Fitawek W, Hendriks SL, Reys A and Fossi F. (2020). The effect of large-scale agricultural investments on household food security in Madagascar. Food Security, June 2020. https://doi.org/10.1007/s12571-020-01055-6. https://rdcu.be/b5BwK

The effect of large-scale agricultural investments on household food security in Madagascar

Wegayehu Fitawek[1], Sheryl Hendriks[1,2*], Aurélien Reys[3] and Filippo Fossi[1]

[1]Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, South Africa

[2] Institute for Food, Nutrition and Well-being, University of Pretoria, South Africa

[3]French Agricultural Research Centre for International Development (CIRAD), Montpellier, France

* Corresponding author: sheryl.hendriks@up.ac.za

Abstract

Large-scale agricultural investments in developing countries have escalated over the past decade. While much is written about the potential adverse effects of these acquisitions on local communities, there is a paucity of evidence of these impacts. This paper explores the effect of large-scale agribusinesses on household food security in two locations in Madagascar. One is plantation area or Location A and the other one is contract farming area or Location B. The sample of 601 households was classified into households (i) in which at least one member was employed or (ii) contracted to the agribusiness, (iii) in the same area that were neither employees nor contractors (non-engaged) and (iv) counterfactual households from another community. Employment opportunities from the agribusinesses seemed to improved food security. Dietary quality, food security and resilience were higher among employed households. Contract households were generally more food insecure than the counterfactual and non-engaged households. Living in the zone of influence did not seem to have major adverse effects on the food security of non-engaged households. However, female-headed households seemed disadvantaged in terms of access to employment and contracting opportunities. Unless attention is paid to women's access to employment and contracting opportunities, inequality may be exacerbated.

Keywords: Food security, large-scale agricultural investment, dietary diversity, coping strategies, Madagascar

1 Large-scale land acquisitions and their potential effects on food insecurity

There has been an increase in large-scale land acquisitions in developing countries following the 2007/8 food price crisis (Cotula 2009; Cotula *et al*. 2014; Deininger *et al*. 2011). These acquisitions take the form of purchases, long-term (99-year) leases or concessions of more than 200 hectares by an external actor for agricultural production (food or agro-fuel production), timber extraction, carbon trading, mineral extraction, conservation or tourism (Nolte *et al*. 2016). The Land Matrix reported in 2016 that there had been a steep increase in the number of new deals since 2000 (Nolte *et al*. 2016). Eleven African countries were among the most targeted investment destinations; including the Democratic Republic of the Congo (DRC), Ethiopia, Ghana, Liberia, Madagascar, Morocco, Mozambique, Sierra Leone, South Sudan, Sudan and Zambia (Nolte *et al*. 2016). Interestingly, many of these destination countries are net food importers of food and recipients of emergency food assistance (Shepard 2011).

Most large-scale acquisitions in Africa involve investors from beyond the continent, mainly from developed countries (Nolte *et al*. 2016). Historical ties also remain strong; for example, French investors focus interests in West Africa and Madagascar, whereas Portuguese investors mainly focus on Angola and Mozambique. Belgian investors are primarily active in the DRC (Nolte *et al*. 2016). The domestic food security concerns of the investor countries are one driver of the acquisitions, especially among food-importing countries (for example the Gulf countries, China and Japan) with low agricultural production potential (Deininger *et al*. 2011; GRAIN 2008). Many developing country governments see these investments as an opportunity to increase revenue and modernise their agriculture sector (Cotula 2009). However, these large-scale investments have been challenged with regard to how investments contribute to rural development and poverty alleviation (de Schutter 2011). However, very little attention has been paid to the potential effect of these investments on household food security.

Land is important to the livelihoods, food security and social identity of many people (Cotula 2011; Cotula 2009; Daniel 2011). A lack of adequate and secure access to land and natural resources is a cause of hunger and poverty. Globally, half those suffering from hunger are smallholder farming households, one in five of these households are landless (Grover 2009). Agricultural investments can create job opportunities, offer contracting or outgrower

prospects, enable land rental markets, improve market access and stimulate infrastructure development (Cotula *et al*. 2014; Anseeuw 2013; FAO 2014; de Shutter, 2011; World Bank 2007). Anseeuw (2013) postulated that in such investments may only benefit better-off local farmers through grower or sharecropping schemes.

To the contrary, large-scale agricultural investments could lead to a loss of land rights, threatening household food sovereignty (Cotula *et al*. 2014; GRAIN 2008; Ronald 2014). Such investments may have potentially adverse effects on local livelihoods for both the current land users that may face increased commercial pressure on land as well as for those who depend on the commons for grazing, fishing and forest access (de Shutter, 2011). Others in the community, particularly those who lose their land, face a risk of income loss, especially if employment alternatives are limited or the investment constrains or competes with traditional livelihood activities. In some cases, the anticipated jobs do not materialise as companies hire in labour from outside the community. In some cases, they bring their own labourers, especially for more skilled jobs (Anseeuw 2013).

Investments in otherwise underdeveloped areas may well bring much-needed employment and income opportunities in the agricultural, non-farm and services sectors. Such opportunities could play a role in reducing poverty and improving food security through increasing incomes, improving infrastructure and the distribution of food. Von Braun and Meinzen-Dick (2009) have postulated that other possible positive spill overs could include resources for new agricultural technologies and practices and increase food production that could supply local and national consumers in addition to exports and stabilise prices. Yet, Shepard (2011, p34) states that: "Land deals diminish the possibility of reaching food self-sufficiency for poor nations and some view land concessions as governments out-sourcing food at the expense of their most food-insecure citizens". Diverted water sources and pesticides pollution could damage ecosystems and pose a threat to animal and human health, negatively affecting food production and productivity (Dheressa 2013; de Schutter 2011).

Figure 1 presents the possible effects of large-scale agricultural investments on food security. In theory, household food security should improve if food crops are produced through contract farming while producing cash crops through contract farming may negatively affect food security (Bellemare and Novak 2017; Olounlade et al. 2020). However, large-scale

agricultural investments often create employment opportunities for local labour, helping households access additional income that may improve dietary quality. Yet, some large-scale agriculture investments displace smallholder households negatively affecting food security.

