Horticultural exports and food security in Senegal

Goedele Van den Broeck[1], Kaat Van Hoyweghen[1] and Miet Maertens[1]

[1] Division of Bio-Economics, Department of Earth and Environmental Sciences, KU Leuven, Belgium

Contribution presented at the XV EAAE Congress, "Towards Sustainable Agri-food Systems: Balancing Between Markets and Society"

August 29th – September 1st, 2017

Parma, Italy

Horticultural exports and food security in Senegal

VAN DEN BROECK Goedele[1], VAN HOYWEGHEN Kaat[1] and MAERTENS Miet[1]

[1.] Division of Bio-economics, Department of Earth and Environmental Sciences, KU Leuven

Key words: high-value food exports, food security, food access, Sub-Saharan Africa

JEL Codes: F1, F6, I3

Abstract

Horticultural exports from developing countries are expanding. While concerns are rising about the consequences of this growth for local food security, there is no empirical evidence that directly measures this impact. We provide such evidence for Senegal, one of the African countries with a sharp growth in horticultural exports. Using secondary data and panel survey data, we analyse the link between horticultural exports and the availability, access, utilization and stability components of food security. Results suggest that horticultural exports contribute to the capacity to import food, and do not jeopardize availability of food at the macro-economic level. At the micro-economic level, we find that female wage employment in the horticultural export sector reduces the probability of food insecurity, improves the quality of food consumption, and shortens the hunger season.

Highlights

- Horticultural exports do not reduce food availability at the macro level
- Horticultural exports improve households' food security through wage employment
- Intra-household gender effects are important in these food security impacts

1. Introduction

Horticultural exports from developing countries have increased tremendously during the last two decades. Average annual growth rates over the period 1995-2014 amount to 6.3% for developing America, 7.5% for Africa and 7.8% for developing Asia (Van den Broeck and Maertens, 2016). Horticulture has become the most important agri-food export sector for developing countries, having surpassed traditional tropical commodities, such as tea, cocoa and coffee. They are mostly destined for high-income countries, where consumer demand for year-round availability of fresh produce and for tropical fruits is increasing. These exports are often realized by medium- and large-scale farms who hire local labourers to work on their fields and in their processing units. A large number of workers are employed in horticultural export sectors; e.g. 35,000 in the Ghanaian fruit sector, 85,000 in the Ethiopian flower industry and 100,000 in the Peruvian horticultural sector (Jaffee, 2003; Mano et al., 2011; Schuster and Maertens, 2016).

Concerns have risen about the food security consequences of these exports in the countries of origin. Many countries that have become important suppliers of horticulture produce to the world market – such as South-Africa, Kenya, Ethiopia and Peru – have high rates of poverty and food insecurity within their borders, and especially so in rural areas. Despite these concerns, Van den Broeck and Maertens (2016) conclude in a recent review article that there is no empirical evidence that directly measures the impact of horticultural exports on food security in developing countries. However, many studies have investigated the implications of horticultural exports, both at the macro- and micro-economic level, which allows to shed some light on the channels through which horticultural exports can affect food security.

At the macro-economic level, horticultural exports may affect a country's food security status both positively and negatively. On the one hand, horticultural produce is characterized by a high and relatively stable value which raises national foreign exchange earnings and a country's capacity to import food. On the other hand, dependency on food imports and fluctuating international staple food prices may increase a country's vulnerability (Khoury et al., 2014). Also, the competition for resources (e.g. land, labour and water) between export production and food production for the domestic market may lead to general equilibrium effects that cause further food price increases (Patel-Campillo, 2010). Lately, concerns have been raised on the environmental sustainability of horticultural exports, such as the

overexploitation of water and soil nutrients, and pollution through overuse of chemical fertilizer and pesticides. The existing evidence largely refutes these concerns, yet the evidence on water overexploitation is more mixed (Asfaw et al., 2009; Sierra et al., 2015; Schwarz and Mathijs, 2017).

At the micro-economic level, wage employment in a horticultural export sector influences households' food security through different channels. First, households' direct access to food (i.e. through own food production) might decrease because land and labour are allocated to export production – as has been documented for example for the Colombian cut-flower industry (Patel-Campillo, 2010). However, if cash constraints are more important in smallholder production, wages earned in the export sector might alleviate cash constraints and result in increased investments in own farm production, leading to higher farm output and revenues. This has been the case for example in the Senegalese horticultural export sector (Maertens, 2009). Second, households' indirect access to food (i.e. through the market) might improve if employment leads to higher income levels. It has been demonstrated for Senegal that wage employment results in upward income mobility, particularly for the poorest households (Maertens et al., 2011; Van den Broeck et al., 2017). Yet, if food prices are increasing more rapidly than wages, households' purchasing power decreases, which might lead to food access problems – as has been shown for the horticultural export sectors in Mexico, Argentina and Colombia (Barron and Rello, 2000; Ortiz and Aparicio, 2007; Patel-Campillo, 2010). Third, the majority of workers in horticultural export sectors are women (sometimes up to 90%) (Barrientos et al., 2003). The creation of off-farm wage employment opportunities for women, especially in areas where such opportunities are limited, may lead to important gender and empowerment effects (Newman, 2002; Maertens and Verhofstadt, 2013; Said-Allsopp and Tallontire, 2015; Van den Broeck and Maertens, 2015). It has been documented that if women earn their own income, it can increase their bargaining power in the household, which might further result in higher food and nutrition expenditures (Duflo and Udry, 2004; Doss, 2006; Fischer and Qaim, 2012).

The available evidence shows a mixture of effects but does not allow to draw firm conclusions on the link between horticultural export growth and food security because direct evidence on this link is lacking. In this paper, we provide such evidence by investigating the effect of horticultural export growth on food security in Senegal. We focus on Senegal as one among quite a few African countries with net imports of staple food crops, with rapidly increasing horticultural exports - from 25.8 million USD in 2000 to 123.6 million USD in

2015 (UNCTADSTAT, 2017), and with a remaining food security problem – with a daily food supply of 2,454 kcal per capita per day and 11.3% of the population undernourished in 2013 (FAOSTAT, 2017). We provide both macro- and micro-economic evidence on the link between horticultural export growth and food security, and analyse the four different components of food security (availability, access, utilization and stability). We use secondary data for macro-level effects and primary data from a two-round panel household survey for micro-level effects. The survey data are detailed and allow to use different indicators to capture the different components of food security, and to analyse possible gender effects. The panel structure of the survey data allows us to accurately estimate impacts of households' wage employment in the horticultural export sector on food security using fixed effects regressions.

