Emerging Medium-Scale Tenant Farming, Gig Economies, and the COVID-19 Disruption: The Case of Commercial Vegetable Clusters in Ethiopia

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Abstract
Driven by the fast spread of private irrigation pumps, there has been a rapid expansion of intensive vegetable cultivation in the central Rift Valley in Ethiopia, making it the most important commercial vegetable production cluster in the country. Supporting that “quiet revolution” has been an inflow of migrant laborers—paid through daily, monthly, or piecemeal contracts, with few employment benefits attached to them—and a gig economy as widely used contractors organize, among others, mechanized land preparation, the digging of wells and ponds, seedling propagation, and loading of trucks. Almost 60% of the irrigated area is cultivated by medium-scale tenant farmers relying on short-term rental contracts. It seems that gig economies characterized by flexible contract arrangements implemented by outside contractors, which are increasingly fueling sophisticated sectors in developed countries, are important in these commercial agrarian settings in Africa as well. We further find that the COVID-19 pandemic has led to significant disruptions of this model, as seen by more limited access to services and the unavailability or high price increases in factor markets, especially for labor, and large but heterogenous price changes in output markets.

Resume
Grâce à la diffusion rapide des pompes d’irrigation privées, la culture intensive de légumes a connu une expansion rapide dans la vallée centrale du Rift en Éthiopie, ce qui en a fait le groupe commercial de production maraîchère plus important du pays. Cette « révolution tranquille » a été soutenue par un afflux de travailleurs migrants—rémunérés au moyen de contrats journaliers, mensuels ou au coup par coup, qui comportent peu d’avantages en matière d’emploi—et par une économie de petits boulots, puisque des entrepreneurs largement utilisés organisent, entre autres, la pré-

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paration mécanique du sol, le forage de puits et d’étangs, la propagation des semis et le chargement des camions. Près de 60 pour cent de la superficie irriguée est cultivée par des locataires fermiers de taille moyenne qui dépendent de contrats de location à court terme. Il semblerait que les économies de petits boulots, caractérisées par des contrats flexibles mis en œuvre par des entrepreneurs extérieurs, qui alimentent de plus en plus les secteurs sophistiqués dans les pays développés, sont également importantes dans ces milieux agricoles commerciaux en Afrique. Nous constatons en outre que la pandémie de COVID-19 a entraîné des perturbations importantes de ce modèle, comme en témoignent un accès plus limité aux services et l’indisponibilité ou de fortes augmentations de prix sur le marché des facteurs, en particulier pour la main d’œuvre, et des variations de prix importantes mais hétérogènes sur les marchés des produits.

Introduction

Driven by improved connectivity and the spread of the internet, labor relationships are changing and gig economies are becoming more important in a number of sectors in developed countries, leading to a heated debate on disadvantages and benefits for workers and consumers (De Stefano 2015; Aloisi 2015). Friedman (2014) describes this workplace as follows: “A growing number of American workers are no longer employed in ‘jobs’ with a long-term connection with a company but are hired for ‘gigs’ under ‘flexible’ arrangements as ‘independent contractors’ or ‘consultants,’ working only to complete a particular task or for defined time and with no more connection with their employer than there might be between a consumer and a particular brand of soap or potato chips.” (Friedman 2014, p. 171). While such gig economies are widely studied in developed countries, little research, however, has been done on this in developing country settings, especially so in agricultural and rural economies.

Agricultural economies are rapidly transforming in developing countries (Reardon et al. 2019). This is also the case in Africa where increasing urbanization, population growth, income growth, policy reform, and better road and communication infrastructure are leading to a ‘quiet revolution’ in food systems (AGRA 2019). These changes have enormous implications on the way that agriculture is done and on how food and agricultural markets function. For example, while smallholder agriculture has been a defining characteristic for most of Africa, there is now increasing evidence in a number of countries on the emergence of medium- and large-scale farmers who increasingly see potential in agriculture as a source of profits and livelihoods, as these farmers satisfy rapidly growing urban demand and benefit from urban residents increasing ability and willingness to pay for food (Jayne et al. 2016, 2019; Sitko and Jayne 2014). Although there is an emerging literature on these larger-scale farmers, there are only a few authors (e.g., Wineman et al. 2020; Burke et al. 2020) who have looked at their link with rural transformation processes overall, their role in reshaping rural economies through service and labor contracts, and the possibly important spillovers of this agricultural transformation on these economies more broadly.
We focus on the case of commercial vegetable clusters in Ethiopia. This is an interesting case for a number of reasons. First, Ethiopia has seen rapid growth in its cereal economy (Bachewe et al. 2018), but it is unclear what has been happening in its horticultural sector where production growth is much desired as diet diversity is low in the country and prices are rapidly increasing, making vegetables often unaffordable, especially for the poor (Bachewe and Minten 2019; Hirvonen et al. 2018). The perception is that few changes have happened in this sector, seemingly because transformation is harder to achieve for these crops given more difficult growing—due to pest and diseases—and marketing requirements—due to their perishability. Second, job creation is high on the agenda of policy makers, locally and internationally (e.g., IFAD 2019; Mueller and Thurlow 2019). It is therefore relevant to study job creation in these commercial clusters and the type of labor markets and service contracts that are emerging in these agrarian and rural economies. Third, cluster-based development has shown important successes in countries such as China (e.g., Zhang and Hu 2014), and these models are increasingly being promoted elsewhere, including Ethiopia (Diriba and Man 2019). However, there is little evidence to date on how this is playing out in practice and what the implications of such developments are on related sectors. Finally, we look at how commercial vegetable clusters have been affected by the COVID-19 pandemic.\(^1\) There has to date not been any empirical and representative assessment.

Based on a large vegetable producer survey fielded in January and February 2020, we show—driven by increasing urban demand and the fast spread of irrigation through the use of private pumps—a rapid increase over the last decade in vegetable production in the central Rift Valley in Ethiopia, making it the most important commercial vegetable cluster in the country and the major supplier of vegetables to Addis Ababa, Ethiopia’s capital. We note important spatial spreads in irrigation uptake—more than a doubling of land under irrigation in the off-season—and wide use of improved imported seeds, of agro-chemicals, and of fertilizers, mostly obtained from private agro-dealers. Linked with this and with improved communication being available, we note the emergence of a service economy with flexible contracts delivering different types of services. Contractors organize the digging of wells and ponds, seedling propagation, spraying, mechanized land preparation, harvesting, and loading of trucks. Medium-scale tenant farmers cultivate almost 60% of this irrigated land, relying on relatively short-time rental contracts. Their increasing importance is seen by the more than tripling of land rented in by them over the last decade. These medium-scale farmers cultivate on average almost 5 hectares of vegetables, which is relatively small for international standards but high locally, as the annual value of their produce is estimated at 52,000 USD, 60 times Ethiopia’s GDP

\(^1\) On March 13, 2020, the first COVID-19 case was confirmed in Ethiopia. Three days later, the government closed schools, banned all public gatherings, and recommended social distancing. Other measures to contain the spread of the virus soon followed. Travelers from abroad were put into a 14-day mandatory quarantine and travel through land borders was prohibited. Several regional governments banned all public transportation and imposed restrictions on other vehicle movement between cities and rural areas (these restrictions were relaxed later). While these actions were expected to slow the spread of the virus, they may have had substantial effects on food value chains (Tamru et al. 2020).
per capita. We further see an inflow of laborers into the region, paid through daily, monthly, or piecemeal contracts, but with little employment benefits—such as health services—beyond their salaries. Gig economies, which are increasingly important for service sectors in developed countries, are shown to have emerged quickly in the case of this commercial agrarian sector in Ethiopia as well.

