World Development 141 (2021) 105384

Contents lists available at ScienceDirect

World Development

journal homepage: www.elsevier.com/locate/worlddev

Agricultural land acquisitions unlikely to address the food security needs of African countries

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ARTICLE INFO

Article history:
Accepted 22 December 2020
Available online 23 January 2021

Keywords:
Food security
Land grabbing
Sustainable development
Land conflict
Livelihood
Deforestation
Extractivism

ABSTRACT

In recent years, Large Scale Land Acquisitions (LSLA), direct land tenure changes have been gaining momentum in developing countries. In this study, we evaluate the potential extent to which agricultural land deals in Africa are able to address the host countries' food security needs, a commonly cited motivation for their establishment. First, we develop a framework to evaluate the priority food security needs of 38 African countries in 2000 based on indicators of food availability, accessibility, stability, and utilization. Second, we estimate whether the crops from land deals would be sold on export or local food markets based on the origin of investments (domestic, foreign or mixed), type of investors (eg. agribusiness, finance, or government) and the intended crops (eg. food, cash crop, or biofuel). This enables us to estimate how likely the investment is to improve in-country food security, versus serving other purposes (e.g., speculation, enclosure of natural resources). Third, we account for the characteristics of the locations where the deals happen (population density, land cover and distance to markets) in order to estimate the level of conflict and deforestation that they could exacerbate. We find that LSLA are only likely to address the identified food security needs of 7 countries. LSLA are also at risk of increasing land pressures and conflicts or deforestation on 83% of the acquired area, including in countries where they could meet food security needs. We also find that the more productive lands are most often allocated to flex crops, while food crops are produced on more marginal lands. We thus argue that even when their purpose is agricultural production, most LSLA are not likely to improve food security; rather, they often serve the financial interests of transnational companies and local elites with the support of host governments. Finally, we recommend agricultural investments to be elaborated in consultation with local communities and marginalized groups to sustainably support their socio-ecological systems.

1. Introduction

Humanity faces the major challenge of sustainably feeding the world while avoiding additional greenhouse gas emissions in a shrinking land area per capita. Despite an increase in global food production over the past two decades, nearly 690 million people (about 9% of the global population) remain undernourished globally, of which 250 million (36%) live in Africa (FAO, IFAD, UNICEF, WFP, & WHO, 2020; Foley et al., 2011). The Millennium Development Goal's (MDG) target of halving the number of undernourished people by 2015 has been met in 72 developing countries (FAO, IFAD, & WFP, 2015). However, even though humans produce enough food for the current global population, geopolitics and global economics hinder its equal distribution (FAO et al., 2020; Vivero-pol, 2017). Today 53 countries, mostly in Asia and Africa, still struggle to feed their populations and require international food aid due to high volatility of food prices, lack of access to food in the poorest regions, and political crises hindering economic development (FAO et al., 2015; FSIN, 2019).

Looking ahead, food security remains in the top priorities for the Sustainable Development Goals (SDG) with a new target of "Zero Hunger" for 2030 (Porter et al., 2014; United Nations, 2016). Achieving this goal is challenging in light of the need to feed more people from the expected increasing global population (United Nations, 2017), as well as potential negative impacts of climate change on agricultural production. Moreover, the current COVID-19 pandemic with its negative economic impacts, as well as the recent large scale Desert Locus outbreaks in Eastern Africa are expected to increase the number of undernourished people by 83 to 132 million by the end of 2020 (FAO et al., 2020). This poses considerable doubts on our ability to achieve the Zero

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https://doi.org/10.1016/j.worlddev.2020.105384
0305-750X/

Hunger goal by 2030, particularly when considering the reversal of the undernourishment trend that has been on the rise since 2014 (FAO et al., 2020).

In an effort to increase food production in developing countries with high yield gaps, agricultural investments (in machinery, irrigation, fertilizers, and pesticides) have been pushed forward to modernize agriculture and increase yields (UNCTAD, 2009; World Bank, 2007). In recent years however, these investments have grown to include Large Scale Land Acquisitions (LSLA) in the form of direct land lease or ownership investments (Anseeuw et al., 2012; Cotula, Vermeulen, Leonard, & Keeley, 2009; De Schutter, 2011b; UNCTAD, 2009; Zoomers, 2010).

Recent work shows that LSLA have been targeting densely populated, easily accessible and oftentimes agricultural areas rather than remote idle lands (Messerli, Giger, Dwyer, Breu, & Eckert, 2014). This has posed concerns over the potential environmental and social impacts from LSLA, including deforestation (Conigliani, Cu, & Agostino, 2018; Davis et al., 2020) and changes in access to water resources (Johansson, Fader, Seaquist, & Nicholas, 2016; Rulli, Saviori, & Odorico, 2012). Agricultural expansion from LSLA, has also caused land conflicts between farmers and pastoralists (Oberlack, Tejada, Messerli, Rist, & Giger, 2016; Soeters, Weesie, & Zoomers, 2017), decreased overall employment due to mechanization, increased the casualization of agricultural labor associated with lower incomes and insecurity (Li, 2011; Nolte & Ostermeier, 2017; Yaro, Teye, & Torvikey, 2017), and did not adequately promote investments in needed rural infrastructure such as roads, water or sanitation (Nolte, Chamberlain, & Giger, 2016).

Achieving food security has been commonly cited as motivation for LSLA through closing yield gaps, expanding agricultural areas and fostering rural development (Deininger et al., 2010; World Bank, 2007). Yet the current research on LSLA has only recently started to account for impacts on food security in host countries (Nyantakyi-Frimpong & Kerr, 2017; Rulli & D'Odorico, 2014; Yengoh & Armah, 2015). Other studies have attempted to assess the linkages and spillover effects these deals might have on the surrounding communities, specifically in terms of employment and capacity transfer (Deininger & Xia, 2016; Glover & Jones, 2019). These analyses are however often either limited to case studies or only focus on the production dimension of food security.

By introducing a multidimensional set of indicators, the FAO has highlighted that food security is constrained by availability, accessibility, stability and utilization rather than production alone (FAO IFAD & WFP, 2013). As such, research on LSLA's impacts on food security should address all these aspects. To date, Rulli & D'Odorico (2014) estimated that by closing yield gaps, land acquisitions could in theory feed an additional 211.7 million people in Africa, which is more than the number of currently undernourished people in the continent (FAO, 2019). Nevertheless, when the authors consider that 50% of the palm oil and sugar cane production might be used for biofuels, this number is reduced to 132.6 million (Rulli & D'Odorico, 2014). The authors have however failed to consider the use of maize and soybean for biofuel and feedstock (Borras, Franco, Isakson, Levidow, & Vervest, 2014; Sorda, Banse, & Kemfert, 2010), or the fact that a large portion of the production in the continent is destined for export.

