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Working like machines
Exploring effects of technological change on migrant labour in Dutch horticulture

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Abstract

This paper engages with the translation of technological upgrading into migrant workers' opportunities for employment and decent work in agriculture, a sector commonly disregarded in the debate about the future of work in an era of automation. Zooming in on migrant workers in Dutch horticulture, it explores how technological innovation in horticulture is connected to the scope and conditions of employment and proposes a heuristic to conceptualise the observed dynamics. Our analysis that reads interview data with actors in the Dutch agri-food sector through the lens of the global value chain (GVC) literature contrasts with the pessimistic prediction of widespread technological unemployment. We find product upgrading, e.g., into high value-added products, and process upgrading, e.g., through climate control in greenhouses, to offer potential for more and secure employment. However, workers' higher work intensity and the dismantling of entitlements to rest and reproduction in an attempt to 'make people work like machines' represent the underbelly of these dynamics.

Keywords

Employment, global value chains, horticulture, migrant labour, the Netherlands, precarious work, technological change.

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1 Introduction

> There are actually two worlds [in Dutch agriculture]. One world uses drones, robots to harvest asparagus. Huge investments are made to improve quality, to save money, save energy. On the other hand, there is a vast demand for cheap labour. (Trade union representative to the Social and Economic Council of the Netherlands (SER))

Processes of automation and digitalization in the world of work have raised challenging questions about the future of employment. They have sparked a renewed interest in work conditions and the notion of technological unemployment, characterized by Keynes (2010: 325) as "[…] unemployment due to our discovery of means of economizing the use of labour" (Autor et al. 2003, Acemoglu and Restrepo 2016, Arntz et al. 2016, Korinek and Stiglitz 2019, Swan 2017, Spencer 2018).

According to Frey and Osborne's (2013) influential study, 47 per cent of all jobs in the US labour market fall into a high-risk category which means that they could be completely automated in the next decade. In contrast, Arntz and colleagues (2016), based on an analysis of 21 OECD countries, argue that these predictions are an overestimation. Nevertheless, they do contend that the current technological changes outpace all the previous ones, and that labourers engaged in manual work will be most affected. Whereas in the past technological changes in fact often spurred the need for new kinds of employment, this time it might be different. Moreover, even when new employment is created, Mokyr and colleagues (2015: 38) remind us that "[…] while the predictions of widespread technological unemployment were, by and large, wrong, we should not trivialize the costs borne by the many that were actually displaced". This is relevant, as the employees we examine, namely migrant workers in horticulture, do predominantly manual work, and unlikely to be able to shift easily into newly created jobs.

This paper engages with the role of technological change for workers in the agri-food sector, an industry commonly disregarded in predictions of technological unemployment. The Netherlands' position as one of the world's top agricultural exporters (FAOSTAT 2021) backed by a high degree of technological innovation (OECD 2015: 14) makes it an interesting case for the exploration of the effects of technological change. Yet, currently, in the 'national sociotechnical imaginaries' (Lei 2021: 5) that shape the debate on the

[1] This paper is based on: Ivosevic, P. (2018) *Treating People as Robots: The Effects of Technological Changes in the Dutch Agro-food Sector on Central and Eastern European Migrant Workers*, MA thesis. The Hague: ISS.

[2] We gratefully acknowledge excellent research assistance by Tyler Williams.

future of work in the Netherlands, agriculture is only an afterthought. Listing automation as one of the three most significant ongoing developments with potentially far-reaching consequences for the amount and conditions of work, Engbersen et al.'s (2020: 22-24) recent advice to the Dutch government, discusses only technologies' implications for the services sector. The Social and Economic Council of the Netherlands (SER) foregrounds the opportunities of the ongoing 'digital transition' for welfare but largely delinks this trend from its advice on the labour market and agriculture (SER 2021, 2016).

We zoom in on migrant workers in Dutch horticulture, the country's most successful and most labour-intensive agricultural sub-sector. As highlighted in the introductory quote, the precariousness of the migrant workers employed in this "highly competitive industry in a wealthy country" (Kroon and Pauwe 2014: 20) is the flipside of its export successes. The availability of migrant workers from Central and Eastern European (CEE) countries since the EU enlargements in the 2000s has enabled employers to segment employment patterns and pay by immigration status (Burchell and Rubery 1990: 551). Mostly recruited via temporary work agencies, CEE workers are invisibilised in labour statistics, and - more importantly – have only minimal economic and social entitlements (Siegmann and Williams 2020).

We explore the role of technological change in Dutch horticulture for these migrants through the lens of what the scholarly work on global value chains (GVCs) has termed 'economic upgrading', i.e., improvements in firms' ability "[…] to move to more profitable and/or technologically sophisticated capital- and skill-intensive economic niches" in a GVC (Gereffi 1999: 51-2). Whereas early GVC studies narrowly focused on firms, more recently, connections between technological upgrading and impacts on workers have been studied in the literature that relates such economic to social upgrading. It distinguishes the quantitative amount and qualitative characteristics of employment as different aspects of social upgrading in GVCs (e.g. Milberg and Winkler 2011: 344). These quantitative and qualitative dimensions match concerns for technological unemployment on the one hand and precarious work on the other as possible consequences of ongoing automation, robotisation and digitalization (Marengo 2019, Pierce et al. 2019). The lens of economic upgrading allows us to go beyond a rather broad-brush assessment of technologies' impact, and instead enables us to discern differentiated (and sometimes counterrotating) tendencies.

This way, our analysis not only provides fresh perspectives from a sector by and large ignored in literature on the future of work amidst the so-called 'fourth industrial revolution' (Schwab 2015), but also proposes a heuristic to conceptualise the dynamics we observe. The qualitative data we analyse enable us to distinguish diverse forms of technological change that upgrading may take. By focusing on an OECD country, we address GVC studies' bias towards 'developing countries' that assumes that rich countries provide high value-added activities, based on decent labour conditions, to the value chain (Fernandez-Stark and Gereffi 2019: 63). Nikulin et al. (2021: 2) question this assumption by pointing out that: '"Made in Europe' is not automatically

equivalent to 'fair labour conditions'". This seems especially true for sectors that thrive on migrant labour.

The paper proceeds by conceptualising technological change in the agri-food sector through a global value chains lens (section 2), and subsequently introduces the study's methodology (section 3). To embed the analysis in the context of the Dutch horticultural sector, the importance of CEE migrants for and recent technological trends for this sector are briefly explained in section 4. Based on the empirical data presented in section 5 and the heuristic built on them in section 6, we argue that changes in the production process that seek to 'make people work like machines' cause both technological unemployment and heightens the income insecurity and labour intensity that workers experience. Product innovation, in contrast, holds more potential to increase labour demand and to offer more stable, direct employment relations. In section 7, we conclude with an outlook for change.

2 Technological change in the agri-food sector through a global value chains lens

According to the critical global value chains (GVCs) literature, the coexistence of the 'two worlds' of high tech and low labour standards in agriculture sketched in the opening quote is not coincidental. Rooted in various strands of structuralist theory, this literature identifies precarious migrant labour as constitutive of value creation in globalized agri-food chains (e.g. Azmeh 2021, McGrath 2013, Phillips 2016). It contrasts with early conceptualisations of GVCs which view economic upgrading as an unequivocally desirable process. At the firm level, Humphrey and Schmitz (2002) distinguish four types of such upgrading. They include process upgrading, e.g., by introducing superior technology, product upgrading, for instance, by moving into the production of higher value items, functional upgrading, which entails an increase in the overall skill and value-added content of the activities and, finally, chain or intersectoral upgrading, where firms move into new industries (Fernandez-Stark and Gereffi 2019: 61). Product and process upgrading are often mutually dependent, e.g., when technological upgrading of the production process leads to a new category of products (Matheis and Herzig 2019: 130). These two types of upgrading have been the focus of agri-food chain analyses (Matheis and Herzig 2019: 127) and of this paper, too.

The recognition that not all producers and workers involved in GVCs gain from upgrading led to the more recent distinction of economic and social upgrading (Barrientos et al. 2011, Milberg and Winkler 2011). With Barrientos et al. (2016: 1274), we understand social upgrading as access to better employment opportunities, improved working conditions and wages as well as firmer guarantees of enabling rights, such as freedom of association and non-discrimination. Milberg and Winkler (2011: 344) highlight that the assumed association between economic and social upgrading is underpinned by neoclassical theory, in which technological change determines labour demand, and thus wages. Institutionalist theory, in contrast, delinks wages from

technological change and rather associates them with social institutions, such as protective legislation and collective bargaining processes.