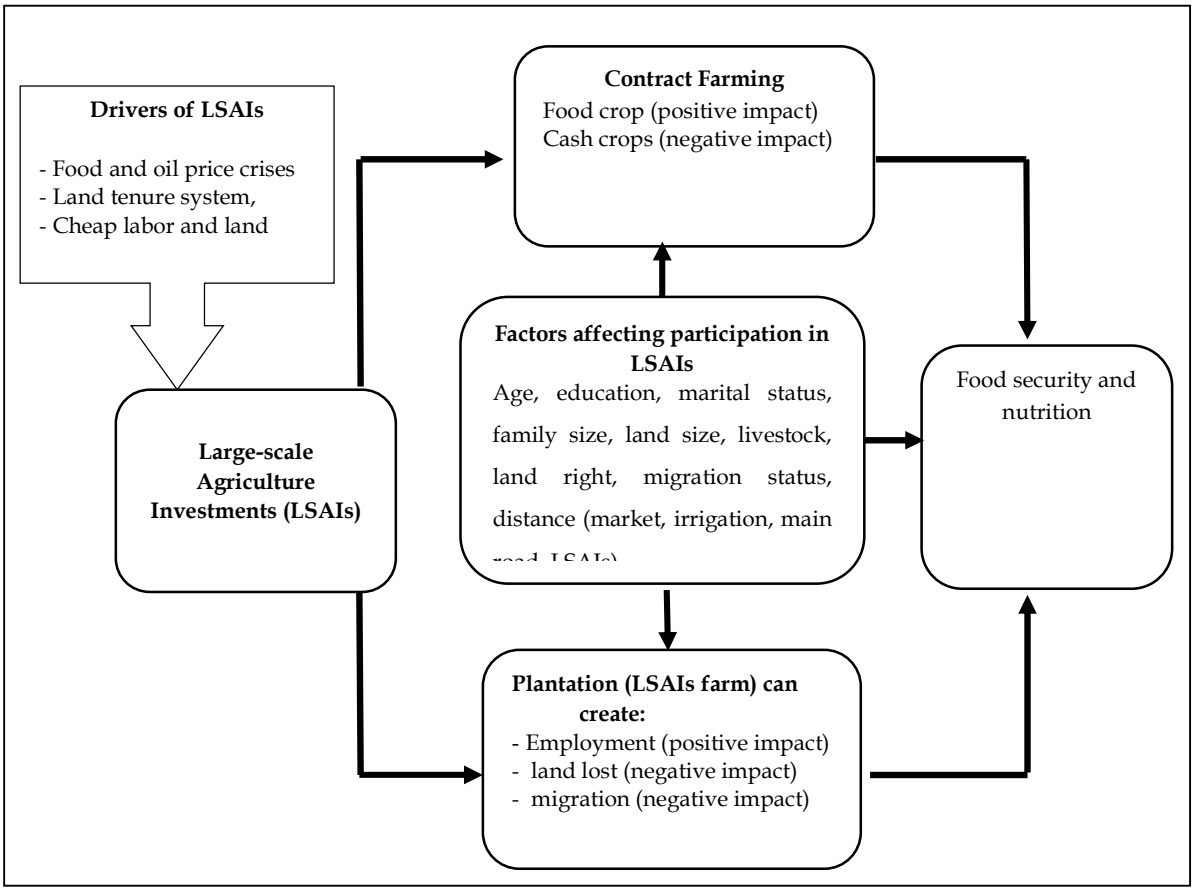

Fig.1 Conceptual framework for the study (authors' own work)

Despite critique in academic papers and popular media, no attempt has far been made to determine the local effect of large-scale investments on the food security of households. Most empirical studies of land acquisitions in Africa focus on administration efficiency, environmental impact, social implications and the labour and poverty effects (Kibugi et al. 2012; Kibugi et al, 2015; Klopp and Lumumba 2017; Smalley 2013; Zaehringer et al. 2018). Studies have been conducted on the impact of large-scale agricultural investments in Madagascar have focussed on environmental, social and ecological issues and land rights

rather than food security (Andriamanaliana-Ratsialonana et al. 2011; Burnod et al. 2013; Burnod et al. 2015; Reys et al. 2018).

Very few studies provide evidence that large-scale acquisitions positively or negatively affect household food security and rural livelihoods. Studies that have focused on food security used descriptive analysis (see Table 1). Where food security was examined, the researchers have used only one or two food security indicators (Bosch and Zeller 2013). For example, Hufe and Heuermann's (2017) review of large-scale land purchases in Africa found that only four of 60 case studies (covering 146 acquisition projects in 22 countries), showed adverse food security effects. Hufe and Heuermann (2017) observed an exception to this when Jatropha was intercropped with traditional food crops However, many cases do not provide insight into the underlying reasons for an improvement or deterioration in household food security levels.

Table 1: Overview of case studies on the impact of LSAIs on food security in Africa

Source	Country	Purpose	Method	Impacts
Aabø and Kring (2012)	Mozambique	The political economy of large-scale agricultural land acquisitions: Implications for food security and livelihoods	Descriptive analysis	Projects built infrastructure and generated employment, but it have a significant number of land conflicts and a series of negative social, economic and environmental impacts of many of these projects.
Baumgartner *et al.* (2015)	Ethiopia	Impacts of large-scale land investments on income, prices, and employment	Linear programming model	Simulation result shows smallholder commercialization have more significant and longer- lasting positive effects on local livelihoods and market integration can improve local food security.
Burnod *et al.* (2015)	Madagascar	Large-scale plantation and contract farming effects	qualitative and quantitative assessment method	The result mention large-scale plantations worsen poverty, because the company only contributes on employment partly to their reconstruction efforts. Contract farming models, were more profitable for the company, the farmers and
Daniel (2011)	World	Land grabbing and potential implications for world food security	Reviewed literature	Land deals diminish the possibility of reaching food self-sufficiency for poor nations and some view land concessions as governments out-sourcing food at the expense of their
Dye (2014)	Ethiopia and Tanzania	The impact large-scale land acquisitions on food security	qualitative and case study methodology	Large-scale land acquisitions maintain a system of social, political, and economic entitlements that foster uneven structures that result in low levels of food security and access to

Kronenburg (2015)	Kenya	Food security and land governance	Reviewed literature	Land rental markets are the most important means available to smallholder farmers to access additional land for cultivation and increase their food security. However, biofuel production and the leasing out of agricultural land for
Lay *et al*. (2017)	Zambia	large-scale farms and smallholders: evidence from Zambia	Difference-in-Difference methods	Smallholders inwards with large□scale farms increase their area cultivated and maize yields, which improve food availability.
Lisk (2013)	Africa	'Land grabbing' or harnessing of development potential in agriculture? East Asia's land-based investments in Africa	Reviewed literature	'land grabbing', which limits access of smallholder farmers to land, deprives local people of their livelihoods and threatens local and national food security across the continent.
Matondi *et al*.(2011)	Africa	The impact of land grabbing for growing biofuels and to ensure food security	Reviewed literature	The study argues that 'the rapid growth in biofuel production will affect food security at the national and household levels mainly through its impact on food prices increase.
Miggiano *et al*.(2010)	World	Links between land tenure security and food security	Reviewed literature	Lack of access to land increases farmers' vulnerability to food insecurity. Without access to land, farmers would depend on seasonal farm work.
Moreda (2018)	Ethiopia	to explore the implications of large-scale agricultural investments for local food security and the right to food	Case study	It argues that large-scale agricultural investments pervert the realisation of food security. This is due to, declining access to agricultural, pastoral and forest land resources among the rural poor.
Hall *et al*. (2017)	Ghana, Kenya and Zambia	Plantation, out growers and commercialisation and implications on employment	Business model	Good opportunity for livelihood improvement (additional source of income, especially poor women).
Schoneveld (2011)	Ghana	analysed the impact of biofuel feedstock development in Ghana.	Case study	Results shows that this can significantly aggravate rural poverty as communities lose access to vital livelihood resources. Vulnerable groups, such as women and migrants, are found to be most profoundly affected.
Shete and Rutten (2015)	Ethiopia	Impacts of LSAIS on economic development, household food security and the environment	Multiple regression, PSM, NPV, Consumption Expenditure,	Short-run positive effect on food security (around crop produced company) and negative food security impact for those losing their land. Negative socio-economic and
Speller (2016)	Ethiopia, Cambodia, Mozambique and Tanzania	Analyse the impact of vegetable contract farming income	Comparative analysis	Finding shows that employment creation remained a principal benefit that communities perceived from the presence of an investor, especially in terms of income and food security
Yengoh and Armah (2015)	Sierra Leone	Effects of large-scale acquisition on food insecurity in Sierra Leone	A mixture of quantitative and qualitative research methods	Increase in the severity of food insecurity and hunger. Household income from agricultural production has fallen. This is because of employment by the land investing company is limited and wages from employment cannot meet the staple food needs of its employees.

2 Madagascar as a destination for large-scale investments in Africa

Madagascar has been one the primary target for land-based investments in Africa (Cotula 2009). Between 2000 and 2017, 96 companies announced plans to develop a large-scale farm. Seventy-six percent of companies had withdrawn their investment projects due to political instability (Andrianirina-Ratsialonana *et al*. 2011; Burnod *et al*. 2013; Reys *et al*. 2018). The promotion of large scale agricultural investment remains high on the political agenda (Burnod *et al*. 2017).

The Land Matrix reported that by October 2017, 14 large-scale land acquisitions transactions had been concluded in Madagascar, amounting to 588 322 ha (formal contracts or informal contracts). Nine of these transactions related to cereal production. The investors were mainly from Western Europe and Asia. Only half of all deals lead to productive projects (start-up phase and ongoing), with any abandoned applications and projects (Nolte and Ostermeier 2017).