In this study, we introduce a food security score based on all four dimensions and use it to identify priority needs at the country level. To the best of our knowledge, we present for the first time an assessment of the destination markets of land deals, as well as the socio-economic and environmental risks associated with LSLA at a continental scale. In doing so, we evaluate if and how agricultural land deals address the food security needs of the 38 African countries in which they occur by answering the following questions: 1. What was the state of food security in 2000 and what were the priority food security needs for the 38 African countries studied? 2. How likely are the crops grown on the acquired lands to contribute to the host countries' food security? 3. What potential land disturbances could LSLA cause at the local level?

First, we identify the food security needs of countries by evaluating the status of all four dimensions in 2000. Second, we estimate the destination of crops produced through analyzing the origin of investment (domestic, foreign or mixed), type of investors (e.g., agribusiness, finance, government), and the type of crops (e.g., food stuff, cash crop, biofuel) intended for production on the acquired land. This enables us to determine whether LSLA have the capacity to address the identified food security needs of countries. Third, we consider the potential contribution of LSLA to land pressure or deforestation (measured by distance to markets, population density and previous land cover).

2. Data and methods

2.1. Agricultural land deals in Africa

We used the new version of the Land Matrix dataset as of 1st March 2019 (The Land Matrix Global Observatory, 2019). We collected all concluded deals (that did not fail) intended for agriculture or biofuel production in Africa. The vast majority of these deals cover an area larger than 200Ha due to this threshold being set by the Land Matrix (The Land Matrix Global Observatory, 2019). These deals also included domestic actors as unique investors. We count 498 deals by 504 investors aimed for the production of 81 different crops on a contracted area of around 8.8 MHa (larger than the size of Austria) hosted by 38 African countries between 2000 and 2015 (the remaining 16 African countries had no data on agricultural land deals, and thus are assumed not to host any).

2.2. Identifying the food security needs of targeted African countries

We first established a baseline of the status of food security of each studied country in 2000 and then identified their priority food security needs. The year 2000 was chosen as a baseline of the food security status of countries because it is the starting date of land acquisitions reported in the Land Matrix dataset used in this study. Since we aim to assess the potential contribution of LSLA to the food security needs of the countries where they occur, it is important to identify those needs at the time these investments started. Nevertheless, we do acknowledge that the food security situation across the continent has changed over the past two decades, and include a similar evaluation of food insecurity severity and priority needs for 2017 (extracted from FAOSTAT on February 17th, 2020).

We used two indicators for each of FAO's four dimensions of food security, and scored each dimension between 0 and 2 based on the number of indicators passing thresholds mostly derived from the SDGs (FAO IFAD & WFP, 2013; United Nations, 2016) (Table 1). We used the domestic supply of vegetables and fruits rather than the share of cereals and tubers as a proxy for the availability of nutritional food in the countries, because the share of cereals alone does not indicate what other components make up the rest of the diet. We set a threshold of 400 g/day of fruits and vegetables for a diversified diet as per the recommendations of the WHO (WHO, 2003). We also constructed an index approximating food affordability whereby we considered food to be affordable when the prevalence of undernourishment was lower than that of poverty (at national poverty line) suggesting that a portion of poor people manage to gain access to sufficient food. We assessed self-sufficiency by deducting the imported calories from the average dietary energy supply adequacy, rather than using the share of imported cereals indicator from the FAO suite. As no threshold was found in the literature for estimating import capacity, we

Table 1
Selected food security indicators and thresholds to assess FAO's four dimensions of food security in 38 African countries (FAO, 2018; United Nations, 2016) (see SI 1 for details).

Dimension	Indicator	Threshold	Source
Availability	1.1 Average dietary energy supply adequacy (%)	≥95%	Inspired by (United Nations, 2016)
	1.2 Domestic supply of vegetables and fruits (g/day/capita)	≥400 g	(WHO, 2003)
Accessibility	2.1 Prevalence of undernourishment (% of population)	≤5%	(United Nations, 2016)
	2.2 Affordability index	>0	own assumption
Utilization	3.1 Access to improved water sources (%)	≥95%	(United Nations, 2016)
	3.2 Access to improved sanitation facilities (%)	≥95%	(United Nations, 2016)
Stability	4.1 Self-sufficiency	≥95%	Inspired by (United Nations, 2016)
	4.2 Value of food import over total merchandise exports (%)	≤11%	(African Average in 2012)

chose the average value of food import over total merchandise exports for Africa in 2012 as a threshold (FAO, 2019).

We considered a country to be relatively food secure if it fulfills at least the average dietary energy supply adequacy threshold, one of the stability thresholds and a prevalence of undernourishment below 10%. Countries with negative affordability index, prevalence of undernourishment ≥30%, or insufficient average dietary energy supply were considered as severely food insecure. The rest of the countries were considered moderately food insecure.

As nutritional value is more based on intake than availability, and utilization is difficult to relate to LSLA, we prioritized the food security needs of countries based first on availability (sufficient calories), then accessibility, stability and lastly utilization. This also stems from the fact that most of the continent has issues with utilization. Indeed, for the 38 countries studied here, over 30% of the population did not have access to safe water in 26 countries and to improved sanitation facilities in 35 countries in 2000 (FAO, 2019). For stability, we further distinguished between countries that should actively pursue higher levels of self-sufficiency as opposed to relying on imports. According to Clapp (2017), these include poor countries with high food insecurity, net food importers with sufficient agricultural land, volatile export earners dependent on a small number of suppliers for their staple foods, and countries that are politically unstable or with a large population. We used results from Fader et al. (2013) to identify countries where self-sufficiency is limited by natural resource availability and used the UNCTAD dataset to determine if countries have sufficiently diversified export earnings (UNCTAD, 2019b).

2.3. Estimating the destination market of the production from land acquisitions

Based on the crops intended for production and the types of investors, we estimated the likelihood of the production to be sold on local, export or both markets; thus informing on the ability of deals to increase food availability (indicators 1.1 and 4.1), produce more diversified crops (indicator 1.2) or increase export revenues (indicator 4.2).

As the Land Matrix reports 81 different intended crops and 540 investors, we reclassified both crops and investors into fewer groups for analysis. We first classified intended crops into the main food groups: cereals (including wheat, maize, rice), roots and tubers (including cassava and potatoes), legumes and pulses (including beans, peas and lentils), vegetables and fruits (including onions, tomatoes and apples), oils and sugars, livestock and feed, and finally cash crops (including jatropha, coffee and rubber) (Table S1). Since most of the deals include more than one crop, we further simplified this classification by distinguishing between food and flex crops. Food crops are those cereals, legumes, tubers and vegetables that are used as food, while flex crops such as maize, soybeans, oils and sugars can also be used as feed or fuel (Borras et al., 2014). Deals only concerning cash crops, biofuels and/or trees were all grouped as cash crops and were considered as not food since they do not increase calorie intake and they are mostly produced for export (Table S1) (Borras & Franco, 2012; Cotula et al., 2009).