In a follow-up survey with the same vegetable producers three months later (May 2020)—after the start of the social and economic disruptions linked to the COVID-19 pandemic—we find that the input markets, agricultural service provision, and labor markets that have been fueling this agricultural transformation in vegetable production in the central Rift Valley have been significantly and negatively affected by the COVID-19 crisis. Because of a disruption in logistics, the majority of farmers report problems in accessing these markets and services. Especially labor markets have been most dramatically impacted—the lack of access to daily labor together with rapidly increasing wages in the major producing areas is leading to a significant disruption in normal production patterns. Moreover, access to fertilizers and agro-chemicals has become more difficult, the latter linked to land border closings, which have blocked (sometimes illegal) imports from neighboring countries, and to reduced imports from China where supply chains have been affected. Half of the farmers estimate that yields during this production cycle would already be lower than typical during the same period in a normal year.

These findings do not bode well for the future of this important emerging sector, and they lead to a number of implications. First, the upscaling process and the ongoing transformation in rural areas have helped to deliver more and higher-quality vegetables to the growing urban market and beyond, which is important for nutrition in Ethiopia as consumption of vegetables and desired diet diversity is low. That process has clearly been disrupted. Second, access to improved hybrid seeds and agro-chemicals, important to achieve high yields, was already difficult pre-COVID-19, often linked to cumbersome red tape but also due to foreign exchange shortages (World Bank 2019). The effect of the COVID-19 pandemic on the decline in export earnings and economic growth in the country might have exacerbated this situation and might have led to a further deterioration of Ethiopia’s trade balance and foreign exchange situation, complicating this access to crucial inputs. Third, given cost changes and problems in accessing agricultural inputs, labor, and services due to COVID-19, farmers are facing higher production costs. These might affect incentives for growing vegetables and also eventually impact the availability, overall market pricing, and the affordability of vegetables in Ethiopia.

Finally, the analysis further indicates an inadequacy of official statistics in measuring what are often highly clustered and seasonal high-value agricultural production activities. Sampling frames and survey calendars used by national statistical services typically center around staple and rainfed crops, usually the country’s main cereals. High-value agricultural production such as horticultural crops, poultry, dairy, and small stock fattening often take place in tightly clustered settings spatially uncorrelated with major cereals. Many are concentrated in peri-urban or even urban
settings,\(^2\) which the national agricultural surveys either under-sample or ignore. With horticulture, the problem of undercounting is especially severe because dry-season irrigated harvests are often much larger than the rainy season crops. This indicates the importance of special-purpose surveys that are systematically conducted in helping to fill these important gaps in our understanding of agricultural transformation in Africa.

**Background**

Ethiopia’s agricultural economy has been rapidly transforming over the past 20 years, driven by increases in income, urbanization (and the increasing food demand from the relatively richer consumers in these cities), improved road and communication infrastructure, and a pro-active government committed to agricultural and rural growth (Dorosh and Minten 2020; Bachewe et al. 2018). Most of the changes, however, have happened in the cereal sector. Transformation in the high-value and nutritious food sectors is lagging behind, as illustrated by their rapidly increasing prices, seemingly driven by increasing demand outstripping supply, at least at the national level (Bachewe and Minten 2019).

We focus in this paper on the case of vegetables in particular. Consumption levels of vegetables in Ethiopia are low. This is associated with low diet diversity in the country as a whole, one of the major causes of poor national nutritional indicators (Baye and Hirvonon 2020). However, changes are noted in consumption of vegetables in the most recent periods for which data are available. Figure 1, based on the nationally representative Household Consumption and Expenditures Surveys (HCES), shows increasing consumption of fruits and vegetables (F&V) as a share of the overall food budget and increasing quantities being consumed in both urban and rural areas over time (note that fruits make up a minor part in this overall F&V

\(^2\) See Minten et al. (2020) for the case of dairy in Ethiopia.
consumption, i.e., 6 and 5% in 2011 and 2016, respectively). Figure 1 also shows that the quantities consumed in urban areas are significantly higher than in rural areas.

In the case of Addis Ababa, Wolle et al. (2020) find that 19% of the food budget of city residents was devoted to vegetables in 2020, significantly higher than national levels (Fig. 2). These vegetables are mostly procured from areas such as the Central Rift Valley. Results from the survey presented below show that almost three-quarters of the four main vegetables in Addis Ababa were procured from that area at the time of the survey. The emergence of the Central Rift Valley for vegetable cultivation is seemingly due to a number of reasons. First, there are a number of lakes (e.g., Lake Ziway, Koka Lake) from which water can be easily used for irrigation. Soils around other lakes in Ethiopia often suffer from high salinity or difficult topography (steep shores) that inhibit their use for irrigated agriculture. Where there is no access to a lake, there is also the potential of river irrigation and groundwater levels in the Central Rift Valley are good in general. Second, the area is located on a good road a three-hour drive from Addis Ababa, allowing for reasonably good market access to the biggest city in the country. A number of major secondary cities—Hawassa, Debre Zeyt, and Adama—are also close by. Third, the region is part of the sub-tropical semiarid agro-climatic zone, which is well suited for vegetable cultivation when irrigation water is available.

**Data and Methodology**

To understand transformation processes in this commercial cluster and the disruption to the cluster caused by the COVID-19 crisis, two rounds of surveys were implemented. In the first round done in late January and in February 2020, 810 farmers were interviewed. The sample was set up as follows. We collected information on all the irrigated areas where vegetables are cultivated in the East Shewa zone of the Central Rift Valley. These areas include the woredas of Dugda, Adama Tuli, Bora, and Lume. We selected those kebeles in these four woredas that had more than...
100 hectares of irrigated land. In each kebele, a list was made of all vegetable cultivators, listing the irrigated area per cultivator and assessing if the land was rented in. Those cultivators that rented in more than 0.5 hectares were considered ‘medium-scale tenant farmers’. In each kebele, 22 farmers were interviewed. One-quarter of the farmers interviewed were randomly selected from the medium-scale farmers list and three-quarters from the list of smallholders producing vegetables under irrigation. A community questionnaire was fielded in each kebele as well. After the selection of the sample households, a comprehensive household survey was fielded in which information was collected on household characteristics, income generating activities, assets, and details on vegetable activities.

The second-round survey done in May 2020 was a phone survey, in which we sought to understand the impact of the COVID-19 crisis on these vegetable farmers. Given the more complicated implementation and short duration phone connections with survey respondents, mostly qualitative questions were asked in this second survey. The questions focused on problems in input markets, access to services, labor markets, output markets, income changes, and behavioral changes because of COVID-19. We also collected information on prices in input and output markets. While all medium-scale tenant farmers from the first round were targeted for the phone survey, about half of the smallholder farmers of the first round were randomly selected for the second survey round. In total, 505 households were reached by phone and the complete interview was administered to 433 of them (72 farmers were not growing any of the key vegetables at the time of the May survey, so were not interviewed).