For agri-food chains, in particular, economic upgrading strategies often translate into job insecurity and the associated vulnerability of livelihoods (Matheis and Herzig 2019: 132). In their research on agri-food chains, Matheis and Herzig (2019: 127) point out that "[…] process upgrading can imply a replacement of manual tasks by a machine, leading to a decrease in positions for low-skilled workers and those without formal contracts, while medium- and high-skilled workers are still in demand for maintenance, supervision and training". The downsides of economic upgrading (paralleled with social 'downgrading') do not affect employees homogeneously within a sector. Overall, cheap labour costs and flexible and vulnerable labour arrangements have been identified as intrinsic especially to buyer driven GVCs dominated by powerful transnational corporations or lead firms (Rossi 2019: 273).

The GVC literature has identified key value chain actors that mediate the effects of upgrading for workers. Lead firms' market power, derived from their oligopolistic position, plays a central role here. It enables them to pass on competitive pressure on prices to growers and workers. This may lead to a dynamic that counters the assumption in much of the GVC literature (e.g., Lutz and Olthaar 2017, World Bank 2007) of the rise of improved technologies through value chain insertion, as buyers' price pressure catalyses investment in labour-saving technologies. In the Dutch horticulture such price pressure instead leads to downward pressure on real wages. The financialization of, for instance, large retailers, further aggravates farmworkers' exploitation by increasing workloads, pushing down real wages, and heightening the insecurity of their positions (Isakson 2014: 749). Besides, Barrientos et al. (2011: 330) draw attention to the role of third-party labour contractors in seasonal employment in agri-food chains. While enabling growers to offset production or market risks and minimize labour costs and potentially helping workers to enhance their continuity of employment between different producers, "it can also open up space for unscrupulous agents who expose workers to high levels of exploitation both on and off site". Overall, Matheis and Herzig (2019: 126) flag that, in fact "[…] economic upgrading can also be achieved by a deliberate degradation of conditions for the workforce, or "social downgrading", when labour cost savings lead to increased profit margins, at least in the short run."

Bearing these dynamics in mind, our paper links the high-tech features of the Dutch horticultural sector with the low status of CEE migrant farmworkers and asks how ongoing technological changes affect CEE migrant workers' employment and working conditions.

3 Methodology: Fieldwork on workers in Dutch fields

To capture the diverse facets of changes in employment and working conditions that may result from technological advances in agri-food chains, we conducted qualitative research in the Dutch horticultural sector.

Semi-structured interviews were considered sufficiently flexible to engage both with quantitative and qualitative shifts in CEE migrant workers' employment conditions, while simultaneously allowing for comparison between different (groups of) interview partners. The resulting in-depth conversations focused on workers' conditions and concerns in Dutch horticulture, and how new technologies influence these conditions - presently and possibly in the future.

Often used when working with populations that are not easily accessible, we applied what is called chain or snowball sampling: interviewees were asked to suggest further interview partners. This was very appropriate with CEE migrant farmworkers who are often reluctant to talk about their experience, fearing that it might negatively affect their employment status (cf. McGauran et al. 2016: 7).

Existing contacts with representatives of the Netherlands Trade Union Confederation FNV in the agricultural sector helped to identify, and facilitated access to, most interviewees. To enable triangulation, we reached out to different actors, ranging from migrant workers themselves to representatives of unions, employers, various government bodies as well as academics (Table 1).

Table 1
Research participants' background

Name	Gender	Nationality	Occupation & affiliation
Julius	M	Dutch	Consultant FNV/Agrarisch Groen
Agnieszka	F	Polish	Consultant FNV/Agrarisch Groen
Gerda	F	Dutch	Project Leader FNV/Enforcement
Ron	M	Dutch	Researcher Tilburg University
Inge	F	Dutch	Labour Policy Advisor Westland Municipality
Joost	M	Dutch	Socio-Economic Advisor LTO Nederland
Robert	M	Polish	Worker/Shop steward FNV/Flower Sector
Tomasz	M	Polish	Worker/Shop steward FNV/Meat sector
Jan	M	Dutch	Worker/Shop steward FNV/Flora Holland
Frank	M	Dutch	Manager FNV/Agrarisch Groen
Ursula	F	Dutch	Socio-Economic Advisor Social and Economic Council of the Netherlands (SER)
Geert	M	Dutch	Advisor FNV/Industrial policy, Restructuring, Workplace Innovation

Based on informed consent, all but one of the 12 resulting interviews were recorded, transcribed, and analysed together with the notes that were taken during every conversation. To protect interviewees' identities, their names have been changed. The interview data were coded based on an initial code list inspired by Pajnik's (2016: 161) framework for the analysis of migrant precarity in European labour markets. It foregrounds the role of features of the labour

process (including technology), the governance of immigration and employment, as well as workers' social identities. The resulting codes were enriched inductively based on the interview data. The coded material was subsequently annotated, focusing on data segments that were labelled both with a group of codes related to 'Technology' and either the code 'Employment: quantity' or 'Employment: quality'. Based on this inductive process, we identified conceptual connections between different types of technological upgrading in Dutch horticulture and their implications for the amount and quality of CEE migrants' employment.

4 Migrants and machines in the Netherlands' high-tech horticulture

> [The] Netherlands have many cheap people to work, mostly migrants. If you go to the supermarket, you get two cucumbers for the price of one, that's not possible! Somebody pays the price for this! (Labour Policy Advisor Westland Municipality)

4.1 Horticulture in the Netherlands

Horticulture is a key sub-sector of the Netherlands' highly productive agriculture. In 2018, agriculture accounted for 6.4 per cent of the country's GDP (Afrian et al. 2020). By reaching record values of 94.5 billion euros in 2019, the Netherlands reaffirmed its position as the world's second largest agricultural exporter, with horticultural - flower, vegetable and fruit - cultivation achieving the single-highest export value (CBS 2020a).

Dutch horticulture is regionally concentrated. Many open field fruit and vegetable farms are located in the southern provinces of North Brabant and Limburg, while North Holland is a hub for flower bulbs production and other open field floriculture. The Westland municipality in South Holland is the 'capital' of greenhouse horticulture. Over the years, farm numbers have shrunk, while acreage has remained stable or has even increased (CBS 2021a). Trade unionist Frank explains this with the dominant role of retailers in the buyer-driven horticultural chain: "The prices are dictated by the retail sector, that's a big problem at the moment, because you have three big companies in Europe who are setting the conditions, and they determine the price as well. This is why only big farmers are able to cope with that pressure and to survive." (interview Frank 2018).

In line with a broader pattern in the global agri-food supply chain (Isakson 2014), Frank's explanation reflects that the traditional auction system for agricultural goods in the Netherlands has increasingly been bypassed by retailers who control the supply chain through direct contracts with growers (Kroon and Pauwe 2014: 25). In 2019, the five biggest supermarkets in the Netherlands held a combined market share of 79 per cent, and the largest two alone accounted for over 55 per cent. This concentration has risen over the years (Distrifood 2021). While this concentration has gone hand in hand with

large price margins for retailers, retail prices of labour-intensive fruits and vegetables have declined, and farmers' income is under pressure (Kroon and Pauwe 2014: 25). This pressure is passed on to workers whose workload has increased while their real wages have gone down.

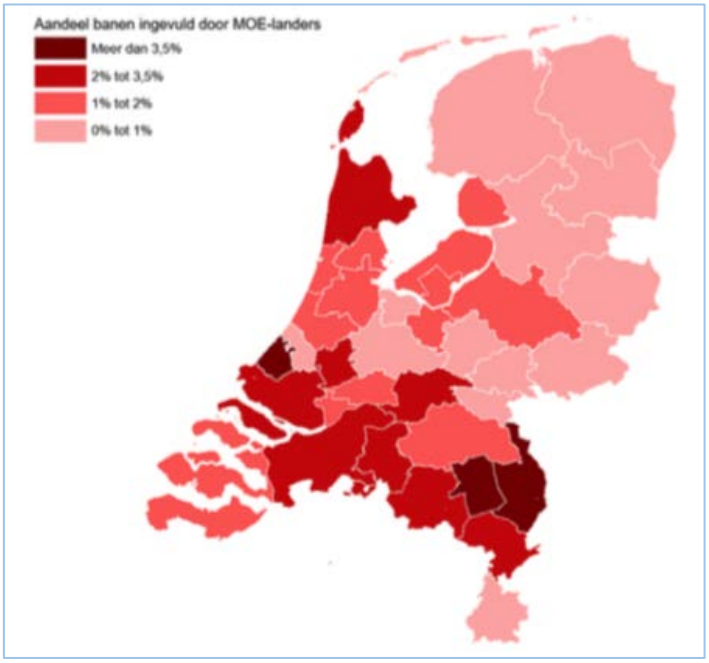
4.2 Migrant labour in the Dutch agri-food chain

The regional distribution of the agricultural labour force follows the pattern of horticultural production in the Netherlands. Labour-intensive agriculture is concentrated in northern Limburg, eastern Brabant and Westland municipality in South Holland – the main regions of horticultural cultivation. Among others, the high labour intensity in horticulture is related to the fact that EU subsidies have enabled dairy and beef producers to invest in labour-saving technologies, while hardly benefitting horticulturalists (OECD 2015: 218).