We then classified investor origin by first distinguishing between domestic and foreign (where at least one investor is not from the host country) investors (Fig. S2 a). We then used the information on investors provided by the Land Matrix and distinguished between private, stock-exchange listed, state-owned companies, investment funds, individual entrepreneurs, and Non-Profit Organizations (NPO) (Fig. S2b). We complemented this classification by our own internet searches for companies based on their main sector of activity: agriculture (39% of acquired land), finance (25%), government (6%) and others (including energy, construction and infrastructure and forestry companies, tourism and conservation institutions as well as NGOs) (Fig. S2c).

We used the information on intended markets (available from the Land Matrix in 65% of the deals) in combination with the types of crops and investors as a training dataset for the random tree classification algorithm of the Weka software (Hall et al., 2009). The algorithm calculates the probability of a deal's production to be intended for local, export or both markets based on any occurring crop/investor combination and extrapolates to those deals where the market destination is unknown (Table 2). For example, we find that 90% of the deals involving domestic, state-owned agribusinesses producing food crops supply local markets, so we consider any other deals with this combination for which the destination market is unknown to also supply local markets (Table 2).

Acknowledging the level of uncertainty related to this approach, resulting in a 75% market attribution accuracy, we reclassified the final market predictions based on three scenarios. The "most likely" scenario follows the algorithms' classification. The "local oriented" scenario adds deals classified as "export" with a probability lower than 1 to the deals contributing to the local food market. Finally, the "export oriented" scenario only considers deals classified as "local" with a probability of 1 to contribute to the local market. Furthermore, we treat deals aimed at flex crop production and classified as "local" differently based on each scenario. For the "most likely" scenario, we consider that only half the area covered by these flex crop deals contributes to local food markets under the "most likely" scenario, 75% for the "local oriented" and 25% for the "export oriented" one. Finally, as the main aim is to assess whether or not LSLA can contribute to food security rather than the actual extent of their contribution, we assume that all the contracted land is utilized, even though the area under production is generally lower than the acquired area (The Land Matrix Global Observatory, 2019).

2.4. Assessing the potential contribution of land deals in addressing the food security needs of African countries

We evaluated what contribution agricultural land acquisitions might have in addressing the priority food security needs of host countries based on the destination market of the production. We assumed that if the production is destined to local food markets, it could increase food availability (indicator 1.1) and the country's

Table 2
Visualization of the probabilistic assessment for market prediction based on the various crops and investors involved. Colors represent the most probable destination market. Numbers refer to the probability of deals to be destined for the market indicated by the color.

Domestic	Agri						Finance						Gov	Others				
	Indiv.	Fund	NPO	Private	State	Listed	Indiv.	Fund	NPO	Private	State	Listed		Indiv.	NPO	Private	State	Listed
Cash & flex			1	0.8	1											1		
Cash & staple				1														
Flex				1	0.7	1												
Food			1	0.6	0.9			1					0.9			1		
Livestock																		
Staple & flex	0.8	1		0.8	0.8	0.9		1					1			1	1	1

Foreign	Agri						Finance						Gov	Others				
	Indiv.	Fund	NPO	Private	State	Listed	Indiv.	Fund	NPO	Private	State	Listed		Indiv.	NPO	Private	State	Listed
Cash & flex				0.7	0.8	0.5	1	1		1			1			1		1
Cash & staple				0.7						1			1			0.6		
Flex				0.5	0.6	0.5				1		0.8		1		0.6	0.8	1
Food		0.6		0.7	0.8	0.5		0.9	1	0.8			1	1	0.5	0.8		
Livestock				0.6	1	1					1					1		
Staple & flex		0.9	0.8	0.6	1	0.8		0.7	1	0.8	0.6	0.8	0.8			0.6		

Markets Local Both Export

self-sufficiency (indicator 4.1). It could also improve the diet diversification in a country if it is intended to produce fruits and vegetables or livestock (indicator 1.2). On the other hand, if production is destined to export markets, we assumed that it would only directly contribute to increasing the import capacity of a country (indicator 4.2).

Unfortunately, at this level of aggregation and without field data, it is impossible to assess the direct impacts of LSLA on accessibility (through income) or utilization (through infrastructure building). We thus assumed that the land deals might not be needed to improve food security in countries that are relatively food secure. However, in the countries where accessibility is to be prioritized, we assumed that if food is affordable (indicator 2.2), then the issue might be related to a lack of physical access to food, in which case only deals contributing to local markets could improve accessibility by hopefully producing more food or creating markets in more remote areas. In the case that food is not affordable, then both market destinations could potentially contribute to accessibility either as a result of lower food prices from increased availability or attributed to higher incomes associated with exports. We are aware that these assumptions might not hold true in cases where exports displace local food production thus requiring higher imports that might be more expensive, or that higher incomes from exports are not necessarily accrued by the more vulnerable farmers (Manda, Tallontire, & Dougill, 2020), or even that local food produced from LSLA might be of higher value and thus less affordable to the poorest households. However, as we are unable to assess these impacts at such a large scale, we classified the contribution to food security in countries suffering from economic accessibility issues as unclear.

2.5. Assessing the extent of potential land disturbances in the areas where deals occur

Regardless of the potential benefits to food security at national level, LSLA have direct impacts on people and the environment in the locations where they occur. We thus evaluated the potential impacts of deals in terms of land pressures and deforestation based on the land cover in 2000, proximity to markets, and population density surrounding the deals' locations. Locations were defined as a 10Km buffer around the exact location provided by the Land Matrix for the 127 deals (26%) where the coordinates were available. For the remaining deals where the administrative region was provided, we set the 2nd level of administrative division as the buffer zone http://www.gadm.org, and finally we set the 11 deals with only the country as location to not available.

Following the approach used by Deininger (2011) and Messerli et al. (2014), land cover was classified as grassland, forest, cropland and sparsely vegetated. In 40% of the deals, previous land cover was provided by the Land Matrix, which we complemented with extracted land cover in 2000 from a satellite-based land cover product for the remaining locations (ESA, 2017). Proximity to the closest urban area with over 50,000 people was assumed to be accessible for a trip of 6 h or less, otherwise the location was deemed remote (Nelson, 2008). Finally, an area was considered as densely populated after exceeding 25 people/Km^2, else it was sparsely populated (CIESIN, 2016). These spatial datasets were then aggregated by buffer zones to characterize the majority land cover, average accessibility, and average population density of a deal's location.

We considered deals to cause minimal land pressure if they targeted remote, sparsely populated and sparsely vegetated or grasslands areas (blue in Table 3) (Cotula et al., 2009; Deininger, 2011; Messerli et al., 2014). However, if deals targeted densely populated or accessible grasslands areas or croplands, then they would likely displace smallholder farmers and pastoralists, increase pressures on land, and could even result in violent conflicts (Cotula et al., 2009; Deininger, 2011; Messerli et al., 2014). Finally, deals that targeted forested areas were classified separately as causing deforestation (Table 3). In cases where deals targeted multiple

Table 3
Potential levels of land pressure caused by deals depending on locations where they occur (land cover, distance to markets and population density).

