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ORIGINAL PAPER

Large-scale agricultural investments and local food security – Evidence from a mixed-method case study in Benin

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Abstract
Large-scale agricultural investments (LSAIs) and their impacts on local communities in host countries have been controversially discussed in recent years. As scholars increasingly call for more structured and comprehensive analyses, we develop a mixed-method approach using an expanded version of the "Right to Food" (RtF) framework to systematically investigate the local food security impacts of a recently established tomato-producing LSAI in Central Benin, West Africa. We find that the LSAI keeps natural resources as accessible as possible for the local community and provides employment opportunities, leading to higher dietary diversity of employees and multiplier effects in the local economy. At the same time, we find inequalities regarding the compensation of former land users as well as high job insecurity for temporary laborers who face high transportation costs to reach the LSAI. We argue that fair and inclusive compensation, improved access to markets and machinery, access to natural resources for often overlooked groups (pastoralists, hunters, fishermen) and social infrastructure are crucial factors in promoting positive outcomes of LSAIs on communities and that strong local institutions play a key role for achieving this. We conclude that the specific characteristics of our case (relatively small size, labor-intensive crop, focus on regional markets) provide favorable conditions for positive impacts on local food security. We encourage further, structured mixed-method studies, ideally including longitudinal and comparative research designs, to investigate the multidimensional effects related to the establishment of LSAIs. The extended RtF framework can thereby serve as a structural lens to systematically analyze the findings.

Keywords Foreign direct investment · Land acquisition · Land deal · Land grabbing · Land transfer · Livelihood

JEL Classification Codes Q12 · Q15 · I39

1 Introduction

Triggered by the global food price surge of 2007/08 and increasing resource constraints, a growing interest of private investors and governments in the acquisition of land rights in countries of the Global South can be observed (Cotula, 2012; Deininger & Byerlee, 2011; Hallam, 2011). Capital-abundant countries with limited natural resources seek to ensure their food self-sufficiency through investments beyond national boundaries (De Schutter, 2011). Thereby, Sub-Saharan-Africa is a prominent region in the focus of investors (Land Matrix, 2023). According to theory, investments from capital-rich countries in regions where capital is scarce but other production factors such as land and labor are abundant, can lead to efficiency gains for both sides and can promote the development of the agricultural sector in host countries (Azadi et al., 2013; Hallam, 2011).

Yet, with respect to large-scale agricultural investments (LSAIs), several studies found that such "win–win-situations" (Azadi et al., 2013) are not always reached and instead the benefits of the investors are often to the detriment of the local communities (Yang & He, 2021).

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Reasons for this include a loss of access to resources such as farmland, pastures and relevant communal infrastructure such as water bodies and roads (e.g. Alamirew et al., 2015; Twomey et al., 2015),[1] land dispossession of farmers without adequate compensation (Mabe et al., 2019; Porsani et al., 2017), or no compensation at all for pastoralists (Lavers, 2012), as grazing land is often regarded as "unused" (Nalepa et al., 2016). In several cases the promised opportunities for employment generation are not met as most investments produce cash crops with low labor intensity (Moreda, 2018) and many created jobs are only seasonal (Alamirew et al., 2015; Borras et al., 2011; Moreda, 2018). Also, scholars report missing income and employment benefits for the most vulnerable, thus potentially exacerbating social inequalities in affected communities (Bottazzi et al., 2018; Fitawek et al., 2020; Schoneveld et al., 2011). For all these reasons, several studies found a decline in local food security indicators (Alamirew et al., 2015; Bottazzi et al., 2018; Guyalo et al., 2022; Kebede et al., 2023).

While the existing body of literature is thus overwhelmingly critical of how LSAIs perform in terms of their impacts on local communities, there is also much criticism on how these evaluations have been reached. Scholars such as Yang and He (2021) in their systematic review of the empirical LSAI literature and Guyalo et al. (2022) on food security point particularly to (i) narrow research designs which fail to capture both all relevant stakeholders' perspectives as well as all multifaceted and interlinked impact chains, (ii) a strong bias towards purely qualitative and mostly descriptive case studies with poorly documented research methodologies, e.g. sample size and sample collection (Oya, 2013), and (iii) a general lack of structured research designs that enable holistic analysis, case-comparison, and generalization.

Against this background, we designed our case study on local food security impacts of a tomato-producing LSAI in Central Benin, the "LSAI Collines". In contrast to much of the existing case-study research on food security, we applied both a multidimensional understanding of food security encompassing the availability, accessibility and utilization of food over time (FAO, 1996), and a mixed-method approach that combines the merits of a rich qualitative data set with the assets of a quantitative household survey which allows for the calculation of quantitative food security indicators.

The aim of this study is to construct a "many-voiced story" (Yang & He, 2021) to discover the many different impact pathways through which the LSAI Collines is affecting the food security of the local population. Due to inconclusive results of previous studies, no explicit a priori hypotheses on cause-effect relationships were developed. However, we assumed the LSAI to be an interesting case for the following reasons: Firstly, with a long-term lease of 265 hectares, it is a rather small LSAI producing only for regional (Nigeria) and local markets (Central Benin) — thus having the potential to positively contribute to local food security. Secondly, as the production of vegetables is more labor intensive than the production of most typical cash crops, the company potentially provides larger opportunities for employment and income generation than other investments. Last but not least, to the best of our knowledge, this is the first analysis of how an LSAI affects food security in Benin, making it another case worth investigating in order to enrich the empirical knowledge of LSAIs and their impact on local food security.

The remainder of this article is organized as follows. Section 2 explains the chosen methodological approach. We first introduce the "Right to Food" (RtF) framework serving as our analytical lens in this study (Section 2.1). Secondly, we describe our explorative, mixed-method approach to data collection and analysis (Section 2.2). Section 3 then introduces the LSAI under study, i.e. the "LSAI Collines" in Central Benin. Section 4 comprises our results which we present along the six categories of the extended RtF framework. In Section 5 we discuss the main outcomes of this study in light of the recent literature on LSAIs and local food security (Section 5.1) and reflect on the methodological approach pursued (Section 5.2). Finally, we draw conclusions on what can be learned from this particular case, both with respect to the methodological design of future studies as well as for the future implementation of LSAIs (Section 6).

2 Methodological approach

Studying the impacts of land-based foreign investments on local food security requires adequate operationalization of the concept of food security and deciding upon a strategy for data collection and analysis. This study is based on a multidimensional understanding of food security using an expanded version of the RtF framework (Twomey et al., 2015) to systematically analyze the different aspects and pathways through which food security can be impacted by an LSAI (Section 2.1).

As for our empirical strategy in the field, we decided on a mixed-method approach that combines participatory qualitative methods with key-expert interviews, focus group discussions and a household survey. In the survey we included two common food security indicators, namely the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007) and the Food Consumption Score (FCS) (WFP, 2008) (Section 2.2). This approach allowed us to quantitatively estimate how the LSAI Collines affects

[1] More detail on the case studies discussed in this paragraph can be found in Appendix.

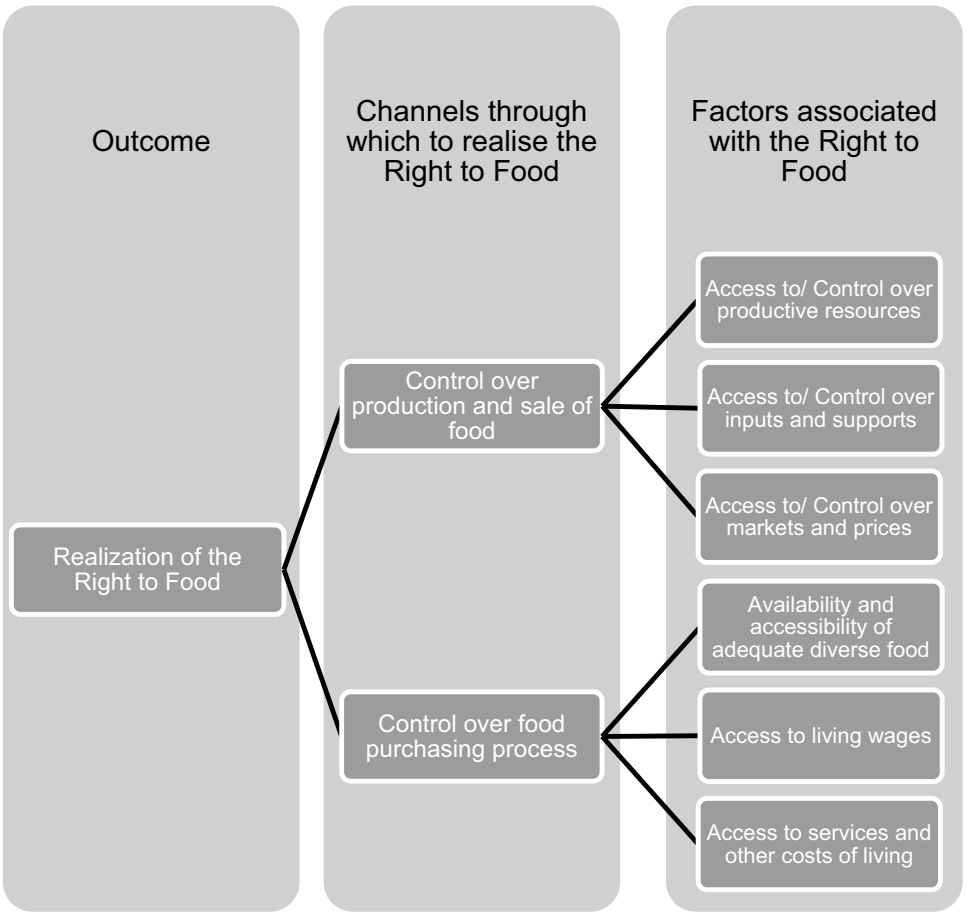

Fig. 1 The channels and associated factors shaping the "Right to Food" (RtF). Source: Own elaboration based on Twomey et al. (2015), p.21

local food security and at the same time to systematically categorize our discoveries on the different impact pathways using the RtF framework.