**Patterns of Transformation**

**Vegetable Production**

In Table 1, we report major trends in vegetable cultivation in the surveyed villages based on data obtained from community focus groups in the first round of the survey. The area cultivated in the rainy season did not change very much over the last decade. However, we see more than a doubling of the area under irrigation, from 215 to 469 hectares per kebele (village) on average. Because of this irrigation, about one-third of the land in these kebeles is cultivated more than once, although more frequent cultivation is still relatively rare (2% of the land is cultivated three times and 5% is used for perennial crops, usually papayas). This area under irrigation is almost exclusively used for vegetable cultivation, as focus groups in these kebeles indicated 95% of that area used for that purpose. However, some of the land during the main rainy season (the Meher season) is also used for vegetable cultivation (about 20%, with little change seen over the last decade).³

³ Vegetable cultivation was often deemed more complicated and costly during the rainy season because of higher disease incidence.
The most important vegetables grown in the survey area are tomato and onions, with 33 and 31% of the area allocated to these two crops, respectively. Cabbage, green pepper, and Ethiopian kale are estimated to be grown on 8, 8, and 9% of the land, respectively. Other crops make up 12%. Focus groups were also asked about average yields at the time of the survey and ten years earlier. We see that yields improved if not much, increasing between 5 and 15%. It is worth noting the high yield levels that are reached for these vegetables. For example, yields for tomatoes (65 tons/hectare) are more than 10 times the level of the best performing cereal (maize) in the country. These numbers also allow us to assess the importance of this cluster for the supply of vegetables at the aggregate level. Doing back-of the
envelope estimates, we estimate that the value of production from this commercial cluster is approximately 200 million USD, close to the value of the much-heralded flower exports from Ethiopia.

These data indicate that there have been significant changes in vegetable production in this commercial cluster over the last decade, making it the most important vegetable producing cluster in the country and the major supplier of vegetables to the city of Addis Ababa and beyond. The biggest contributor to the increase of vegetable production has been area expansion during the irrigation season from September to May, when rains are limited. These changes in vegetable production—as well as the increasing intensification in land use—have not been well documented. However, these findings are clearly important for the transformation agenda in Ethiopia and in Africa more broadly, as transformation in the domestic horticultural sectors has not been well understood. We next focus on two important factors linked to this “quiet revolution”, i.e., access to irrigation that allowed for this area expansion, and the active use of rental markets. Afterwards, we discuss changes in input markets which enabled the high land productivity.

**Irrigation and Land Rental Markets**

Irrigation can lead to major changes in agricultural economies in developing countries. In Ethiopia, the majority of agricultural production is rainfed. The importance of irrigation is relatively minor and localized (Mulat 2011), although it recently has received more emphasis from government and development partners alike (Dorosh and Minten 2020). The increase in irrigated area has been linked with different types of irrigation, i.e., river, lake, pond (where water harvesting is practiced), and groundwater irrigation. Figure 2 shows that lake, river, and groundwater irrigation are almost equally important, while pond irrigation is still at low levels.

The share of groundwater irrigation, specifically, increased over the decade studied by more than 11 percentage points, leading to a 240% increase in the area under groundwater irrigation. Improved access to and availability of private pumps have played a major role in this expansion of irrigated areas. Almost three-quarters of the pumps used by these farmers were pumps owned by farmers themselves. That is in contrast to a decade earlier when private pumps owned by farmers themselves only made up 46% of the pumps used. The pumps that are found in the market are mostly imported from China. Private pumps are now more readily available, and there is more competition and choice (Table 2).

Active land rental markets have been very important in this transformation as well. While land regulations in Ethiopia are often presumed not to be conducive

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4 Using average prices at the time of the survey, average reported yields, similar yields and prices as green pepper (the vegetable with the lowest yields and prices of the four main vegetables) for “other vegetables”, and one harvest a year.

5 Hossain (2009) for example has shown how it has affected in a major way the way that rice cultivation is done in Bangladesh and how the availability of cheap pumps allowed for a doubling of the country’s rice output.
for secure land rental arrangements (Holden and Ghebru 2016), this does not seem to have been a hindrance for its widespread use in these areas. A large number of medium-scale and capital-intensive farmers—sometimes coming from outside the region but increasingly from the woreda (district) itself⁶—are renting in land to grow vegetables. It was estimated at the time of the survey that 57% of the vegetable land is cultivated by these medium-scale tenant farmers (Fig. 2). Figure 2 further shows that the area cultivated by these medium-scale tenant farmers has been steadily increasing over time, more than tripling over the last decade.

These tenant farmers typically rent in land based on short-term (written) leases. Of the medium-scale tenant farmers, 65% reported that they had leases for one year, while the rest had it only for one season (Table 3). Surprisingly no longer-term leases were reported by any of these interviewees. The average price paid for a one-season lease is 10,908 Birr (340 USD) per hectare, a relatively small amount compared to

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⁶ In the initial period of the transformation process, most of the rental farmers were coming from outside the area (often richer urban-based investors from Addis Ababa and from the northern region Tigray, where the ruling class in the country used to come from) but over time, a number of local—from the kebele or woreda itself—richer farmers started renting in land as well. This shift in the origin of the tenant farmers is also partly linked to ethnic tensions in the country, as people of Tigrayan origin have increasingly been sidelined.

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Table 2  Change in use of irrigation pumps in vegetable production over past 10 years

| Share of irrigated land                        | Ten years before survey | At survey |
|-----------------------------------------------|-------------------------|-----------|
| a. Private pumps owned by farmers themselves  | % 45.7                  | 72.6      |
| b. Private pumps owned by somebody else       | % 18.7                  | 11.5      |
| c. Communal pumps                              | % 20.8                  | 9.4       |
| b. No pumps—gravity irrigation                 | % 14.9                  | 6.5       |
| Total                                         | % 100.0                 | 100.0     |

Private pumps

Pumps from

| Source                                      | Household survey |
|---------------------------------------------|------------------|
| Pumps from                                  |                  |
| a. China                                    | % 59.5           | 75.7     |
| b. India                                    | % 10.8           | 5.4      |
| c. Europe                                   | % 16.2           | 13.5     |
| d. Other (Japan)                            | % 13.5           | 5.4      |
| e. Do not know                              | % 0.0            | 0.0      |
| Total                                       | % 100.0          | 100.0    |

There is choice in pumps to buy

| Source                                      | Household survey |
|---------------------------------------------|------------------|
| There is choice in pumps to buy             |                  |
| a. No choice                               | % 24.3           | 2.7      |
| b. Little choice                            | % 59.5           | 21.6     |
| c. A lot of choice                          | % 16.2           | 75.7     |
| Total                                       | 100.0            | 100.0    |
the total value of output coming from such areas. For example, the average value of output from a hectare of tomatoes during that period would be around 10,000 USD.7

These medium-scale tenant farmers have typically more capital at their disposal than smallholders to invest in required equipment (digging of wells; investments in pumps, water hoses, or generators), to finance upfront costs of labor and agricultural inputs, and to absorb risks in vegetable cultivation and marketing. They might also have more know-how. Table 4 illustrates some of the differences between medium-scale tenant farmers and smallholders. The former are significantly more educated (7.5 years of schooling on average compared to 5 years for smallholders) and they are significantly better-off economically. While 10% of smallholders considers themselves to be among the richest in the kebele, that percentage is as high as 40% for the medium-scale tenant farmers. Medium-scale farmers also rely significantly more on more costly groundwater irrigation (46% of medium-scale farmers) than do smallholders.