2. Background and data

2.1. The Senegalese horticultural export sector

The horticultural export sector in Senegal has expanded rapidly during the past 15 years. The sharp boom in horticultural exports fits within the country's strategy of agricultural export diversification towards higher-value commodities, which was adopted since the devaluation of the FCFA in 1994 and after decades of dependency on groundnuts as the main agricultural export commodity throughout the 1960s, 1970s and 1980s. The government has actively attracted (foreign) private investors in the sector. Nowadays fresh fruits and vegetables are the most important agricultural export commodity, ahead of cotton and groundnuts.

One of Senegal's principal horticultural export zones comprises the departments of Saint-Louis and Dagana in the Saint-Louis region in the north of Senegal. A first horticultural export company invested in this area in 2003. Since then the number of exporters has increased to six, and the cultivated area and produce variety are still expanding. Production occurs mainly from October to May, when horticultural production in Europe is less competitive. All the export companies rely completely on a vertically integrated production system with primary production, post-harvest handling and exporting organised by the company. The investments have created approximately 6,000 jobs, of which 80% is occupied by women. Workers are involved in harvesting, transformation and packing activities, and are

hired on a permanent, seasonal or day-to-day basis. The employees mainly come from the surrounding villages.

2.2. Data collection

We use secondary data to analyse effects at the macro-economic level and primary data from a two-round panel household survey to analyse micro-economic effects. We derive secondary data on national food security and food production from FAOSTAT for 2000 - 2013 and data on national export values and trade balance from UNCTADSTAT for 2000 - 2015.

Household survey data are collected from the departments of Saint-Louis and Dagana, the principal horticultural export zone in Senegal. We purposely selected three rural communities (Gandon, Diama and Fass Ngom) where the main export activities take place. We distinguish an area north of Saint-Louis town and the N2 road to Ross-Béthio (i.e. the Senegal River Delta), where most of the export companies are located and exports are realized since 2003, and an area south of Saint-Louis town where a company started exporting in 2014. Households in the research area are farm-households deriving the majority of their income and livelihood from cropping (mainly irrigated rice production and rain-fed vegetable production) and livestock-rearing (selling of meat and milk from cattle, goats and sheep). Households increasingly diversify their incomes through wage employment in the horticultural export sector and employment in the non-farm sector.

We conducted a two-round panel household survey using a two-stage stratified sampling design. During the first round in April – June 2013 (i.e. *before* export activities started in the south area), we selected 34 villages across the three rural communities in the first stage and stratified according to the distance from horticultural export companies with an oversampling of villages closer to the companies. In the second stage, we selected 500 households within these villages and stratified according to whether a household member was employed in the horticultural export sector during the 12 months prior to the survey with an oversampling of employed households. During the second round in June – July 2016 (i.e. *after* export activities started in the south area), we tried to track all the households of the previous round. We defined a household to be the same across survey rounds if they were living in the same compound, and if the household head was still the same person or if someone else who was also living in the household in 2013 had taken over the responsibility as household head (e.g. the widow or the oldest son of the head). We could not track 36 households of the original

500, resulting in an attrition rate of 7.2%. We do not know why these households moved out of the region, but attrition bias is deemed to be sufficiently low because the relocated households are statistically not different from other sampled households. Three households were dropped from the final sample because of outlying observations. The final sample consists of a balanced panel of 461 households, including 161 households who were employed in the horticultural export sector in the first round, of which 137 remained employed in the second round, and 83 who newly entered employment in 2016 as a result of expanding investments in the horticultural export sector in the region.

We use in both rounds the same structured quantitative questionnaire with fine-tuning of the questions and modules for the follow-up survey. The survey provides household-level data on crop and livestock production, food security status, land assets and living conditions, and individual-level data on demographic characteristics, employment (in horticultural companies) and other off-farm income sources. Household survey data are complemented with village survey data on geographic and institutional characteristics of the sampled villages.

3. Methods

3.1. Approach

We measure food security as defined by the 1996 World Food Summit and analyse four different components: 1) availability, which entails a sufficient supply of food in a specific area, 2) access, which entails the ability to obtain food, 3) utilization, which entails appropriate use of food in order to absorb nutrients, and 4) stability, which entails sustained availability and access. We first assess macro-economic effects, focussing on availability and stability components, and then assess micro-economic effects, focussing on access, utilization and inter- and intra-annual stability. We try to identify the causal effect of wage employment in the horticultural export sector on households' food security using fixed effects regressions.

3.2. Measurement of food security

Food availability entails a sufficient supply of food in a certain area. At the macro-economic level the supply of food is determined by food production for the domestic market within a country's boundaries, food stock levels and net food imports. We measure availability using secondary data from FAOSTAT on daily food supply and prevalence of

undernourishment. We also assess national food production, imports and exports (expressed in volume) and the agricultural trade balance and horticultural exports (expressed in value).

Food access implies the ability to obtain a sufficient quantity of sufficiently nutritious food, and is determined by resources, markets and policies. We measure access using the Household Food Insecurity Access Scale (HFIAS), which is developed by the Food and Nutrition Technical Assistance (FANTA) program of USAID (Coates et al., 2007). This index has been demonstrated to provide a representative image of a households' food security status and to be suitable for impact assessment (Knueppel et al., 2009; Kabunga et al., 2014). Using nine fixed questions, this indicator measures the access to food (both in terms of quantity and quality) that a household experienced during a four weeks period prior to the survey. For each question, respondents are asked to indicate how often they experienced food insecurity problems: never, rarely (1-2 times), sometimes (3-10 times) and often (more than ten times). The different questions and its responses are presented in **Table 1**. We follow the guidelines proposed by Coates and co-authors (2007) and recode the HFIAS into four different classes (food secure, lightly food insecure, moderately food insecure and severely food insecure). Maxwell and co-authors (2014) show that the HFIAS is a very sensitive index because it also includes less severe manifestations of food insecurity, including anxiety and uncertainty about household food access. Therefore, we define a binary variable *Insecurity in food access*, equalling one if a household is moderately or severely food insecure and zero if a household is food secure or lightly food insecure.