2.1 The 'Right to Food' (RtF) framework as an analytical lens

The RtF framework was originally developed by Twomey et al. (2015) to analyze the impacts of LSAIs from the point of view of small-scale farmers in the Southern Highlands of Tanzania. The framework is based on a multidimensional understanding of food security as coined in the final declaration of the World Food Summit in 1996: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Following a right-based approach, "the right to adequate food is realized when every man, woman and child, alone or in community with others, has physical and economic access at all times to adequate food or means for its procurement" (UN Committee on Economic, Social, and Cultural Rights 1999, p.3).

In line with this understanding, Twomey et al. (2015) suggest to analytically differentiate two basic channels through which the RtF can be realized: producing food and purchasing food. Smallholder farmers often use both channels: they mostly produce their own food, sell the surplus of their harvest and sometimes they even have other forms of income apart from their own farm revenue. The latter channel is essential for landless households dependent on wage labor and typically gains importance because the establishment of an LSAI often impedes the first channel (e.g. Alamirew et al., 2015; Mabe et al., 2019; Porsani et al., 2017; Twomey et al., 2015) (Fig. 1).

Depending on the channel of realizing the RtF, Twomey et al. (2015) point to five factors that shape one's ability to have physical and economic access to adequate food at all times:

(a) "Access to/ Control over productive resources": Comprises the basic resource needs of a farmer for food production and includes, for instance, (fertile) land, labor, tools and water sources.
(b) "Access to/ Control over inputs and supports": Comprises of the secondary resources for food production and includes for instance credit, training, technical assistance, fertilizers, technical knowledge and accompanying technologies.

(c) "Access to/ Control over markets and prices": This factor takes into account that small-scale farmers often sell some of their products to earn money that they can use to supplement their diets and fulfill other needs. The factor is linked to the price-setting processes as well as physical market access, e.g. through roads, storage facilities and community market spaces.
(d) "Availability and accessibility of adequate, diverse, healthy food for sale": Meaning that food must be physically available, healthy, and affordable.
(e) "Access to living wages": Workers must earn sufficient living wages to ensure sufficient purchasing power for food.

In the research process, it turned out that local stakeholders mentioned several aspects that did not directly fall into the existing categories but are also relevant as they affect household income and hence the ability to purchase food. Therefore, we added another factor, namely:

(f) "Access to services and other costs of living": Accounting for non-food expenditures of local households, which may be affected by the establishment of an LSAI. These can be savings, e.g. due to services provided through the LSAI or additional costs the households might face due to the LSAI. Both cases affect the availability of money to buy food and hence the realization of the RtF.

Going beyond Twomey et al. (2015), we apply the factors of the RtF framework to all local households, irrespective of whether they are engaged in farming or not. While Twomey et al. (2015) put a strong emphasis on the role of the state in the realization of the RtF, this study focuses more on the impacts of the LSAI itself and uses the RtF as a scheme for systematic classification with the RtF factors as basic categories.

2.2 Data collection and analysis

The first challenge in analyzing the multitude of perspectives of potential local stakeholders of an LSAI is the identification of the different groups of people affected and the multilayered interactions between an LSAI and the local community. To address this challenge and to capture a wide range of initially unknown effects, we combined secondary information on the case and context with participatory qualitative methods from the Rapid Rural Appraisal (RRA) tool kit (Chambers, 1992), focus group discussion, key-expert interviews, and a household survey. Table 1 displays all data collection methods used in this study and specifies their objectives and outcomes.

2.2.1 Getting to know the field – participatory qualitative methods

Data collection took place between September and November 2019, around four years after the establishment of the analyzed LSAI. To get access to the field, familiarize with the LSAI and its surroundings and identify themes and issues revolving around the LSAI, RRA methods of village and farm walks as well as a participatory mapping with seven villagers were applied. In a second step, semi-structured key-expert interviews were conducted with the proprietor as well as managers and workers of the LSAI, local pastoralists, the traditional king of the two considered villages, the mayor of the municipality, the president of a regional farmer's cooperative, a mediator in charge for the relationship between the LSAI and the villages, the head of the plant production division of the regional agricultural ministry and the country head of a development organization.

2.2.2 Household survey

Sampling The household survey was conducted in two villages, which were purposively selected due to their proximity to the LSAI Collines. The sample selection followed a two-stage process. Firstly, 30 households were randomly selected, using a household list provided by the Ministry of Health of the municipality as a sampling frame. The households were grouped into households with members regularly working for the LSAI (WORK), households who stated to have noticed other impacts of the LSAI on their food security ("other impacts noticed" (OIN)), e.g. through loss of land/access to other resources or trade with the LSAI (compare "grouping questions", Supplement A) and households which did not report any impacts of the LSAI on their food security ("no impacts noticed" (NIN)). Within this sample, two WORK households were identified and 10 households were classified as NIN, while 18 households noticed a diversity of other LSAI impacts (OIN).

In a second step, 48 further households belonging to the WORK and NIN groups were purposively selected for a more robust sample size to allow for quantitative analysis of the impacts of the LSAI on households with members working on the farm, using the NIN group as control. The final sample thus consisted of 78 households, of which 30 households had members working for the LSAI (WORK), 30 stated that they were not affected in any terms (NIN) and 18 were grouped as OIN.

Questionnaire Data were collected face-to-face using a structured questionnaire (see Supplement A). The design of the household questionnaire followed an iterative process: A first draft based on literature and information provided

Table 1 Applied data collection methods

Method	Participants	Objectives	Themes	Outcomes	RtF framework factor addressed
Analysis of secondary information	First author	Overview of region and agricultural production Detailed information on LSAI Triangulation of information	Demographic and economic information, production statistics, LSAI boundaries, business structure of LSAI	Background information for following steps and design of questionnaire Knowledge of local land tenure system	-
Village walks (VW)	First author and enumerator, partially accompanied by a villager	First impressions of villages, population, available resources and food availability	Natural resources, land use, distance between villages and LSAI Main cultivated crops, local market, food sellers	Establishment of contact with "village king", permission to conduct research Household list Participants for KEI and PM	Productive resources Market and prices Adequate diverse food
Farm walks (FW)	First author and enumerator, partially accompanied by a farm manager	Familiarization with LSAI, its land use and agricultural practices First impressions of working conditions in LSAI	Boundaries of LSAI, access to land and natural resources on LSAI, facilities on LSAI Cultivated crops, use of technology Working times, number/ treatment of workers	Participants for FGD and KEI Written report with a description of LSAI and photos	Productive resources Living wages Services and other costs of living
Participatory mapping (PM)	7 villagers	Getting a figurative imagination about previous land use patterns Information about natural resources and the process of land transfer	Size of land, distribution of cultivated crops Water resources, forests, pastures Lost access to farmland, compensation	Hand-drawn map of farmland sketching the distribution of natural resources and land allocation before establishing LSAI Written documentation on farmers involved and compensation	Productive resources
Focus group discussions (FGD)	10 workers (first FGD) 8 workers (second FGD)	Better understanding of working conditions, identification of alternative regional employment opportunities and further themes not yet considered	Working conditions and wages, reasons for/satisfaction with working for LSAI, problems Changes in food security since working for LSAI Alternative employers, job experiences before working for LSAI	Written documentation of working conditions Participants for KEI Extension of HH questionnaire	Living wages Adequate diverse food Services and other costs of living
Key-expert interviews (KEI)	15 key-experts	Getting specific information on relationships between LSAI, the local community and the wider context	Various, depending on the informant	Written report on background information	All factors

Table 1 (continued)

Method	Participants	Objectives	Themes	Outcomes	RtF framework factor addressed
Household survey (HH)	78 household heads	Collecting data on household demographics and RtF factors	Socioeconomic household characteristics, households' agricultural production systems, LSAI-related changes in access to land, water, inputs, extension, markets, changes in food supply, consumption, prices, income and expenditure	78 completed questionnaires	All factors

Source: Own elaboration

by the managers of the LSAI was later adjusted to include additional information gathered on-site. Interviews were conducted with the help of a local enumerator, mainly in the regional language Nagot. To ensure interview uniformity, avoid different interpretations, prevent misunderstandings and thus minimize bias, the interviewers were trained in a simulation and the questionnaires were pre-tested under field conditions (United Nations, 2005). The interviews' purpose and the interviewers' independence were pointed out to the interviewees. Furthermore, all interviews were conducted anonymously.