We further find that medium-scale tenant farmers are able to produce more vegetable output. First, they cultivate more vegetable land than smallholders—in the irrigation season they cultivate on average 4.6 hectares of vegetables, six times the vegetable area of smallholders. The large majority of the land of these medium-scale farmers (77%) is rented in. Second, they grow different vegetables than smallholders. They focus more on higher-value vegetables that require more investments in labor and inputs. 40% of the vegetable area cultivated by medium-scale farmers is allocated to tomato, while this is only 10% for smallholders. They also grow significantly more onions. Smallholders on the other hand focus relatively more on green

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Table 3  Land rental practices in vegetable production

| Have a written lease | %  | 89.2 |
|----------------------|----|------|
| **Typical length of lease** |    |      |
| a. One-season lease   | %  | 35.1 |
| b. One-year lease     | %  | 64.9 |
| c. Two-year or longer lease | % | 0.0 |
| Total                | %  | 100.0 |
| **Price for agreement (mean)** |    |      |
| a. One-season lease   | Birr/ha | 10,908 |
| b. One-year lease     | Birr/ha | 16,208 |
| **After land has been used by investors for vegetables, is land degraded?** |    |      |
| a. A lot             | %  | 48.7 |
| b. A bit             | %  | 29.7 |
| c. No different from other crops | % | 21.6 |

*Source* Household survey

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7 Yields of 60 tons per hectare; 5 Birr per kg; 300,000 Birr output per hectare.
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pepper and Ethiopian kale. Third, they use land more intensively and are able to obtain significantly higher yields even if they grow the same crops (Fig. 3). T tests show that these differences are significant for three out of four crops.

8 Chapoto et al. (2013, 2020) show a clear sequencing of crops grown by novices and more experienced commercial horticulture farmers. In Zambia, the novice farmers begin with starter crops such as kale and cabbage, given their lower perishability, pest vulnerability, and input requirements. Those who succeed with the starter crops accumulate sufficient capital, agronomic skills, management and trading experience to move up to more lucrative but more costly crops like hybrid tomatoes. Similar processes might be at work in Ethiopia. This is left for future research.

Table 4 Characteristics, medium-scale vegetable farmers versus smallholders

|                          | Farmers |                  |                  |                  |                  |
|--------------------------|---------|------------------|------------------|------------------|------------------|
|                          | Smallholders | Medium-scale tenants | t test | value | Prob() |
| **Background**           |         |                  |                  |                  |                  |
| Education level          | Years of schooling | 5.1 | 7.5 | 6.74 | 0.00 |
| Age                      | number | 41.5 | 37.9 | -3.19 | 0.00 |
| Gender                   | % male | 94.6 | 98.9 | 2.41 | 0.02 |
| **Compared to rest of the kebele, your household is** | | | | | |
| Among richest in kebele | %      | 10.3 | 39.8 | 9.82 | 0.00 |
| Richer than most in kebele | % | 15.9 | 22.7 | 2.11 | 0.04 |
| About average            | %      | 57.3 | 35.2 | -5.26 | 0.00 |
| A little poorer than most in kebele | % | 11.2 | 0.6 | -4.43 | 0.00 |
| Among poorest in kebele  | %      | 5.4  | 1.7  | -2.06 | 0.04 |
| **Vegetables production** | | | | | |
| **Type of irrigation used** | | | | | |
| Lake                     | % of irrigated area | 34.7 | 35.8 | 0.26 | 0.79 |
| River                    | % of irrigated area | 24.0 | 16.4 | -2.22 | 0.03 |
| Ground water             | % of irrigated area | 37.0 | 46.4 | 2.33 | 0.02 |
| Pond                     | % of irrigated area | 4.2  | 1.4  | -1.80 | 0.07 |
| **Total**                | | 100.0 | 100.0 | | |
| **Area of vegetables cultivated** | | | | | |
| Rainy season             | Hectares/farmer | 0.6  | 0.9  | 1.82 | 0.07 |
| Irrigation season        | Hectares/farmer | 0.8  | 4.6  | 15.20 | 0.00 |
| Area rented in during irrigation season | Hectares/farmer | 0.3  | 3.5  | 18.83 | 0.00 |
| **Type of vegetable grown** | | | | | |
| a. Tomato                | % vegetable area | 10.0 | 39.1 | 11.74 | 0.00 |
| b. Onion                 | % vegetable area | 37.3 | 43.8 | 1.84 | 0.07 |
| c. Cabbage               | % vegetable area | 7.5  | 5.8  | -0.97 | 0.33 |
| d. Green pepper          | % vegetable area | 12.8 | 5.4  | -3.18 | 0.00 |
| e. Ethiopian kale        | % vegetable area | 24.9 | 4.1  | -6.91 | 0.00 |
| f. Other                 | % vegetable area | 7.5  | 1.7  | -3.10 | 0.00 |

Source: Household survey
While these tenant farmers farm small areas in international terms, they are large for Ethiopia—where average landholdings are around 1 ha (Dorosh and Minten 2020)—and also are large when we look at output values. We estimate the average value of their vegetable output in the year before the survey at about 52,000 USD, or 60 times the average GDP per capita in 2019.9,10

**Modern Input Use**

The increase in vegetable production is also linked to the intensive use of modern inputs. First, hybrid seeds are widely used in vegetable cultivation, in contrast with other crops in Ethiopia (Table 5). These seeds are all imported—as shown in the registration records of their improved seed varieties, a number of bigger multinational

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9 857 USD in 2019 (World Bank, [https://data.worldbank.org/](https://data.worldbank.org/)).

10 Their success is in contrast to larger-scale “investors” that were offered cheap land or land for free, typically in the range of 30–50 hectares, and cheap loans. Nearly all failed (personal communication, Gerrit Holtland).
Table 5 Use of modern inputs in vegetable production

| Seed | Share of area on which imported hybrid seed used | Farmers | r test | r value | Prob() |
|------|-------------------------------------------------|---------|--------|---------|--------|
|      |                                                 | Smallholders | Medium-scale tenants |        |        |
| a. Tomato | % | 62.1 | 82.5 | 3.46 | 0.00 |
| b. Onion | % | 8.6 | 25.7 | 4.78 | 0.00 |
| c. Cabbage | % | 51.0 | 71.3 | 0.84 | 0.41 |
| d. Green pepper | % | 17.2 | 70.0 | 3.17 | 0.00 |

| Seeds mostly obtained from | | | | | |
|---------------------------|---------|-------|--------|---------|--------|
| a. Cooperatives | % | 12.3 | 10.2 | − 0.75 | 0.45 |
| b. Private agro-dealers | % | 66.7 | 55.1 | − 2.85 | 0.00 |
| c. Private seed distributors (e.g., Agro Greenlife) | % | 5.7 | 31.3 | 10.07 | 0.00 |
| d. Not bought, from own farm | % | 2.4 | 0.6 | − 1.52 | 0.13 |
| e. Others (NGO, etc.) | % | 12.9 | 2.8 | − 3.86 | 0.00 |
| Total | % | 100.0 | 100.0 |       |        |

| Chemical fertilizer use | Fertilizer application rate | | | | |
|-------------------------|-----------------------------|--------|---------|---------|--------|
| a. Tomato | kg/ha | 942 | 1,284 | 3.01 | 0.00 |
| b. Onion | kg/ha | 845 | 1,008 | 2.43 | 0.02 |
| c. Cabbage | kg/ha | 647 | 1,088 | 1.95 | 0.06 |
| d. Green pepper | kg/ha | 499 | 1,360 | 4.53 | 0.00 |