Food utilization entails aspects of nutritional quality and safety and sanitation of consumption. We measure utilization by exploiting the nature of the questions asked in the HFIAS, with some of them more related to quality of food and some to quantity of food. We apply a factor analysis on the nine questions to find a number of latent variables that fit common patterns in the data. We keep two factors with an eigenvalue higher than one, and perform a varimax rotation to ease the interpretation of the factor loadings (Table 1). Factor 1 is highly correlated with questions 2, 3 and 4, which are all related to quality aspects of food consumption – hence this variable is called *Insecurity in food quality*. Factor 2 is highly correlated with questions 6, 7 and 8, which are all related to quantity aspects of food consumption – hence this variable is called *Insecurity in food quantity*. These variable express insecurity with higher scores meaning a lower quality or quantity of food consumption.

Stability of food security refers to continued availability and access to food and is related to food resilience and environmental sustainability. At the macro-economic level, we assess inter-annual fluctuations in horticultural export earnings. At the micro-economic level, we assess intra-annual stability using the Months of Adequate Household Food Provisioning (MAHFP), which is also an indicator developed by FANTA (Bilinsky and Swindale, 2010). Households answer the question 'Were there months, in the past 12 months, in which you did not have enough food to meet your family's needs?'. If yes, they indicate in which months they experienced food insecurity. We define this variable as length of the hunger season, so that 12 represents a whole year of food insecurity. Especially in our research area, where agriculture is mostly rain-fed and a rainy season only occurs from July to September, it is specifically important to measure whether a household experiences food insecurity during a particular moment in the year.

3.3. Econometric analysis

We analyze the impact of wage employment in the horticultural export sector on households' food security status according to the following model:

$$Y_{it} = \beta EM_{it} + \gamma EF_{it} + \delta X_{it} + \alpha_i + \theta_t + \varepsilon_{it}, \quad (1)$$

where β, γ and δ are coefficients to be estimated, α_i is a set of time-constant unobservable household variables, θ_t is a year dummy (taking the value of one for 2016) and ε_{it} is a set of time-variant unobservable household variables. The dependent variable Y_{it} is the food security status of household *i* at time *t* and is measured as 1) *Insecurity in food access*, 2) *Insecurity in food quality*, 3) *Insecurity in food quantity*, and 4) *Length of the hunger season* (see section 3.2 for more details). The main variables of interest EM_{it} and EF_{it} represent dummy variables equalling one if male respectively female members of household *i* were wage employed in the horticultural export sector during the 12 months period before the survey. In addition, we include a vector of other explanatory time-variant household variables X_{it} that are likely to influence food security. We control for human capital by including age, education, and gender of the household head, household size (both number of men and women able to work, and number of dependents) and the share of literate men and women able to work; and for physical capital by including productive assets of a household (landholdings and livestock units) and whether they have access to electricity and clean sanitation in their compound. We control for total household income as well to control for all other income sources besides wages earned in the export sector. All income data are real data and inflated to 2015 consumer

index prices. The variable θ_t captures all temporal variation in the region between 2013 and 2016, such as weather shocks and price variations.

We use a fixed effects regression to reduce the bias caused by a non-random assignment of households into wage employment. This model focuses on the variation within households over time and removes all time-invariant observable and unobservable household characteristics. This approach solves the potential endogeneity related to unobserved time-invariant heterogeneity. Twenty percent of the sampled households switched wage employment status over time, which renders sufficient within-household variation to use a fixed effects approach.

4. Results and discussion

4.1. Macro-economic effects

Figure 1 presents the evolution of food availability in Senegal over the period 2000 - 2013. Food availability measured as food supply has significantly improved over time; from 2,164 kcal per capita per day in 2000 to 2,454 kcal in 2013; and prevalence of undernourishment has decreased from 29.4% of undernourished people in 2000 to 11.3% in 2013. However, daily food supply is still below the food security threshold of 2,500 kcal per capita per day. While the macro-level data do not distinguish between urban and rural areas, we can plausibly assume that food insecurity is more severe in rural areas, given higher poverty levels in rural Senegal.

Food production within Senegal has (slightly) increased over time; from 4.4 million tonnes in 2000 to 5.0 million in 2013 (Figure 1). On the other hand, food imports have more than doubled over time; from 1.3 million tonnes in 2000 to 2.8 million in 2013. This implies that Senegal imported 36.1% of its total food supply in 2013. Senegal is a net importer of staple food crops: e.g. the domestic production in 2013 of rice (Senegal's main staple crop) was 0.4 million tonnes in 2013 while imports amounted to 1.1 million tonnes. At the same time, food exports increased as well at a similar rate (an increase of 96.4% between 2000 and 2013), but the absolute quantities are much lower than those of imports (e.g. total exports in 2013 amounted to only 19.5% of total imports).

The trend of Senegal's high dependency on food imports also showcases in the national agri-food trade balance (Figure 1). Especially in 2008, during the food price crisis, the trade

balance became highly negative. The trade deficit started to decrease again from 2012 onwards and accounted for 236 million USD in 2015. The decrease in trade deficit is associated with an increase in horticultural exports. The value of horticultural exports has more than quadrupled over the past 15 years – from 25.8 million USD in 2000 to 123.6 million USD in 2015. Especially since 2012, when exports reached almost 100 million USD, the agri-food trade deficit became smaller. Senegal's main export crops are French beans, tomatoes and mangoes, but produce variety is still expanding. The direct, long-term commercial relations between the horticultural export companies and European retailers also contribute to more stability in exports.

4.2. Micro-economic effects

Table 2 presents the different indicators of food security across households with and without male / female wage employees in the horticultural export sector for 2013 and 2016. In sum, households with employees in the horticultural export sector face a shorter hunger season and households with female employees consume food of higher quality. However, households with employees consume less food during the four weeks period before the survey. Figure 2 depicts the intra-annual dimension of food security and reveals two trends. First, access to food is not equal over the whole year and more households experience hunger during June, July and August than during the rest of the year. These months coincide with the last months before the first rainfall and the period in which export companies hire fewer workers. Second, households with employees are less likely to experience a month with insufficient food access than households without employees. This is consistent across the twelve months and in both survey rounds.