Land cover	Marginal Land		Grassland		Cropland		Forest	
Distance to market	Remote	Accessible	Remote	Accessible	Remote	Accessible	Remote	Accessible
Sparse Pop.								
Dense Pop.								

Land pressure Low High Deforestation

locations, we assumed that the land area was divided equally between all locations.

3. Results

3.1. Food security needs of African countries in 2000

Food insecurity was widespread for most studied African countries in 2000. Apart from utilization, only 10 countries passed at least one threshold per food security dimension in 2000 and Ethiopia did not pass any (Fig. 1a, Fig. S3, Table S2).

In terms of availability, Morocco, Egypt, Cameroon, Gabon, and São Tomé and Principe (STP) reached the thresholds for both calorie sufficiency and nutrition in 2000 (Fig. 1a), while Rwanda was the only country with nutritious food but insufficient caloric availability. Ethiopia, Central African Republic (CAR), Angola, Zambia and Zimbabwe also had insufficient calories available to feed their populations (Fig. 1a). These six countries are thus considered severely food insecure and need to prioritize increasing food availability (Fig. 1b, Table S2).

For accessibility, Egypt and South Africa were the only countries with affordable food and prevalence of undernourishment below 5% in 2000 (Fig. 1a). In the other countries, the prevalence of undernourishment exceeded 5% but remained below the prevalence of poverty, suggesting that poor people were somewhat able to afford to pay for food if they have physical access to it. Amongst these countries however, the level of undernourishment is uneven: below 10% of the population in Morocco, Gabon and Nigeria but exceeds 30% in nine countries (CAR, Mozambique, Tanzania, Madagascar, Kenya, Congo, Cameroon, Liberia and Sierra Leone) considered severely insecure and in need to prioritize food accessibility (Fig. 1b).

Almost all African countries had utilization problems in 2000 (Fig. 1a). No country provided universal access to improved sanitation for its population, and only Egypt and Mauritius provided access to improved water to above 95% of their populations (Fig. S3).

Côte d'Ivoire (CIV), Ghana, Nigeria, Malawi and South Africa were the only countries to fulfill both stability thresholds, and Benin, Egypt, Ghana, Mali and Uganda were the only self-sufficient countries in 2000 (Fig. 1a). This means that the rest are dependent on food imports to fulfill the dietary energy supply threshold when they have limited import capacity (except for Angola, Congo, Gabon, Zambia and Zimbabwe) (Fig. 1a). As such, these countries need to prioritize self-sufficiency, not only to support spending their national budget on non-food needs, but also to avoid being vulnerable to international food price shocks (Clapp, 2017). The only exceptions are Guinea-Bissau, Mauritius, Morocco, Namibia and The Gambia that do not possess sufficient land and water resources to be self-sufficient and would have to improve their import capacity while also increasing production (Fader et al., 2013).

Finally, we find that while most indicator values changed over the past two decades, they only contributed to a change in food insecurity severity in 11 countries (seven improvements) and to a change in priority needs in 17 countries (Fig. S4). While the number of severely food insecure countries decreased, Ghana, Mali and South Africa are the only countries to be considered as relatively food secure in 2017; as Egypt lost its stability status and the proportion of undernourishment exceeded 10% of the population in Nigeria and Gabon (Fig. S4). Uganda is the only country to have become severely food insecure in 2017. Moreover, while accessibility is still a major issue to be prioritized in the continent, stability has become the most common priority need (Fig. S4).

3.2. Deals contribution to the food security needs of host countries

Overall, the land allocated for producing food crops (roots and tubers, fruits and vegetables and cereals) and livestock by LSLA represented 35% of the acquired area in the continent (Fig. S1b) with only 14% intended for either livestock, fruits, or vegetables (Fig. S1b) needed for a diversified and nutritious diet which is lacking in Africa overall (Willett et al., 2019). Instead, the acquisitions in the continent were mostly targeting flex crops (41% in Fig. S1b)

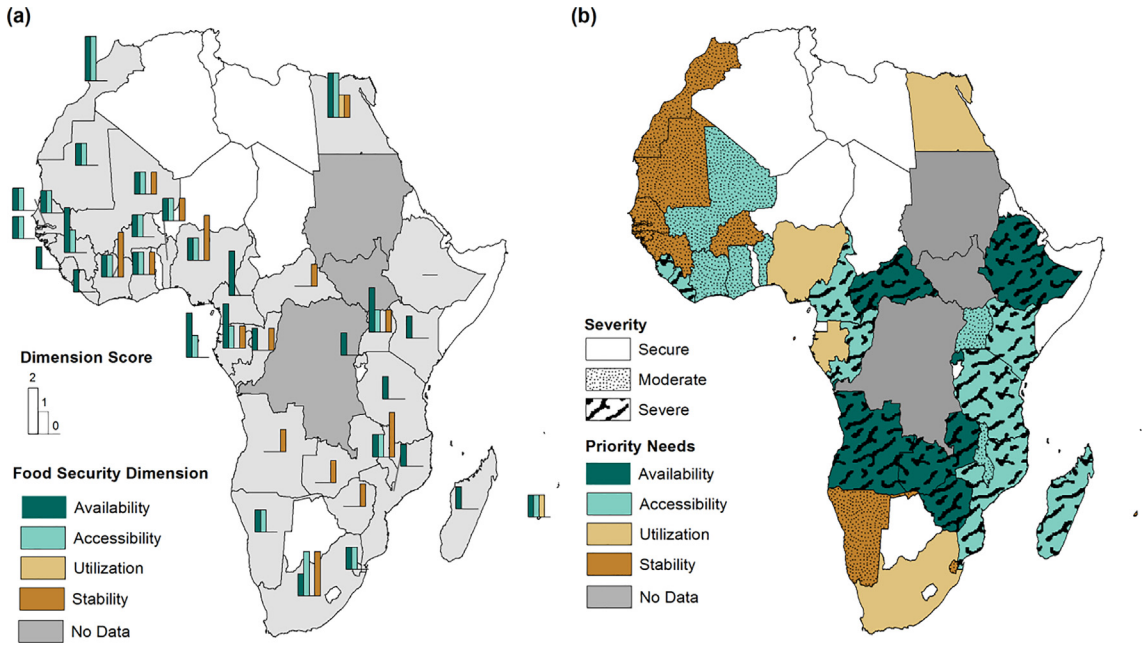

Fig. 1. (a) Food security scores based on number of indicators passing thresholds (see Table 1) for each food security dimension in 2000. (b) Identified priority food security needs per country (based on the dimension scores) and the severity of food insecurity (based on the sufficiency of available calories and the proportion of undernourished people).

that are most often used for the production of biofuel (Borras & Franco, 2012; Borras et al., 2014) and cash crops (22% in Fig. S1b), both mostly intended for export (Table 2).