Besides general and demographic data of the household, the questionnaire focused on the six factors of the extended RtF framework (Fig. 1) to find out how far these factors are fulfilled and influenced by the LSAI. The different factors were addressed individually with closed and open questions such as, "Did you use or own land for crop production before 2015″ (Proxy, Access to productive resources) or "Why or why not did you start to work for the LSAI?" (Proxy, Access to living wages). The final section of the questionnaire was devoted to two well-established quantitative food security indicators which are described in the next section.

To get a picture of the effects caused by the LSAI, respondents were asked to describe their current status in comparison to the situation before the establishment of the LSAI. Additionally, the interviewees were encouraged to add further aspects regarding experiences of food insecurity (see Supplement A, Q.74–76). Thus, the survey outcomes strongly reflect the interviewee's perceptions of changes in their food security status before and after the establishment of the LSAI. We critically reflect upon this in Section 5.2.

Household Food Insecurity Access Scale (HFIAS) and Food Consumption Score (FCS) The HFIAS, as described in Coates et al. (2007), asks whether incidences of food insecurity occurred in the past (such as whether a meal had to be reduced or skipped) and serves in recent quantitative food security assessments as a proxy for the access dimension of food security (Guyalo et al., 2022; Roba et al., 2019). The FCS, in contrast, is based on questions regarding the frequency of consumption of different food groups consumed, thus serving as a proxy for dietary quality. It is calculated based on the WFP (2008) approach and has been widely applied as well (e.g. Alamirew et al., 2015; Fitawek et al., 2020; Guyalo et al., 2022). Both indicators are described in more detail in Supplement B.

To analyze whether being employed by the LSAI has a significant impact on the food security outcome of workers, the HFIAS and the FCS of the WORK group were

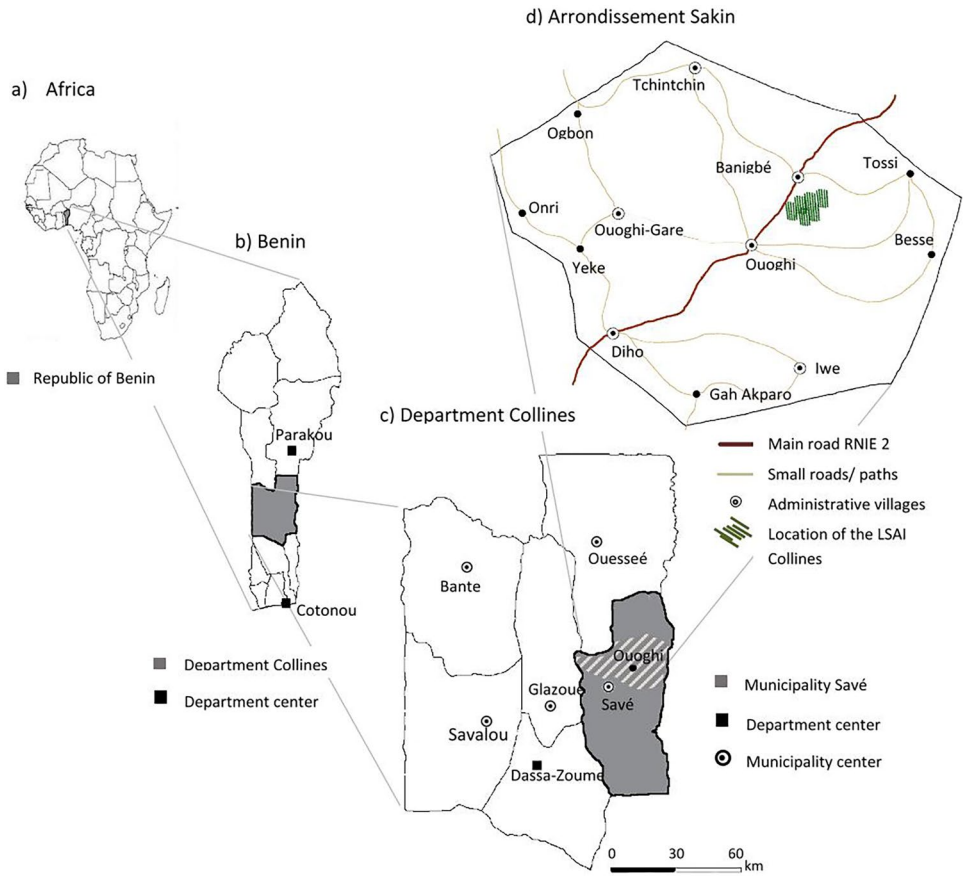

Fig. 2 Map of the research area, showing the location of Benin in Africa (**a**), the location of the department Collines in Benin (**b**), the location of the municipality Savé in Collines (**c**) and the location of the LSAI Collines in the arrondissement Sakin (**d**). Source: Own elaboration, based on Adjimoti and Kwadzo (2018)

compared statistically to the NIN group as a control.[2] The samples of WORK and NIN were unpaired. It was assumed that households within the two groups were normally distributed. An F-test revealed that there were no significant differences in the variances. Hence, an independent two-sample t-test was chosen to test the hypotheses that the WORK group and the NIN group do not differ in their mean HFIAS and FCS. The alternative hypothesis was that the HFIAS is significantly higher for the NIN group and that the FCS is significantly higher for the WORK group.

2.2.3 Data triangulation

When analyzing the data of this case study, triangulation was applied to cross-check the data, to confirm accuracy of results and to complement the information from different sources with each other. To ensure data quality, we scrutinized inconsistencies. For example, we assessed the accessibility of the land and other natural resources on the property of the LSAI from several perspectives. On the one hand, the household survey included closed questions on whether people are still allowed to cross the land and use its natural resources. On the other hand, we gathered information on this point from key-expert interviews with farm managers and pastoralists, through participatory mapping and observations. Similarly, the food security indicators were complemented by the RtF Framework, which would provide explanations for pathways through which the establishment of the LSAI Colines affected the food security of different households in the research region.

3 The case: a large-scale tomato farm in central Benin

The research was carried out in central Benin (Fig. 2). The department Collines is the most important region for the production of roots, tubers and vegetables in Benin. Yet the food security situation in the region is critical and 37.5% of households have been found to be food insecure (Adjimoti & Kwadzo, 2018). Access to food is strongly linked to households' own food production, as either households eat what they cultivate or buy food from the income they earn from selling surpluses (Adjimoti & Kwadzo, 2018).

[2] As the impacts of the LSAI on the OIN group were quite heterogenous (positive and negative) it was excluded from the statistical analysis.

The analyzed LSAI is a tomato farm, which was established by an Indian investor in 2015. As shown in Fig. 2, the LSAI is located between two villages: 3.0 km north of Ouoghi with 759 households and 4,649 inhabitants and 2.5 km south of Banigbé (no household numbers available but fewer than in Ouoghi). 71% of the households in the arrondissement Sakin are dependent on agriculture (INSAE, 2018). The Sudano-Guinean climate in the region is characterized by a rainy season lasting from April to October (Saïdou et al., 2008).

The LSAI Collines is situated directly next to the arterial tarmac road that connects the port city Cotonou and Parakou in the north of Benin, which facilitates transportation. 265 hectares have been leased out to the investors for 50 years in a contract negotiated between representatives of the villages Ouoghi and Banigé and the investors. The contract included that the LSAI needs to provide jobs for local people and a monetary compensation for displaced farmers.

As of 2019, the LSAI Collines crops 145 hectares, while the rest of the lease is still unexploited. The core business is the production of tomatoes, whereby drip irrigation allows for production throughout the year. A share of the produced tomatoes is marketed locally and sold directly to consumers or to local traders, who sell on the markets in Ouoghi and Savé, a regional center 15 km away from the LSAI Collines. However, the lion's share of the harvest is sold to traders who resell the tomatoes on larger markets, for instance in Cotonou, Parakou and also export to Nigeria. The LSAI Collines was established with the capital of an agricultural trading company owned by investors. In 2019 this parent company started to purchase cashews and soybeans from surrounding farmers of the LSAI Collines for export. The contract for the sale of the crops was agreed upon between the parent company and a local farmer's cooperative.