As in other African countries, large-scale agricultural investments in Madagascar have led to in-migration from the surrounding areas (Burnod *et al*. 2013; Cotula 2009; Cotula 2011; Görgen *et al*. 2009). The employment opportunities have benefited local smallholders. Andriamanaliana-Ratsialonana et al. (2011) and Medernach and Burnod (2013) have reported that recent land use changes in the Mivili area in Madagascar affected wealthy livestock farmers through the loss of pastoral land, reducing extensive grazing opportunities and restricting access to traditional livestock movement routes. However, contract farming in this area did not seem to lead to land tensions. Instead, it stimulated market and non-market land transactions improving the efficiency and equity of land distribution (Burnod *et al.* 2013).

Burnod *et al*. (2015) also investigated the labour effects of large-scale land acquisition in the Merina and Betsileo areas of Mozambique. They found that the company generated the equivalent of one full-time job per hectare, offering income opportunities for four-fold more households. However, the company's pay was a third lower than the income these households generated from their own plots before their engagement with the company. The company's outgrower/contract scheme created an equivalent of 1.3 full-time jobs per hectare. Although the contract farming scheme did not increase agricultural revenue, it improved remuneration

for labour and access to inputs and led to a reduction in the use of pesticide. The contract farming models seemed to be more profitable for the company, more beneficial for the farmers and generally contributed more to local development than direct employment.

No attempt far has been made to determine the local impact of large-scale investments on households food security of in areas surrounding large-scale land investments in Madagascar. This study set out to compare the levels of household food security in two areas (Location A and Location B) that host large-scale land acquisitions in the central region of Madagascar.

3 Methodology

A shortlist of companies with large-scale land investments was drawn up from the Land Matrix country profiles to select the sites for this study. The selection criteria were: the level of development of the business; the area cultivated; the number of households potentially affected (through contracts, jobs or land losses) and the willingness of the large company to work with the researchers (Harding *et al*. 2017). From the list, one company was selected in municipal Location A (labelled Company X case "plantation") and two companies in municipal Location B (labelled Company Y and Z case "production schemes"). Company X was an Italian company that had been operational in the area for ten years. The company produced maize, soja, geranium and other crops on about 3500 ha in Location A. Company Y was a Malagasy outgrower scheme that contracted 2000 households to produce barley. The company had operated in Location B for 20 years. Company Z was a Malagasy company created in 2005 with foreign capital. It produced *artemisia* (wormwood) for export to Europe for pharmaceutical products. In 2016, the company signed contracts with about 8,000 farmers, covering an area over 2 000 ha (Fig. 2).

Fig. 2 Location of the case studies

As a recent census of households was not available, the numbers of households in each area were estimated from available satellite images. Six hundred and one households were randomly selected for interviews (304 from Location A and 297 from Location B). Table 2 presents the sample distribution for the households.

Table 2 Sample size distribution

Location	Number of HH interviewed	Factual			Counterfactual
		Total HH Employee in LSAIs	Total HH engaged in contract	Non-engaged HH	
Location A	304	61	-	141	102
Location B	297	-	110	89	98
Total sample	601	61	110	230	200

Source: Afgroland (2017)

Households were classified into four categories based on their location and whether they were in the factual or counterfactual samples. These categories included: (i) households where at least one member was employed by a company (termed employed households), (ii) households where at least one member of the household was farming under contract to a

company, (iii) households in the surrounding areas of the two companies but where household members were neither employed or contracted by the companies (non-engaged) and (iv) counterfactual households residing 25km away from the zone of influence of the particular companies. In this paper, we define the zone of influence as areas that are within 25km radius within those large-scale agricultural investment companies (Reys and Burnod 2017). Interviewers checked that counterfactual households were neither employed by or engaged in a contract with the companies. Primary data were collected from March to April 2017 (Reys and Burnod 2017). A proportional sample weight was applied.

Food security is multidimensional and has no single internationally recognised measure (Hendriks *et al*. 2016). Therefore, we used seven internationally recognised food security indicators for a comparative analysis of the different dimensions of food security (see Table 3). These indicators included the household dietary diversity score, women's dietary diversity score, the food consumption score, months of adequate household food provision, the coping strategy index, asset and Consolidated Approach for Reporting Indicators of Food Security (CARI). The food consumption score, months of adequate household food provision and CARI measured food availability. The household dietary diversity score and women's dietary diversity score measured the adequacy of nutrient intakes. The coping strategy index measured food accessibility. The asset index was used as a proxy of the stability dimension of food security.

Table 3 Food security indicators

Indicator	**Recall period**	***Descriptions***
Household Dietary Diversity Score (HDDS)	24-hours	HDDS is measures diet quality by capturing the total number of food groups consumed (12 food groups). (FANTA 2006, Hendriks *et al*. 2016; Hirvonen *et al*.2016; IFPRI 2006; Mekonnen 2017). Then households were categorized into three group as: lowest dietary diversity (HDDS ≤ 3), medium dietary diversity (HDDS 4 and 5) and high dietary diversity (HDDS ≥ 6) (FAO 2006)
Women's Dietary Diversity Score (WDDS)	24-hours	WDDS assessed the micronutrient adequacy of the diets of women of reproductive age (15-49 years of age) (Chagomoka *et al*. 2017; Chagomoka *et al*. 2016; FAO 2014; Kennedy *et al*. 2010; Leroy 2015).

Food Consumption Score (FCS)	7-days	The frequency of consumption of the last seven days and then weighted by a coefficient. (Hendriks *et al*. 2016; Leroy 2015; WFP 2008). The results were classified as: 0-21 or poor food consumption, 21.5-35 or borderline food consumption and above 35 for acceptable food consumption (WFP 2008)
Months of Adequate Household Food Provisioning (MAHFP)	12- months	MAHFP measures household food access over a year. Sum of the months of adequate provision (Africare 2007; Bilinsky and Swindale 2010)
Coping Strategies Index (CSI)	7-days	CSI is an indirectly measures of food security. It measure severity of behaviours that household engaged in to mitigate food shortages (Hendriks *et al*. 2016; Leroy 2015; Maxwell and Caldwell 2008)
ASSET	Current	Total number of asset that the household own (both house and farm equipments) that shows ability to cope with shocks (Chambers 2006; Maxwell and Smith 1992; Swift 2006)
Consolidated Approach for Reporting Indicators of Food Security (CARI)	7-days and 12 months	It combines food security indicators (current status and coping capacity) into a summary called the Food Security Index (FSI), representing the overall food security status (Butaumocho and Chitiyo 2017). A combination of three food security indicators: FCS, CSI and food expenditure share (WFP 2014)

Principal component analysis (PCA) was used to examine the patterns of household food consumption and coping strategies. PCA is a multivariate analysis that describes the underlying relationships amongst variables by creating new indicators (factors or principal components) (Conte, 2005).

PCA takes linear combinations of a correlated set of indicators and reduces them into factors (components) by extracting the most considerable variance in the original variables (Field 2009; Reig 2012). The principal components capture the essence of the associations between variables (Wineman, 2016; Wineman and Liverpool-Tasie, 2017). The first factor in principal component analysis captures the maximum variation between the factors and the subsequent components capture new but lower variation.

The factor mathematically model as follows:

$$Y_i - b_1 X_{1i} + b_2 X_{2i} + \cdots . + b_n X_{ni}$$

Where Y_i represent factors or a linear combination of variables (in this study the two food security indicators), X_{ni} represents indicators from one to *n*, and *b* denoted the factor loading.

In this study, the PCA generated three uncorrelated variables or principal components (PC) that accounted for the variability in the data associated with all groups. Eigenvalues greater than one were considered for further analysis using Kaiser's criteria (Field 2009). Zero variance indicated that all values within a set of numbers were not significantly different (identical), while all variances that were non-zero were expected to have positive values.

4 Results

Thi section is presented in three sub-sections. The first subsection presents the demographic and socioeconomic characteristics of sampled households. The second subsection presents the results of the food security indicators analysis. The last subsection presents the results of principal component analysis.

4.1. Description of the sample

More than 75% of the household heads were male. There were proportionally more male-headed engaged households in Location B (22%) compared to female-headed contract farming households (12%), counterfactual households in Location A (12%) and employed (13%) households (Table 4).

The majority of household heads were married (more than 70%). There were more divorced household heads among the non-engaged group compared to other households in Location B samples (Table 4).