While labour demand has reduced over time, it is still high for two diverging types of tasks in Dutch horticulture (Kroon and Pauw 2014: 24): 1) skill and knowledge-intensive tasks, like the management of climate systems, and 2) skilled work for which no specific education is needed, though, such as planting or harvesting fruit. Most labourers are employed in this second category, predominantly CEE migrants.

CEE migrants have shouldered most work in Dutch horticulture since the EU enlargements in 2004 and 2007 enabled their intra-union mobility (Snel et al. 2015). Heyma et al. (2018: 5) estimate that, in 2016, 371,000 persons from CEE countries were employed in the Netherlands, the largest share of which

Figure 1
CEE migrant workers as share of total employment by region (%)



Source: Heyma et al. (2018: 7)

was employed in agriculture either directly or via recruitment agencies (Heyma et al. 2018: 7-8). These estimates are more than twice the total regular workers in agriculture that labour statistics record, out of which about a tenth are non-Dutch nationals (CBS 2021b, 2020b). It comes as no surprise then, that regions with the highest concentration of CEE migrant workers map onto the centres of horticultural production in northern Limburg, Westland municipality, North Brabant, and the tip of North Holland (Figure 1). Polish citizens represent the largest group among them, followed by workers from Romania and Bulgaria. While women and men are represented quite equally, with most workers below 35 years, the migrant workforce in agriculture is relatively young (CBS 2020b).

CEE migrants' significance for the Dutch economy is in stark contrast to the precarious conditions of their work. Rather than crowding out of nationals, observers identify labour market segmentation that maps the two types of tasks sketched above onto the immigration status of the workforce (Heyma et al. 2018: 19). Migrant workers in the Netherlands are usually employed in jobs that Dutch workers are reluctant to take (Cremers 2018: 11, Cremers 2016: 22, Engbersen et al. 2020: 199). They are are particularly susceptible to experiencing low and insecure wages, flexible employment relations and physically hazardous conditions (ISZW 2019: 16, McGauran et al. 2016).

Such precarity has been enabled by the highly flexibilised Dutch labour market. This includes the legalisation of indirect employment contracts with recruitment agencies that most CEE migrant workers hold through the 1999 Flexibility and Security Act. The relevant collective bargaining agreements (CBAs) provide agency workers with staggered economic and social entitlements: During the first phase of up to 26 weeks, their contract may be terminated at any time and workers are paid for hours worked only, while workers in the last phase must be offered a permanent contract and receive payment even if there is no work for them (McGauran et al. 2016: 51-2, Van Liemt 2013: 12-3). Dismissal after the first phase and reemployment after a period of unemployment is common, resulting into most CEE migrants holding first phase contracts. The modest unemployment benefits that workers are entitled to are part of a business model that ensures maximum flexibility at low costs to growers.

Shortages of skilled workers have been observed for both segments of the horticultural labour force. On the one hand, the recent economic growth in the Polish and Romanian economies and amendments in Polish taxation aimed to discourage emigration have encouraged many migrants to return since the wage gap between their countries and the Netherlands has been narrowing (Pekkeriet and Splinter 2020: 15). This is why more agricultural employers have started looking towards Ukraine, the Balkans or even Southeast Asia in the hope to find labourers against the applicable wage (ISZW 2019: 5). For knowledge-intensive support tasks in greenhouse horticulture, Pekkeriet and Splinter (2020: 9, 16) identify bottlenecks especially in tasks that combine knowledge of cultivation with IT skills.

The lack of skilled workforce and increased labour expenditure, but in some cases also a negative image that the Dutch agricultural sector earned due

to the ill-treatment of workers and/or use of illegal migrant labour, have convinced some producers that the orientation towards agricultural robots is the best possible solution for the future (de Wilde 2016).

4.3 Technological dynamics in Dutch horticulture

Supported by government policies (e.g. Hoste et al. 2017: 9-12), the Netherlands has been among the global frontrunners when it comes to the technological upgrading of agricultural processes. Technological upgrading covers a diverse range of processes. Here, Pekkeriet and Splinter (2020: 10) distinguish automation, for instance the independent performance of (part of) a production process that follows logical rules, from robotization, in which whole processes can be flexibly taken over by robots.

Some automated farming systems, such as automatic sprinklers, have been in use in the Netherlands for quite some time. The 'digital agricultural revolution' is considered to have started in the early 2000s with the appearance of the first commercially available tractor that enabled automated planting and harvesting of crops (Innovation & Tech Today 2019). In Dutch greenhouses, to date, most procedures have been automated, except for pruning and harvesting (Hoste et al. 2017: 27, Pekkeriet and Splinter 2020: 19).

Recent years have seen the scope for agricultural automation shrink. Observers argue that, while further mechanisation of production is still underway, most of the likely automation has already taken place (Kroon and Pauwe 2014: 24-5, Cremers 2018: 15, 17). Pointing to the complexity of automation that affects the living product, Pekkeriet and Splinter (2020: 13) offer a possible explanation for such a 'ceiling effect' in technological innovation.

Agricultural robots are primarily used for shoot production, crop protection, sorting and packaging (de Wilde 2016: 30). Even though there has been an increasing focus on making harvesting and weeding robots more sophisticated, they are still not perceived as sufficiently effective. Work on automating harvesting processes was especially noticeable for high value crops whose cultivation requires a substantial manual labour input (Bac et al. 2014). Mirroring experiences in the electronics industry where "despite the hype about robots, manual labour has proven better suited to a large range of tasks" in assembly (Lei 2021: 12), the complexity of matching the human dexterity in dealing with living plants leads to a situation in which, e.g., the use of harvesting robots is presently confined to experimental greenhouses (Hoste et al. 2017: 27-8, Pekkeriet and Splinter 2020: 19).

In some cases, technological improvements have helped to turn greenhouses from 'energy guzzlers' into energy sources (Hoffman and Loeber 2016: 704). A good example for that is tomato cultivation that is based on a combination of intensified thermal screens use and ventilation systems that provide higher concentrations of CO2 which enable growers to reduce their energy input by 40 percent (de Gelder et al. 2011). More energy efficient light sources, such as LED lighting, has contributed to the more than doubling of

the tomato and sweet pepper yields over the last three decades (Marcelis et al. 2019: 3-4).

Engineers and economists, in particular, often assume these and other forms of technological upgrading to generate positive impacts on working conditions (e.g., Marcelis et al. 2018: 2). While such scenarios rarely engage with workers' own experiences, in the following section we will do exactly that, exploring the effects of technological upgrading in Dutch horticulture on migrant workers through our interviewees' lenses.

5 Exploring effects of technological upgrading on migrant labour

5.1 Technological dynamics witnessed in the horticultural sector

The research participants identified various technological dynamics in the Dutch horticultural sector (see Table 2). Several of these technologies are applied in the greenhouse economy of Westland, in particular. They range from different technologies for climate control, such as through highly efficient use of solar energy and the production of geothermal energy, via LED lighting to extend the cultivating season, to the automation and robotisation of different stages of cultivation in flower nurseries. These innovations affect the production of a wide array of crops, from vegetables via soft fruit and grapes to flowers. Proudly, the policy advisor to Westland municipality highlights the

Table 2
Types of technological upgrading observed by research participants

Technology	Crop(s)	Production phase	Type of upgrading
Automation of planting, laser marking, internal transport in flower nurseries	Orchids, other flowers	Cultivation	Process
Automation of harvesting through combines	Blueberries, strawberries	Harvest	Process
Automation of bundling and tying of flowers in open field operations	Flowers	Post-harvest processing	Process
Innovation in solar and geothermal energy uses for climate control in greenhouses	Asparagus, soft fruit, cucumber, salad, grapes	Cultivation	Process
LED lighting in greenhouses	Tomatoes, orchids, amaryllis	Cultivation	Process
Product innovation	Small bell peppers, cherry tomatoes, new colour orchids	-	Product

Source: Authors' compilation

high degree of robotisation in orchid production: "You have to visit the orchid production. Every day, they produce 5 million orchids. [They are put on a] conveyor belt, planted in a pot, laser marked about their colour – all of that is done by a robot." (interview Inge 2018).