The LSAI Collines employs around 34 workers permanently and, depending on the season, usually around 30–100 temporary workers per day. Permanent workers have regular tasks, for instance, the construction, implementation and maintenance of the irrigation system, while temporary workers are responsible for daily varying tasks such as weeding or harvesting. While the number of temporary workers fluctuates, there is some work for temporary workers throughout the year.

4 Impacts of the LSAI Collines on local food security

4.1 Access to productive resources

The land leased out to the LSAI Collines was previously operated by the villages of Ouoghi and Banigbé, under community ownership. The participatory mapping with villagers brought to light that it was used in a variety of ways before the land transfer took place. Five kinds of land uses and the associated user groups could be identified: Farming, pastoralism, hunting, fishing and waste disposal. As the LSAI Collines is not fenced off and as of 2019 not the whole leased area is cultivated, the establishment of the LSAI Collines compromised these activities to varying degrees. Also, the related interest groups were affected by and involved in the land transformation process at different levels.

4.1.1 Farming

Before the establishment of the LSAI Collines, the leased-out land was largely used as cropland by local smallholder farmers in a traditional, extensive rainfed production system with a low degree of technology. During the participatory mapping it was estimated that roughly 80 farmers mainly grew cashews, groundnuts, yams, cassava, maize and mango on that land. Many of them were associated with an agricultural cooperative.

After the land was leased out, this occupation was forced to stop entirely. The farmers were ordered by the local authorities to leave the land. Different from other regions, arable land in the proximity of the LSAI Collines is not scarce and there are still many unexploited areas that can be cropped. According to key-experts and interviewed households, the communities offered the farmers new plots of land of mostly similar size and quality at another site for free as compensation. Yet, in most cases that land was further away from the respective villages. Furthermore, according to key informants, all farmers were compensated financially by the investors in relation to the size of the previously cropped land and the standing crop. Thereby, the investors negotiated the amount of compensation with the users of the land individually.

Of the 78 households interviewed, six were identified that had to abandon their farmland or parts of it due to the establishment of the LSAI Collines. One of these households indicated to have received only a one-hectare plot, while having to abandon a plot of six hectares. Another household claimed not to have received any land at all. The interviews revealed that these two households did not inherit the land but migrated to the region only some years ago. They were then granted the right to only use a plot of land free of charge but without ownership.[3] Thus, the community did not feel

[3] Traditionally, farmland in the region is collectively managed, meaning that there are no formal land titles but native farmers get their right to make use of the land through intrafamilial inheritance or through a transfer of rights from the traditional village king (see also Saïdou et al., 2007; Bio Akpo & Li, 2017). In former times, migrants who came to the region had the obligation to provide labor in order to get a plot of land for their own use. More recently, this system changed to a form of monetary compensation, whereby amount and modality of the rent are negotiable and migrants who stay at least 10–15 years in the village are charged less or even exempt (see also Saïdou et al., 2007).

obligated to compensate them when the LSAI Collines was established. The two households coped with this situation by entering into a sharecropping agreement or renting out additional land.

One of the two households along with another household also reported not to have received any monetary compensation. The household head said that he gave his land voluntarily for free as he saw high benefits for the village, while the head of the other household claimed that he was neither informed about the land acquisition process nor compensated by the community with land nor by the investors with money.

The amount of compensation that other households obtained varied widely, depending on the crop grown: one household head stated to have received one million CFAF (1,800 USD) per hectare of cashew trees, another mentioned 50,000 CFAF (90 USD) per hectare of maize before the harvest, while a third household indicated 10,000 CFAF (18 USD) per hectare of maize after the harvest. All six households who gave parts of their land to the investor cropped a smaller plot of land than before the establishment of the LSAI Collines. However, all of them indicated that this was not due to a lack of land but to various other reasons, including a lack of funds to purchase inputs to start or increase their production in a new place. As none of the interviewed households practiced irrigated agriculture, no changes in the availability of irrigation water as a potentially important agricultural production factor were identified.

The participatory mapping, interviews with key informants and the household survey revealed that information about the land transfer reached the households very unequally. They were informed between one year and only a few weeks before the establishment of the LSAI Collines. None of the interviewed households' heads were involved in the negotiation process and thus could not influence the terms of the contract struck between the community and the investors.

4.1.2 Pastoralism

The participants of the participatory mapping explained that pastoralists had used part of the land leased out to the LSAI for cattle grazing. Three pastoralist households which had previously used this land were identified. For two of these households, pastoralism was the main source of income, while the other household owned a smaller herd and mainly focused on crop farming.

All of the pastoralist households indicated that their access to pastureland had changed through the establishment of the LSAI Collines. Generally, the size of the land which they could use for their cattle decreased, as the communities gave a part of the pastures to the LSAI. Although there is further grazing land close by, the affected pastoralists could not use it, as this area is already extensively used by others. The pastoralists did not receive any kind of compensation. Yet, the LSAI Collines allowed them to let their cattle graze on fallow plots after the tomato harvest. The owner of the LSAI explained that he intends to establish a good relationship with the villages and to create no disadvantages for previous users of the land. All pastoralists mentioned that the main change in their situation is that access to the land is no longer unrestricted, and they now needed the assent of the investors. Although the coexistence with the LSAI Collines worked well so far and the pastoralists did not have any conflicts with the farm managers, this dependency made them worry about their future.

Two pastoralists mentioned that their animals are thinner during the rainy season compared to before the LSAI Collines was established, which, however, may also be influenced by an increasing cattle population in the area and hence a greater strain on grasslands in the last years, as indicated by all pastoralists. In contrast, all pastoralists agreed that the feed for their cattle in dry seasons is now more sufficient and nutritious owing to the grazing on the cleared tomato fields, which had been irrigated. One pastoralist emphasized that he prefers the situation since the establishment of the last LSAI Collines and does not want the company to leave; despite the fact that in rainy seasons his situation is more difficult. That said, in the dry seasons there is now more feed for his cattle. The other two pastoralists agreed that the existence of the LSAI Collines is acceptable for them, as long as they are allowed to use the land for their cattle.

4.1.3 Other uses

Teak and Cailcedra trees were planted on the land many years before the establishment of the LSAI Collines to reforest some of the area. This afforested area was used sporadically for hunting and wild fruit picking. During the participatory mapping, participants could not indicate how important this leased-out area was for these activities before. Among the 78 interviewed households, one household was identified that used the forest for hunting and fruit-picking activities before the LSAI Collines was established. This household's head indicated that these activities had to completely cease on the land of the LSAI Collines. According to him, the area had been completely deforested by the LSAI Collines and there is neither game nor wild fruits to be found there any longer. He had to resort to farther away forests, which consequently reduced his hunting and gathering activities, as he instead focused more on farming.

A small river crosses the land now operated by the LSAI Collines. 12 households indicated that they engage in fishing for their own consumption in the area around Ouoghi. They described the river as rather small and of

minor importance for fishing. Three of them indicated that they have lost access to the river on the LSAI land. All the other households stated that they still have access to the river and fish there, although the surrounding land is used by the LSAI Collines. Observations revealed no barriers that would prevent fishers from using the river, and, what's more, fishing in the river was in fact observed. The owner of the LSAI Collines indicated that he supports fishing in the river. That the three fishermen are no longer using the river is more a result of miscommunication and a lack of information.

A small part of the land now occupied by the LSAI Collines used to be a waste dumping ground for the surrounding villages. Observations in the villages, key-expert interviews and the participatory mapping revealed that no new dumping ground had been established. Therefore, there is no longer a common site for waste disposal, and villagers now need to find other ways to dispose of waste, such as burning it.

4.2 Access to inputs and supports

4.2.1 Access to production inputs and machinery

Generally, none of the interviewed households engaged in farming noticed a change in access to inputs such as fertilizers and pesticides that could be traced back to the establishment of the LSAI Collines. According to key-experts, the LSAI Collines directly imports large quantities of fertilizers and pesticides from India and only rarely purchases inputs locally. It also does not sell inputs to local farmers.

Since 2019, the LSAI Collines offered a ploughing service to local farmers. Based on expert information, an area of 60 hectares was ploughed by farm employees for local farmers in the first year of this service. Interviewed farming households believed the price of this service to be fair, as alternative operators would charge 20% more. Household heads who used this service reported that it allowed them to increase their production area, underscoring the observation that not land so much as capital is the limiting factor in the region. Thus far, this service has been offered only to households that cultivate soybean and sell shares of their produce to the parent company of the LSAI Collines in a newly established out-grower scheme. The household heads reported that they would not have to pay for the ploughing service directly; instead, the ploughing service fee would be deducted from the proceeds of their harvest. This scheme was highly valued by the household heads, as they had neither to make an advanced payment nor run into debt.