Only eight percent of non-engaged households in Location B had large households (more than eight members). The majority of household heads in Location B were non-migrants while the majority of employed households in Location A (73.8%) were migrants from other districts. Less than 10% of household heads in the counterfactual zone in Location A were migrants (Table 4).

Table 4 Demographic characteristics results, 2017

	Location A	Location B

Demographic variable	**Variable descriptions**	**Sample size**	Employed (n=61)	Non-engaged (n=141)	Counter factual (n=102)	Chi-square (χ^2)	Contract (n=110)	Non-engaged (n=89)	Counter factual (n=98)	Chi-square (χ^2)
			%	%	%	p-value	%	%	%	p-value
Sex	Male	601	86.5	84.1	87.9	0.128	88.2	77.5	82.7	0.000
	Female		13.5	15.9	12.1		11.8	22.5	17.3	
Age	Age < 30	601	18.0	26.7	23.9	0.000	16.6	20.8	16.3	0.016
	Age 30-39		37.8	24.6	30.7		23.4	21.7	20.4	
	Age 40-49		20.7	22.1	25.7		24.0	23.9	33.7	
	Age 50-59		11.7	12.8	10.8		21.5	18.0	16.3	
	Age >60		11.7	13.8	8.9		14.4	15.5	13.3	
Marital	Single	601	5.4	3.1	3.4	0.000	1.0	0.0	2.0	0.000
	Married		74.8	79.5	87.1		81.3	73.2	83.7	
	divorce		11.7	13.3	7.5		8.5	16.6	8.2	
	Others		8.1	4.1	2.0		9.2	10.2	6.1	
Family Size	Small (1-4)	601	55.9	42.6	33.5	0.000	35.2	53.5	33.7	0.000
	Medium (5-8)		30.6	43.6	53.5		52.9	38.9	47.9	
	Large (>8)		13.5	13.8	13.0		11.9	7.6	18.4	
Migrant	Non-Migrant	601	19.8	48.2	90.7	0.000	67.7	67.9	60.2	0.017
	Migrant nearby		6.3	11.8	4.7		30.3	30.7	35.7	
	Migrant far		73.9	40	4.6		2.0	1.4	4.1	
Education	No school	600	13.5	12.8	13.3	0.000	12.7	7.0	13.3	0.012
	Primary		56.8	55.4	67.3		67.9	74.4	65.3	
	Secondary		26.1	31.3	17.3		18.3	17.7	20.4	
	College/Universi		3.6	0.5	2.1		1.0	0.8	1.0	
Land size	Very small (< 1	601	66.7	44.1	15.0	0.000	63.8	76.6	59.2	0.013
	Small (1-3 ha)		25.2	26.7	35.8		28.1	17.2	31.6	
	Medium (3-15		4.5	23.6	37.9		8.1	6.2	9.2	
	Large (>15 ha)		3.6	5.6	11.3		0.0	0.0	0.0	
Livestock ownership	Small (< 10)	601	93.7	75.9	50.7	0.000	99.4	100.0	93.9	0.000
	Medium (10-30)		5.4	13.8	25.6		0.6	0.0	6.1	
	Large (>30)		0.9	10.3	23.7		0.0	0.0	0.0	
Land grab	Yes	601	3.6	7.7	0.0	0.000	0.0	0.0	0.0	
	No		96.4	92.3	100.0		100.0	100.0	100.0	

The majority of household heads had completed primary school. Employed and non-engaged household heads in Location A had finished secondary school (over 30% of household heads)) compared with the counterfactual household heads in Location A and Location B. This indicated that educated household heads were more likely to be employed (Table 4).

Only a few households reported losing land rights in Location A (4% of employed households and 8% of non-engaged households). Landholdings were larger in Location A than Location B. In particular, counterfactual households in Location A had larger farms. More than 60% of employed households in Location A and all households in Location B held less than one hectare of land. Non-engaged households in Location B reported slightly

smaller landholdings than other groups (Table 4). This may have been due to the proportionally higher number of female-headed households in this group.

4.1 Food security outcomes

As mentioned above, there is no universally accepted indicator for food security. Available indicators measure different aspects of food security. For this reason, seven internationally recognised indicators were used to measure the various dimensions of food security.

Based on the household dietary diversity score, all households consumed more than five food groups within the 24-hours Recal period. On average, employed households in Location A and contract farming households in Location B consumed more food groups than other groups (6.4 and 6.1, respectively) (Appendix 1).

Generally, households in the counterfactual zone of Location A had higher food consumption scores than other groups. The diets of the majority of households in all groups were classified as acceptable except for the non-engaged households in Location B. For this indicator, households in Location A were more food secure than their counterparts in Location B.

As with the above dietary diversity indicators, employed female-headed households consumed more diverse foods than others. Overall, female-headed households in Location A consumed more diverse diets than their counterparts in Location B. A higher proportion of non-engaged and counterfactual households in Location B consumed diets with inadequate dietary diversity, only consuming two to three food groups (Appendix 1). This may be due to divorced female-headed households losing their land rights and finding it more difficult to secure employment or contracts (Daley *et al*. 2013).

Households typically had adequate food access for more than seven months of the year. More employed and non-engaged households in Location A reported access to adequate food for ten months of the previous year than reported by households in other groups. Contract households had less adequate food access (were able to access food for 7.2 months on average compared to an average of more than nine months for the other groups) (Appendix 1).

Households did not adopt many of the coping strategies. This may have been because the data were collected during the harvesting season when food was more plentiful. The most practised strategies included: consuming less expensive foods; limiting portion sizes; restricting the consumption by adults and reducing the number of meals. Contrary to the findings of the other indicators that showed that employed households were comparatively more food secure, employed households adopted more coping strategies than other groups (Appendix 1).

In general, counterfactual households in Location A owned more assets than other groups, including beds and mattress, sofa sets, tables and mobile phones. However, more households in Location B owned farm equipment (Appendix 1). On average, almost 90% of Location A households and more than 60% of Location B households owned beds. More households owned sofa sets and tables in Location A. More than half the households in Location B owned radios.

More than 45% of the households were classified as marginally food secure by the CARI (Table 5). They met the minimum adequate food consumption requirement without engaging in erosive coping strategies. Still, They could not afford some essential non-food items such as medicine, transport, education and coal or gas. Comparatively more employed households (36%) were classified as food secure by the CARI classification. In Location B, 44%of contract and 48% of non-engaged households (48%) were classified as moderately food insecure

Table 5 CARI console

Domain	Indicator	Household Group (%)	Food secure (1)	Marginally food secure (2)	Moderately food insecure (3)	Severely food insecure (4)
Current Status (CS)	Food Consumption Score (FCS)	Employed in Location A	80.1		17.1	1.8
		Non-engaged for Location A	72.3		27.2	0.5
		Counterfactual for Location A (%)	88.5		10.2	1.3
		Contract in Location B	53.3		44.7	2.0
		Non-engaged for Location B	45.9		51.3	2.8
		Counterfactual for Location B	64.3		35.7	0.0
Coping Capacity (CC)	Food Expenditure Share	Employed in Location A	15.3	28.8	23.4	32.4
		Non-engaged for Location A	20.2	10.4	16.1	53.4
		Counterfactual for Location A (%)	16.7	5.5	20.5	57.3
		Contract in Location B	4.3	10.8	12.2	72.8

	Non-engaged for Location B	3.1	6.3	16.6	74.0
	Counterfactual for Location B	10.2	13.2	14.3	62.2
Livelihood Coping Strategy	Employed in Location A	92.7	1.8	5.5	0.0
	Non-engaged for Location A	96.9	2.1	1.0	0.0
	Counterfactual for Location A (%)	95.2	2.8	2.1	0.0
	Contract in Location B	77.2	8.7	14.1	0.0
	Non-engaged for Location B	73.2	11.5	15.2	0.0
	Counterfactual for Location B	87.8	5.1	7.1	0.0
Food Security Index (FSI)	Employed in Location A	36.4	47.5	16.1	0.0
	Non-engaged for Location A	20.4	58.0	21.5	0.0
	Counterfactual for Location A	12.4	75.4	12.2	0.0
	Contract in Location B	10.1	44.5	44.3	1.1
	Non-engaged for Location B	2.6	47.8	48.1	1.5
	Counterfactual for Location B	11.6	58.9	29.5	0.0

Source: Author analysis using the survey data

4.2 Principal Component Analysis (PCA)

Table 6 illustrates the consumption patterns of households. Two of the twelve food groups (cereal and condiments), were dropped from the PCA analysis because of a lack of variance in the data. Grains were the staple diets in these households.