Yet, the double hurdle of lacking financial resources and robots' current lack of sophistication prevents a widespread uptake of robotics. "The margins in many of these greenhouses are so extremely low that the immediate reaction from the employers is to say that it's impossible that the consumer has to pay more, and they [consumers] will not do it. Apart from some technological problems. If you have a, like, paprika robot if there's a leaf and the robot does not recognize paprika, so the best option is to have a leafless plant." (interview Ron 2018).

In open field agriculture, different types of technological innovations were observed. The harvest of soft fruit, such as blueberries, is sometimes mechanised through combines and extended into the night through special lights. The delicate nature of these crops presents a challenge to automation. A trade union consultant concludes that, so far: "Employers prefer regular pluckers, they are more careful with the fruit." (interview Agnieszka 2018) Similar to earlier studies' findings reported above, given their current lack of sophistication, harvesting robots, for instance for apples, asparagus or paprika are still employed on an experimental basis only. This lack of sophistication is illustrated when a worker points out that uneven floors prevent robotization of the internal transport in the Dutch flower auction: "So, the problem is that we've found in our building there is unevenness on the floor, the ground is elevated in some parts and, basically, that's the reason why robots cannot operate. So, there is still a need for human labour, for us to drive those lorries." (interview Jan 2018) Post-harvesting automation in open field horticulture that research participants describe involves, for example, the automatic bundling and tying of flowers in floricultural enterprises.

In addition to the different types of technological upgrading of the production process described above, some of the interviewees identified product innovations. Orchid producers in Westland, for instance, have multiplied the number of varieties based on customers' demand (interview Inge 2018, see also Wright 2017). Crop innovation, such as in the form of cultivating cherry tomatoes or mini bell peppers is seen as a way to increase growers' margins (interview Ron 2018).

5.2 Technological unemployment among CEE migrant workers in Dutch agriculture?

Do these innovations trigger technological unemployment in Dutch horticulture? This question does not yield a straightforward 'yes-no' answer. Three different - in part counterrotating - dynamics can be identified here, namely, firstly, investment that saves labour use per unit of production, secondly, the technology-enabled extension of the cultivation period that leads to an annual increase in labour demand and, lastly, employment generation through market extension.

While the interview data reflect the current infant stage of robotization in Dutch horticulture, they corroborate that automation has already replaced human labour in different parts of the horticultural chain. As exemplified by the variation of labour demand over time for the cultivation of tomato, paprika and chrysanthemum (Pekkeriet and Splinter 2020: 14), these dynamics differ per crop. Jan, who has been employed in the horticultural chain since the 1990s observes that in flower nurseries, automation is not a new phenomenon: "When it comes to nursery, there has been a lot of automation going on, but it hasn't been recent, it has been happening for years now. Some nurseries have many robots moving and shipping young plants from one side to another and moving plants from one side of the greenhouse to another. That part of the cultivation has been automated for years now" (interview Jan 2018). As a result, employment has been reduced drastically. For orchid cultivation, the Westland policy advisor observes that: "Only one person is managing this process. It is almost without people." (interview Inge 2018).

The introductory quote reflects that labour-saving technologies and the employment of a low-paid migrant labour force represent alternative strategies to increase farms' profitability. While researcher Ron assumes Westland employers to eschew automation and robotization because of the still large reservoir of CEE migrant workers, this does not explain the variegated investment in technological innovation in horticulture. Company size matters for growers' ability to invest. FNV advisor Geert observes that: "If you are not in the higher end, then you would not invest in technology." (interview Geert 2018) The causality suggested by Ron becomes even clearer when one adds up the different comparative advantages of the employment of migrant labour: No upfront investment is required like in the case of technological innovation, indirect employment relations ensure that growers can recruit and discharge workers following the seasonality of demand while only incurring flexible costs, and last but not least, human labour is more flexible compared to technology.

From growers' perspective, the only disadvantage is migrant workers' need for social reproduction that distinguishes them from robots and other technologies, something discussed in greater detail below.

In contrast to automation, advances in climate control and lighting in greenhouses since the turn of the millennium have stabilised or even increased labour demand. Trade union consultant Agnieszka describes how asparagus, grape and strawberry cultivation in Limburg have been shifted from open fields to greenhouses. She points out that the longer cultivation cycle that this enables is an advantage for CEE migrants as it stabilises their employment. Policy advisor Inge corroborates this: "It is not true that people are staying for a short period. Maybe in strawberries, but not in Westland. Work in the greenhouses is stable. Now the work continues until November, from February" (interview Inge 2018). These assumptions are supported by a 2017 survey among Westland growers. More than a quarter of the respondents expected labour demand to grow in 2018, while about 70 per cent assumed demand to remain stable (Cremers 2018: 8).

Lastly, product innovation is seen as a cause of rising labour demand. Inge points out that technologies that enable product upgrading, for instance into a greater variety of orchids, create new jobs. She relates this to customers' higher expectations. Pekkeriet and Splinter (2020: 14) elaborate that, for pot plant companies, in particular, the demand for added-value products has made packaging more time-consuming: "The orders are becoming smaller and more customer-oriented (for example your own stickers, cover and chosen pot). Not only the physical actions themselves take time, but also the organization of the orders." Researcher Ron, too, quotes growers of new crops, such as mini bell peppers, who assume that, this way, more employment would be created. Overall, according to Pekkeriet and Splinter (2020: 15-6) such employment growth is likely to take place in supporting tasks, such as energy management, sales and marketing, process automation, personnel management and administration, machine maintenance and in logistics where employees must deal with the increasing diversity of products. Given the segmentation of horticultural employment with most regular employees being Dutch nationals, it is questionable whether these new jobs will benefit CEE migrant workers, though.

5.3 How technological upgrading shapes CEE migrants' working conditions

If quantitative employment effects of upgrading in Dutch horticulture are ambiguous, the implications of technological innovation on working conditions are complex, to say the least. While automation comes with increased intensity and flexibility of work for the remaining migrant workers, technology-enabled extension of the cultivation period holds both the promise of greater employment security and the pitfall of an extension of the working day, often under harsh climatic conditions. Finally, the higher price margins associated with product innovation may enable direct contractual relations between growers and CEE migrant workers, in turn enhancing the latter's employment and income security.

Automation in horticulture is likely to increase the labour intensity for the remaining workers. Horticultural worker Jan summarises that: "[…] all the improvements were just aimed towards increasing speed and performance" (interview Jan 2018). He suggests that the objectives of technological innovation and labour governance are identical, namely, to increase productivity. While the possibilities for replacing human labour by machines are limited by the nature of tasks, though – namely, whether they are routine or not - rather than workers' skills, these limits further reinforce labour market segmentation. Lei (2021: 3) points out that "[t]he material constraint of technology in substituting for non-routine tasks and the movement of people from routine, middle-skilled jobs to non-routine, low- skilled jobs have led to occupational polarisation".

Pekkeriet and Splinter's (2020: 14) sober statement that: "For the same kilos from the past, a little less labour is needed every year", too, reflects that labour-saving automation and higher labour intensity for the remaining

workers are two sides of one coin. Trade union consultant Julius suggests that workers compete with machine's productivity when he states: "Employers see those people like machines, you have to produce as much as you can." (interview Julius 2018). Mostly only large firms can afford such technological upgrading (interview Agnieszka 2018). Agnieszka underlines that the repetitive work comes with high risks of physical and psychic harm (see also Pot 2018: 188): "This does not mean that these workers have nothing to do. On the contrary, one person often does four people's work. […] It's inhumane work, they do this to keep their job." (interview Agnieszka 2018).

Thus, flexible labour is the flipside of automation. The experience of a Polish worker in McGauran et al. (2016: 29) illustrates this connection: "The conveyor belts always go up in speed, they never slow down. The tempo is extremely high. There is no way that we can complain about this. 'If you can't keep up, you can return to Poland,' is what we are told. And this is not just a threat; colleagues who complain or can't keep pace with the belt receive a phone call that they don't need to come back to work the next morning." The loss of control over the work pace buttressed by the threat of dismissal implies precarity for the affected workers (Rodgers 1989: 3). National and EU labour regulation enables the disposability of migrant labour by sanctioning the wide-spread use of low-waged indirect employment, on the one hand, and buffering CEE migrants' unemployment through the entitlement to modest unemployment benefits, on the other.