| Fertilizer obtained from | | | | | |
|--------------------------|---------|-------|--------|---------|--------|
| a. Cooperatives | % | 59.8 | 65.3 | 1.34 | 0.18 |
| b. Private agro-dealers | % | 21.0 | 19.3 | − 0.48 | 0.63 |
| e. Others (local traders, other farmers, etc.) | % | 19.2 | 15.3 | − 1.18 | 0.24 |
| Total | % | 100.0 | 100.0 |       |        |

| Agro-chemicals | Number of sprayings | | | | |
|----------------|---------------------|--------|---------|---------|--------|
| a. Tomato | Number | 18.5 | 22.4 | 1.31 | 0.19 |
| b. Onion | Number | 11.0 | 11.3 | 0.37 | 0.71 |
| c. Cabbage | Number | 12.4 | 13.5 | 0.19 | 0.85 |
| d. Green pepper | Number | 8.5 | 15.3 | 1.06 | 0.10 |

| Agro-chemicals obtained from | | | | | |
|-----------------------------|---------|-------|--------|---------|--------|
| a. Cooperatives | % | 11.2 | 12.5 | 0.48 | 0.63 |
| b. Private agro-dealers | % | 69.6 | 72.7 | 0.81 | 0.42 |
| c. Other local traders | % | 17.8 | 14.8 | − 0.95 | 0.34 |

Source Household survey
seed companies are involved. Table 5 shows that hybrid seeds are especially important in the case of tomato growers. We further see significant differences between smallholders and the medium-scale tenant farmers with the latter relying significantly more on such hybrid seeds. Most of the vegetable seeds are obtained from private agro-dealers, while government-supported cooperatives play a relatively minor role in the distribution of these seeds. It also noteworthy that medium-scale tenant farmers rely significantly more on the services of specialized seed distributors.

Second, we see a large use of chemicals in vegetable production. All producers use large amounts of fertilizers, averages ranging between 1.0 and 1.4 tons per hectare—depending on the crop—for medium-scale tenant farmers, i.e., significantly above the level used for cereals and the official recommendation of 0.3 tons/ha. Medium-scale farmers again use inputs more intensively than smallholders. The fertilizer is mostly obtained from cooperatives. However, about 30% of vegetable farmers obtain fertilizers through other channels. In doing so, they pay relatively higher prices for these fertilizers, as they typically are obtained from the informal market (only cooperatives distribute major fertilizers in Ethiopia (Rashid et al. 2013)).

We also note a high use of agro-chemicals. The number of sprayings is highest in the case of tomato with up to 22 per cultivation season for medium-scale tenant farmers compared to 18 for smallholders. It is lowest in the case of green pepper, but on average still 8 spraying were done by smallholders. Overall, we see no significant differences in number of sprayings between smallholders and medium-scale tenant farmers. However, the types of agro-chemicals might be different with medium-scale farmers often focusing on more expensive agro-chemicals. These agro-chemicals also are mostly obtained from private agro-dealers, who have catered to their increased demand, leading to significant business growth in this area.

Previous assessments on agricultural transformation in Ethiopia have highlighted the important role that the government has played in driving that transformation through the provision of widespread extension advice and the distribution of modern inputs through government-supported cooperatives (Bachewe et al. 2018; Rashid et al. 2013). In contrast, the transformation in the vegetable sector in the Central Rift Valley has been mostly private-sector led—we see the importance of widespread adoption of imported hybrid seeds and agri-chemicals distributed by private agro-dealers and chemical fertilizers that are regularly obtained through non-official channels at higher prices. Moreover, agricultural extension on horticulture by the public sector is extremely limited. As the vegetable sector has received little attention from the government, which has been mostly focused on cereal production and export crops, it seems that these changes have been happening mostly under the radar, largely driven by rapid demand changes, mostly from urban areas.

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11 A lack of diversity of active ingredients in pesticides means that farmers repeatedly use the same pesticides, which imply that crops become increasingly resistant, which forces the farmers to apply even more pesticides (Gerrit Holtland, personal communication).

12 For example, key informants indicated that at the time of the survey 35 shops were selling agro-chemicals in the main town of Meki, supplying a number of these villages that we interviewed. This compares to only 10 such shops ten years before the survey.
Emerging Medium-Scale Tenant Farming, Gig Economies, and Vegetable Services

Labor Contracts

Vegetable farmers rely heavily on hired laborers in the process of vegetable cultivation. Table 6 shows that the majority of work in vegetable cultivation is outsourced, with own family labor accounting for a small part of all the work done in vegetable cultivation. This pattern stands in sharp contrast to how family labor is employed for other crops (Bachewe et al. 2020). Own labor typically accounts for less than 40% of labor use for any agricultural task related to vegetable production for smallholders and less than 10% in the case of medium-scale farmers.

The outsourced laborers are offered different arrangements in the form of daily, monthly, or piecemeal contracts. Piecemeal contracts—under which workers are paid for a job done instead of for a day of work—are especially important for plowing and fencing and are significantly more used by medium-scale tenant farmers than by smallholders.

Contracts of different durations are used—permanent, seasonal, and daily (Table 7). For the longer-term contracts, wages offered vary between 44 and 54 USD per month for smallholders or medium-scale farmers, respectively, and depend to some degree on whether the contract duration is seasonal or permanent. Daily wages are on average 3.7 and 4.4 USD per day for daily laborers for smallholders and medium-scale farmers, respectively. Wages paid by medium-scale tenant farmers are on average significantly higher than those paid by smallholders. Wages are, by international standards, low but they are on average higher than those paid in

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Table 6 Family labor as share of all labor used in vegetable cultivation, by activity

| Own labor as share of activity | Farmers | Proportion test | t value | Prob() |
|-------------------------------|---------|----------------|--------|--------|
|                               | Smallholders | Medium-scale tenants |        |        |
| a. Guarding field (%)         | 29.9    | 3.6            | − 7.30 | 0.00   |
| b. Plowing (%)                | 37.1    | 4.5            | − 8.71 | 0.00   |
| c. Fencing (%)                | 35.1    | 6.4            | − 6.77 | 0.00   |
| d. Planting (%)               | 14.8    | 0.0            | − 5.51 | 0.00   |
| e. Sticking/building ladders  | 21.6    | 0.0            | − 5.76 | 0.00   |
| f. Tying plants (%)           | 16.1    | 0.9            | − 4.32 | 0.00   |
| g. Spraying (%)               | 41.5    | 5.1            | − 9.49 | 0.00   |
| h. Fertilizer use (%)         | 46.8    | 8.0            | − 9.90 | 0.00   |
| i. Irrigation (%)             | 41.0    | 6.8            | − 8.88 | 0.00   |
| j. Harvesting (%)             | 16.0    | 0.0            | − 5.77 | 0.00   |