These observed differences do not automatically imply a causal effect of wage employment in the horticultural export sector, because households do not randomly self-select into employment. Households with employees have an older and more educated head, more (literate) household members, less landholdings and livestock units, and better access to electricity and sanitation (**Table 3**). With fixed effects regression models we control for these differences in observed characteristics and for time-constant unobserved heterogeneity; and attempt to estimate the causal impact of wage employment in the horticultural export sector on the different indicators of food security (**Table 4**). Income earned by men in the export sector does not have a significant effect on any of the food security indicators. Income earned by women, on the other hand, reduces insecurity in food access, improves quality of food consumption and shortens the hunger season. It does not affect the quantity of food consumed

during the last four weeks. The effects are quite large: female wage employment decreases the probability of insecure access with 11.1% and the length of the hunger season with 24 days; a relative reduction of 77.7%.

These results are not in line with studies expecting the expansion of horticultural exports to lead to increased vulnerability of poor households (Barron and Rello, 2000; Ortiz and Aparicio, 2007; Patel-Campillo, 2010). Our results on the direct food security effect of employment in the horticultural export sector complement previous findings on income-increasing and poverty-reducing effects of wage employment in large-scale export sectors (Maertens et al., 2011; Herrmann, 2017; Van den Broeck et al., 2017). Our results are also in line with the more general literature on nonfarm employment that finds a positive impact on households' food security and nutrition (e.g. Babatunde and Qaim, 2010; Owusu et al., 2011; Tsiboe et al., 2016).

Other variables in the models influence food security as well. The coefficient for the year 2016 is significantly positive in the estimations of insecurity in food access, quality and quantity, but not in the estimation of the length of the hunger season. This means that *ceteris paribus* food security worsened over time in our sample, but that households with female employees in the export sector were able to mitigate this negative evolution. This is in line with a study in Madagascar by Bosch and Zeller (2013), who show that wages earned on a jatropha plantation helped to mitigate income losses from agricultural production due to climatic reasons. The proxies for human capital do not seem to influence households' food security, except for the age of the household head, which reduces food insecurity and improves food quality, and share of literate women, which increases quantity of food consumption. Land holdings do not affect food security while livestock contributes to a higher food quality, likely because it improves the direct access to dairy products and meat. Access to electricity and clean sanitation matter as well, as they both reduce insecurity in food access. Access to electricity also reduces the length of the hunger season and increases food quantity, while access to sanitation improves food quality. As we control for total income (which improves food security as expected), all these effects need to be interpreted as additional to an income pathway (e.g. improved awareness, better cooking facilities).

4.3. Discussion

The positive effects in our study can be explained through low competition for resources on the one hand and female empowerment on the other hand. The low competition for labour

between production for the export sector and the domestic market contributes to a higher indirect access to food for households with employees. Income per capita is higher for households with employees in 2016, and the wages of these employees constitute the main source of household income; 43.2% on average (Table 3). The timing of activities at the own farm and in the export companies is depicted in Figure 2. Employment in the horticultural export sector is mainly seasonal, as companies only produce during the off-season in Europe and need extra workers during the harvest. In June, July and August activities are reduced to a minimum. Employment in the own farm mainly occurs during two peak harvest moments: one during June-July when irrigated rice is harvested, and one during September-October when rain-fed crops are harvested (e.g. cowpea beans and groundnuts). We need to note that we only have data on the timing of harvesting and not on other farm activities. Employment in the export sector alternates with family labour on the own farm, and competition for labour is fairly low. Wages earned in the export sector are particularly important for bridging the season when own farm production is low.

Also competition for land between the export sector and domestic food production is low. In 2016, horticultural export companies cultivated approximately 2,700 ha in total in the departments of Dagana and Saint-Louis. They do not possess this land but lease it from the rural communities. Before the land lease deals, most of this land was common pasture land and extensively used by (semi-)nomadic pastoralists, particularly during the rainy season (from June until September). Smallholder farmers are not able to produce crops on these lands during the dry season as they are located too far from a river or lake for small-scale irrigation. However, farm households in our sample did cultivate less land or had fewer livestock units between 2013 and 2016 (**Table 3**) but were nevertheless able to increase their farm revenues (**Table 2**). This points to intensification of small-scale crop and livestock production, implying that smallholders' direct access to food was not necessarily reduced in the region.

Our results point to gender differences. Despite incomes of households with male employees being significantly higher than incomes of households with female employees, male employment does not contribute to food security while female employment does. This indicates that preferences and expenditure patterns differ by gender, and that women are more likely to spend money on food. This has been shown before for other West-African countries; e.g. Ghana (Doss, 2006) and Côte d'Ivoire (Duflo and Udry, 2004). Our results fit in both a cooperative household model, in which spouses bargain to spend money on different items, or in a non-cooperative model, in which separate spheres of decision-making are assumed.

Through increasing their share of total household income (28.9% in households with female employees compared to only 8.1% in households without female employees), it is assumed that women increase their bargaining power as well. Even if women do not need to bargain over food expenditures – which is likely the case in Senegal, as women are responsible for food preparation (Sow, 2010) – employed women earn more than non-employed women and are thus able to spend more on food.

5. Conclusion

In this paper we investigate the effect of horticultural export growth on food security in Senegal. We find that at the macro-economic level, food availability improved over time, while horticultural exports, domestic food production and food imports increased as well. These trends do not imply any causation, but they suggest that horticultural exports contribute to Senegal's capacity to import food, and that they do not necessarily jeopardize availability. At the micro-economic level, we find that female wage employment in the horticultural export sector is conducive for households' food security; it reduces the probability of being food insecure, improves quality of food consumption and shortens the hunger season. We do not find a significant effect for male wage employment. These effects are likely related to the higher income levels of households with employees, differences in expenditure patterns across gender and a low competition for land and labour between production for the export sector and the domestic market.