In contrast to the automation of horticultural production that goes hand in hand with higher precarity for CEE migrant workers, the technology-enabled extension of the cultivation period also brings advantages for workers. The discussion above already suggested that the shift from open field to greenhouse horticulture stabilises the level of migrant workers' employment. This translates into greater individual employment security for workers (interview Agnieszka 2018) and even pleas for direct employment relations rather than agency-mediated recruitment (Cremers 2018: 17, Pekkeriet and Splinter 2020: 5). However, the question remains whether these biological and technological features of horticultural production are more influential for growers' recruitment practices compared to the legal framework that governs labour costs. The fact that the Westland policy advisor observed a drop in CEE migrants' employment in 2016 after a legal change had stipulated the mandatory payment of a transition fee for workers (interview Inge 2018), suggests that growers' effort to keep labour costs low and achieve 'unconditional flexibility' (McGauran et al. 2016: 20) in the recruitment and discharge of workers trumps. This would imply that - independent of the length of the cultivation season –agency workers' contracts will be discontinued at latest before transition into the second contractual phase in order to save growers costs for the associated economic and social entitlements.

Technological upgrading that extends the season affects working conditions in other ways, too. The use of harvesting combines, for instance, in the blueberry harvest, enables longer working days: "With the help of special lamps, people can continue working at night" (interview Agnieszka 2018). In

combination with the perishability of such soft fruit, this leads to a high amount of overtime that CEE workers make. The resulting higher earnings in part compensate for the fact that they are often not paid the overtime premium they are entitled to and not even the hourly minimum wage stipulated by the CBA (interviews Julius, Agnieszka 2018). Yet, as a result: "[…] they do not have any social life" (interview Agnieszka 2018). In other words: Humans' reproductive needs are being ignored to bring workers' productivity closer to that of robots.

Migrant workers – framed as prototypical homo economicus whose separation from their original environment frees them from social obligations – form an ideal here (McGovern 2007: 218). It enables growers to contest the obligation to cater for migrant workers' reproductive needs. They depict migrant workers as solely oriented towards making money quickly to return to their country of origin subsequently. Trade union consultant Julius sketches this perception as: "'Migrants don't want to play football with their kids on Saturday'. There is a perception that they embrace the idea of working throughout the weekend." (interview Julius 2018). Cremers (2018: 18) quotes growers in Westland who argue that: "Migrant workers come from far away and would like to work more (for example more than 45 hours a week)". This narrow space offered for migrant workers' social reproduction is exemplified in the fact that in this municipality with its large foreign workforce of an estimated 12,000, in total, less than 100 children of migrant workers are registered (interview Inge 2018). If migrant workers' productivity is compared to machines, as Julius suggested, what needs to be aligned from employers' perspective is indeed the time and associated cost of workers' social reproduction. For employers, this has the additional benefit of leaving less time to learn the language, a crucial tool to raise awareness about rights and develop social networks (van Ostaijen et al. 2017: 13).

While shifting cultivation to greenhouses has undoubtedly benefited some workers because they no longer have to endure harsh weather conditions in the fields, climate control in greenhouses also comes with challenges. The Westland policy advisor flags that: "Work in greenhouses is very difficult, you have to start early at 5am in summer, it will be 50 degree in the afternoon." Plants and their needs are more central than those of the worker – and the "[p]lants seem to be able to cope with higher temperatures that do not feel comfortable for humans" (Pekkeriet and Splinter 2020: 20). In addition to these difficult climatic conditions that have also been observed in earlier research (Munteanu 2015: 24), workers are getting affected by agrochemicals, but often do not dare to complain (e.g. Boxmeer 2019: 17, McGauran et al. 2016: 23, 28, 30).

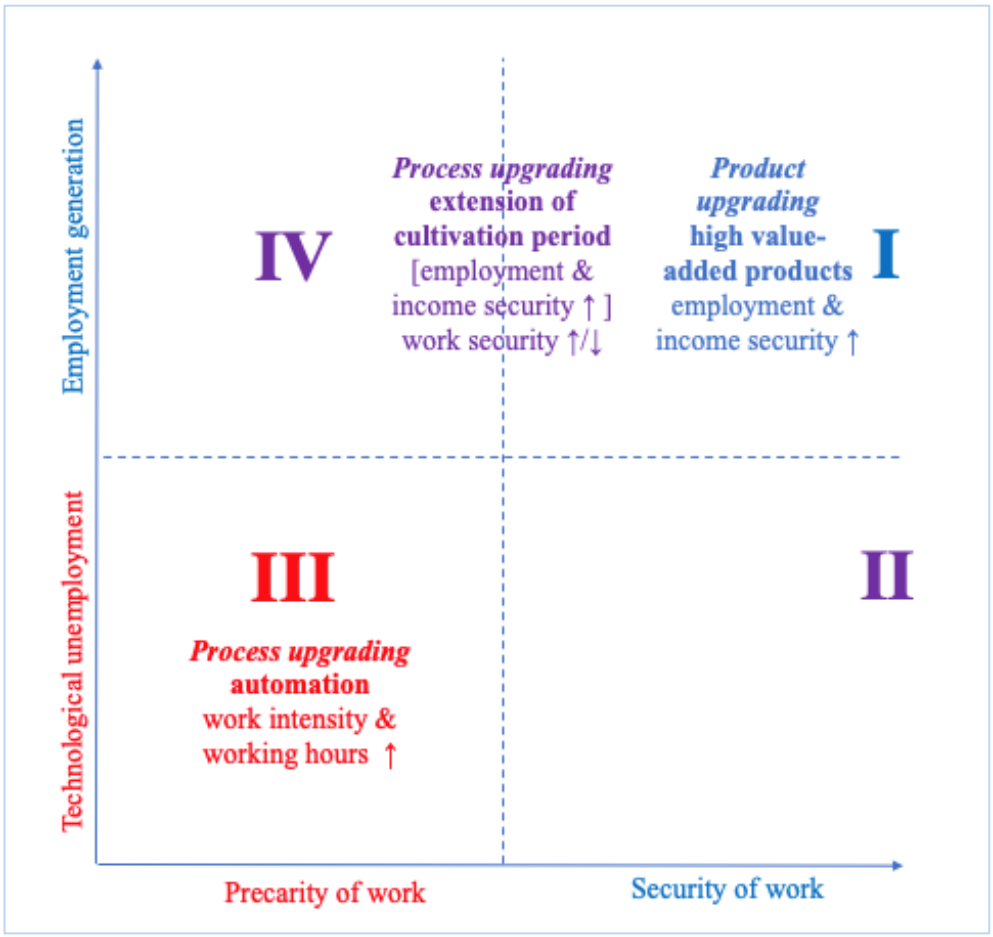
In contrast to the different forms of upgrading of the horticultural production process, technological upgrading of products can lead to an improvement in working conditions. Ron projects that the higher margins achieved through product innovation create the financial space that enables growers to employ migrant workers directly (interview Ron 2018). Such a shift from agency-based recruitment would be an important contribution to increase migrant workers' employment and income insecurity. Besides, Pekkeriet and

Splinter (2020: 15-6) assume that new tasks created, e.g., by product differentiation, require a higher level of knowledge and are likely to be carried out in comparatively better working conditions, e.g. free from noise, free from machines' work pace and under good climatic conditions. It remains to be seen whether such improvements materialise and whether migrant farmworkers benefit from them.

6 Discussion

Similar to Bernhardt and Milberg (2011: 7-8) who use a parsimonious 2*2 matrix to relate economic to social upgrading, Figure 2 summarises the broad pattern of how different types of technological upgrading in Dutch horticulture translate into the quantity and quality of CEE migrants' employment that emerges from the empirical analysis above.