Source Household survey

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13 At an exchange rate of 32 BIRR/USD in February 2020.
the newly established industrial parks located close to this area (Gordon 2019; Blattman and Dercon 2018) and in the rest of the country, on average 3.28 USD per day mid-2018 (Bachewe et al. 2020). Hired workers in vegetable production typically do not come from the local village, but the majority migrate from the poorer south

| Table 7 | Labor contract conditions in vegetable cultivation |
|---------|---------------------------------------------------|
|         | Farmers | Proportion or t test | t value | Prob() |
|         | Smallholders | Medium-scale tenants |         |        |
| Daily contract |         |                     |         |        |
| Contracts used by farmer | % yes | 72.6 | 79.0 | −1.51 | 0.13 |
| If yes, |         |                     |         |        |
| Typical salaries paid last year | Birr/day | 120 | 140 | −6.82 | 0.00 |
| Share women that have these contracts | % | 35.4 | 30.0 | 2.09 | 0.04 |
| Who pays for housing? | % worker | 95.9 | 95.7 | 0.10 | 0.92 |
| ... for food/drinks? | % worker | 51.1 | 46.8 | 0.62 | 0.54 |
| ... for health care when sick? | % worker | 97.6 | 96.4 | 0.76 | 0.45 |
| ... for phone costs? | % worker | 90.4 | 85.0 | 0.50 | 0.62 |
| ... for clothes at work? | % worker | 98.8 | 94.1 | 2.53 | 0.01 |
| Workers wear protective equipment? | % worker | 20.0 | 18.7 | 0.15 | 0.88 |
| Seasonal contract |         |                     |         |        |
| Contracts used by farmer | % yes | 56.9 | 85.8 | −6.26 | 0.00 |
| If yes, |         |                     |         |        |
| Typical salaries paid last year | Birr/month | 1365 | 1603 | −4.68 | 0.00 |
| Share women that have these contracts | % | 3.6 | 3.5 | 0.09 | 0.93 |
| Who pays for housing? | % worker | 34.9 | 22.5 | 1.37 | 0.17 |
| ... for food/drinks? | % worker | 28.0 | 17.9 | 1.06 | 0.29 |
| ... for health care when sick? | % worker | 70.6 | 55.6 | 2.54 | 0.01 |
| ... for phone costs? | % worker | 89.2 | 76.2 | 3.44 | 0.00 |
| ... for clothes at work? | % worker | 87.4 | 81.0 | 1.42 | 0.16 |
| Workers wear protective equipment? | % worker | 22.7 | 18.5 | 0.46 | 0.64 |
| Permanent contract |         |                     |         |        |
| Contracts used by farmer | % yes | 4.1 | 14.2 | −1.26 | 0.21 |
| If yes, |         |                     |         |        |
| Typical salaries paid last year | Birr/month | 1398 | 1,728 | −1.73 | 0.09 |
| Share women that have these contracts | % | 8.0 | 3.3 | 0.95 | 0.35 |
| Who pays for housing? | % worker | 26.9 | 24.0 | 0.12 | 0.90 |
| ... for food/drinks? | % worker | 26.9 | 20.0 | 0.28 | 0.78 |
| ... for health care when sick? | % worker | 53.9 | 60.0 | −0.33 | 0.74 |
| ... for phone costs? | % worker | 92.3 | 64.0 | 2.24 | 0.03 |
| ... for clothes at work? | % worker | 85.0 | 83.3 | 0.13 | 0.90 |
| Workers wear protective equipment? | % worker | 26.9 | 28.0 | −0.05 | 0.96 |

Source Household survey
of the country (the Southern Nations, Nationalities, and Peoples’ (SNNP) Region). The majority of workers were reported to be hired from daily labor markets that are organized in the center of the woredas. Women are rarely employed under longer-term contracts, but they make up about one-third of daily laborers.

There are only a limited number of additional benefits on top of wages with these contracts, especially if workers have daily contracts (Table 7). For example, only 3 to 4% of daily workers receive help from the employer for health care. This increases to close to 50 percent for seasonal and permanent workers. Housing is often provided by the employer in the case of longer-term contracts. Food and drink are often provided by employers—about three-quarters of the seasonal and permanent workers and half of the daily workers receive food and drink from their employer. However, phone and costs for clothes or are typically not included in the contract, and a minority of farmers report that their workers wear protective equipment (such as gloves and masks) despite possible health impacts due to the high use of agro-chemicals on these vegetables.

We further estimate direct job creation for agricultural laborers in this horticultural cluster at 4350, about 20% of the level of workers employed in the successful Hawassa industrial park nearby. However, the number of people employed is higher during the irrigation season as less laborers are required during the Meher season, when mostly less labor-intensive cereal crops are grown. This estimate also does not take into consideration the additional job demand in the service economies supporting vegetable cultivation.

Service Economy

For the different services required in vegetable cultivation, contactors are widely used. Table 8 shows the extent of the use of such services. For example, 89 and 49% of the medium-scale tenant farmers and smallholders, respectively, indicated that they use machines to plow their vegetable plots, a significantly higher rate than is used in other crop sectors in Ethiopia (Berhane et al. 2021), with most using mechanization service providers. Other contractors are relatively less important, but they still are a sizable number—for digging wells, 32 and 36% of medium-scale farmers and smallholders, respectively, use contractors, while for ponds, 57 and 43% of medium-scale farmers and smallholders, respectively, do so. In the case that no contractors were used, laborers hired-in by the cultivator play a significant role in these activities—indicating again the importance of these labor markets for the vegetable sector. For all such activities in vegetable production, smallholders do these tasks significantly more themselves and rely significantly less on hired-in labor or contractors.

14 While brokers were reportedly used by some farmers, they are relatively less important.
15 See Jepson et al. (2014) who quantify potential health risks from growing pesticide use and generally inadequate availability of protective equipment on African farms.
16 By looking at the hired workers on these farms and using a conservative estimate of number of days worked per year by them (190 days/year).
We further see the use of larger companies and enterprises that do the propagation of seedlings for the farmers. They are significantly more used by medium-scale farmers compared to smallholders. In the case of tomato, 55% of the area cultivated by medium-scale farmers was planted with seedlings produced by a contractor, while for smallholders, only 25% was. We further see significant
differences by crop. Commercial seedling propagation is relatively more common for tomato and green pepper.

In output markets, produce is mostly sold at the farmgate, but medium-scale farmers do this more than smallholders—95 and 63% of the produce is sold at the farmgate by medium-scale farmers and smallholders, respectively. As farmers seldom travel to markets to sell vegetables, buyers have to be found differently. Brokers paid on commission often facilitate the finding of buyers (Table 5). The services of a broker are again much more used by medium-scale farmers (82% of sales) than by smallholders (57% of sales). Moreover, if a broker is used, the type of broker that medium-scale farmers rely upon is different, as medium-scale farmers more often contact brokers located in big cities, while smallholders rely on local ones. Buyers pick up produce at the farm and provide a number of other services, often sub-contracted. While contracting for harvesting is relatively less used (7%), loading of the truck is usually contracted out to buyers, but significantly more so by medium-scale farmers than by smallholders.\footnote{Recently, a number of youth groups have become involved in such work and have started monopolizing these activities in some areas at high rates.}

We further asked how contractors were contacted. While the spread of mobile phones in Ethiopia has been slower than in other countries (Nakasone et al. 2014), they are increasingly being used in these commercial vegetable areas. We see that mobile phones are widely used to contact well diggers, mechanization service providers, and output buyers. While half or more than half of smallholders (48, 69, and 64%, respectively) indicated using mobile phones to obtain these services, this was however much higher for medium-scale farmers at 69, 90, and 86%, respectively.

We therefore find that private agricultural service providers and contractors for short-term tasks are actively used for a large number of activities in vegetable production. These service providers are often contacted through mobile phones and search transaction costs have been significantly reduced because of these easier communication means. While the spread of mobile phones to rural areas might not have been the cause of the emergence of this gig and service economy, it seems that it might have significantly contributed to its emergence.