This paper is the first to provide quantitative evidence on the link between horticultural exports and food security. Detailed panel data allow a causal analysis on different food security components at the micro-economic level. Yet, our research has some limitations. We did not measure food consumption, so we could not calculate daily calorie intake or micronutrient deficiencies, which are often put forward as the golden standard to measure households' food and nutrition security (de Haen et al., 2011). However, indicators based on the HFIAS and MAHFP have been proven to be easily collectible tools that validly evaluate impacts in different contexts (Gebreyesus et al., 2015). Another limitation is that we did not investigate the environmental impact of horticultural exports. This issue requires more scientific attention to assess the stability and sustainability impact on food security.

We focus on Senegal but our findings have wider implications for other countries and areas with horticultural export production under similar circumstances. The horticultural sector in the Saint-Louis region is large-scale and labour-intensive. Private sector investments have created a boom in off-farm wage employment opportunities, especially for women. This employment does not coincide with the main agricultural season and does not interfere with own farm production. Companies are striving for year-round production, enabling people who would otherwise be part-time or unemployed to earn an income throughout the year. They cultivate land that was not used by smallholders and lease it from the rural communities themselves. If these conditions are different in other settings, for example if competition for land and labour is higher or if the local population does not benefit from employment, then implications for food security could be less positive and even detrimental. More research in other settings, both at the macro- and micro-level, is needed to draw more general conclusions.

Acknowledgements

This research was funded by FWO (Research Foundation Flanders) PhD and Postdoctoral scholarship and the KU Leuven Research Fund (Methusalem Program). We thank Hannah Pieters and the University of Gaston Berger in Saint-Louis, Senegal, for their highly appreciated assistance in data collection. We thank Jo Swinnen and seminar participants in Göttingen for their comments on earlier versions of this paper.

References

Asfaw, S., Mithöfer, D., Waibel, H. (2009) EU food-safety standards, pesticide use and farm level productivity: the case of high-value crops in Kenya. *Journal of Agricultural Economics* 60(3): 645-667.

Babatunde, R.O., Qaim, M. (2010) Impact of off-farm income on food security and nutrition in Nigeria. *Food Policy* 35: 303-311.

Barrientos, S., Dolan, C., Tallontire, A. (2003) A Gendered Value Chain Approach to Codes of Conduct in African Horticulture. *World Development* 31(9): 1511–26.

Barron, M.A., Rello, F. (2000) The impact of the tomato agroindustry on the rural poor in Mexico. *Agricultural Economics* 23: 289–297.

Bilinsky, P., Swindale, A. (2010) Months of Adequate Household Food Provisioning (MAHFP) for Measurement of Household Food Access: Indicator Guide. Washington, DC: Food And Nutrition Technical Assistance Project (FANTA).

Bosch, C., Zeller, M. (2013) The Impacts of Wage Employment on a Jatropha Plantation on Income and Food Security of Rural Households in Madagascar: A Panel Data Analysis. *Quarterly Journal of International Agriculture* 52(2): 119-140.

Coates, J., Swindale, A., Bilinsky, P. (2007) *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide.* Washington, DC: Food And Nutrition Technical Assistance Project (FANTA).

de Haen, H., Klasen, S., Qaim, M. (2011) What do we really know? Metrics for food insecurity and Undernutrition. *Food Policy* 36: 760-769.

Doss, C. (2006) The Effects of Intrahousehold Property Ownership on Expenditure Patterns in Ghana. *Journal of African Economies* 15(1): 149–180.

Duflo, E., Udry. C. (2004) *Intrahousehold resource allocation in Côte d'Ivoire: Social norms, separate accounts and consumption choices.* NBER Working Paper Series 10498. Cambridge, MA: National Bureau of Economic Research.

FAOSTAT (2017) http://www.fao.org/faostat/en/

Fischer, E., Qaim, M. (2012) Gender, agricultural commercialization, and collective action in Kenya. *Food Security*, 4: 441–453. Gebreyesus, S.H., Lunde, T., Mariam, D.H., Woldehanna, T., Lindtjorn, B. (2015) Is the adapted Households Food Insecurity Access Scale (HFIAS) developed internationally to measure food insecurity valid in urban and rural households of Ethiopia ? *BMC Nutrition* 1(2) : 1-10.

Herrmann, R. (2017) Large-Scale Agricultural Investments and Smallholder Welfare: A Comparison of Wage Labor and Outgrower Channels in Tanzania. *World Development* 90: 294–310.

Jaffee, S., (2003) From Challenge to Opportunity: Transforming Kenya's fresh vegetable trade in the context of emerging food safety and other standards in Europe. *Agricultural and Rural Development Discussion Paper 2003*. Washington, DC: World Bank.

Kabunga, N.S., Dubois, T., Qaim, M. (2014) Impact of tissue culture banana technology on farm household income and food security in Kenya. *Food Policy* 45: 25-34.

Khoury, C.K., Bjorkman, A.D., Dempewolf, H., Ramirez-Villegas, J., Guarinof, L., Jarvis, A., Rieseberg, L.H., Struik, P.C. (2014) Increasing homogeneity in global food supplies and the implications for food security. *PNAS* 111(11): 4001–4006.

Knueppel, D., Demment, M., Kaiser, L. (2009) Validation of the Household Food Insecurity Access Scale in Rural Tanzania. *Public Health Nutrition* 13(3), 360–367.

Maertens, M. (2009) Horticulture exports, agro-industrialization, and farm–nonfarm linkages with the smallholder farm sector: evidence from Senegal. *Agricultural Economics* 40: 219-229.

Maertens, M., Colen, L., Swinnen, J.F.M. (2011) Globalization and poverty in Senegal: a worst case scenario? *European Review of Agricultural Economics* 38(1): 31-54.

Maertens, M., Verhofstadt, E. (2013) Horticultural exports, female wage employment and primary school enrolment: Theory and evidence from Senegal. *Food Policy* 43: 118–131.

