have noted the value of remote sensors and irrigation for maximising efficiencies as well as the leverage that real-time market and weather data provide for grain crop negotiations, leaving 'supersized farms' more empowered than ever before (Bunge, 2017, 2018). Within this context, future research might consider the possible implications of these shifts in power for more marginalized actors in the system, such as racialized and migrant farm workers?

5. Discussion

5.1. The socio-political landscape of agricultural labour amid digitalization

In both the workshops and interviews, participants were asked to reflect on how they foresee labour shifts and digitalization impacting social actors in agriculture. The key takeaway is that while digitalization is supporting farmers and companies to advance productivist, export-oriented agriculture, there are concerns that this will occur at the expense of labour equity and fairness. Participants noted that, without adequate political shifts, vulnerable groups like racialized migrant workers are likely to be most heavily impacted by labour disruptions caused by digitalization.

By briefly reflecting on the political structure and trajectory of Canadian agriculture, we gain valuable insight into the logic of this concern. While a comprehensive analysis is beyond the scope of this paper, a number of studies have effectively assessed the socio-political and racial structures that underpin Canadian agriculture (Carter, 1990; Holtslander, 2015; Laliberte and Satzewich, 1998; Preibisch, 2007; Thobani, 2007; Walia, 2010). This scholarship illustrates that the agri-food system has been built on and through structures of settler colonialism wherein white settler privilege over agricultural lands and resources resulted directly from the dispossession, dislocation, and exploitation of Indigenous lands and peoples alongside the maintenance of a landless pool of heavily exploited racialized and/or migrant labour. So, while many small and medium sized farmers have become increasingly economically oppressed by corporations in the food system—which may be exacerbated with the rise of sharecropping of agricultural data—economic oppression exists within a larger system of settler colonialism. In light of this, settler colonialism ought to be better integrated into academic and political discussions of labour moving forward since labour restructuring most often works in the interests of those who have shaped the larger system through which this (re) structuring operates. It is worth noting, after all, that Canada placed a series of often insurmountable barriers in the way of Indigenous farmers specifically. These included the pass and permit systems, which effectively barred Indigenous farmers from selling their own farm produce or even leaving the reserve without the permission of a settler Farm Instructor or Indian Agent. As Carter's (1990) work has made clear, these barriers effectively ensured the failure of Indigenous agricultural enterprise on the Canadian prairies and, in the process, provided a cheap labour pool for white settler farmers. Acknowledging the settler

colonial structure of contemporary agriculture helps to remind us that racialized and Indigenous peoples again face the potential for further marginalization through processes of labour restructuring and digitalization.

The reasons for the continued exploitation of racialized and Indigenous peoples under agricultural digitalization are directly related to how labour exploitability has been structured in the agri-food sector over time. As a representative of an Indigenous food organization argues,

> We have Indigenous people here that could go to nearby farms and develop reciprocal working relationships in agriculture. Many Indigenous communities nearby would love that work, but we cannot compete because the seasonal agricultural workers program is so heavily supported and assumed as status quo. Foreign labour is now just so heavily exploited for the growth of agriculture.

This statement illustrates how Indigenous and migrant labour has been transposed in Canadian agriculture according to different socio-political conditions of exploitation and expansion over time. For instance, as Indigenous farm workers began to demand better working conditions under the 'grab-a-hoe Indian' program, it became more difficult for farmers to exploit Indigenous labour (Carreiro, 2017). Rather than focusing on creating more socially just agricultural labour programming in partnership with Indigenous peoples, the government refocused its efforts on expanding the migrant worker program so as to capitalize on the exploitability of foreign labour; which now makes up half of the horticultural labour in Ontario (Wells et al., 2014). Indeed, the 'foreignness' of migrant workers has long been used to defend hyper-exploitation (Sharma, 2006), which can also be framed in terms of cultural, racial, and socio-economic factors. For example, one farmer notes, "The labour force is a huge bottleneck that is only going to get worse. I find here, it is very very hard to get reliable help. It doesn't matter what you seem to pay. It doesn't change the work ethic of society these days." Multiple farmers argued that racialized migrant workers are simply 'harder workers' who are 'better suited' to farm conditions (see also, Bélanger and Candiz, 2014), while 'Canadians' (which we may take to mean white settler citizens), 'don't want to do this work'.