Figure 2
Connecting technological upgrading with the amount and quality of employment



Source: Authors' design

The situation depicted in Quadrant I offers the most positive scenario for migrant workers, yet, at the same time, it seems to be the most speculative of the observed dynamics. Product upgrading through innovation in vegetables and flower varieties is expected to increase customers' product demand and requires more care in the preparation of orders. Both translate into employment generation. These dynamics parallels historical experiences with product upgrading (e.g. Mokyr et al. 2015: 36) and more recent findings from horticultural value chains in South and East Africa: "Work opportunities are created where global and regional supermarkets increase demand for more skilled workers to meet higher product and process quality standards." (Barrientos et al. 2016: 1276). The question remains whether these new jobs benefit CEE migrant workers, though, who have been concentrated in tasks directly related to the primary horticultural production process. From the perspective of labour segmentation theory, this depends on the seasonality of the work, with migrant workers in peripheral employment attached to fluctuating production (McGovern 2007: 226). Higher seasonality makes 'migrant others' a more attractive workforce compared to Dutch nationals who are perceived as being entitled to greater economic and social security (e.g., Remery et al. 2002: 486-487). At the same time, such innovations have offered higher margins for growers, enabling them, in turn, to offer greater employment and income security to horticultural workers.

The scenario summarised in Quadrant III, in contrast, seems most bleak, yet, most common. While technological unemployment is the direct consequence of process upgrading through automation, the remaining workers are made to adapt to and compete with machines' productivity. This translates into high work intensity and long working hours, both squeezing the time available for migrant workers' social reproduction. Besides, their bargaining power is weakened by the threat of dismissal. Such disposability is the most extreme expression of labour flexibilisation that complements technological investment. National and EU labour regulation have flanked this flexibilisation by sanctioning the wide-spread use of indirect employment at low cost, on the one hand, and buffering CEE migrants' unemployment through the entitlement to modest unemployment benefits, on the other. Labour market segmentation theory has conceptualised this connection: "Capital, as a fixed factor of production, cannot be kept idle because its owners will have to bear substantial costs. By contrast, labour, as a variable factor of production, can be laid off because it bears the costs of its own unemployment. Whenever possible, employers use capital to meet the stable, fixed part of demand and labour for that which fluctuates" (McGovern 2007: 225-6). Migrants are likely to be concentrated in the more labour-intensive, yet, precarious secondary sector, rather than in the capital-intensive primary sector "because it is more likely to have openings and they are less troubled by the prestige of their work" (McGovern 2007: 226). The deskilling of tasks increases both worker disposability and the potential for automation. This way, process upgrading in horticulture weakens workers' bargaining power both through the competition with each other and the machine. Employers' bargaining power increases as a result. Pot (2018: 196) characterises this as employers opting for class warfare

rather than co-creation that reduces mind-numbing work and asks rhetorically: "Or do we not care so much about the inhumanity of [repetitive work] because it often involves people who are already happy to have a job, such as foreigners and Dutch people 'with a distance to the labour market'?".

Against this backdrop, it is surprising that even trade union representatives seem to welcome labour-saving technological upgrading. Is this related to the expectation that innovation enhances the competitiveness of Dutch agriculture? In the mid- and long-term, this can be considered an important mechanism to guarantee jobs. Cremers' (2018: 17) observation that technical development often increases labour demand because volumes are growing considerably supports this view. Post-Keynesian theory conceptualises this dynamic as a virtuous cycle of output growth in the presence of an elastic labour supply, triggered by the greater specialisation and thus productivity that results from market expansion (Tejani 2016: 846).

Compared to the bleak implications of automation and the promises of product innovation, process upgrading that leads to an extension of the cultivation period comes with a mixed bag of effects on CEE migrant workers. This locates this scenario between Quadrants I and IV. Other factors remaining stable, innovations in climate control and lighting have increased growers' annual labour demand. While potentially, this can translate into greater employment security, it is unclear whether individual workers benefit in terms of greater contractual and income security. The same types of upgrading may shield workers from harsh outdoor working conditions, yet, working in greenhouses, comes with challenging climatic conditions, too. Labour process theory helps to make sense of these mixed impacts of technological upgrading by relating them to their influence on workers' bargaining power. Improved thermal screens in greenhouses, for instance, neither directly compete with CEE migrants' labour nor deskill the tasks that greenhouse workers perform. As a result, while the subordination of humans to the productivity of plants' growth comes with the endurance of difficult climatic conditions and health hazards, there are possible benefits to reap in terms of greater stability of employment and income.

7 Conclusion and outlook

Engaging with the effects of technological changes in Dutch horticulture for CEE migrant workers, this paper contributes to the scholarly literature on the future of work against the backdrop of the '4th industrial revolution' with fresh empirical perspectives and conceptual innovation.

Through qualitative empirical inquiry, we explore the effects of technological upgrading in Dutch horticulture. This way, we address a gap in debates around the future of work, which commonly ignore agriculture despite the sector's crucial role both for a vast share of the global labour force. We zoom in on the case of the Netherlands which is significant here on account of the country's highly productive agriculture, built on the 'twin pillars' of migrant labour and technological innovation (Williams 2019: vii).

Conceptually, we make GVC analysis – a framework largely applied to value chains that connect production in the global South to consumption in the global North - fruitful for the context of agri-food chains in the midst of European countries. Looking at upgrading in Dutch horticulture through a GVC lens enables us to distinguish effects on employment and working conditions based on whether technological innovation upgrades horticultural production processes or products themselves. We find that, short-term, process upgrading that seeks to 'make people work like machines' causes both technological unemployment and heightens the insecurities that workers experience, both at the workplace and beyond. Product innovation, in contrast, holds the promise of increasing price margins that can translate into better working conditions and increasing labour demand. These findings provide nuance to the argument that social and economic upgrading may not move in tandem and can even operate at each other's expense.

Our discussion of these variegated patterns in the horticultural chain helps to identify both their structural causes and levers for change. Labour market segmentation theory explains the concentration of CEE migrant workers in tasks that are more labour-intensive and more aligned to the seasonality of horticultural production. The precarity of migrants' indirect employment in horticultural production is the flipside of flexibility for growers. It enables them to buffer the competitive price pressure from retailers, in particular, while modest entitlements to social security help workers to endure periods of unemployment. While it is unclear whether these very tasks in cultivation, harvesting and post-harvesting operations can be automated or taken over by agricultural robots, migrant workers performing these tasks are made to 'work like machines': adjusting to machines' rhythm and speed on the one hand and competing with their productivity on the other hand.

Labour process theory highlights how automation aggravates CEE migrants' marginalisation in class-based power hierarchies. This marginalisation translates into increased precarity of their working conditions and the threat of technological unemployment. These dynamics are intertwined as the threat of automation makes workers bear increased work intensity, duration, and insecurity. The absence of a direct link between process upgrading and the labour process explains the more mixed experience for technologies that extend the cultivation period.

Reading our empirical material from the perspective of workers' bargaining power also enables us to identify levers for change. While growers' labour governance seeks to align the productivity of workers ad machines in order to survive in the competitive pressures of agri-food chains, numerous examples illustrate that workers do not work like machines, but that workers' adaptability is unmatched by automated processes. This adaptive capacity gives workers structural power as "power that results simply from the location of workers within the economic system" (Wright 2000: 962).

While the currently weak levels of organisation of CEE migrant workers in the Netherlands form an obstacle to use this structural power (Connolly et al. 2014: 16, de Beer and Berntsen 2019: 257), individual examples of collective

action, such as a strike against wage theft and poor housing conditions among Polish nursery workers in Brabant (no author 2015), are promising. At the level of such associational power as "the various forms of power that result from the formation of collective organizations of workers" (Wright 2000: 962), trade unions need to question their wide-spread frame that migrants facilitate their own exploitation by undercutting the wage and working time norms stipulated in the CBA. This frame reproduces the 'othering' of migrant workers, rather than building solidarity.

An alternative frame foregrounds CEE migrant workers' essential role in Dutch horticulture. Trade union calls to realise that, without the migrant workforce, "the engine will stop in many companies" (Bouten and Sekhuis 2019: 8) signals a shift in this regard – at the rhetoric level, at least. Based on the experience of the anti-sweatshop movement, Anner (2013: 34) stresses that such an empowering frame is likely to motivate more bottom-up worker organisation while simultaneously raising consumer awareness and paving the way to alliances.

The actualisation of CEE migrant workers' diverse power resources may contribute to "shifts in what is considered an 'innovation'" (Hoffman and Loeber 2016: 706) – namely from economic upgrading for few large horticulturalists to social upgrading for many actors involved in horticultural production in the Netherlands – including CEE migrant workers.

Last but not least, the dynamics depicted in Figure 2 call for further investigation. They represent empirically grounded hypotheses to be tested and refined based on a larger number of observations. The dynamics we have traced also offer potential for cross-country comparison of the implications of technological innovation in agri-food chains. Such comparative studies might be particularly relevant and enlightening among competing producers and countries in which they are located. Overall, follow-up research building on our empirical and conceptual contribution is necessary not just to illuminate future scenarios in the world of work, but also to gauge to role of labour and technology for food security.