We found that all the deals in Benin, The Gambia, Morocco, Rwanda, Guinea-Bissau and Swaziland were intended for export or non-food markets, while no country exclusively hosted deals targeting local food markets (Fig. 2a, Table S2). Instead, the targeted area by LSLA was mostly intended for non-food crops or export markets in 19 countries (including Cameroon, Angola and Ethiopia) and mostly for local food markets in six countries (including Mauritania, Mali and South Africa) (Fig. 2a, Table S2). In the remaining seven countries, deals were found to supply both markets almost equally (between 40% and 60%). These results reflect the most likely scenario and only differ for seven countries when considering the "export oriented" or "local oriented" scenarios (Fig. S5). Indeed, most of the acquired land in Burkina Faso was only destined for export under the "export oriented" scenario, and for local food markets only under the "local oriented" scenario in CIV, Kenya, Uganda and Zambia (Fig. S5).

As such, based on the most targeted markets, we found that land deals are only capable of addressing the priority food security needs of seven out of the 38 countries where they occur. These include countries with stability issues such as Morocco and Mauritius that could improve their import capacity by targeting export markets and those like Burkina Faso and Mauritania that could improve their self-sufficiency status through deals intended for local food markets (Fig. 2b, Table S2). LSLA are however found to be inappropriate in 14 countries including the severely undernourished ones with insufficient food availability such as Ethiopia and Angola (Fig. 2b, Table S2). Deals in these countries mostly targeting export markets not only oppose their needs, but risk aggravating an already dire situation. Finally, LSLA's contribution is less clear for the 14 countries that need to prioritize accessibility and utilization (Fig. 2b, Table S2).

3.3. Potential local impacts of the land deals

Land deals covering 83% of the acquired area were likely to compete with existing croplands or grassland used for grazing or forest, and/or put pressure on densely populated areas potentially leading to conflicts as they were located in densely populated, easily accessible agricultural or forested regions (Fig. 3, Table S2). Indeed, across the continent, existing croplands are the most targeted land cover (48%) followed by forests (31%) mostly for the production of flex crops, and marginal lands (14%) and grasslands (5%) for the production of food crops (Fig. S6). All land deals were likely to lead to high land pressures in the areas where they occurred in Mauritania, Côte d'Ivoire, Burkina Faso, Benin, Rwanda, Malawi, Swaziland and South Africa and to deforestation in Guinea-Bissau and São Tomé and Principe (Fig. 3a, Table S2). Only in Morocco and Namibia did all the deals potentially cause low land pressures and over half of the acquired land in Egypt and Sudan occurred in areas leading to low land pressures (Fig. 3a, Table S2). Unfortunately, due to lack of location data, it was not possible to assess the level of disturbance caused by deals in Mauritius, The Gambia and Senegal.

These results highlight the high potential of negative local impacts in six of the seven countries (except Morocco) where land acquisitions were found to potentially contribute to food security and they only seem to cause low conflicts in two (Egypt and Namibia) of the 14 countries with unclear impacts on food security (Fig. 3a, Table S2). Moreover, while the targeted areas remain relatively small (less than 1% of total national land area in most of the countries) at the scale of the countries that host them, they still have the potential to impact 5.3 million people in the continent, which corresponds to the entire population of Norway (Fig. 3b). Targeted areas were also home to over 5% of the rural population of South Africa, Mozambique, Ghana, Sierra Leone, Liberia and STP and more than half of that of the Congo in 2000. Even where deals would pose relatively low conflicts, such as in Morocco, Sudan and Egypt, the acquired land was large enough to potentially impact up to 70,000 people either through dispossession or reduction in available natural resources to use, if the entire planned LSLA area was operationalized for production (Fig. 3). As such, Namibia emerges as the only country where LSLA would negatively impact the least people (less than a 1000) and which contribution to food security is potentially positive (unclear) based on our results (Fig. 3).

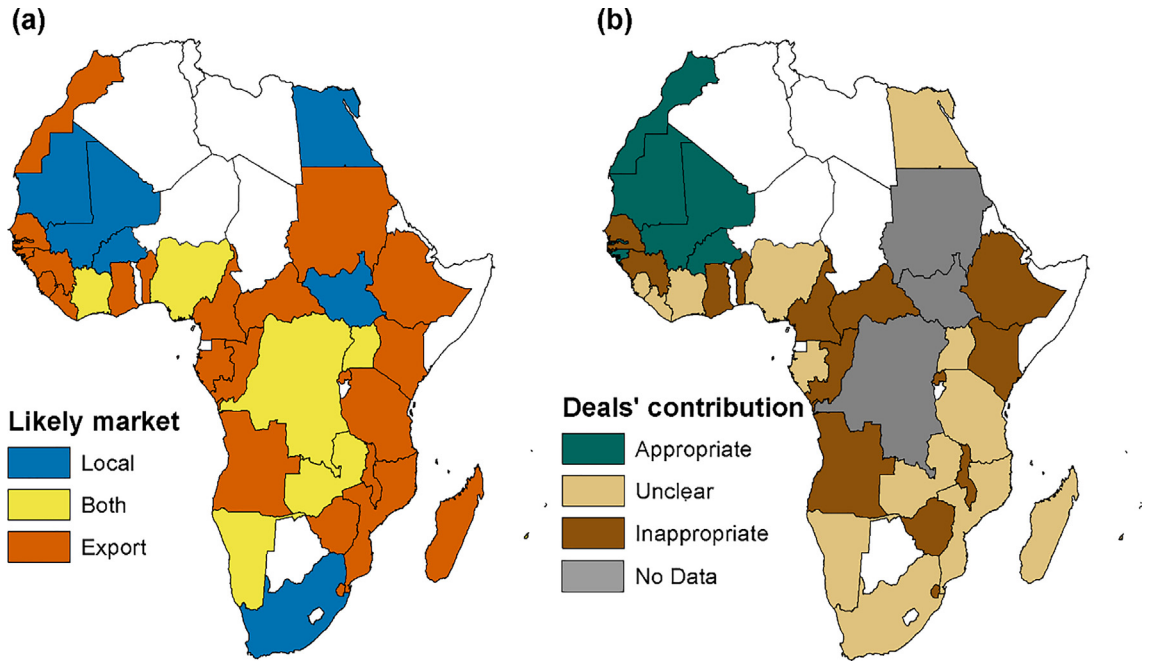

Fig. 2. (a) Market attribution of the majority of acquired area in each country (based on crops and investors involved under the most likely scenario –Table 2). (b) Ability of LSLA to contribute to the identified food security needs of countries (based on countries' needs – Fig. 1b – and the most likely markets targeted by deals – Fig. 2a).