Employed household were more likely to consume vegetables, eggs, legumes nuts and seeds, milk product and oil and fats followed by meat and fish and other seafood. Employed households were less likely to consume white tubers and roots, fruit and sugar and sweets. The consumption patterns of non-engaged and counterfactual in Location A were similar except that non-engaged households were more likely to consume white tubers and roots in addition to cereal, milk and oil and fats. Counterfactual households were more likely to consume fish, cereal, milk and oil and fats. Both groups were less likely to consume meat, fruits and eggs. Non-engaged and counterfactual households were less likely to consume vegetables, legumes and sugars and sweets.

Contract households seemed more likely to consume cereals and meat daily and white tubers roots, vegetables, eggs, fish and seafood and milk products regularly. Contract households were less likely to consume legumes, nuts and seeds, fruit, oils and fats and sugars and sweets (Table 7). Non-engaged households in Location B were more likely to consume cereals, milk, meat and legumes, nuts and seeds followed by vegetables, white tubers and eggs. Non-

engaged households in Location B were less likely to consume fruit, oils and fats and sugars and sweets. In general, contract and counterfactual households in Location B consumed less diversified diets than non-engaged households.

Table 6 Food consumption patterns of principal components in Location A

Food type	**Employed**			**Food type**	**Non-engaged**			**Food type**	**Counterfactual**		
	PC1	PC2	PC3		PC1	PC2	PC3		PC1	PC2	PC3
Vegt.	0.456			White tub	0.449			Milk	0.526		
Eggs	0.300			Milk	0.448			Oil & fat	0.518		
Legumes	0.408			Oil & fat	0.602			Fish	0.444		
Milk	0.471			Meat		0.618		Fruits		0.615	
Oil & fat	0.485			Fruits		0.479		Meat		0.402	
Meat		0.512		Egg		0.456		Egg		0.348	
Fish		0.626		Vegt.			0.555	White tub			0.429
White tub			0.565	Fish			0.300	Vegt.			0.438
Fruits			0.258	Legumes			0.435	Legumes			0.486
Sweets			0.403	Sweets			0.545	Sweets			0.362
Eigenvalue	2.05	1.56	1.45	Eigenvalue	1.77	1.61	1.42	Eigenvalue	2.06	1.57	1.30
Percentage variability	18.7	14.2	13.2	Percentage variability	16.1	14.6	13.0	Percentage variability	18.8	14.3	11.8

Table 7 Food consumption patterns of principal components in Location B

Food type	**Contract**			**Food type**	**Non-engaged**			**Food type**	**Counterfactual**		
	PC1	PC2	PC3		PC1	PC2	PC3		PC1	PC2	PC3
Meat	0.429			Milk	0.533			Milk	0.481		
White tub		0.283		Meat	0.572			Meat	0.493		
Vegt.		0.392		Legumes	0.497			Legumes		0.542	
Eggs		0.470		White tub		0.555		Fish		0.682	
Fish		0.438		Vegt.		0.471		Egg		0.525	
Milk		0.406		Egg		0.312		Vegt.			0.388
Legumes			0.437	Oil& fat			0.336	White tub			0.376
Fruits			0.402	Fruits			0.352	Fruits			0.456
Oils & fat			0.530	Fish			0.507	Oil & fat			0.600
Sweets			0.460	Sweet			0.427	Sweets			0.369
Eigenvalue	2.18	1.34	1.25	Eigenvalue	2.05	1.52	1.33	Eigenvalue	2.05	1.42	1.28
Percentage variability	21.8	13.4	12.5	Percentage variability	18.6	13.9	12.1	Percentage variability	20.1	14.2	12.8

The PCA was also run to explore the food consumption-related coping strategies adopted by households. Following Maxwell and Caldwell (2008), precautionary strategies were classified into four phases. The first phase included strategies such as eating less preferred and expensive foods, cutting meal sizes and reducing the number of meals eating in a day. The second phase contained households adopting strategies that sought to increase the short-term food availability, including buying food on credit, borrowing food from relatives or

friends, only feeding working members of the households and sending household members to eat elsewhere. The third phase included practices such as restricting consumption of adult and eating seed stocks. The final category included rationing strategies such as sending household members to beg, going days without meals and gathering and eating wild fruit or immature crops.

Counterfactual households in Location A and contract farming households in Location B were more food secure than other households, implementing fewer severe coping strategies. The more severe coping strategies such as gathering wild food, consuming seed stock for food, begging for food and skipping days without food were rarely adopted by counterfactual in Location A and contract farming households (Tables 8 and 9).

Non-engaged households in both locations and counterfactual households in Location B adopted more coping strategies than other households. Employed households occasionally adopted some of the more severe coping strategies such as begging for food and gathering wild food.

Table 8 Patterns of principal components of coping strategies Location A

Coping Strategy	Employed			Coping Strategy	Non-engaged			Coping Strategy	Counterfactual		
	PC1	PC2	PC3		PC1	PC2	PC3		PC1	PC2	PC3
Con. less expensive	0.374			Con. less expensive	0.329			Con. less expensive	0.432		
Borrow food	0.389			Borrow food	0.367			Limit port. food	0.393		
Limit port. food	0.399			Begging	0.386			Restrict cons. adult	0.498		
Restrict cons. adult	0.375			Gather wild food	0.300			Purchase food credit	0.444		
Purchase food credit		0.353		Reduce no. of meals	0.356			Borrow food		0.541	
Gather wild food		0.398		Skip days	0.300			Eat elsewhere		0.495	
Begging		0.484		Purchase food credit		0.463		Reduce no. of meals			0.507
Feed working		0.535		Restrict cons. adult		0.348		Gather wild food			0.588
Eat elsewhere			0.686	Limit port. food		0.356		Consume seed stock			0.325
Consume seed stock			0.237	Consume seed stock			0.747	Feed working			0.368
Reduce no. of meals			0.469	Feed working			0.499	Skip days			0.425
Eigenvalue	4.28	1.70	1.38	Eigenvalue	4.73	1.44	1.31	Eigenvalue	3.19	1.39	1.05
Percentage variability	38.9	15.5	12.6	Percentage variability	39.4	12.0	10.9	Percentage variability	39.9	17.5	13.1

Table 9 Patterns of principal components of coping strategies Location B

Coping Strategy	Contract			Coping Strategy	Non-engaged			Coping Strategy	Counterfactual		
	PC1	PC2	PC3		PC1	PC2	PC3		PC1	PC2	PC3
Limit port. food	0.385			Borrow food	0.377			Borrow food	0.341		
Restrict cons. adult	0.391			Purchase food credit	0.379			Purchase food credit	0.304		
Reduce no. of meals	0.415			Gather wild food	0.328			Gather wild food	0.329		
Purchase food on	0.385			Consume seed stock	0.356			Limit port. Food	0.411		
Consume seed stock		0.482		Reduce no. of meals	0.404			Restrict cons. adult	0.382		
Feed working		0.704		Restrict cons. adult	0.339			Reduce no. of meals	0.409		
Cons. less expensive			0.426	Con. less expensive		0.522		Feed working		0.714	
Borrow food			0.433	Limit port. food		0.421		Eat elsewhere		0.605	
Gather wild food			0.398	Eat elsewhere			0.290	Con. less expensive			0.566
Skip days			0.614	Feed working			0.468	Consume seed stock			0.418
Eat elsewhere			0.321	Skip days			0.292	Skip days			0.356
Eigenvalue	3.88	1.33	1.21	Eigenvalue	3.32	1.62	1.13	Eigenvalue	3.44	1.48	1.31
Percentage variability	35.3	12.1	11.0	Percentage variability	33.2	16.2	11.3	Percentage variability	34.3	14.8	13.1

5 Comparison of the outcomes for the indicators

Table 10 provides a summary of the findings. The chi-square results showed a significant difference between the groups (p-value = 0.000) in all the food security indicators. Except for non-engaged households in Location B, diets of the majority of households were classified as acceptable. More households in the counterfactual zone in Location A had acceptable food consumption (88% of households). However, the diets of the majority of female-headed households in both locations were not sufficiently diverse. Interestingly, 66% of female-headed employed households in Location A consumed moderately diverse diets.