4.2.2 Access to credit, extension service, training and knowledge

None of the interviewed households noticed a change in credit, extension service or training since the LSAI Collines was established. Although the availability of overall agricultural training did not increase in the region, most of the interviewed households reported a knowledge transfer: households with members working for the LSAI Collines indicated that through on-the-job training they gained new skills and knowledge about tomato production, such as tying up the plants to increase yields. Other households not directly linked to the LSAI had also acquired knowledge of this technique.

Furthermore, permanent workers especially profited from such newfound knowledge regarding modern commercial agricultural production methods. When employed by the LSAI Collines they were trained in irrigation technology, usage of fertilizers and pesticides, as well as in the operation of machinery. They perceived this training as having broadened their opportunities on the labor market.

Apart from training their own workers, the managers of the LSAI Collines collaborate with the University of Parakou. The University organizes excursions to the LSAI Collines for students to become better acquainted with modern agricultural production methods in practice and to see up-to-date machinery and drip irrigation systems.

4.3 Access to markets and prices

An important livelihood strategy for smallholder farming households in the region is to sell their production surplus and use the money to buy products they do not produce themselves. Several farming households mentioned that they often face problems marketing their produce: Traders come to the region only irregularly to buy cashews and soy for export markets, mainly when passing by on the nearby highway connecting Cotonou and Parakou. They only come if there is high demand and they also set the prices. One household head described it as a "take it or leave it" decision. Thus, households have no guarantee that they can sell their produce and cannot rely on a stable income.

Vegetables, fruits and staple crops can be sold on the weekly market in Ouoghi. Customers are mainly from the village itself and few travelers pass by. For tomatoes, the marketing situation of local farmers has been largely described as worse compared to that before the establishment of the LSAI Collines. Most of the interviewed households indicated that the supply of tomatoes in the region increased since the establishment of the LSAI Collines. They traced this back primarily to the supply from the LSAI

Collines but also to additional tomato production by smallholders in the villages. According to key-experts, the general interest in tomato production in the area increased since the establishment of the LSAI Collines. Increased knowledge about production techniques and the discovery of the LSAI's profitable tomato trading activities incentivized many smallholders to participate, allowing them to obtain higher yields. Although the demand for tomatoes in the village increased, as many traders came to purchase them, the additional supply significantly exceeds demand. Thus, according to key-experts and the results of the household survey, the prices for tomatoes in the region decreased.

In contrast, the marketing opportunities for soybeans and cashews improved, as the LSAI Collines provided a new marketing channel: in 2019 the parent company of the LSAI Collines established an out-grower scheme and purchased around 300 metric tonnes (MT) of cashews and closed a contract with a local farmer cooperative over purchasing 60 MT of soy at a fixed price. According to the president of the cooperative, the prices and conditions in the contract were negotiated between the company and the cooperative. He emphasized that he would like to further develop trade relations with the company. Interviewed households engaged in these trading activities mentioned the independence from price fluctuations, the higher price for their products, additional marketing options and higher income stability as definite advantages of this relationship. The proprietor of the LSAI Collines said also that the vast storage capacities of the LSAI, the already installed weighbridge and the location of the LSAI in the middle of the country constitute favorable conditions for the establishment of a trade post on the LSAI site. He considered the implementation of this plan and stated that local farmers could benefit from increased trade in the region.

4.4 Availability and accessibility of adequate, diverse food

The household survey showed that households did not notice any change in the physical availability of food in general – except for that of tomatoes, for which the majority of households (71%) reported that the quantity of available tomatoes increased – which was also confirmed by key-experts. Furthermore, the survey revealed that the supply of tomatoes throughout the year had become more stable and diverse due to the planting of other varieties and irrigation by the LSAI Collines.

With respect to food prices in general, households did not notice any changes since the establishment of the LSAI Collines. That said, for tomatoes, most households (71%) perceived a price drop, which again was supported by key informants. Several households indicated that due to the price decline, they would now buy tomatoes more frequently, thus enhancing the diversity of their food consumption.

The statistical analysis of the food security status between different household groups showed that those households with members working for the LSAI Collines (WORK) and those that did not notice any impacts of the LSAI (NIN) featured a relatively low HFIAS with an average of 6.6 and 7.9, respectively. While no significant difference could be found between the two groups, the variation of the HFIAS of the NIN group was higher, suggesting that fewer households in the WORK group had lower access to food. Also, the mean FCS of the WORK group was found to be significantly higher than that of the NIN group (Supplement C), pointing to a more diverse dietary intake of households working for the LSAI.

4.5 Access to living wages

The interviewed households described their opportunities for earning wages in the region as very limited, with the exception of those provided by the LSAI Collines. Besides farming activities, the primary sources of income before the establishment of the LSAI Collines were mainly to work as a street vendor, hairdresser, moto-taxi driver, wage-laborer for other farmers and as a wage-laborer for a sugar-producing company in Savé, another LSAI about 15 km to the South. The latter option was lost a few years ago, however, when the company stopped its shuttle service.

As of October 2019, the LSAI Collines employed 34 workers permanently and hired, depending on its needs, usually between 30 and 100 temporary workers per day. Permanent workers were mainly hired as supervisors, technicians, tractor drivers, warehouse keepers or part of the irrigation team. Apart from the agricultural jobs, there were also permanent workers hired as gatekeepers, housekeepers, cooks and doctors. The wage of permanent workers was between 40,000 and 120,000 CFAF per month (72.1—216.2 USD), a rate similar to the wages paid at the aforementioned sugar company. It was found that permanent workers worked largely independently, had a higher level of education and had more demanding tasks compared to temporary workers.

Temporary workers were hired for irregular tasks as required, such as farm duties like weeding, planting, tying up plants or harvesting. They were employed at a daily rate of 1,500 CFAF (2.70 USD). In contrast to permanent workers, temporary workers faced a high degree of job insecurity. As the amount of work largely varied from day to day, these workers did not find daily employment and thus could not anticipate their disposable income. Many of them stated that at the start of the

work day it is often chosen who is employed that day and who is not. If not selected, workers had to go back home without any compensation. This was perceived as a problem, due to the distance of 2.5 and 3 km between the LSAI Collines and the villages. This meant workers either had to accept a long walk or face transportation costs (see Section 4.6).

As the working conditions became a controversial and pressing topic among villagers during the research process in Collines, the village king convened a consultative meeting with the LSAI farm managers and representatives of the village. As head of the village, he felt the need to intervene, represent the interests of the community and to discuss options for improvements. As a result of this meeting, the farm managers agreed that they would in the future provide estimates of their labor need for the next day at the end of a working day.

To balance out the income uncertainty, many temporary workers pursued other activities as well, such as working on their own farms, to generate income. This also caused problems for the LSAI Collines, as in times when temporary workers were preoccupied with other income-generating activities and did not appear at the LSAI Collines' work site.

4.6 Access to services and other costs of living

Households with members who regularly work at the LSAI Collines reported a higher cash income since working for the LSAI Collines but that their expenses largely increased as well. Many of them had been managing their own farms before, which due to time restrictions, had to be scaled down. Thus, the expenditures for food increased for most households. Households with members working for the LSAI Collines reported that workers have less time to prepare meals and thus buy already prepared food more often than before – which in turn translates into higher monetary expenses for food but also provides increased revenues for local food stalls as confirmed in a household interview with a street-food vendor.

Most of the workers complained about the high costs of getting to the LSAI Collines. For instance, taking a moto-taxi from Ouoghi to the LSAI costs 200 CFAF (0.36 USD) one way. Bearing in mind the return trip, the transportation costs constitute 27% of the income a temporary worker would earn in a day. A few workers indicated they would rather walk to the LSAI Collines to save money. Observations revealed that workers also wait for transporters passing by with an empty load bed to pick them up free of charge. The travel cost issue becomes especially critical when considering it together with the above-mentioned employment- uncertainty: to have a chance at employment for the day, workers have to make an advanced payment, regardless of whether or not they are in fact employed. If they are not picked that day, they take a loss and easily get into financial difficulties. Due to this reason, a few households reported that their members stopped seeking work at the LSAI Collines after not being selected multiple times in a row. To save transportation costs for workers, managers of the LSAI Collines provided the option to stay overnight in a room on the work site free of charge. Some workers made use of this during the time of the investigation, while a few rooms remained empty. Workers reported that they would be very pleased with this option, as it allows them to save time and money. Others did not want to accept this offer because they preferred to stay in the village with their families and the rooms were located in a remote place amid the farmland.