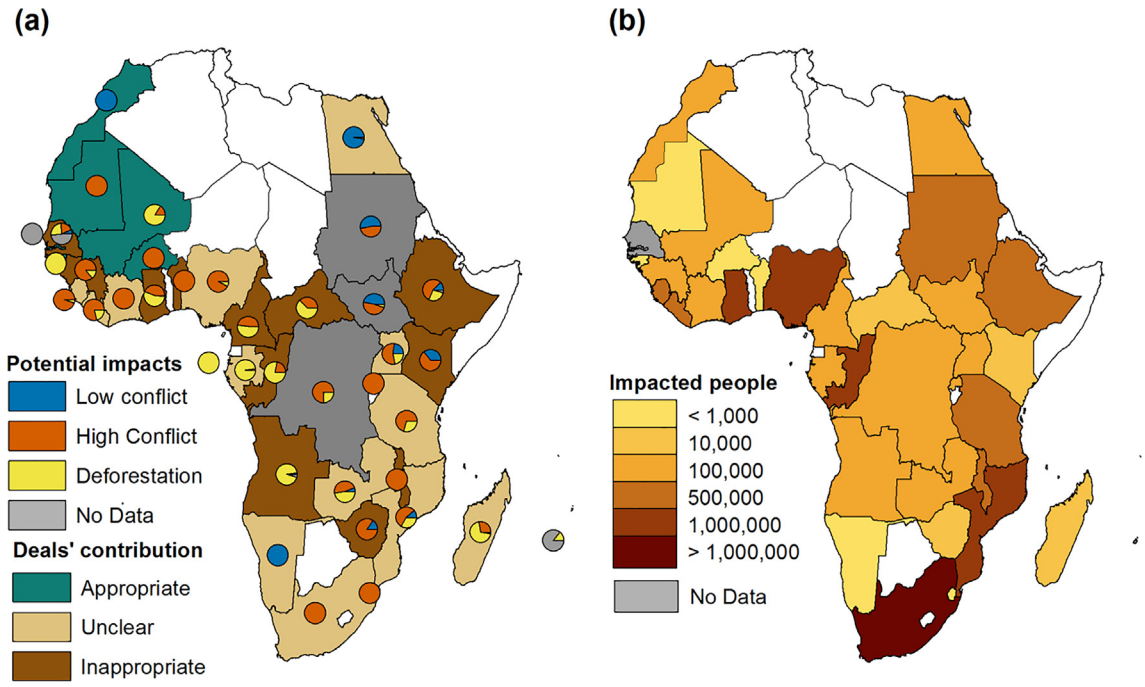

Fig. 3. (a) Potential levels of land pressures resulting from LSLA in the regions where they occur overlayed on top of the potential deals' contribution to food security (Fig. 2b). Pie charts represent the proportion of acquired land area affected by each level of pressure (Table 3). (b) Number of potentially impacted people by LSLA based on the acquired area and the population density (CIESIN, 2016) of the regions where deals occur.

4. Discussion

We find that in the year 2000, over 65% of the 38 African countries where land deals occurred were limited with respect to at least one food security dimension (discarding utilization) and could benefit from investments (Fig. 1). However, only nine of them received investments potentially fitting their food security needs (Fig. 2b). Moreover, in 34 countries, these deals occurred in densely populated, agricultural or forested regions (Fig. 3a). This means that they have a high likelihood of increasing pressures on land, potentially resulting in conflicts as well as deforestation. Therefore, current LSLA do not seem to address the food security needs of the African countries that host them in a sustainable manner.

In the following section, we further discuss these results by first engaging with debates regarding the identification of priority food security needs of countries. We bring to light the extent to which LSLA and food security needs mismatch in the continent. We then look into the ways LSLAs impact local populations, where nutrition security, infrastructure needs, social and political stability and environmental degradation are not considered as priorities in investment decisions. Finally, we explain how LSLA can be understood and analyzed as stemming from a neo-extractivist logic rather than one seeking to secure food.

4.1. The multi-dimensionality of food security

4.1.1. Centering accessibility and marginalized groups

Agricultural programs and investments for achieving food security have been mainly focused on increasing agricultural production, i.e. availability, and have largely ignored accessibility issues. As a matter of fact, Clapp and Murphy (2013) argue that policies directed towards hunger eradication by the G20 are still prioritizing the availability aspect of food security. Yet, it has been shown since the 1980s (Sen, 1981) that people's ability to access food is a major determinant in eradicating hunger, and that "having enough food to feed a population within a country's borders, or even globally, is no guarantee that everyone will be well fed" (Clapp, 2015, p. 2). Our results show that for 28 countries with sufficient food available, 22 present levels of undernourishment and 3 of severe undernourishment (Fig. 1).

In order to tackle hunger and malnutrition, it is important to focus hunger eradication efforts on the most vulnerable groups within society such as indigenous peoples, women, children, rural populations, and poorer populations (Fonjong & Gyapong, 2021; German & Parker, 2019; Von Grebmer et al., 2017). The 2017 Global Hunger Index (GHI) report (2017) argues that food insecurity is nowadays driven by unequal distribution of power and resources, rather than a lack of quantity of food produced. Such inequalities can materialize from within the smallest societal structure, for example through the correlation between gender inequality and malnutrition within poor households, to the impact that large transnational food companies have on food policies at various economic, political, and administrative levels (Fonjong & Gyapong, 2021). The level of inequalities within countries could explain the difference in prevalence of undernourishment between countries with similar poverty incidence. However, just like Clapp's (2015) critique, the GHI report (2017) also shows that current development initiatives still do not address the structural issues underlying food and hunger problems.

4.1.2. Self-sufficiency versus import capacity debates

Food trade has been increasingly encouraged and favored at the global scale either due to the vulnerability of production to climatic shocks, or in the continuation of the liberalization policies of the 1980s (Clapp, 2015, 2017; Pirkle, Poliquin, Sia, Kouakou, & Sagna, 2014; World Bank, 2007). As such, the notion of comparative advantage has pushed many African economies to rely on the export of a few commodities, mostly fuel, minerals, and selected cash crops such as cotton, coffee, and cacao (Clapp, 2017; Pirkle et al., 2014). This resulted in a neglect of the agricultural sector by African governments and has turned many

previously self-sufficient countries into net food importers between 1960 and 2000 (Clapp, 2017).

Such import dependence for food security has been problematized after the 2008 food crisis when food prices skyrocketed (UNCTAD, 2019a). Indeed the combination of the food and financial crises have shed light on the fragility of trade systems and the dangers of an over-financialization of agriculture (Anseeuw, Roda, & Ducastel, 2017; Clapp & Helleiner, 2010; De Schutter, 2011a; Genoud, 2018). This has brought the issue of self-sufficiency and food sovereignty back in international policy debates (Clapp, 2017). Food sovereignty is centered on improving self-sufficiency especially for smallholder farmers, following agro-ecological farming practices, and respecting food and land rights (Burnett & Murphy, 2014; Clapp, 2015). However, while trade cannot be considered an exclusive or sustainable way of securing food, it can't be ignored either as most people, including farmers, rely on markets for their livelihoods (Clapp, 2015), and international food trade currently meets the nutritional needs of hundreds of millions of people globally (Wood, Smith, Fanzo, Remans, & Defries, 2018).