According to the months of adequate household food provisioning indicator, 54% of employed households and 54% of non-engaged were classified as 'least food insecure'. Over 65% of the counterfactual and contract households were moderately food insecure (able to access food for 6-10 months).

Similarly, almost 60% of the households in Location A fell into the moderate resilient category compared to fewer than 40% of households in Location B in terms of the asset indicator. The majority of the households in Location B area were classified as 'least resilient' (Table 10)

Fewer households (from all groups) were food secure according to coping strategy index indicator, except for counterfactual households in Location A. Almost 80% of households in the counterfactual and 59% of contract households in Location A were food secure. To the contrary, only 45% of the employed households were food secure (Table 10).

In general, our findings showed that the employed households were more food secure than other households, but their diets lacked diversity (Table 10). Employed households also experienced less hunger and fewer months of inadequate food provision. However, they did consume less nutritious foods more often. Their relatively low asset bases made them moderately resilient to food security shocks.

The contract-farming households enjoyed diets with higher dietary diversity than employed households. However, they consumed less diversified diets than non-engaged and counterfactual households. Contract households adopted sever strategies like consuming seed stock, skipping meals and gathering wild foods to meet their food requirements. Contract households were also the least resilient regarding asset ownership. Contract households generally produced non-food crops and received lumpy contract payments compared to the consumption-smoothing monthly or weekly payments of employed households. Contract farmers in the study area grew barley. However, the main staple foods in Madagascar are rice, maize and cassava. If household land was under barley production, the amount of land for food production would have dropped. Giger *et al*. (2019) used remote sensing data analysis results in the same study areas and found that the companies had changed land-use patterns such as converted grassland to cropland. However, these changes did not result in major off-site land use/land cover changes in the vicinity of investment areas (Giger *et al*. 2019).

Non-engaged households in the zone of influence enjoyed similar dietary diversity to counterfactual households. A similar proportion of non-engaged households in the two areas were classified as food secure based on the coping strategy index. Still, most non-engaged

households in Location B fell into the least resilient group. Table 10 presents a summary of the classifications. The categorisation of households is detailed in Table 3.

Table 10 Summary of Food Security Indicators

Indicator or Index	Category	Category description	Range	Location A				Location B			
				Employed (n=61) %	Non-engaged (n=141) %	Counterfactual (n=102) %	Chi-square (χ^2) p-value	Contract (n=110) %	Non-engaged (n=89) %	Counterfactual (n=98) %	Chi-square (χ^2) p-value
Household dietary diversity score	1	Adequate dietary	≥ 6	57.7	65.6	62.5	0.000	62.2	55.8	70.4	0.000
	2	Moderate dietary	4-5	42.3	29.7	29.9		35.8	39.2	29.6	
	3	Inadequate	≤ 3	0.0	4.7	7.6		2.0	5.0	0.0	
Food consumption score (FCS)	1	Acceptable	>35	80.2	72.3	88.5	0.000	53.3	45.9	64.3	0.000
	2	Borderline	21.5	18.0	27.2	10.2		44.7	51.3	35.7	
	3	Poor	0-21	1.8	0.5	1.3		2.0	2.8	0.0	
Women's Dietary Diversity (WDDS)	1	Adequate dietary	≥ 6	11.1	5.9	0.0	0.000	6.7	5.9	0.0	0.001
	2	Moderate dietary	4-5	66.7	29.4	40.0		13.3	41.2	20.0	
	3	Inadequate	≤ 3	22.2	64.7	60.0		80.0	52.9	80.0	
Months of adequate household food provisioni	1	Least food	≥ 10	54.1	53.8	35.0	0.000	25.6	18.3	21.4	0.001
	2	Moderately food	6-10	44.1	44.1	65.0		64.6	71.0	72.5	
	3	Most food insecure	3-6	1.8	2.1	0.0		9.8	10.7	6.1	
Coping Strategy Index (CSI)	1	Food secure	0-2	45.0	49.2	79.9	0.000	58.7	49.0	47.9	0.000
	2	Mildly food	3-12	19.8	25.1	12.7		13.5	23.3	13.3	
	3	Moderately food	13-40	29.8	13.8	3.9		19.5	16.3	27.6	
	4	Severely food	>40	5.4	11.9	3.5		8.3	11.4	11.2	
Asset Indicator	1	Most resilient	≥ 10	13.5	17.9	21.1	0.000	15.9	9.6	9.2	0.000
	2	Moderately	6-10	64.9	59.5	63.0		39.6	25.9	28.6	
	3	Least resilient	3-6	21.6	22.6	15.9		44.5	64.5	62.2	
CARI (Food Security Index)	1	Food secure		36.4	20.4	12.4	0.000	10.1	2.6	11.6	0.000
	2	Marginally food		47.5	58.0	75.4		44.5	47.8	58.9	
	3	Moderately food		16.1	21.5	12.2		44.3	48.1	29.5	
	4	Severely food		0.0	0.0	0.0		1.1	1.5	0.0	

6 Conclusions

While direct attribution of the influence of large-scale agribusiness is not possible from the data, the study did not find a definitive adverse influence on food security at the time of the survey. In general, households with at least one member who was employed by the companies were better off regarding dietary quality, food security and resilience. Their steady income seemed to smooth consumption. However, depending on a wage for purchasing food

(rather than producing it yourself) could make these households more vulnerable to fluctuations in market prices.

Contract households were worst off in terms of many food security indicators than the employed, counterfactual and non-engaged households. However, contracting households seemed to own more assets. These assets could provide liquidity in times of food stress. The periodic contract payments seem to favour the purchasing of assets but lead to higher levels of food insecurity at the time of the survey.

Living in the zone of influence did not seem to have significant adverse effects on the food security of non-engaged households. The counterfactual households seemed to have enjoyed greater dietary quality and owned more assets than the non-engaged households in the zone of influence. The counterfactual households applied fewer coping strategies than the non-engaged households immediately after the production season. However, the food security levels could well have been worse if the interviews were conducted a few months earlier before the harvest. The findings suggest that female-headed households may well be disadvantaged in terms of access to employment and contracting, affecting their food security and dietary quality.

It was not possible to draw a concrete conclusion on whether the presence of the large-scale investment had an impact on the food security of the households investigated due to a lack of a baseline. Further research is necessary to monitor the impact of these enterprises over time. National surveillance systems are required to monitor the food security situation of households in these areas over time. Such systems could facilitate accountability systems to ensure that the food security and welfare of the local communities are not compromised and that the necessary action is taken in the case of deterioration or should the agribusiness withdraw from the area or go out of business. Policies related to quotas favouring female employment and preference for contracts could provide an option to address the findings related to female-headed households.

Conflict of Interest

The authors declared that they have no conflict of interest.

References

Aabø, E. and Kring, T. (2012). The political economy of large-scale agricultural land acquisitions: Implications for food security and livelihoods/employment creation in rural Mozambique. United Nations Development Programme Working Paper, 4, 1-61.

Africare (2007). Guidance: How to Measure Months of Adequate Household Food Provisioning (MAHFP) Based on *Participatory Rural Appraisals in Food Security Interventions. Africare Food Security Review, No. 1*, September. Washington DC: Africare/Headquarters.

Andrianirina Ratsialonana, R., Ramarojohn, L., Burnod, P., and Teyssier, A. (2011). After Daewoo? Current status and perspectives of large-scale land acquisition in Madagascar.

Anseeuw W. (2013). The rush for land in Africa: Resource grabbing or green revolution?, *South African Journal of International Affairs*, 20:1, 159-177,DOI: 10.1080/10220461.2013.780326.

Baumgartner, P., Von Braun, J., Abebaw, D., and Müller, M. (2015). Impacts of large-scale land investments on income, prices, and employment: Empirical analyses in Ethiopia. World Development, 72, 175-190.