5.1.1. How is the socio-political landscape shaping agricultural digitalization and labour realities?

Agribusiness firms are largely driving ag-tech development, and these private companies have largely focused on farmer capitalization, with scarce support for labour welfare (McMichael, 2013). In the process of technological advancement then, ag-tech companies are unlikely to produce technologies directed at improving migrant farm labour conditions and training, especially if farmers can instead be convinced to further capitalize by adopting technologies that displace labour. In other words, current economic conditions lock employers (who are, in this case, farmers) into a decision between retaining manual workers or replacing them with technology. Under these conditions, a company would not be compelled to develop technologies that improve migrant labour conditions or support—fair and effective—integration of labour into increasingly automated farm systems. So, while farmers noted a desire to engage in labour up-skilling, mentorship, and cooperative labour pooling as well as collectivized/cooperative automation, these practices largely work against the economic objectives of the ag-tech industry. Moreover, historical and current trajectories indicate that the economic benefits of integrating labour equity into digitalized farming systems would not be accrued by the employer. Rather, such an approach might increase the economic costs for farmers because their labour expenses may remain the same while their equipment costs rise. After all, public programming is not focused on building migrant workers' 'tech-savvy' skills, and new technologies in agriculture have not demonstrated a focus on making their working lives safer or more pleasant. For now, the primary focus for developers seems to be offsetting the need for migrant workers altogether.

As agricultural technology evolves, it is clear that manual labour opportunities will decline alongside a rise in technological design and management opportunities. Within this political and economic context, who then will be able to access such opportunities, and how? If sufficient public support is not provided for vulnerable groups to access material resources and training, they are likely to be further marginalized across the sector, and the economy more broadly. This, we argue, is of fundamental concern.

Pertaining to the issue of 'skill' specifically, recent employment reports show that those with greater resources available to prepare and adapt to labour shifts in the new 'skills economy' will likely 'win out' (RBC, 2018). Another report notes that, "many workers will need to upskill or retrain as their roles evolve to incorporate AI - one positive is that for employees who are highly skilled in tech there will be many opportunities to progress and develop. As their skillset becomes more sought after, there will also be a greater case for higher salaries" (Jobbio, 2018, p. 6). The recent Advisory Council on Economic Growth report supports this projection and argues that 'soft' digital skills are the fastest growing job-related needs, such as critical thinking, and social and emotional intelligence. The report also states that "technological innovations will heavily affect groups already underrepresented in the labour market." As a result,

> … there is an economic and social imperative to raise workforce participation among Indigenous people, lower-income workers, women with young children, Canadians over the age of 55, and persons with disabilities. That task will become all the more difficult as technology replaces many of the jobs people in these groups currently perform[…]the global job-loss rate among women will be double that of men over the next five years as automation heavily disrupts office and administrative roles that are largely filled by women (Advisory Council on Economic Growth, 2017)[7]

Our data support this projection and indicate that employment opportunities in the field of digital technologies are increasingly accessed by privileged populations, raising questions of equity for those who do not have access to the skills needed to thrive in the new economy. For example, neither policy nor technology has advanced public access and monitoring to ensure that migrant farm workers are being treated well on farms. And, while the technology is theoretically available to provide this information, we still know very little about the conditions for migrant farm workers. For instance, while the Occupational Health Clinics for Ontario Workers (OHCOW) have recently established a program to educate migrant farm workers and employers about on-farm health and safety, there is no government-mandated monitoring of migrant worker health. As a labour representative argued, "occupational health is an important issue. There are no protections around pesticides and chemicals or around providing bathrooms on farms, or health and safety. There are no specific regulations, and that's also because of the influence of employer organizations." From this perspective, we can predict that digital agricultural technologies will be applied in the service of companies and—to a lesser degree—farmers, without being used to address the needs of vulnerable migrant farm workers themselves.

5.1.2. The spatial effects of digitalization for labour and rural communities

Finally, the data reveal pertinent spatial features of digitalization for labour and rural communities. Firstly, our data confirm recent research that has shown how lower levels of education and skills in rural areas disempower agricultural workers and impact their capacity to adopt emerging technologies (Salemink et al., 2017). Additionally, while automation technologies are being developed to serve small-scale and niche producers as well as large commodity farmers, economic

[7] We want to note that while the gender dimension is beyond the scope of this paper, it is an important and under-researched concern.

conditions in agriculture continue to facilitate farm scale growth and farmland consolidation. This trajectory is occurring alongside the increase in demand for workers with more flexible, digital skills, which together support rural-to-urban migration. That said, this trend does not hold true in all rural communities.