Further results point to changes in medical expenses of workers, whereby contradictory statements were found. On the one hand, workers indicated that medical expenses declined for them since the LSAI Collines employed a doctor who could be consulted by workers for basic medical treatments free of charge. In contrast, a few workers reported an increase in medical expenses due to more frequent and more serious health problems since working for the LSAI Collines. They pointed out that they suffered more frequently from headaches, stomachaches as well as fatigue and that their vulnerability to malaria increased due to the exhaustive work and long hours in the heat. A few workers mentioned suffering from illness when pesticides were sprayed on neighboring fields.

Furthermore, the proprietor of the LSAI mentioned establishing a kindergarten free of charge for children of workers in the future. He explained that local families would profit from the kindergarten, as the children would be supervised and the parents could go to work in the meantime. Especially for single parents this would be a great advantage. He added that the LSAI Collines would also benefit from the kindergarten as workers become more flexible and a larger workforce becomes available.

4.7 Impacts on different groups within the local community

Overall, our analysis brought up positive as well as negative impacts of the LSAI Collines on most local stakeholders (Table 2). Farmers, pastoralists, hunters and fishermen reported differences, particularly with respect to compensation payments and access to formerly common resources.

Table 2 Positive and negative impacts on different groups within the local community

	Negative impacts	Positive impacts
Farmers	– Lost access to farmland – Tomato prices declined – Inequitable compensation – Not all farmers compensated	Cooperative members: – Compensated with new plot of land and monetary compensation – Better access to machinery – Marketing of soy and cashew
Pastoralists	– Reduced access to pastures – No compensation	– In dry season more feed on the pastures
Hunters	– Lost access to forest – No compensation	None expressed
Fishermen	None expressed	None expressed
Workers of the LSAI	– Increased food expenditures – Some workers reported increased medical expenses – High transportation costs to reach the LSAI – Temporary workers face uncertainty	– Access to training and knowledge in tomato production – Increased monetary income – More diverse diet – Medical services provided free of charge
People engaged in the local economy	None expressed	– Higher income due to increased demand for goods and services
Households buying food	None expressed	– Diversity of tomato supply increased – Availability, accessibility and diversity of tomatoes increased – Tomato price declined

Source: Own elaboration

While some farmers were compensated satisfactorily others received a lower compensation or no compensation at all. Due to better access to machinery and marketing opportunities for soy and cashews, particularly, the members of the farming cooperative were benefiting from the LSAI Collines more than non-members. Hunters, in contrast, reported only negative effects since they were not compensated for their loss of access to the forest, while fishermen reported no change as the river on the land of the LSAI Collines is still accessible. Some categories that we investigated with the RtF Framework (e.g., access to fertilizers, extension service, credit) remained unchanged and are thus not listed in Table 2.

Stakeholder groups which did not compete for resources with the LSAI Collines reported mainly positive impacts. This was achieved, especially through the provision of employment, which also created additional demand for goods and services and thus multiplier effects in the local economy and through the enhanced supply of tomatoes to the local market.

When comparing the HFIAS and the FCS of households with members working for the LSAI (WORK) to a control group (NIN), no statistical differences with respect to food access were found. However, the WORK group adopted a significantly more diverse diet, mainly due to the higher share of purchased food. This group, in replacing self-produced food (mainly roots and tubers), also over proportionally benefitted from the lower tomato prices in the local market.

5 Discussion

5.1 Impacts of the LSAI Collines compared to other case studies

Table 3 summarizes the main findings of our study and contrasts them with findings of other selected case studies on LSAIs in Sub-Saharan Africa published between 2011 and 2023. Further information on the selected case studies (host country, origin of investor, size and cultivated crops) is provided in Appendix.

Regarding the factor "access to natural resources" for the local community, this case thus shows that the site chosen for an LSAI is crucial for the impact it has on local food security. Although local authorities had declared large parts of the land as "unexploited" before it was given to the LSAI, it was used in multiple ways and made an important contribution to the food security of the local community. Similarly, for Ethiopia, Nalepa et al. (2016) found that while land that is declared as "unused" or "marginal" is given to LSAIs it is still often used for pastoralism or other forms of extensive land usage, has overlapped with natural protection areas or includes surface water resources. Therefore, for the future design of LSAIs, a careful evaluation of the existing utilization of potential lease-land and a consideration of the multiple stakeholders is crucial to minimize the deterioration of local livelihoods. This should not be limited to the farmland but should also include other

Table 3 Comparison of the findings for the case of the LSAI Collines with other case studies

Findings of other studies	Findings for the LSAI Collines (Main data sources)
Access to natural resources	
Land acquisition process and compensation	
• Lack of fertile, cultivable land to compensate farmers (Twomey et al., 2015)	• Enough land available to compensate farmers (HH_Q.9–10, Q.23, KEI, VW)
• Most farmers reduced plot size due to lack of fertile, cultivable land (e.g. Alamirew et al., 2015; Bottazzi et al., 2018; Twomey et al., 2015)	• Farmers reduced plot size mainly due to monetary constraints to purchase production inputs (HH_Q.9–10, Q.23)
• Only few farmers compensated with a plot of land, unequal compensation among farmers (Porsani et al., 2017)	• Most farmers compensated with a plot of land (of similar size) and money, unequal compensation among farmers (HH_Q.10, KEI, PM)
• Land that is used by pastoralists is declared as "unused", pastoralists and other users are not considered for compensation (Lavers, 2012)	• Pastoralists and other users did not receive any compensation, neither land nor money (HH_Q.21, PM, KEI)
Accessibility of investment area and availability of natural resources	
Pastures:	
• Loss of access to pastures (Alamirew et al., 2015; Lavers, 2012; Twomey et al., 2015)	• Decreased access to pastureland in terms of size, but pastoralists can use the land of the LSAI Collines after the tomato harvest (HH_Q.15–18, KEI, FW)
• Livestock reduction due to pasture shortage and change from grazers to small ruminants (Shete & Rutten, 2015)	• More feed for the cattle in dry seasons (KEI) • Pastoralists became dependent on the goodwill of the investor to access the land (KEI) • Pastoralists described their food security situation as unchanged since the establishment of the LSAI Collines (KEI)
Water:	
• Loss of access to water sources and springs (Alamirew et al., 2015; Twomey et al., 2015)	• Access to a river on the land of the LSAI Collines is not hindered (HH_Q.15–18, KEI, FW, PM)
• Increased pressure on water sources due to irrigation of LSAI (Twomey et al., 2015)	• No change in the availability of water observed (HH_Q.4)
• No significant difference in the share of fishing as income source between investment and control village (Bottazzi et al., 2018)	• Fishers are still allowed to use a river on the land of the LSAI Collines (HH_Q.15–18, KEI, PM)
Pathways:	
• Fencing off land by LSAIs prevents access to pathways to reach natural resources (grazing areas and springs) (Alamirew et al., 2015; Twomey et al., 2015)	• Land is not fenced off, pathways on the land can be used (HH_Q.24–28, KEI, PM, FW)
Access to inputs and supports	
• Some farmers worked for LSAIs to receive on-the-job trainings for their production but could not develop their technical skills in the way they had expected (Twomey et al., 2015)	• Many farmers working for the LSAI Collines gained a lot of knowledge to improve their tomato production (HH_Q.44, Q.64–66, KEI) • The LSAI Collines does not provide advice but offers a plowing service for farmers and serves as a showcase to University students (HH_Q.29–32, Q.40–43, KEI)
• No technology transfer (Alamirew et al., 2015)	• Technology transfer observed (e.g. binding of tomatoes) (HH_Q.64–66, KEI)
• Access to chemical inputs does not/only marginal change (Twomey et al., 2015)	• Access to chemical inputs did not change (HH_Q.36–39, Q.44, KEI)
Access to markets	
• Farmers in an out-grower scheme for rice became dependent on the LSAI due to advanced payments for production inputs and thus faced much higher production risks (Porsani et al., 2017)	• Marketing opportunities increased but prices of tomatoes decreased due to a larger supply (KEI, HH_Q58-63)
• Farmers have only little bargaining power when negotiating with the LSAI as they have no other selling opportunities (Lavers, 2012)	• An out-grower scheme for cashew and soybeans with the LSAI Collines allows farmers to have a higher certainty and improved marketing opportunities, a fair contract was negotiated, farmers are free to choose their production technology and pay for services at harvest (HH_Q.48–51, KEI)

Table 3 (continued)