Mano, Y., Yamano, T., Suzuki, A., Matsumoto, T. (2011) Local and Personal Networks in Employment and the Development of Labor Markets: Evidence from the cut-flower industry in Ethiopia. *World Development* 39(10): 1760-1770.
Maxwell, D., Vaitla, B., Coates, J. (2014) How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia. *Food Policy* 47: 107-116.
Newman, C. (2002) Gender, Time use and Change: The impact of the cut flower industry in Ecuador. *The World Bank Economic Review* 16(3): 375-396.
Ortiz, S., Aparicio, S. (2007) How labourers fare in fresh fruit export industries: lemon production in Northern Argentina. *Journal of Agrarian Change* 7(3): 382–404.
Owusu, V., Abdulai, A., Abdul-Rahman, S. (2011) Non-farm work and food security among farm households in Northern Ghana. *Food Policy* 36: 108-118.
Patel-Campillo, A. (2010) Agro-export specialization and food security in a sub- national context: The case of Colombian cut flowers. *Cambridge Journal of Regions, Economy and Society* 3: 79–294.
Sow, F.D. (2010) Intrahousehold resource allocation and well-being: The case of rural households in Senegal. PhD dissertation Wageningen University.
Said-Alssopp, M., Tallontire, A. (2015) Pathways to empowerment?: dynamics of women's participation in Global Value Chains. *Journal of Cleaner Production* 107: 114-121.
Schuster, M., Maertens, M. (2016) Do private standards benefit workers in horticultural export chains in Peru? *Journal of Cleaner Production* 112 (4): 2392-240.
Schwarz, J., Mathijs, E. (2017) Globalization and the sustainable exploitation of scarce groundwater in coastal Peru. *Journal of Cleaner Production* 147: 231-241.
Sierra, J., Causeret, F., Diman, J.L., Publicol, M., Desfontaines, L., Cavalier, A., Chopin, P. (2015) Observed and predicted changes in soil carbon stocks under export and diversified agriculture in the Caribbean: The case study of Guadeloupe. *Agriculture, Ecosystems and Environment* 213: 252–264.
Tsiboe, F., Zereyesus, Y.A., Osei, E. (2016) Non-farm work, food poverty, and nutrient availability in northern Ghana. *Journal of Rural Studies* 47: 97-107.
UNCTADSTAT (2017) http://unctadstat.unctad.org/EN/
Van den Broeck, G., Maertens, M. (2015) Female employment reduces fertility in rural Senegal. *PLoS One* 10(3): 1-15.
Van den Broeck, G., Maertens, M. (2016) Horticultural Exports and Food Security in Developing Countries. *Global Food Security* 10: 11-20.
Van den Broeck, G., Swinnen, J.F.M., Maertens, M. (2017) Global Value Chains, Large-Scale Farming, and Poverty: Long-Term Effects in Senegal. *Food Policy* 66: 97-107.

Tables

Table 1: Household Food Insecurity Access Scale: Questions, responses and factor analysis.

Question	Year	Percentage response on occurrences over last 30 days					Factor 1: *Insecurity in food quality*	Factor 2: *Insecurity in food quantity*
		Never	Rarely	Sometimes	Often			
1. In the past four weeks, did you worry that your household would not have enough food?	2013	72.45	18.66	8.68	0.22	***	0.58	0.19
	2016	59.22	26.46	13.45	0.87			
2. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	2013	63.56	23.64	11.71	1.08	***	**0.85**	0.07
	2016	46.42	34.49	17.79	1.30			
3. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	2013	66.38	21.69	10.85	1.08	**	**0.83**	0.03
	2016	59.44	23.21	17.35	0.00			
4. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	2013	72.89	18.22	7.81	1.08		**0.74**	0.18
	2016	69.85	17.57	11.93	0.65			
5. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	2013	85.03	11.50	3.25	0.22		0.49	0.37
	2016	87.64	6.29	6.07	0.00			
6. In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	2013	96.53	0.87	2.60	0.00	***	0.24	**0.75**
	2016	91.76	5.42	1.52	1.30			
7. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	2013	98.48	1.30	0.22	0.00	***	0.06	**0.77**
	2016	93.93	3.69	0.22	2.17			
8. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	2013	99.57	0.22	0.22	0.00	***	0.04	**0.81**
	2016	96.10	1.95	1.52	0.43			
9. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	2013	99.78	0.00	0.00	0.22	**	0.04	0.29
	2016	98.48	1.30	0.22	0.00			

Wilcoxon rank-sum tests are used to test differences between 2013 and 2016. Significant differences are indicated with $p<0.1$ *, $p<0.05$ **, $p<0.01$ ***. 'Never' indicates 0 times, 'rarely' 1-2 times, 'sometimes' 3-10 times, and 'often' more than 10 times. Factor loadings higher than 0.6 are presented in bold.

Table 2: Food security status and income of households with and without male / female employees in horticultural export sector for 2013 and 2016.

	2013			2016		
	Households without employees in export	Households with male employees in export	Households with female employees in export	Households without employees in export	Households with male employees in export	Households with female employees in export
Number of observations	300	99	101	241	135	161
Insecurity in food access (%)	0.24	0.27	0.21	0.29	0.24	0.31
Insecurity in food quality (index)	-0.05	-0.12	-0.25 **	0.15	-0.12 ***	0.06
Insecurity in food quantity (index)	-0.12	-0.01 **	-0.05 *	-0.01	0.20 **	0.24 **
Hunger season (months)	1.25	1.20	0.92	1.14	0.67 **	0.60 **
Income per adult eq. (1,000 FCFA/year)	468.73	534.82	489.53	431.09	577.3 ***	517.08 **
Income from different sources (1,000 FCFA/year)						
Crop production	403.26	580.70	188.71 **	385.26	570.00 **	484.65
Livestock	206.78	36.95 **	77.97 *	465.99	559.98	449.57
Nonfarm employment	927.29	680.40 *	860.75	1,017.86	782.68 *	836.35
Non-labour income	354.68	315.69	247.29	158.29	149.16	125.91
Male wage employment in export	0.00	962.26 ***	499.00 ***	0.00	1,023.53 ***	514.29 ***
Female wage employment in export	0.00	320.79 ***	622.16 ***	0.00	386.99 ***	627.80 ***

Hunger season is based on MAHFP and the other food security indicators are based on HFIAS. Significant differences between households with and without employees are indicated with $p<0.1$ *, $p<0.05$ **, $p<0.01$ ***.

Table 3: Characteristics of households with and without male / female employees in the horticultural export sector for 2013 and 2016.