The COVID-19 Disruption

While the vegetable sector has shown important changes over the last decade, the COVID-19 crisis has created obvious issues for the sector. First, there was a reduction in the demand of vegetables, partly driven by income effects but also by a perception of raw vegetables being linked to infection by the virus (Hirvonen et al. 2020; Tamru et al. 2020). Moreover, transporters were increasingly worried about going to rural areas given uncertainty surrounding travel as well as the possible risks of getting infected (Tamru et al. 2020). As the government blocked land transport from neighboring countries, this also affected international trade, leading to the
disruption of modern input supply chains—especially of seeds and agro-chemicals—that vegetable producers significantly rely upon.

Table 9 shows the extent to which vegetable farmers adjusted their behavior since the start of the pandemic. It is clear that farmers are aware of problems that infection by the virus might cause and they have adapted their behavior accordingly. The majority of farmers indicated that they have avoided hiring workers and going to labor markets to hire workers. They have also avoided going to agro-dealers out of fear of getting infected and have reduced their contacts with extension agents, other farmers, and traders. We further note that the provision of services has been disrupted and only a small share of farmers indicate that they can easily find mechanization service providers, quality seed, and companies to propagate their seedlings. However, medium-scale farmers, who typically use these services relatively more, complain less about these disruptions and constraints than do smallholders.

To assess the impacts of COVID-19 disruptions on their vegetable production activities, we asked qualitative questions on the effects on access to inputs and services, access to labor markets, output market functioning, and plans for the future. On the input side, we see a significant worsening in their functioning, although not all of this change may be linked to the COVID-19 crisis, given the foreign exchange problems in the country (World Bank 2019). Table 10 shows that the majority of farmers indicate that they use less fertilizer, spray less, and use less labor than normally. Given that medium-scale farmers rely more on these labor markets than smallholders, they are more impacted by their disruption—68% of the medium-scale farmers indicated that they used less labor now than normally for vegetable production, a significantly higher number than for smallholders (52%).
Emerging Medium-Scale Tenant Farming, Gig Economies, and…

... half of the vegetable farmers further indicated that they expect their yields will be lower than normal. Medium-scale farmers and smallholders were impacted in a similar manner, as we see no significant difference between them in their expectations on yields. The major reason reported for the expected lower yields was lack of access to inputs (agro-chemicals and fertilizers). While medium-scale farmers mentioned the lack of labor relatively more as a major reason than smallholders, that difference, however, is not significant. On the marketing side, we see that medium-scale farmers have been more impacted by an inability to sell their vegetables in the month before the survey. While 43% of medium-scale farmers mentioned problems in selling all their vegetables, only 17% of smallholders reported such problems.

We further asked farmers about ongoing prices for some inputs, such as plowing, labor, and fertilizers, as well as about output prices. We then compare those to the situation three months earlier at the time of the first round of the survey. To test for differences over this period, we perform a $t$ test for all observations in first and second rounds and then ran a fixed effect model in the case of output prices to analyze

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**Table 10 COVID-19 effects on vegetable cultivation**

|                       | Farmers | Proportion test |
|-----------------------|---------|-----------------|
|                       | Smallholders | Medium-scale tenants | $z$ value | Prob() |
| **Production and inputs** |          |                 |            |        |
| ... that spray less than normally | % 42.8 | 38.8 | 0.49 | 0.62 |
| ... that use less fertilizer than normally | % 48.2 | 45.5 | 0.35 | 0.73 |
| ... that use less labor than normally | % 51.8 | 67.9 | -2.46 | 0.01 |
| ... that expect or have yields that are lower than normal | % 51.2 | 50.0 | 0.16 | 0.87 |
| **Major reasons for lower yields** | | | |
| a. Lack of good seed | % 1.3 | 4.5 | -0.20 | 0.84 |
| b. Lack of fertilizer | % 41.8 | 22.4 | 1.40 | 0.16 |
| c. Lack of agro-chemicals | % 34.0 | 28.4 | 0.45 | 0.65 |
| d. Lack of labor | % 10.5 | 17.9 | -0.57 | 0.57 |
| e. Other | % 12.4 | 26.9 | -1.11 | 0.27 |
| Share of farmers able to sell all vegetables | % 82.9 | 57.8 | 3.46 | 0.00 |
| **Income changes** | | | |
| Much less | % 8.7 | 10.5 | -0.18 | 0.856 |
| Less | % 50.8 | 53.0 | -0.30 | 0.765 |
| Same | % 28.1 | 26.1 | 0.22 | 0.826 |
| More | % 11.0 | 9.7 | 0.13 | 0.895 |
| Much more | % 1.3 | 0.8 | 0.05 | 0.962 |

*Source* Household survey, phone follow-up survey

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About half of the vegetable farmers further indicated that they expect their yields will be lower than normal. Medium-scale farmers and smallholders were impacted in a similar manner, as we see no significant difference between them in their expectations on yields. The major reason reported for the expected lower yields was lack of access to inputs (agro-chemicals and fertilizers). While medium-scale farmers mentioned the lack of labor relatively more as a major reason than smallholders, that difference, however, is not significant. On the marketing side, we see that medium-scale farmers have been more impacted by an inability to sell their vegetables in the month before the survey. While 43% of medium-scale farmers mentioned problems in selling all their vegetables, only 17% of smallholders reported such problems.

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the effects specifically for those households that were interviewed in both rounds, controlling for household characteristics. In the fixed effect model, we further interact with a medium-scale tenant farmer dummy to test if medium-scale farmers have been affected in a different way than smallholders.

Table 11 shows the results for factor prices. We note that all factor prices have significantly increased over the three-month period as shown by the $t$ tests. While inflation is relatively high in Ethiopia—it stood at 19.8% per year in May 2020 (CSA 2020)—factor costs have been changing more rapidly, especially so for wages. Plowing costs increased significantly by 12% between the two periods. The prices of the three main fertilizers used (DAP, Urea, and NPS) also increased significantly by 9, 11, and 6%, respectively. However, the biggest increases were noted for agricultural wages which increased by 36% over the period considered. Given that the latter is a major cost for the production of vegetables, this suggests that production cost increases for vegetable production have been substantial since the start of the COVID-19 pandemic.

To understand to what extent farmers’ incomes and profits have been affected since the start of the pandemic, we also look at output prices (Table 12). We see large changes in prices for all vegetables, but different patterns by vegetable. Onion and tomato show large increases at 54 and 33%, respectively. On the other hand, pepper and cabbage have shown large decreases by 66 and 41%, respectively. The significant increase in the price of onions might have been linked to the closure of some regional borders as well as land borders with Sudan due to the COVID-19 pandemic. In a typical year, Ethiopia imports a significant tonnage of onions from

| Table 11 Factor prices in vegetable cultivation under the COVID-19 pandemic |
|---------------------------------------------------------------|
| Plowing | Wages | DAP fertilizer | Urea fertilizer | NPS fertilizer |
| Birr/ha | Birr/day | Birr/kg | Birr/kg | Birr/kg |
|---------|---------|----------|---------|---------|
| Mean | 522.2 | 126.9 | 1502.9 | 1412.4 | 1518.9 |
| Std. dev | 47.7 | 23.7 | 109.2 | 126.8 | 89.6 |
| Median | 500 | 120 | 1500 | 1400 | 1500 |
| Observations | 452 | 555 | 336 | 720 | 518 |

$t$ test

Jan–Feb survey (1st round)

| Mean | 578.2 | 173.6 | 1623.7 | 1564.2 | 1627.6 |
| Std. dev | 80.5 | 44.8 | 140.5 | 155.3 | 134.8 |
| Median | 600 | 160 | 1600 | 1600 | 1700 |
| Observations | 431 | 432 | 352 | 414 | 102 |

$t$ test

$t$ value | $-12.65$ | $-21.06$ | $-12.55$ | $-17.85$ | $-10.19$ |
prob() | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
Sudan—e.g., 16.1 million USD in 2018. However, as borders have been closed, the shortage of onions from Sudan seemingly has led to a significant price increase, as was indicated in a number of our key informant interviews.