Findings of other studies	Findings for the LSAI Collines (Main data sources)
Availability and accessibility of adequate diverse food	
• Alamirew et al., 2015; Twomey et al., 2015, Guyalo et al., 2022; Kebede et al., 2023; Shete & Rutten, 2015 find overall lower food security level	• Supply of tomatoes increased, prices dropped, additional varieties were introduced, supply and prices of all other food crops remained stable (HH_Q.58–63)
• Bottazzi et al., 2018 find overall higher food security level	
• Wage labor opportunities from the LSAI increase the dietary diversity of workers (Bosch & Zeller, 2019; Fitawek et al., 2020) but still lack food in lean seasons (Bosch & Zeller, 2019), people feel more food secure in times of food shortages (Bottazzi et al., 2018)	• Employment by the LSAI Collines increased dietary diversity of workers, while access to food remained unchanged (HH_Q.61–63, Q.70–71, Q.74 -Q.76, KEI)
• Lower food expenditure in the investment village (Kebede et al., 2023)	• Workers have higher food expenditure (HH_Q.70–71, KEI)
• Higher food expenditure in the investment village (Alamirew et al., 2015), for workers (Bosch & Zeller, 2019)	
Access to living wages	
• Employment varies widely (1–70 jobs per 100 ha), mostly dependent on the cultivated crops, whereby tree crops and perennials are most labor-intense (Deininger & Byerlee, 2011)	• Higher labor requirements (about 58 jobs per 100 ha) compared to other LSAIs due to a low degree of mechanization and high labor intensity in tomato production (KEI, FW)
• Mostly seasonal jobs (Alamirew et al., 2015; Porsani et al., 2017)	• Little seasonality due to irrigation thus year-round demand for work (KEI), yet daily labor requirements vary a lot (FW, HH_Q.72) making the access to wages uncertain for temporary workers (HH_Q.72–73)
• Share of small businesses as income source is not significantly different between investment and control village (Bottazzi et al., 2018)	• Improved access to living wages within local economy, e.g., for vendors and moto-taxi drivers (HH_Q.76)
Access to services and other costs of living	
	• Increased expenditures for workers due to transportation costs to the LSAI Collines (FGD, HH_Q.70–72)
	• Saving of money due to free on-farm basic health service for workers (KEI, FGD, HH_Q.72–73)
	• Increased expenditures for workers because of higher risks for work-related serious health problems (FGD, HH_Q.73)

Source: Own elaboration

HH household survey (with appropriate question number), *KEI* key-expert interview, *FGD* focus group discussion, *PM* participatory mapping, *VW* village walks, *FW* farm walks

natural resources like pastures, forests and surface water, which may be also important for local food security but frequently overlooked in this context.

The LSAI Collines is much smaller than many other LSAIs and fertile land is not scarce in the area. Therefore, most of the interviewed farmers who lost parts of their farmland have been compensated with a new piece of land by the local authorities. Additionally, they received financial compensation from the investor. However, monetary compensation varied widely and users of the land other than farmers (pastoralists, fishers, hunters) were not compensated at all, a finding which is backed up by many other cases (Alamirew et al., 2015; Lavers, 2012; Twomey et al., 2015).

Yet, in contrast to other LSAIs, the owner of the LSAI Collines tries to keep natural resources on the land for the local community as accessible as possible without fencing off the property. Thus, pedestrians and motorbikes frequently pass through, and it is possible to fish in the river on the property. Also, while the access to grazing land on the LSAI Collines decreased in terms of size, this access is granted the local community as often as possible by the farm managers. The case of the LSAI Collines seems to be exceptional regarding this aspect, as the literature review found no other case in which the access to land of an LSAI was handled in the same manner. In contrast, Shete and Rutten (2015) found that pastoralists with nearby investments had to reduce their herd size and progressively changed from large to small ruminants due to the loss of access to land now owned by an LSAI. Going even further, Alamirew et al. (2015) and Twomey et al. (2015) found that local people not only lost access to the grazing land occupied by LSAIs but also to several passageways that would lead them to further grazing areas and springs. Thus, in this respect, the arrangement of LSAI Collines can be seen as a role model for the future design of other LSAIs

to reduce negative impacts on local households, especially since in many cases not the full leased-out area is cropped (e.g. Alamirew et al., 2015).

With respect to the access to inputs and support, our analysis found, similarly to Twomey et al. (2015), no change in access to fertilizers. This can be explained, as supply chains for LSAIs (direct imports, bulk purchase) differ strongly from those of small-scale farmers (purchasing small units from local vendors). Establishing a selling point for agricultural inputs on the LSAI Collines could benefit smallholder farmers in this respect. Especially in combination with an out-grower scheme, this could be of mutual benefit.

On the availability and accessibility of adequate and diverse food, most studies focusing on quantitative indicators found a lower food security level in the respective investment villages compared to a control village. This is often linked to land shortages caused by the establishment of an LSAI (Alamirew et al., 2015; Guyalo et al., 2022; Kebede et al., 2023; Shete & Rutten, 2015). Other studies found reduced food self-sufficiency in households but an overall higher perception of households' food security due to the increase in monetary income (Bottazzi et al., 2018). Yet, a generalization of impacts on food security is hindered by the use of different food security indicators (see Section 5.2).

In the case of the LSAI Collines, we found both, a significantly higher food diversity score and higher food expenditure for households working for the LSAI compared to households that did not feel affected by the LSAI. These effects have been observed in other studies as well (Bosch & Zeller, 2019; Fitawek et al., 2020). We argue that households diversify their diets when they buy food instead of relying mainly on their own production, which are mostly roots and tubers. This is in line with Atuoye et al. (2019) who found that households with diverse income sources and less dependent on their agricultural production, were more likely to be food secure. Thus, the potential of income diversity offered by the LSAI Collines can be seen as beneficial to enhance local food security.

Apart from the higher food diversity effects for households with members working for the LSAI, no changes regarding the affordability and accessibility of adequate diverse food were observed. With respect to tomatoes, the findings were even positive. We argue, that the focus of the LSAI Collines, which is mainly producing for local and regional markets compares favorably to other LSAIs often producing cash crops for export (compare Appendix).

Regarding the access to living wages for the local community, we argue that the LSAI Collines has a greater potential for employment generation than many other cases. While in several other case studies (Alamirew et al., 2015; Porsani et al., 2017) most created jobs have been only seasonal, the LSAI Collines requires workers all year round, as the company uses drip irrigation to cultivate tomatoes throughout the year. Also, the labor requirements of the LSAI Collines are quite high when compared to other LSAIs (Deininger and Byerlee (2011). As the labor requirements mostly depend on the cultivated crop and the respective production system (Deininger & Byerlee, 2011), we argue that tomato production – and vegetable production in general – has a large potential for employment generation due to the low degree of mechanization and high labor intensity.

Finally, our research shows that there are some other critical factors impacting local livelihoods in the surrounding villages of an LSAI that have rarely been touched upon yet in previous research. These include the transportation costs for workers to reach the LSAI, healthcare expenditures for workers and the multiplier effects in the local economy, as the demand for goods and services such as moto-taxi transport and (prepared) food increased.

5.2 Methodological reflections

This study set out to empirically analyze the local food security impacts of a recently established LSAI in Central Benin. To this end, we developed a research design and program meant to best circumvent much of the methodological shortcomings of the existing body of case study literature (see Sections 1 and 2) while at the same time meeting our research budget constraints. In what follows, we reflect upon the approach taken, particularly with respect to four critical design decisions inherent in every empirical research on local food security impacts of LSAIs. These are: (1) the operationalization of food security, (2) the data type generated, (3) the disentangling of impacts from other effects, and (4) the timing of research.

Firstly, upon the operationalization of food security: food security is a multidimensional concept that has been described as a "latent variable" in need of further operationalization (Vaitla et al., 2017). However, large parts of the empirical literature analyzing the impacts of LSAIs focus on a few pre-selected impact channels only, mainly the creation of jobs and the lost access to land (Yang & He, 2021). Furthermore, as also Oya (2013) and Yang and He (2021) point out, LSAIs are often analyzed from a unilateral perspective only focusing on one particular household group (e.g., households with members working for the LSAI, households that lost land), while lacking detail on the impacts an LSAI has on other groups.

Against this background, we assess our decision towards using the RtF framework as our central guide towards data collection quite positively. Using a right-based approach towards food security means focusing on the factors that shape one's ability to be food secure, rather than aiming only at quantifying the food security status. To us, the RtF framework proved to be a helpful lens as it explicitly accounts for diverse strategies in realizing food security on a household level. In this context, including the "Access to services and other costs of living" as an explicit factor in the RtF framework, allowed us to also capture that the establishment of an LSAI can also affect the food budgets of households in more indirect ways.

However, using a framework that explicitly focuses on the household level potentially leaves out many other even more indirect ways of impeding or fostering both the production and consumption channels to realize food security. For instance, the RtF framework is not well suited to analyze the economic impacts the establishment of an LSAI may have on the wider economy. For example, in the case investigated here, there are additional benefits to the transportation sector, as part of the produce is exported and most of the inputs are imported. This certainly also results in additional tax and tariff income to the government, which then in the form of tax rebates, social transfers or increased public investments may again benefit the local population. Similarly, potential impacts on biodiversity or the environment are not captured, as long as respondents do not explicitly link these to their food security status.