	2013			2016		
	Households without employees in export sector	Households with male employees in export sector	Households with female employees in export sector	Households without employees in export sector	Households with male employees in export sector	Households with female employees in export sector
Female head	0.14	0.05 ***	0.12	0.15	0.15	0.17
Age of head	55.40	59.28 ***	59.09 ***	55.90	60.73 ***	60.24 ***
Schooling of head	1.53	2.89 ***	2.57 ***	2.00	2.56 *	2.34
Dependents	5.12	5.93 **	6.28 ***	5.28	5.93 **	5.96 **
Male non-dependents	2.01	3.08 ***	2.33 **	2.20	3.34 ***	2.64 ***
Female non-dependents	2.32	3.03 ***	3.42 ***	2.41	3.24 ***	3.57 ***
Share of literate male non-dependents	0.37	0.57 ***	0.49 **	0.41	0.62 ***	0.52 ***
Share of literate female non-dependents	0.22	0.39 ***	0.41 ***	0.29	0.37 **	0.40 ***
Total livestock units	10.01	4.53 *	4.54 *	3.37	3.28	2.78
Land holdings	3.45	1.97 *	1.23 ***	1.98	1.71	1.87
Access to electricity	0.49	0.62 **	0.60 **	0.63	0.67	0.63
Access to sanitation	0.07	0.12	0.14 **	0.12	0.16	0.17

Significant differences between households with and without employees are indicated with $p<0.1$ *, $p<0.05$ **, $p<0.01$ ***.

Table 4: Regression results of the determinants of food security.

	Insecurity in food access	Insecurity in food quality	Insecurity in food quantity	Length of the hunger season
Dummy for male employment in export	0.028	-0.065	0.128	0.301
	(0.072)	(0.146)	(0.149)	(0.416)
Dummy for female employment in export	-0.117 *	-0.324 ***	0.129	-0.828 **
	(0.059)	(0.120)	(0.123)	(0.344)
Female head	-0.029	0.046	0.063	0.316
	(0.133)	(0.269)	(0.275)	(0.770)
Age of head	-0.009 ***	-0.014 **	-0.004	-0.015
	(0.003)	(0.007)	(0.007)	(0.019)
Schooling of head	0.009	0.010	-0.002	-0.056
	(0.014)	(0.029)	(0.029)	(0.082)
Dependent members	0.010	0.031	-0.011	0.017
	(0.011)	(0.022)	(0.022)	(0.063)
Male non-dependents	0.007	0.045	0.030	0.018
	(0.024)	(0.048)	(0.050)	(0.138)
Female non-dependents	0.025	0.008	0.015	-0.055
	(0.024)	(0.048)	(0.049)	(0.136)
Share of literate male non-dependents	-0.103	-0.179	0.046	-0.410
	(0.071)	(0.145)	(0.148)	(0.413)
Share of literate female non-dependents	-0.053	-0.162	-0.298 *	-0.711
	(0.082)	(0.165)	(0.169)	(0.471)
Total livestock units	-0.001	-0.003 *	-0.001	-0.003
	(0.001)	(0.002)	(0.002)	(0.005)
Land holdings	-0.002	0.004	0.006	-0.009
	(0.004)	(0.008)	(0.008)	(0.022)
Access to electricity	-0.165 **	-0.022	-0.324 **	-0.659
	(0.078)	(0.158)	(0.162)	(0.452)
Access to sanitation	-0.121 *	-0.222 *	-0.133	-0.590
	(0.065)	(0.132)	(0.135)	(0.376)
Total household income	-0.015 *	-0.043 ***	0.004	-0.168 ***
	(0.008)	(0.016)	(0.017)	(0.047)
2016	0.089 ***	0.240 ***	0.224 ***	-0.026
	(0.033)	(0.067)	(0.069)	(0.192)
Constant	1.015 ***	1.243 **	0.211	5.356 ***
	(0.238)	(0.481)	(0.492)	(1.375)
Number of observations	922	922	922	922