In some rural communities, an urban-to-rural exodus is occurring as a result of high urban real estate prices along with the rise in ICT (i.e., telecommunications and remote opportunities) and the expansion of broadband networks (Pant and Odame, 2016). As a result, as noted in a U.S. study by Nelson et al. (2014), some rural communities are experiencing an influx of in-migration from baby boomers and im-migrants, which has stimulated expansion in auxiliary sectors like construction, restaurants, and housekeeping. The authors argue that, in these communities, migrant workers provide the labour flexibility needed to support shifting demand. Further, they identify this labour as essential to the economic development of these rural "amenity destinations," but note that this influx of flexible labour is largely benefitting local employers while still marginalizing migrant workers.

Similar dynamics are emerging in some rural areas of Canada. Wealth and demographic disparities across the Niagara Region of Ontario illustrate this. For instance, the rural revitalization of destinations such as Niagara-on-the-Lake (NOTL) stand in stark contrast to the poverty experienced by large numbers of migrant workers who are living on the outskirts of Virgil, Ontario—a small rural community just 6 km down the road from NOTL.

Niagara-on-the-Lake has become an upscale tourist destination replete with many fine dining and retail outlets. It attracts thousands of visitors annually through promoting its arts and cultural events and historic sites. In contrast, Virgil is a residential community nestled next to large-scale winery, tender fruit, and nursery operations. Due to its proximity to such companies, it is often a preferred destination for migrant labour housing. In fact, the gentrification of the Niagara-on-the-Lake community *relies on* the impoverishment of temporary migrant workers who reside nearby, but not, of course, within NOTL. Gentrification in NOTL is deeply dependent on local tender fruit and grape production, as local wine and cuisine are central drivers of tourism and economic development. In order to accumulate the capital necessary for gentrification, these primary industries often require cheap, migrant labour. Specifically, migrant worker exploitation allows for the tender fruit and wine industries as well as auxiliary sectors to thrive and grow, which is vital to the gentrification process of Niagara-on-the-Lake. Within this context, there is a need for research that specifically examines how the economic dynamics in rural communities like NOTL might impact agricultural labour as digitalization evolves. While the fate of towns like Virgil remain to be seen, gentrified areas like NOTL will likely need less migrant labour in the future. Will Virgil then be absorbed into the gentrified area, or will it fall further into rural isolation as the community of migrant workers are no longer needed?

Similarly, how might ongoing racial and cultural tensions in rural communities impact agricultural labour as digitalization evolves? Farmer respondents referred to growing social conflict in rural communities between settler residents and migrant farm workers. As one farmer notes, "you go to Simcoe on a Thursday or Friday and the whole town is full of other ethnicities … there is a bunch of workers from Jamaica. At some point during that evening there will be some altercation between an idiot who's from Simcoe an idiot who is from Jamaica." Such tensions elucidate the 'discomfort' felt by white settler culture in interacting and sharing space with racialized peoples (e.g. many local residents avoid shopping when racialized migrant workers have time off and are out and about in town) and reveal the ongoing imaginary of rural spaces as white settler spaces (Bonds and Inwood, 2016; Gahman, 2016; Panelli et al., 2009; Rotz, 2017). We wonder then how these racial tensions may influence farmers in their decision to displace migrant labour for automation, and how migrant labour displacement will impact the social and economic landscape of many small (and struggling) rural communities. In Leamington, for instance, a town of only 27,000 people, temporary migrant workers contribute approximately $15 million per year in economic activity and have transformed the local economy (Mojtehedzadeh et al., 2017).

6. Conclusion: the future of digital agriculture and labour restructuring

This paper has explored digital agricultural technologies and their potential implications for agricultural labour and rural communities. We acknowledge that digitalization and automation stand to significantly improve the lives of farmers and workers who can afford and utilize these technologies, while creating new agricultural employment opportunities in the digital agricultural sector. However, these benefits sit uneasily with historical processes of exclusion, digital and otherwise, by governments, corporations, and those who are able to fully exploit the benefits of new developments in agriculture. This struggle may be even more pronounced in more marginal locations where labour shortages intersect with poor digital infrastructure and asymmetrical power relations between tech corporations, landowners, and farm labourers—a dynamic that can be better understood through further empirical analysis.

We also know, however, that farmers who are deploying digital agricultural technologies are doing so to build their enterprise and to survive in an increasingly competitive industry. This is not inherently negative, but it does have important implications for the future—and, we argue, is an important topic of prospective research. These technologies are being deployed to advance their economic profits, rather than to improve the lives of more precarious and vulnerable groups in the sector. In particular, digitalization may further propel capital flows from workers to farmers, between farmers (according to their scale of capital accumulation) and from farmers to agribusiness companies and their digital assemblages. Much like in any period of technological transition, there will be winners and losers. While the opportunities for tech savvy, flexible workers in particular are promising, it is essential to consider who exactly is able to access these opportunities, and who is not. Concerning policy, instead of focusing on how we can curtail the need for labour altogether, we must consider what our collective role is in improving the lives and opportunities of the most vulnerable workers in the industry.