Secondly, upon using an explorative mixed-method approach towards data collection: In contrast to much of the existing empirical research, we explicitly combine the merits of a rich qualitative data set with a household survey to also compute quantitative food security indicators. Particularly in the explorative phase of the research, we made extensive use of participatory methods such as village walks or participatory mappings with local actors. We highly recommend such an approach since it proved to be quite helpful in getting an overview of the area as well as identifying relevant stakeholder groups and impact pathways, which may not have been anticipated. As for our quantitative household survey, we acknowledge that the sample size may be small for a statistical analysis of the two food security indicators estimated. Yet, in line with Yang and He (2021), we found implementing a quantitative aspect a useful addition, as it allowed us to more thoroughly analyze the impact of being employed at the LSAI.

Thirdly, upon disentangling impacts of LSAIs from other effects: Reviewing the recent literature on LSAIs and their impacts on food security, we find that many recent studies compare quantitative food security indicators of households close to an LSAI to those of an unaffected control group further away (e.g., Fitawek et al., 2020; Guyalo et al., 2022). Our approach, in contrast, rests upon sampling the interviewed households according to their level of engagement with the investment and a comparison of self-perceived assessments of the food security status before and after the establishment of an LSAI.

It could be perceived as problematic to use households who stated to be unaffected by the LSAI as control group, as they may overlook more general impacts (such as an increase in tomato supply in the case investigated here). Yet, the alternative of using another village as control is also problematic. The selected village needs to be far enough away such that there is no more influence of the LSAI (e.g. on food prices, employment opportunities) but still it should be characterized by similar agroecological and socio-economic conditions. Moreover, it should not be influenced by potential other LSAIs in the region.

Against this background, we consider our approach less prone to selecting a biased control group. In particular, the use of a control group within the affected village allowed us a more in-depth analysis of the impacts on different household groups and potential trade-offs between them. (e.g., declining tomato prices, being negative for tomato producers but positive for consuming households). Ideally, to avoid potentially biased perceptions, longitudinal research should be conducted, including surveys before and after the establishment of an LSAI (see below).

Fourthly, upon the timing of research: In our case, the reconstruction of the land acquisition process was a challenge. Important informants involved in this process including the former village king, the former president of the agricultural cooperative and former managers of the LSAI Collines were not in the region anymore and could not be located. Hence, information regarding some details of the land acquisition remained imprecise. This raises the question about the right timing to conduct such a study. If conducted too early, it can be assumed, that the LSAI has not yet reached maturity for developing its whole effects, while at a later stage, contact persons may not be reachable or reported effects appear only vague as households have started to use adaptation strategies and may not well recall the situation before the establishment of the respective LSAI or have biased memories. Furthermore, over time other factors also change, so impacts on food security may not be caused by the LSAI.

To learn more about such dynamics and to improve LSAI impact research, longitudinal studies should be envisaged (Yang & He, 2021). As perceptions and impacts may change over time with the development of an LSAI (Bosch & Zeller, 2019; Gerlach & Liu, 2010; Rietberg & Hospes, 2018; Tsikata & Yaro, 2011) additional rounds of data collection in regular intervals would be useful. This, however, requires much time and great resources which would go beyond the budget available for this research.

6 Conclusions

This research analyzed the local food security impacts of one particular LSAI in Central Benin, thus producing results bound to its context. While acknowledging this general limitation in terms of argumentative generalization, we argue that our analysis nevertheless carries a number of contributions to the literature:

Firstly, our research provides yet another example highlighting the importance of fair and inclusive land deals regarding compensation matters. It is key to involve and communicate with all affected stakeholders to find fair compensation schemes to ensure that no one in the local community is left worse off after an LSAI is established and inequalities within the local community are not exacerbated. Especially, non-organized groups such as pastoralists, hunters, and fishers should be more involved as their previous land rights under communal ownership and the accompanying livelihood effects are commonly overlooked and not monetarily compensated.

Secondly, one main reason for governments and local authorities to support LSAIs is the hope for job creation. This case study has shown that a labor-intensive horticultural farm has indeed a higher potential to generate employment opportunities and access to additional income sources than many other typical cash crop farms. However, considering the estimated number of farmers who were replaced by the LSAI Collines (80) compared to the number of jobs created (34 permanent employees and 30–100 temporary workers), especially as most of these are only offered on a daily basis, which causes much uncertainty, shows there is room for improvement. In any case, if job creation is the primary focus of the establishment of LSAIs, it is highly relevant to consider the job creation potential of different crops and production systems. More income generated through employment also leads to positive multiplier effects in the local economy through higher demand for local goods and services.

Thirdly, this case has shown that LSAIs which produce food for local consumption can help to improve local food availability and affordability. Yet, the issue of lower tomato prices due to the additional supply in the community around the LSAI Collines also shows the complexity of LSAIs' impacts. While consumers benefited from this, smallholder tomato producers were worse off but could profit from efficiency gains through knowledge transfer. Fostering the knowledge-transfer potential and integrating rules on this in lease contracts could help to mitigate negative implications of an LSAI on local smallholder farmers. This potential certainly depends on the crops and cropping system applied on the leased-out land. If smallholder farmers were also to be offered to market their produce through the LSAI, this transfer of knowledge could be of mutual benefit for smallholders and LSAIs.

Fourthly, in our study, we detected many additional options for mutual benefits which are often overlooked and could be implemented in other cases as well. These include allowing some access to the LSAI, offering new marketing channels, providing transportation for workers and other social infrastructure, for instance, a medical service or the construction of a kindergarten, enhancing employment quality. All this would benefit the LSAI as well as it would help to ensure a steady supply of labor and improve the productivity of workers. Strong local institutions play a key role in achieving this. A strong representation is needed in the negotiating process to make sure that mutually beneficial lease contracts are agreed upon and also include items benefitting the local population. Local institutions also need to oversee these agreements during the operation phase of the LSAI, and in case of arising problems, serve as a contact point, enforce the agreements or agree upon adjustments with the respective partners.

Finally, based on the methodological reflections of our research design and process, we advocate the use of mixed-methods approaches for the future investigation of LSAIs and their multi-layered impacts on local communities. Thereby, with respect to the analysis of food security impacts, the extended RtF framework including more indirect impacts such as the provision of services and impacts on the general costs of living has proven useful to systematically structure a broad spectrum of potential impact pathways. In order to overcome some of the discussed shortcomings of the approach presented here, longitudinal studies should be envisaged and budgeted for, with the first surveys being already conducted before the establishment of the respective LSAI to investigate the development of impacts over time.

Appendix: Selected case studies from Sub-Saharan Africa, 2011 – 2023

Authors	Host country	Origin of investor	Size of investment	Crops
Alamirew et al. (2015)	Ethiopia	India	10,700 ha leased (4,000 ha cultivated)	Maize, palm trees
Borras et al. (2011)	Mozambique	UK	30,000 ha	Sugar cane for ethanol production
Bosch and Zeller (2019)	Madagascar	Not specified	3,000 ha	Jatropha
Bottazzi et al. (2018)	Sierra Leone	Subsidiary of Swiss-based transnational company	33,200 ha leased, 8,000 ha returned to villagers	Sugar cane for biofuel production
Deininger and Byerlee (2011)	19 case studies in seven countries (Congo, Liberia, Mexico, Mozambique, Tanzania, Ukraine, Zambia)	Several	250 ha – 300,000 ha	Several
Fitawek et al. (2020)	Madagascar	Italy	3,500 ha	Maize, soy, geranium and other crops
Guyalo et al. (2022)	Ethiopia	123 investors in the study region (121 are domestic, one from India, one from Saudi-Arabia)	Altogether 93,159 ha leased in the study region	Mainly export crops (e.g. cotton, rice, sesame, green mung beans)
Kebede et al. (2023)	Ethiopia	Over 16 various LSAIs in the investigated district	Not specified	Several, e.g. floricultural horticultural products
Lavers (2012)	Ethiopia	Three cases, among others: case A: European investors, Israeli managers	140,000 ha	Castor
Mabe et al. (2019)	Ghana	Several, not specified	In total ca. 145,000 ha in several districts	Not specified
Porsani et al. (2017)	Mozambique	China	20,000 ha	Rice
Schoneveld et al. (2011)	Ghana	a foreign biofuel company	14,000 ha	Jatropha
Shete and Rutten (2015)	Ethiopia	Not specified	11,700 ha	Maize
Twomey et al. (2015)	Tanzania	Village 1: Singapore	5,000 acres	Coffee
		Village 2: UK	50,000 acres	Not specified
		Village 3: UK	74,000 acres	Not specified
		Village 4: Tanzania, later Norway	Not specified	First not specified, later cattle and livestock feed

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Declarations

Conflict of interest The authors declare that there is no conflict of interest.

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