4.2. The capacity of land deals to address the identified food security needs

Our results highlight the mismatch between countries' needs and land deals' intentions in 14 of the studied countries (Fig. 2b). This is particularly concerning for countries like Ethiopia, Congo and CAR that face alarming levels of undernourishment, due in part to their limited food supplies, and receive deals mostly intended for export markets or for producing oils and sugars that could be used for feed, biofuel and electricity production rather than for food (Anseeuw et al., 2012; Borras et al., 2014; Zoomers, 2010). Even in countries where LSLA are mostly supplying local food markets, it is unclear if and how this production would reach the people who are undernourished due to physical, economic or social inaccessibility. Moreover, deals where the production is intended for export in countries requiring an improvement in their self-sufficiency such as Eswatini and Senegal, face the risk of perpetuating a dependence on volatile commodities which may perpetuate negative food security consequences in the long term (Burchardt & Dietz, 2014; Clapp, 2017; UNCTAD, 2019a).

Our results are however less clear for the countries that we identified should prioritize investments in accessibility or utilization. In terms of utilization, Nolte et al. (2016) explain that it is not uncommon that some investors make the deliberate choice of investing in community infrastructure such as health, education, irrigation, or road infrastructure. However, such investments are up to the discretion of the investor, and might often primarily benefit the investment company itself rather than the local community (Nolte et al., 2016). More so, LSLA often target locations with fertile agricultural land with easy water access for irrigation and as such are not intended to promote rural development (Glover & Jones, 2019; Lay & Nolte, 2018; McMichael, 2012). Our findings also support this idea, as we find that 48% of the acquired land targets previous croplands and 56% is located in accessible regions (Fig. S5).

In theory, accessibility could be improved by LSLA if they increase income through job creation. Behrman et al. (2012) argue that if LSLA are executed in a socially responsible and inclusive way, they could have a transformative potential on the localities they settle into through job creation, income generation and the introduction of new services and technologies. Previous studies found evidence of positive spillover effects of LSLA on income and technology transfer within the communities where deals occur as well as their closest neighbors (Deininger & Xia, 2016; Glover & Jones, 2019; Van den Broeck, Van Hoyweghen, & Maertens, 2018). For example, as a result of increased incomes from biofuel sales, the productivity has been improved in small-scale farms in Ethiopia (Negash & Swinnen, 2013). In Mozambique, the extent of effects varies based on the types of contracts and crops planted as out-grower schemes focused on high value crops seem to have more positive effects than those aimed at producing bulk commodities in terms of employment opportunities and market access (Deininger & Xia, 2016; Glover & Jones, 2019). Moreover, the horticultural export market in Senegal has been associated with both an increase in the import capacity of the country, ensuring sufficient food availability, but also contributed to higher income for women, resulting in higher nutritional value of consumed foods in their households (Van den Broeck et al., 2018). In Western Mount Kenya, Zaehringer et al. (2018) show that the expectation of income opportunities through employment was the main positive spillover of LSLA mentioned by the local population.

However, while continental scale assessment is difficult, there are a number of concerns as to the capacity of LSLA to effectively create higher income and sustainable jobs. A discrepancy appears between the potentiality and expectation of LSLA to create jobs – both from investors and local populations – and their actual capacity to do so in reality. Gyapong (2020), for instance, explains that even though the existence of LSLA is not questioned or resisted within some communities in Ghana, there is still a general frustration from local populations because their expectations – based on verbal promises made prior to the investments – in terms of employment quantity and quality have not been met. In the study previously mentioned conducted in Kenya, Zaehringer et al. (2018) show that despite these assumptions, only one-third of the respondent households have or had a member employed by LSLA, and the employment they provide mostly generates additional income to mitigate crop failures for example, insofar as it is seasonal and unstable.

Furthemore, several studies have shown that LSLA have a negative impact on employment quantity and quality (seasonal and low paid), and on socio-economic equality (Bottazzi, Crespo, Omar, & Rist, 2018; German & Parker, 2019; Lanz, Gerber, & Haller, 2018; Li, 2011; Oberlack et al., 2016; Shete & Rutten, 2015; Zoomers, 2010). For instance, Li (2011) unveiled a discrepancy between the World Bank's reports in terms of employment and field data. Against a claimed 1.7–3 million jobs created on 6 million hectares in palm oil production, in reality only 0.6–1.5 million workers were employed (Li, 2011). Moreover, even in cases where employment is created, providing relatively high income (Herrmann, 2017), it might only be attributed to the initial phases of LSLA projects (Li, 2011; McMichael, 2012; Nolte et al., 2016; Oberlack et al., 2016). LSLA-based employment can also negatively impact food security, as jobs are diverted from small and mid-sized farms, which oftentimes results in lower yields on private farms (Bottazzi et al., 2018). LSLA employment also tends to increase income inequalities between genders, age groups, classes and races or ethnicities as various forms of discrimination are often associated with LSLA employment terms (Behrman et al., 2012; Borras & Franco, 2012; Bottazzi et al., 2018; German & Parker, 2019; Lanz et al., 2018; Yengoh & Armah, 2015).

All the above arguments question the capacity of LSLA to adequately and securely address countries' food security needs, from cash crops and export-led investments in countries with availability needs, to the optional investments in infrastructure in countries with utilization needs. The capacity of LSLA to address countries' accessibility needs is a difficult one to assess. Assuming that accessibility is in big parts addressed by income generation through job creation, there is evidence that the expectation of increased employment is one of the most important positive spillover effects of LSLA. Nevertheless, localized studies by country show discrepancies between promised employment opportunities and actually generated income, especially for marginalized groups and communities. Benefits from LSLA are not consistent across deals and are generally limited to specific communities (Deininger &

Xia, 2016). Thus, they cannot remedy the long-term effects of under-investments in rural and farming communities, and run the risk of increasing already existing inequalities within and across communities as we argue in the next sub-section.

4.3. Local implications of LSLA

Beyond direct indicators of food security used in this study, LSLA have other impacts on populations' livelihoods that affect the extent to which they are food secure. Oberlack et al (2016) have identified archetypes of livelihood vulnerability describing the processes by which LSLAs are established and their respective implications on livelihoods in the regions in which they occur. The most common archetypes they identified are asset enclosure, elite capture, selective marginalization, and polarization of development discourses (Oberlack et al., 2016). They found that enclosures are more prevalent in transnational investments and have the most negative outcomes on local populations, while elite capture targets very large deals and results in negative impacts for disadvantaged populations. Finally discourse polarization is often associated with domestic or mixed investments targeting flex crops and result in increased conflicts (Oberlack et al., 2016). Our results show that transnational investments represent 62% of the acquired land in the continent and domestic or mixed investments on flex crops account for 19% of acquired land (Fig. S1, Fig. S2). Following this logic, negative impacts with high probability of conflicts are likely to occur in 81% of acquired land, which is close to the 90% we found based on the results of Fig. 3a.