Bellemare, M. F., and Novak, L. (2017). Contract farming and food security. American Journal of Agricultural Economics, 99(2), 357-378.

Bilinsky, P., and Swindale, A. (2010). Months of adequate household food provisioning (MAHFP) for measurement of household food access: *Indicator guide. Version 4. Washington, DC: Food and Nutrition Technical Assistance II Project* (FANTA).

Bosch, C. and Zeller, M. (2013). The Impact of wage employment on Jatropha plantation on income and food security of rural households in Madagascar- a panel data analysis. *Quarterly Journal of International Agriculture*, 52, 119-140.

Burnod, P., and Andriamanalina, B.S. (2017). Land reform and home of investors in Madagascar: the ambivalence of the land policy. *Geography, economy, society*, 19(3), 357-376.

Burnod, P., Rakotomalala, H., Rasolofo, P., and Brès, A. (2015). Large-scale plantation and contract farming effects: qualitative and quantitative assessment in Madagascar. *International Conference on Land Governance for Equitable and Sustainable Development,* Utrecht, Pays-Bas, 8 July 2015/10 July 2015. LANDac, pp. 1-30. http://www.landgovernance.org/registration-2015-landac-conference/. Accessed 14 June 2018.

Burnod, P., Andrianirina Ratsialonana, R., and Teyssier, A. (2013). Processus d'acquisition foncière à grande échelle à Madagascar: quelles régulations sur le terrain? Cahiers agricultures, 22(1), 33-38.

Butaumocho, B., and Chitiyo, P. T. (2017). A Comparative Analysis of Household food Security Measure in Rural Zimbabwe. *International Journal of Food and Agricultural Economics*, 5(2), 41.

Chagomoka, T., Unger, S., Drescher, A., Glaser, R., Marschner, B., and Schlesinger, J. (2016). Food coping strategies in northern Ghana. A socio-spatial analysis along the urban–rural continuum. Agriculture & Food Security, 5(1), 4.

Chagomoka, T., Drescher, A., Glaser, R., Marschner, B., Schlesinger, J., and Nyandoro, G. (2017). Contribution of urban and periurban agriculture to household food and nutrition security along the urban–rural continuum in Ouagadougou, *Burkina Faso. Renewable Agriculture and Food Systems*, 32(1), 5-20.

Chambers, R. (2006). Vulnerability, coping and policy (editorial introduction). *IDS Bulletin*, *37*(4), 33-40.

Conte, A. (2005). *Thematic Guidelines. Household Food Security Profiles*. VAM Analytical Approach. World Food Programme.

Cotula, L. (2009). Land grab or development opportunity? Agricultural investment and international land deals in Africa. International Institute for Environment and Development, United Kingdom, London.

Cotula, L. (2011). Land deals in Africa: What is in the contracts? International Institute for Environment and Development, United Kingdom, London.

Cotula, L., Oya, C., Codjoe, E. A., Eid, A., Kakraba-Ampeh, M., Keeley, J., and Asare, R. O. (2014). Testing claims about large land deals in Africa: Findings from a multi-country study. Journal of Development Studies, 50(7), 903-925.

Daley, E., Flower, C., Miggiano, L., and Pallas, S. (2013). Women's land rights and gender justice in land governance: pillars in the promotion and protection of women's human rights in rural areas. Synthesis of contributions by members, partners and individual experts in the International Land Coalition's network.

Daniel, S. (2011). Land grabbing and potential implications for world food security. In Sustainable agricultural development (pp. 25-42). Springer, Dordrecht.

Deininger, K., Ali, D. A., and Alemu, T. (2011). Impacts of land certification on tenure security, investment, and land market participation: evidence from Ethiopia. Land Economics, 87(2), 312-334.

De Schutter, O. (2011). How not to think of land-grabbing: three critiques of large-scale investments in farmland. The Journal of Peasant Studies, 38(2), 249-279.

Dheressa, D. K. (2013). The Socio-Economic and Environmental Impacts of Large Scale (Agricultural) Land Acquisition on Local Livelihoods: A Case Study in Bako Tibe Woreda of Oromia Region, Ethiopia. Unpublished Masters Dissertation, Centre for Development and the Environment, University of Oslo.

Dye, J. (2015). Food Security and Large-Scale Land Acquisitions: The Cases of Tanzania and Ethiopia (Doctoral dissertation, University of Cincinnati).FANTA (Food and Nutrition Technical Assistance Project). (2006). Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (Version 2). Washington DC: FANTA.

FAO (2006). Food and Agricultural Organization of the United Nations. Food Security. Policy Brief No. 2. June. Rome: FAO.

FAO and WFP (2014). The state of food insecurity in the World: Strengthening the enabling environment for food security and nutrition. Food and Agriculture Organization of the United Nations: Rome.

Field, A. (2009) Discovering statistics using SPSS. London: Beverly Hills, CA: Sage Publications.

Giger, M., Oberlack, C., Anseeuw, W., Adelle, C., Bourblanc, M., Kiteme, B., Burnod, P., Eckert, S., Fouilleux, E., Hendriks, S., Mercandalli, S., Reys, A., Da Silva, M., Van Der, L. M., Zahringer, J., and Messerli, P. (2019). How and why large-scale agricultural investments induce different socio-economic, food security, and environmental impacts: Evidence from Kenya, Madagascar, and Mozambique [913]. Open Science Meeting of the Global Land Programme OSM 2019. Bern, Suisse, [913].

GRAIN. (2008). Seized: The 2008 land grab for food and financial security. GRAIN briefing. Available: file:///C:/Users/6020/Downloads/grain-93-seized-the-2008-landgrab-for-food-and-financial-security%20(1).pdf. Accessed: 03 June 2018.

Görgen, M., Rudloff, B., Simons, J., Üllenberg, A., Väth, S., and Wimmer, L. (2009). Foreign Direct Investment (FDI) in Land in Developing Countries. Eschborn, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

Grover, R. (2009). Voluntary guidelines for good governance in land and natural resource tenure (No. 9). Land Tenure Working Paper.

Hall, R., Scoones, I. and Tsikata, D. (2017). Plantations, outgrowers and commercial farming in Africa: agricultural commercialisation and implications for agrarian change, Journal of Peasant Studies. Taylor & Francis, 44(3), pp. 515–537. doi: 10.1080/03066150 .2016.1263187.

Harding, A., Burnod, P., and Chamberlain, W. (2017). Large Scale Land Acquisitions Madagascar Country Profile. Land Matrix.

Hendriks, S. L., Van der Merwe, C., Ngidi, M. S., Manyamba, C., Mbele, M., McIntyre, A. M., and Ngwane, L. (2016). What are we measuring? Comparison of household food security indicators in the Eastern Cape Province, South Africa. Ecology of food and nutrition, 55(2), 141-162.

Hirvonen, K., Taffesse, A. S., and Hassen, I. W. (2016). Seasonality and household diets in Ethiopia. Public health nutrition, 19(10), 1723-1730.

Hufe, P., and Heuermann, D. F. (2017). The local impacts of large-scale land acquisitions: a review of case study evidence from Sub-Saharan Africa. Journal of Contemporary African Studies, 35(2), 168-189, DOI: 10.1080/02589001.2017.1307505.

IFPRI (International Food Policy Research Institute) (2006). Review and Validation of Dietary Diversity, Food Frequency and Other Proxy Indicators of Household Food Security. Report submitted to the World Food Programme, Rome.

Kennedy, G., Razes, M., Ballard, T., and Dop, M. C. (2010). Measurement of dietary diversity for monitoring the impact of food based approaches. In International symposium on food and nutrition security: food-based approaches for improving diets and raising levels of nutrition. Rome, FAO.

Kibugi, R., Mwathane, I. and Makathimo, M. (2012). Large scale land acquisitions for investment in Kenya: Is the participation, and benefits of affected local communities meaningful, and equitable? Available at: https://idl-bnc-idrc.dspacedirect .org/bitstream/handle/10625/56388/IDL-56388.pdf? sequence=2.