References

Afrian, K., R. van der Wal, L. Hoeksma (2020) *De Nederlandse Economie: De landbouw in de Nederlandse economie*. The Hague: CBS. Available at: https://www.cbs.nl/nl-nl/longread/de-nederlandse-economie/2020/de-landbouw-in-de-nederlandse-economie?onepage=true [accessed 8 October 2021].

Anner, M. (2013) "Workers' Power in Global Value Chains. Fighting Sweatshop Practices at Russell, Nike and Knights Apparel', in P. Fairbrother, C. Lévesque and M. Hennebert (eds) *Transnational Trade Unionism: New Capabilities and Prospects: Building Union Power*, pp. 23-41. London: Routledge.

Arntz, M., T. Gregory and U. Zierahn (2016) 'The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis', OECD Social, Employment and Migration Working Papers, No. 189. Paris: OECD Publishing.

Autor, D.H., F. Levy and R.J. Murnane (2003) 'The Skill Content of Recent Technological Change: An Empirical Exploration', *The Quarterly Journal of Economics* 118(4): 1279-1333.

Azmeh, S. (2021) 'Global Value Chains, Production Regimes and the Governance of Migrant Workers', in E. Carmel, K. Lenner and R. Paul (eds) *Handbook on the Governance and Politics of Migration*, pp. 218-228. Cheltenham: Edward Elgar Publishing.

Bac, C.W., E.J. van Henten, J. Hemming and Y. Edan (2014) 'Harvesting Robots for high-value Crops: State-of-the-art Review and Challenges Ahead', *Journal of Field Robotics* 31(6): 888-911.

Barrientos, S., P. Knorringa, B. Evers, M. Visser and M. Opondo (2016) 'Shifting Regional Dynamics of Global Value Chains: Implications for Economic and Social Upgrading in African Horticulture', *Environment and Planning A: Economy and Space* 48(7): 1266-1283.

Barrientos, S., G. Gereffi and A. Rossi (2011) 'Economic and Social Upgrading in Global Production Networks: A New Paradigm for a Changing World', *International Labour Review* 150(3-4): 319-340.

de Beer, P., and L. Berntsen (2019) 'Vakbondslidmaatschap Onder Druk in Nederland, Maar Niet in België', *Tijdschrift voor Arbeidsvraagstukken* 35(3): 255-274.

Bernhardt, T., and W. Milberg (2011) Economic and Social Upgrading in Global Value Chains: Analysis of Horticulture, Apparel, Tourism and Mobile Telephones. Capturing the Gains Working Paper 2011/06. Manchester: University of Manchester.

Bouten, J., and S. Sekhuis (2019) 'Zonder Hen Staat de Motor Stil', *De Limburger* 14 December. Available at: https://www.limburger.nl/cnt/dmf20191212_00137035 [accessed 7 October 2021].

Boxmeer, A. (2019) 'Werkgevers die Regels Overtreden? Direct een Boete Opleggen', *FNV Magazine Agrarisch Groen* 2019(2): 14-17. Available at: https://www.fnv.nl/getmedia/72c977c2-0f2e-4362-a8fa-1cb3347c60a3/Magazine-Agrarisch-Groen-2019-nummer-2.pdf [accessed 7 October 2021].

Burchell, B. and J. Rubery (1990) 'An Empirical Investigation into the Segmentation of the Labour Supply', *Work, Employment and Society* 4(4): 551-575.

CBS (2020a) 'Agricultural Exports Hit Record Level'. The Hague: CBS. Available at: https://www.cbs.nl/en-gb/news/2020/03/agricultural-exports-hit-record-level [accessed 8 October 2021].

CBS (2020b) 'Foreign-born Employees; Resident/Non-resident, Demographic Variables'. The Hague: CBS. Available at: https://opendata.cbs.nl/statline/#/CBS/en/dataset/84750ENG/table?ts=1633681975184 [accessed 8 October 2021].

CBS (2021a) 'Agriculture; Crops, Livestock and Land Use by General Farm Type, Region'. The Hague: CBS. Available at: https://opendata.cbs.nl/statline/#/CBS/en/dataset/80783eng/table?ts=1633698303792 [accessed 8 October 2021].

CBS (2021b) 'Landbouw; Arbeidskrachten Naar Regio'. The Hague: Centraal Bureau voor de Statistiek. Available at: https://opendata.cbs.nl/#/CBS/nl/dataset/80784ned/table [accessed 8 October 2021].

Connolly, H., S. Marino and M.M. Lucio (2014) 'Trade Union Renewal and the Challenges of Representation: Strategies Towards Migrant and Ethnic Minority Workers in the Netherlands, Spain and the United Kingdom', *European Journal of Industrial Relations* 20(1): 5-20.

Cremers, J. (2018) *De Inzet van Arbeidsmigranten in de Gemeente Westland: Eindverslag*. Tilburg: Tilburg Law School.

Cremers, J. (2016) 'Construction Labor, Mobility and Non-standard Employment', *HesaMag* 13: 17-22.

Distrifood (2021) Marktaandelen. Available at: https://www.distrifood.nl/food-data/marktaandelen [accessed 7 October 2021].

Dolman, M.A., G.D. Jukema, P. Ramaekers (eds) (2019) *De Nederlandse Landbouwexport in 2018 in Breder Perspectief*. Wageningen: Wageningen University & Research.

Engbersen, G.B.M., M. Kremer, R.C.P.M. Went and A.W.A. Boot (2020) *Het Betere Werk. De Nieuwe Maatschappelijke Opdracht*. The Hague: Wetenschappelijke Raad voor het Regeringsbeleid.

FAOSTAT (2021) Data: Crops and Livestock Products. Available at: http://www.fao.org/faostat/en/#data/TCL [accessed 7 October 2021].

Fernandez-Stark, K., and G. Gereffi (2019) 'Global Value Chain Analysis: A primer (second edition)', in S. Ponte, G. Gereffi and G. Raj-Reichert (eds) *Handbook on Global Value Chains*, pp. 54-76. Cheltenham: Edward Elgar Publishing.

Frey, C.B., and M.A. Osborne (2017) 'The Future of Employment: How Susceptible are Jobs to Computerisation?', *Technological Forecasting and Social Change* 114: 254-280.

de Gelder, A., E.H. Poot, J.A. Dieleman and H.F. de Zwart (2012) 'A Concept for Reduced Energy Demand of Greenhouses: The Next Generation Greenhouse Cultivation in the Netherlands', in C. Kittas, N. Katsoulas, T. Bartzanas (eds) *International Symposium on Advanced Technologies and Management Towards Sustainable Greenhouse Ecosystems: Greensys2011* 952, pp. 539-544. Athens: ISHS.

Gereffi, G. (1999) 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', *Journal of International Economics* 48(1): 37-70.

Heyma, A., Bisschop, P., and C. Biesenbeek (2018) *De Economische Waarde van Arbeidsmigranten uit Midden- en Oost-Europa voor Nederland*, SEO Economisch Onderzoek, Report 2018-37. Amsterdam: SEO Economisch Onderzoek. Available at: http://www.seo.nl/pagina/article/de-economische-waarde-van-arbeidsmigranten-uit-midden-en-oost-europa-voor-nederland/ [accessed 8 October 2021].

Hoffman, J., and A. Loeber (2016) 'Exploring the Micro-Politics in Transitions from a Practice Perspective: The Case of Greenhouse Innovation in the Netherlands', *Journal of Environmental Policy & Planning* 18(5): 692-711.

Hoste, R., H. Suh and H. Kortstee (2017) *Smart Farming in Pig Production and Greenhouse Horticulture: An Inventory in the Netherlands*. Wageningen: Wageningen University & Research.

Humphrey, J., and H. Schmitz (2002) 'How does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters?', *Regional Studies* 36(9): 1017-1027.

Inspectie Sociale Zaken en Werkgelegenheid (ISZW) (2019) *Staat van Eerlijk Werk 2019: Risico's aan de onderkant van de arbeidsmarkt*. The Hague: Ministerie van Sociale Zaken en Werkgelegenheid.

Ivosevic, P. (2018) *Treating People as Robots: The Effects of Technological Changes in the Dutch Agro-food Sector on Central and Eastern European Migrant Workers*, MA thesis. The Hague: ISS.

Keynes J.M. (2010) 'Economic Possibilities for Our Grandchildren', in *Essays in Persuasion*, pp. 321-332. Palgrave Macmillan, London.