In all cases, medium-scale farmers are impacted to the same extent by these changes as smallholders, as seen by the non-significant interaction coefficients of medium-scale farmers with the second-period dummy in the fixed effect models. However, as noted earlier, medium-scale farmers more intensively use inputs and services and their production costs might therefore have gone up more substantially.

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Table 12  Output prices in vegetable cultivation under the COVID-19 pandemic

|       | Tomato Birr/kg | Onion Birr/kg | Green pepper Birr/kg | Cabbage Birr/kg |
|-------|----------------|---------------|----------------------|-----------------|
| **t test** |               |               |                      |                 |
| Jan–Feb survey (1st round) |               |               |                      |                 |
| Mean  | 5.84           | 13.46         | 21.8                 | 7.24            |
| Std. dev | 2.35          | 3.04          | 9.91                 | 3.49            |
| Median | 5              | 14            | 20                   | 6.75            |
| Observations | 933           | 1052          | 671                  | 670             |
| **May–June survey (2nd round)** |               |               |                      |                 |
| Mean  | 10.47          | 18.88         | 12.02                | 4.46            |
| Std. dev | 2.75          | 4.67          | 6.98                 | 2.71            |
| Median | 10             | 19            | 10                   | 3.5             |
| Observations | 610           | 602           | 337                  | 348             |
| **t value** | −35.25       | −28.56        | 16.21                | 12.96           |
| **prob()** | 0.00          | 0.00          | 0.00                 | 0.00            |
| **Fixed effect model (at farm level)** |               |               |                      |                 |
| 2nd round | ln(Birr/kg)   | ln(Birr/kg)   | ln(Birr/kg)         | ln(Birr/kg)     |
| Coefficient | 0.54          | 0.33          | −0.66                | −0.41           |
| **t value** | 12.98         | 13.88         | −9.83                | −7.60           |
| 2nd round * medium-scale tenants |               |               |                      |                 |
| Coefficient | 0.20          | −0.06         | −0.18                | 0.10            |
| **t value** | 3.58          | −1.41         | −1.49                | 1.21            |
| Quality indicators included?† | Yes           | Yes           | Yes                  | Yes             |
| Observations | 1543          | 1654          | 1008                 | 1018            |
| Groups     | 697            | 713           | 546                  | 539             |
| $R^2$ overall | 0.45          | 0.40          | 0.37                 | 0.24            |

Source  Household survey, phone follow-up survey. Standard errors clustered at the household level

† Quality indicators by vegetable: Tomato: seed type, form, length, ripeness, and overall quality assessment. Onion: seed type, length, moisture, and overall quality assessment. Green pepper: seed type, length, thickness, color, and overall quality assessment. Cabbage: seed type, size, density, and overall quality assessment

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18 Data downloaded from https://comtrade.un.org/data/.

19 The only exception is tomato, where medium-scale farmers saw a 10% higher increase.
(or they might have reduced their input use accordingly). On the other hand, those vegetables that are grown relatively more by medium-scale farmers (onions and tomatoes) have seen price improvements, in contrast to those grown relatively more by smallholders. Finally, it is worth noting that prices of inputs have increased to a lesser extent than prices of output increased for tomatoes. Input/output price ratios have seemingly stabilized for onions, while they have deteriorated for those farmers involved in cabbage and green pepper cultivation. These heterogenous impacts are confirmed by qualitative statements on income changes by vegetable farmers. Overall, 60% of these farmers state that their incomes have deteriorated compared to the same period last year. However, a number of them state that the situation improved (12%), while 28% indicated that there were no major changes.

Conclusions

Important changes have happened in the commercial vegetable sector in Ethiopia. The growing demand from urban areas has led to a rapid expansion of vegetable production in a commercial cluster in the Central Rift Valley in Ethiopia. This increasing production has been private-sector-led and has been driven by a rapid increase in irrigation, investments by richer medium-scale tenant farmers, and the wide use of modern inputs. Moreover, migrant labor and an important service sector have developed that have fueled that change. Our analysis reinforces the sense of speed of adjustments by African farmers, the important scale of this phenomenon, and the spontaneous private-sector-led nature of the responses (see Chapoto et al. (2013, 2020) for similar findings in Zambia). Unlike cotton, tobacco, cocoa, coffee, and flower exports, which have all benefitted from significant, structured public support, the horticultural producers have generally been left to their own devices.

While horticultural production has increased, a number of challenges however remain, including lack of support for horticultural extension by the government, which has been mostly focused on cereal production and less on this high-value products; the overuse of harmful pesticides, possibly leading to environmental problems; and increasing water access and resource overuse (Getnet et al. 2014). Moreover, it is to be stressed that this is a case study of an area with unique features, e.g., rapid rise of irrigation and a focus on vegetable production instead of agriculture more widely. Hence, this case may not be broadly generalizable to most other areas of Africa that remain reliant on rainfed agriculture and where the potential for intensification based on irrigated high-value vegetable production may not be feasible. Nevertheless, it provides a possible indication of the transformation agenda in areas converting from rainfed to irrigated production.

We further show in this paper that changes in this horticultural cluster have been significantly disrupted by the COVID-19 crisis. A large share of the vegetable farmers complained about more difficult access to modern inputs, higher prices for these inputs, lack of access to laborers, and reduced yields since the crisis began. This COVID-19-related disruption seems especially to have had an effect on the larger medium-scale tenant farmers as they rely less on family labor and more on labor markets, they are more involved than smallholders in labor-intensive and risky
vegetable crops, and they use these service economies more intensively. On the other hand, medium-scale tenant farmers mostly benefited from price increases in output markets, while the crops grown by smallholders saw price decreases. Overall, we note heterogenous effects at the farm level on income changes after the COVID-19 pandemic: while about 60% of the vegetable farmers indicated that incomes were lower than normal for the time of the year, 28 percent indicated similar levels, and 12% saw an improvement in income.

While there has been concern globally of the COVID-19 pandemic leading to general food crises, attention has in the short-run mostly focused on trade, logistics, and output markets given that enough produce was available worldwide at the start of the pandemic (Torero 2020). However, this might start to change in some cases. We find here in the case of vegetables in Ethiopia that production in the short-run has already been affected by the COVID-19 crisis, due to the short vegetable production cycles throughout the year. This situation requires close monitoring to understand longer-term effects. Given disruptions in logistics and mostly a deterioration in input and output markets, farmers will have lower incentives to produce vegetables, possibly leading to even lower production in the near future. This is especially important for the vegetable sector if we are to see a continuation in the transformative evolutions realized over the last decade and to contribute to improved nutritional outcomes in the country in the future.

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