Figures

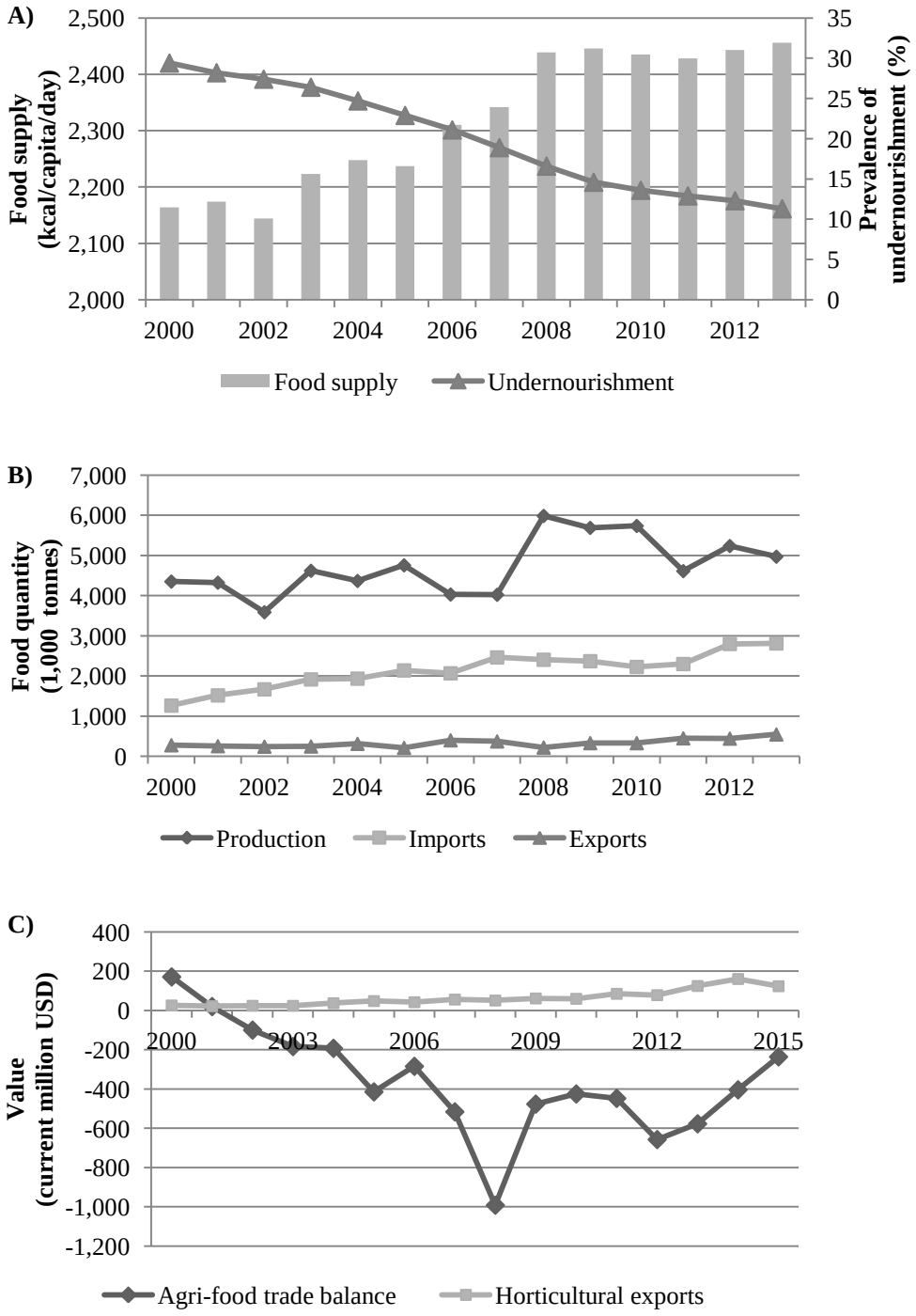

Figure 1: Evolution of food availability in Senegal: A) Food supply and prevalence of undernourishment over 2000 – 2013(Source: Faostat), B) Food production, imports and exports over 2000 – 2013 (Source: Faostat), and C) Agri-food trade balance and horticultural exports over 2000 – 2015 (Source: Unctadstat). Agri-food produce comprises SITC 0 (Food and live animals), SITC 4 (Animal and vegetable oils, fats and waxes) and SITC 22 (Oil seeds and oleaginous fruits).

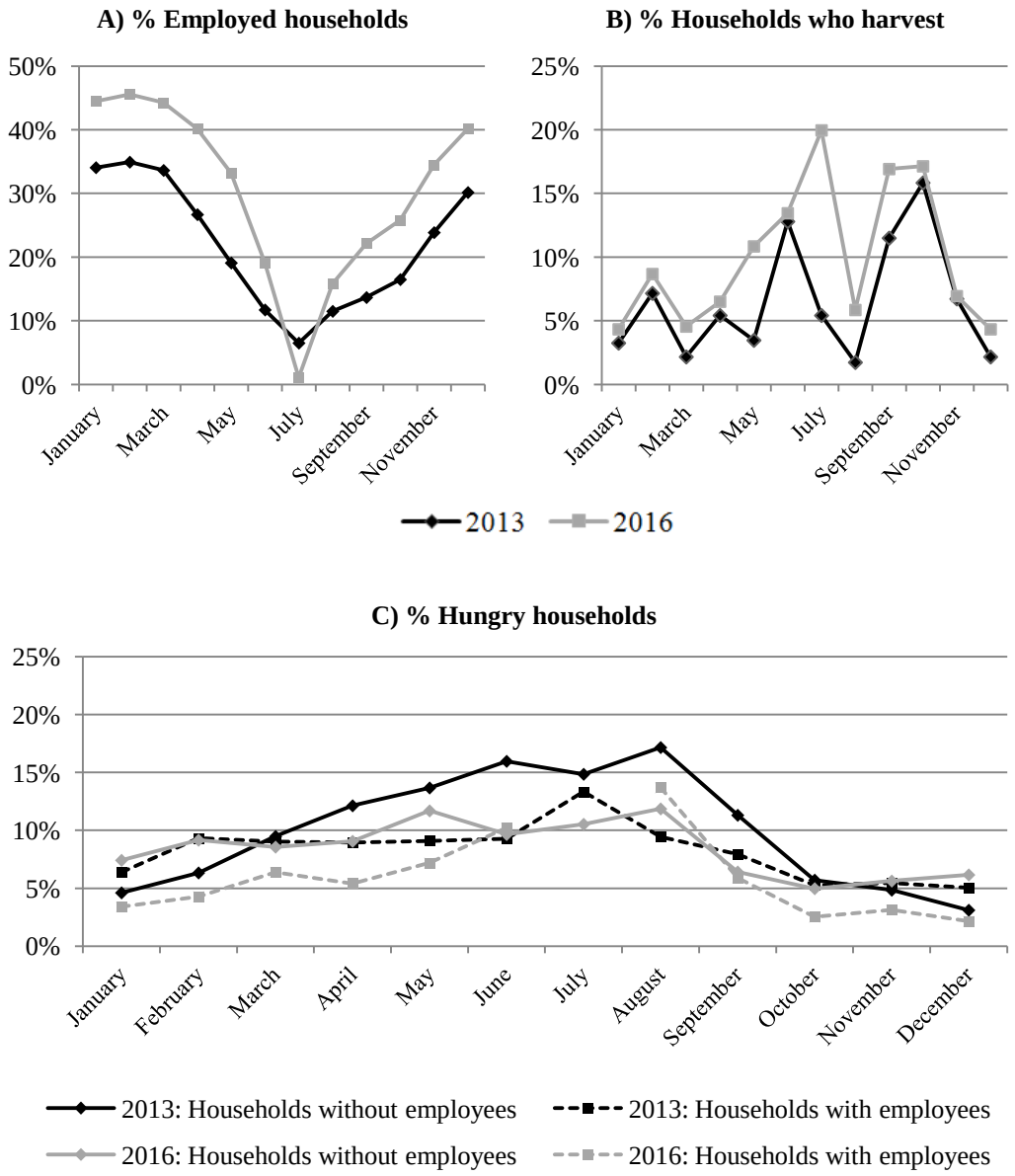

Figure 2: Intra-annual trends in 2013 and 2016 on: A) Share of households with employees in the horticultural export sector, B) Share of households who harvest own farm production, and C) Share of households who experience hunger across employment status.