Kibugi, R., Wardell, D. A., Segger, M. C. C., Haywood, C. and Gift, R. (2015). Enabling legal frameworks for sustainable land-use investments in Tanzania: Legal assessment report (Vol. 191). CIFOR. (Accessed: 24 September 2018).

Klopp, J. M. and Lumumba, O. (2017). Reform and counter-reform in Kenya's land governance. Review of African Political Economy, 44(154), 577-594.

Kronenberg, J. (2014). Viable Alternatives for Large□Scale Unsustainable Projects in Developing Countries: The case of the Kumtor gold mine in Kyrgyzstan. Sustainable Development, 22(4), 253-264.

Lay, J., Nolte, K., and Sipangule, K. (2017). Large-scale farms and smallholders: Evidence from Zambia (No. 310). GIGA Working Papers.

Leroy, J. L., Ruel, M., Frongillo, E. A., Harris, J., and Ballard, T. J. (2015). Measuring the food access dimension of food security: a critical review and mapping of indicators. Food and nutrition bulletin, 36(2), 167-195.

Lisk, F. (2013). 'Land grabbing'or harnessing of development potential in agriculture? East Asia's land-based investments in Africa. The Pacific Review, 26(5), 563-587.

Matondi, P. B., Havnevik, K. J. and Atakilte, B. (2011). Introduction: biofuels, food security and land grabbing in Africa , pp. 1–19.

Maxwell, S., & Smith, M. (1992). Household food security: a conceptual review. Household Food Security: concepts, indicators, measurements. Edited by S. Maxwell and T. Frankenberger. Rome and New York: international Fund for Agricultural Development (IFAD) and United Nations International Children's Emergency Fund (UNICEF).

Maxwell, Daniel and Richard Caldwell (2008). The Coping Strategies Index: Field Methods

Manual.

Medernach, K. and Burnod, P. (2013). Unexpected Changes in a Malagasy Agrarian System: The Role of Agribusiness, pp. 1–20.

Mekonnen, D. A. and Gerber, N. (2017). Aspirations and food security in rural Ethiopia, *Food Security*, 9(2), pp. 371–385. doi: 10.1007/s12571-017-0654-6.

Miggiano, L., Taylor, M., and Mauro, A. (2010). Links between land tenure security and food security. Rome: International Land Coalition.

Moreda, T. (2018). The right to food in the context of large-scale land investment in Ethiopia. Third World Quarterly, 39(7), 1326-1347.Nolte, K., Chamberlain, W. and Giger, M. (2016). International Land Deals for Agriculture Fresh insights from the Land Matrix: Analytical Report II. doi: 10.7892/boris.85304.

Nolte, K. and Ostermeier, M. (2017). Labour Market Effects of Large-Scale Agricultural Investment: Conceptual Considerations and Estimated Employment Effects, *World Development*. doi: 10.1016/j.worlddev.2017.05.012.

Olounlade, O. A., Li, G. C., Kokoye, S. E. H., Dossouhoui, F. V., Akpa, K. A. A., Anshiso, D., and Biaou, G. (2020). Impact of participation in contract farming on smallholder farmers' income and food security in rural Benin: PSM and LATE Parameter Combined. Sustainability, 12(3), 901.

Reig, E. (2012). Food security in African and Arab countries: a review of the topic and some suggestions for building composite indicators with Principal Components Analysis, pp. 1–71. Available at: http://ideas.repec.org/p/eec/wpaper/1210.html .

Reys A. and Burnod P. (2017). African Food, Agriculture, Land and Natural Resource (AGROLAND). Madagascar Sample and Survey Method report. Montpellier: CIRAD

Ronald, P. C. (2014). Lab to farm: applying research on plant genetics and genomics to crop improvement. PLoS Biol, 12(6), e1001878.

Schoneveld, G. C., German, L. A., and Nutakor, E. (2011). Land-based investments for rural development? A grounded analysis of the local impacts of biofuel feedstock plantations in Ghana. Ecology and Society, 16(4):10.Shepard D. (2011). Chapter 2. *Land Grabbing and Potential Implications for World Food Security* In: M. Behnassi et al. (eds.), Sustainable Agricultural Development, Springer Science and Business Media. P 25 – 42 DOI 10.1007/978-94-007-0519-7_2.

Shete, M., and Rutten, M. (2015). Impacts of large-scale farming on local communities' food security and income levels–Empirical evidence from Oromia Region, Ethiopia. Land Use Policy, 47, 282-292.

Smalley, R. (2013). Plantations, contract farming and commercial farming areas in Africa: A comparative review.

Speller, W. (2017). The Impact of Larger-Scale Agricultural Investments on Local Communities: Updated Voices from the Field. World Bank. https://doi.org/10.1596/26487

Swift, J. (2006). Why are rural people vulnerable to famine? *IDS Bulletin*, *37*(4), 41-49.

Von Braun, J., & Meinzen-Dick, R. S. (2009). Land grabbing" by foreign investors in developing countries: risks and opportunities. Washington, DC: International Food Policy Research Institute.

WFP (World Food Programme) (2006). Food consumption analysis: Calculation and use of the food consumption score in food security analysis. Rome, Italy: World Food Program, Vulnerability Analysis and Mapping Branch (ODAV).

WFP (World Food Programme) (2008). Vulnerability Analysis and Mapping. Food consumption analysis: Calculation and use of the food consumption score in food security analysis. Rome: WFP.

Wineman, A. (2016). Multidimensional household food security measurement in rural Zambia. Agrekon, 55(3), 278-301.

Wineman, A., and Liverpool-Tasie, L. S. O. (2017). Land markets and land access among female-headed households in northwestern Tanzania. World Development, 100, 108-122.

World Bank. (2007). World Development Report 2008: Agriculture for development. The World Bank: Washington, DC.

Yengoh, G. T. and Armah, F. A. (2015). Effects of large-scale acquisition on food insecurity in Sierra Leone, *Sustainability* 7(7), pp. 9505–9539. doi: 10.3390/su7079505.

Zaehringer, J. G., Wambugu, G., Kiteme, B., and Eckert, S. (2018). How do large-scale agricultural investments affect land use and the environment on the western slopes of Mount Kenya? Empirical evidence based on small-scale farmers' perceptions and remote sensing. Journal of Environmental Management, 213, 79-89.

Fitawek W, Hendriks SL, Reys A and Fossi F. (2020). The effect of large-scale agricultural investments on household food security in Madagascar. Food Security, June 2020. https://doi.org/10.1007/s12571-020-01055-6. https://rdcu.be/b5BwK

Appendix 1 descriptive results of food security indicators

Indicators	*Location A*									*Location B*								
	Employed			**Non-engaged**			**Counterfactual**			**Contract**			**Non-engaged**			**Counterfactual**		
	Obser	Mea	Std.Dv	Obser	Mea	Std.Dv	Obser	Mea	Std.Dv	Obser	Mea	Std.Dv	Obser	Mea	Std.Dv	Obser	Mea	Std.Dv	Chi2
HDDS	61	6.49	1.69	141	5.92	1.65	102	5.6	1.68	110	6.1	1.49	89	5.8	1.41	98	6.0	1.36	0.004***
FCS	61	48.2	14.95	141	49.9	18.22	102	58.6	19.48	110	38.9	12.17	89	37.1	9.82	98	40.3	11.72	0.000***
WDDS	9	3.8	1.72	18	3.6	1.09	15	2.9	1.25	12	3.6	1.78	17	2.6	0.79	17	2.9	1.05	0.231
MAHFP	61	9.5	1.72	141	9.6	1.83	102	9.3	1.29	110	7.2	2.19	89	7.58	2.28	98	8.1	1.98	0.000***
CSI	61	10.7	14.99	141	5.8	11.70	102	6.0	2..27	110	6.8	12.84	89	8.3	13.17	98	10.2	13.83	0.238
Asset	61	6.78	2.62	141	7.2	2.28	102	8.1	2.67	110	6.9	2.84	89	5.7	2.35	98	5.5	2.35	0.000***
CARI	61	1.8	0.78	141	2.1	0.62	102	2.0	0.51	110	2.3	0.69	89	2.4	0.59	98	2.2	0.62	0.000***