Korinek, A. and J.E. Stiglitz (2019) 'Artificial Intelligence and its Implications for Income Distribution and Unemployment', in A. Agrawal, J. Gans and A. Goldfarb (eds) *The Economics of Artificial Intelligence*, pp. 349-390. Chicago: University of Chicago Press.

Kroon, B., and J. Paauwe (2013) 'Structuration of Precarious Employment in Economically Constrained Firms: The case of Dutch agriculture', *Human Resource Management Journal* 24 (1): 19-37.

Lei, Y. (2021) 'Upgrading China through Automation: Manufacturers, Workers and the Techno-Developmental State', *Work, Employment and Society*. First Published 13 May 2021.

van Liemt, G., (2013) Private employment agencies in Netherlands, Spain and Sweden, Sectoral Activities Department, SECTOR Working Paper No. 290, Geneva: International Labour Office.

Lutz, C., and M. Olthaar (2017) 'Global Value Chains and Smallholders in Sub-Saharan Africa', *Review of Social Economy* 75(3): 251-254.

Marcelis, L.F.M., Kaiser, E., van Westreenen, A. and Heuvelink, E. (2018) 'Sustainable Crop Production in Greenhouses Based on Understanding Crop Physiology', *Acta Horticulturae* 1227: 1-12.

Marengo, L. (2019) 'Is this Time Different? A Note on Automation and Labour in the Fourth Industrial Revolution', *Journal of Industrial and Business Economics* 46(3): 323-331.

Matheis, T.V., and C. Herzig (2019) 'Upgrading Products, Upgrading Work? Interorganizational Learning in Global Food Value Chains to Achieve the Sustainable Development Goals', *GAIA-Ecological Perspectives for Science and Society* 28(2): 126-134.

McGauran, K., de Haan, E., Scheele, F., and F. Winsemius (2016) *Profiting from Dependency: Working Conditions of Polish Migrant Workers in the Netherlands.* Amsterdam: Fair-Work and SOMO.

McGovern, P. (2007) 'Immigration, Labour Markets and Employment Relations: Problems and Prospects', *British Journal of Industrial Relations* 45(2): 217-235.

McGrath, S. (2013) 'Fuelling Global Production Networks with Slave Labour? Migrant Sugar Cane Workers in the Brazilian Ethanol GPN', *Geoforum* 44: 32-43.

Milberg, W., and D. Winkler (2011) 'Economic and Social Upgrading in Global Production Networks: Problems of Theory and Measurement', *International Labour Review* 150(3-4): 341-365.

Mokyr J., C. Vickers and N.L. Ziebarth (2015) 'The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?' *Journal of Economic Perspectives* 29(3): 31-50.

Munteanu, M. (2015) *Bringing Immigrant Voices into Integration Discourse Experiences of Polish Greenhouse Workers in the Netherlands.* MA thesis. The Hague: ISS.

Nikulin, D., J. Wolszczak-Derlacz and A. Parteka (2021) 'Working Conditions in Global Value Chains: Evidence for European Employees', *Work, Employment and Society*. First Published 19 March 2021.

No author (2019) 'How Automation is Revolutionizing Agriculture'. *Innovation & Tech Today* 15 July 2019. Available at: https://innotechtoday.com/automated-agriculture/ [accessed 15 October 2021].

No author (2015) 'Staking 70 Poolse Seizoensarbeiders bij Plantenkwekerij Van Gennip in Gerwen', *Omroep Brabant* 18 March 2015. Available at: https://www.omroepbrabant.nl/nieuws/2062849/staking-70-poolse-seizoensarbeiders-bij-plantenkwekerij-van-gennip-in-gerwen [accessed 8 October 2021].

OECD (2015) *Innovation, Agricultural Productivity and Sustainability in the Netherlands*. OECD Food and Agricultural Reviews, Paris: OECD Publishing.

van Ostaijen, M., U. Reeger and K. Zelano (2017) 'The Commodification of Mobile Workers in Europe - a Comparative Perspective on Capital and Labour in Austria, the Netherlands and Sweden', *Comparative Migration Studies* 5(1): 1-22.

Pajnik, M. (2016). "Wasted Precariat': Migrant work in European societies', *Progress in Development Studies* 16(2): 159-172.

Pekkeriet, E. and G. Splinter (2020) *Arbeid in de Toekomst: Inzicht in Arbeid en Goed Werkgeverschap in de Tuinbouw*. Wageningen: Wageningen University & Research.

Phillips, N. (2016) 'Labour in Global Production: Reflections on Coxian Insights in a World of Global Value Chains', *Globalizations* 13(5): 594-607.

Pierce, J., M. Lawhon and T. McCreary (2019) 'From Precarious Work to Obsolete Labour? Implications of Technological Disemployment for Geographical Scholarship', *Geografiska Annaler: Series B, Human Geography* 101(2): 84-101.

Pot, F. (2018) 'Kortcyclische Arbeid: Maar Sommigen Zijn Meer Ongelijk Dan Anderen', *Tijdschrift voor Arbeidsvraagstukken* 34(2): 187-199.

Remery, C., A. van Doorne-Huiskes and J. Schippers (2002) 'Labour Market Flexibility in the Netherlands: Looking for Winners and Losers', *Work, Employment and Society* 16(3): 477-495.

Rodgers, G. (1989) 'Precarious Work in Western Europe: The State of Debate', in G. Rodgers and J. Rodgers (eds) *Precarious Jobs in Labour Market Regulation: The growth of atypical employment in Western Europe*, pp. 1–17. Geneva: ILO.

Rossi, A. (2019) 'Social Upgrading', 'Social Upgrading', in S. Ponte, G. Gereffi and G. Raj-Reichert (eds) *Handbook on Global Value Chains*, pp. 272-284. Cheltenham: Edward Elgar Publishing.

Isakson, S.R. (2014) 'Food and Finance: The Financial Transformation of Agro-Food Supply Chains', *The Journal of Peasant Studies* 41(5): 749-775.

Schwab, K. (2017) *The Fourth Industrial Revolution*. New York: Crown Business.

Siegmann, K.A., and T. Williams (2020) 'Migrant Labour in Dutch Agriculture: Regulated Precarity', in L. Palumbo and A. Corrado (eds) *Are Agri-food Workers only Exploited in Southern Europe? Case Studies on Migrant Labour in Germany, the Netherlands and Sweden.* Brussels: Open Society European Policy Institute.

Snel, E., M. Faber and G. Engbersen (2015) 'Civic Stratification and Social Positioning: CEE Labour Migrants without a Work Permit', *Population, Space and Place* 21(6): 518-534.

SER (2016) *Mens en Technologie: Samen aan het werk*. The Hague: SER.

SER (Social and Economic Council of the Netherlands) (2021) *Sociaal-economisch Beleid 2021-2025: Zekerheid Voor Mensen, een Wendbare Economie en Herstel van de sSamenleving*. The Hague: SER.

Spencer, D.A. (2018) 'Fear and Hope in an Age of Mass Automation: Debating the Future of Work', *New Technology, Work and Employment* 33(1):1-12.

Swan, M. (2017) 'Is Technological Unemployment Real? An Assessment and a Plea for Abundance Economics', in K. LaGrandeur, J.J. Hughes (eds) *Surviving the Machine Age: Intelligent Technology and the Transformation of Human Work*, pp. 19-33. Cham: Palgrave Macmillan.

Visser, O., S.R. Sippel and L. Thiemann (2021) 'Imprecision Farming? Examining the (In)accuracies and Risks of Digital Agriculture', *Journal of Rural Studies* 86: 623-632.

Tejani, S. (2016) 'Jobless Growth in India: An Investigation', *Cambridge Journal of Economics* 40(3): 843-870.

de Wilde, S. (2016) *The Future of Technology in Agriculture*. The Hague: Stichting Toekomstbeeld der Techniek.

Williams, T. (2019) *Flowery Language. The Promises of New Technology and Impacts on Polish Labor in Dutch Horticulture*. MA thesis. The Hague: ISS.

World Bank (2007) *World Development Report: Agriculture for Development*. Washington DC: World Bank.

Wright, E.O. (2000) 'Working-Class Power, Capitalist-Class Interests, and Class Compromise', *American Journal of Sociology* 105(4): 957-1002.

Wright, J. (2017) 'How to Stand Out in the Orchid Market', Greenhouse Grower. Available at: https://www.greenhousegrower.com/crops/how-to-stand-out-in-the-orchid-market/ [accessed 8 October 2021].