While the digitalization and automation of agriculture may lead to net job losses for low and unskilled workers, it may also lead to evermore marginalization and exploitation of those lower-skilled migrant labourers for whom there *are* still jobs. More pointedly, it appears that the technophilic promise of agtech will likely displace existing agricultural labour hierarchies with a radically bifurcated labour market, where on the one side, highly-skilled, highly-trained workers use digital agricultural technologies to increase productivity and find evermore efficiencies, while on the other side, lower-skilled workers in the fields, greenhouses, processing plants and warehouses are subject to increased employer scrutiny and surveillance, further rationalization of their workplaces, and ever-escalating expectations of productivity. Lessons of digitalization and automation from other sectors are instructive in this regard. For example, the rapid automation of retailing through internet shopping has created an array of new types of warehouse jobs, with workers subject to levels of workplace fatigue and employer surveillance beyond anything imaginable in factory work of the industrial era (Davis, 2014; Mojtehedzadeh and Kennedy, 2017; Soper, 2011). This area of research remains underexplored, but we stress that it is of critical importance to agri-food studies—and critical social sciences more broadly—moving forward.

In this sense, as digitalization evolves in agriculture, the effects on labour are inherently politicized. While decision-makers, companies, and governments are stressing the need for agricultural workers to adapt to disruption in the so-called 'digital age,' what does 'choice' and 'flexibility' mean for vulnerable workers? What support and resources do these populations have to allow them to participate in the 'skills

economy'? This dialogue continues to situate choice within the individual. As digitalization and automation forge ahead, individual workers must then figure out how to flexible-ize themselves. This highlights a number of ethical questions that remain unaddressed.

Primarily, what about government choice and direction? Concerning Canadian governance, automation is reducing the number of exploitative, precarious jobs in the ag-sector and is 'replacing' these jobs with higher paid employment opportunities for domestic University graduates. If digital technology means we trade-off exploitative, migrant jobs for better paying tech and 'soft' skill jobs, do we have a moral obligation to return some of these revenues to migrant workers and their communities, or, at minimum, provide them with relevant training?

Policy, programming and legislation have the potential to help shift the trajectory of digitalization in ways that support food security *as well as* vulnerable agricultural labourers. Indeed, digitalization and automation could, theoretically, benefit marginalized groups. For instance, as mentioned earlier, digitalization could be used to build transparency around labour treatment, fairness and care.

To begin addressing concerns over labour equity and agricultural digitalization, further research and discussions need to consider three priority policy areas. These are not intended to be comprehensive solutions, but necessary first steps:

1. Pathways to agriculture and farming for immigrants and migrant workers. To protect racialized and migrant agricultural labourers from being excluded from the digitalization trend in agriculture, future research and action should seek to improve labour mobility and immigration for these workers and develop programming for entry into agriculture and food growing for new immigrants (including residency, resources for starting a farm, and training opportunities).
2. Support for currently marginalized forms of farming, including for racialized farmers and those who have and continue to be blocked from agricultural enterprise. This requires attention to theories and practices of land repatriation and labour programming for marginalized communities and workers in ways that build agri-food systems that are relevant to them and that *integrate* labour with automation (e.g., collective automation and cooperative labour pooling for smaller farmers in particular).
3. Capacity and skill building support in rural areas for vulnerable populations. In order to access the benefits of new digital agricultural developments, there requires sufficient re-skilling and training for marginalized and racialized labourers to support them in developing their digital agtech skills. Research should consider potential avenues for bringing these activities into rural communities themselves, as well as what is needed to develop rural spaces that immigrant workers feel comfortable residing in.

Overall, we emphasize that the current enthusiasm for digital agriculture should not blind us to ways that new technologies have the potential, as outlined here, to intensify exploitation and deepen marginalization. Digital agriculture holds promise for improving many dimensions of our food system, but the possibilities for equitable, non-exploitative agtech development need to be both enhanced and foregrounded in future policy and research.

Declarations of interest

None.

Funding

This work is supported by the Social Sciences and Humanities Research Council of Canada (SSHRC) and is associated with 'Food from Thought', the University of Guelph's Canada First Research Excellence Fund project.

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