These four archetypes of livelihood vulnerability have resulted in various forms of dispossession of land owners or users from access to natural resources, with the main differences being whether the dispossession is generalized or targeted against groups of people (Lanz et al., 2018; McMichael, 2012; Oberlack et al., 2016). For example, Fonjong and Gyapong (2021) found that women, pastoralist and indigenous people were most often displaced due to LSLA, leading to further food insecurity and marginalization of these already vulnerable groups. The resulting displacement of people has led to higher population densities in more remote and/or less fertile areas, thus pushing people further into poverty and hunger (Bottazzi et al., 2018; Nolte et al., 2016; Oberlack et al., 2016). Our results show that this could apply to up to 5.3 million people across Africa (Fig. 3).

Similarly, the loss of grasslands, which represents 5% of acquired land in our study (Fig. S5), has had major implications on the livelihoods of both smallholders and herders in Ghana and Ethiopia (Lanz et al., 2018; Shete & Rutten, 2015). As the area for grazing shrank, they lost cattle – used for ploughing and/or for dairy production – and substituted them with smaller ruminants (Shete & Rutten, 2015). Shrinking resources have also led to conflicts between old and new comers as well as with pastoralists (Akov, 2017; Oberlack et al., 2016). Deforestation is also likely to occur as a result of agricultural land deals' clearing of large tracts of forests on 2.7 MHa, representing 31% of acquired land in the continent (Fig. S5). This is particularly relevant for flex crops that replaced 58% of cleared forested land (Fig. S6). These results are consistent with the findings of Davis et al. (2020) associating LSLA with high deforestation rates in tropical areas and particularly for areas under palm oil, wood fiber and tree plantations. Such significant forest loss then leads to loss of biomass, erosion and increased greenhouse gas emissions (Chen, Kennedy, & Xu, 2019; Conigliani et al., 2018; Fairhead et al., 2015; Oberlack et al., 2016; Zaehringer et al., 2018).

4.4. Alternative framing for LSLA beyond food security

We have shown that LSLAs are not addressing the food security needs of the countries in which they occur. Rather, the push for LSLA seems to echo the focus on increased production and export in development discourses (Clapp & Murphy, 2013; Oberlack et al., 2016). The frequent shortcomings of increased production alone to achieve food security raise questions about the underlying political economic logics behind LSLAs. Part of the explanation was shown by previous studies to be found in the neoliberal logic of financializing food markets, commodifying land, and increasing commodity dependence of host economies, all for financial gain from transnational companies or domestic elites at the expense of local populations (Akram-Lodhi, 2015; Anseeuw et al., 2017; Burch & Lawrence, 2009; Clapp & Helleiner, 2010; Cotula et al., 2009; De Schutter, 2011a; McMichael, 2012). This is especially apparent when considering that 25% of the land acquired in the continent was by financial institutions (Fig. S2) that could be speculating on land, food and fuel markets without producing any crops (Anseeuw et al., 2017; Borras et al., 2014; Hertel, 2017; Sorda et al., 2010). Therefore, a rhetoric that justifies LSLA as a way to meet food security concerns is not well supported by evidence (Lay & Nolte, 2018; Oberlack et al., 2016).

Furthermore, domestic State actors are responsible for facilitating LSLAs by fostering an environment prone to these types of investments (Bottazzi et al., 2018; Lanz et al., 2018; Oberlack et al., 2016) even if they are only directly involved in 10% of the acquired land (Fig. S2). Thus, we further postulate that LSLAs could be conceptualized as neo-extractivist. Neo-extractivism is a concept that refers to neoliberal policies that give the State an important role in regulating the use, appropriation and distribution of natural resources (Burchardt & Dietz, 2014). This paradigm is argued to be beneficial in the sense that nation-States can generate revenue through the intensification of the exploitation of natural resources and raw materials, and market liberalization of export-led economies (Burchardt & Dietz, 2014). According to the neo-extractivist understanding, this surplus would be reinvested by the State in development and the expansion of social structures (Burchardt & Dietz, 2014). As such, in theory, the State is a crucial player ensuring sovereignty, food security, development, and social and political stability, thus securing the livelihood of the population and the sovereignty of the country (Deonandan & Dougherty, 2016).

In practice, however, the economic and socio-ecological benefits and drawbacks of natural resource extraction are unequally distributed (Burchardt & Dietz, 2014; Nolte & Ostermeier, 2017). More so, neo-extractivism has also been associated with rent-seeking activities (rents, quotas, or licenses) only benefiting elites (Acosta, 2013; Baland & Francois, 2000; Bhattacharyya & Hodler, 2010; Lanz et al., 2018; Ogwang & Vanclay, 2019), thus reproducing the existing unequal power dynamics at a national and global level (Holden & Otsuka, 2014). Such inequalities can potentially lead to corruption and hinder economic growth (Baland & Francois, 2000; Bhattacharyya & Hodler, 2010) rather than fostering agricultural or rural development programs (FAO, 2015; Pirkle et al., 2014). Further in-depth and widely distributed field-based research would be needed to explicitly determine the extent to which LSLAs serve national elites and corporate wealth accumulation as opposed to local populations. Such study should engage with the full network of actors involved and impacted by LSLAs to assess the different ways in which they benefit from them.

5. Uncertainties and limitations

We acknowledge that our results are dependent on the food security indicators and thresholds chosen. The choice of indicators was limited by data availability and attempted to follow FAO's guidelines for food security measurements. However rigid thresholds could lead to overestimations or underestimations of the food

security status of various countries. For example, a threshold of 95% for caloric availability means that Central African Republic (91%) is considered as having limited food availability while Mozambique (95%) is considered as having sufficient food available. Similarly, the constructed affordability index might be overestimated as it does not account for price fluctuations or different periods during which farmers have access to their own produced food. Yet, even with such a generous measure, a large proportion of countries remain limited in terms of accessibility (14 countries in the year 2000).

The safety and nutritional value of the food consumed are also difficult to estimate due to the complexity of the data that needs to be gathered, such as nutrient intake based on physical and health attributes of individuals, food safety throughout the value chain, and water quality and safety (WHO, 2003). Therefore, even though it is not holistic, this study relied on FAO's utilization indicators that only focus on access to safe water sources and sanitation facilities (FAO IFAD & WFP, 2013; United Nations, 2016). Moreover, in relation to nutrition, the recent LANCET report offers guidelines for healthy ranges of different food groups, including the lower boundary of 300 g/day/capita for fruits and vegetables, as opposed to the 400 g that we have used (Willett et al., 2019). Following this less stringent guideline would mean that more countries could be considered able to provide a healthy diet to their population such as Ghana, Côte d'Ivoire, Nigeria and Mauritius.

The methods used in order to estimate the potential of deals to contribute to food security are all data driven and as such are limited by data availability and reliability. Moreover, there might be issues relating to the lack of information on the amount of land allocated to each crop group in multi-crop deals, which cover 55% of the studied acquired land in the continent which could change our results. Yet, since in single crop deals a larger proportion of land is used for high value cash and flex crops than for food crops, we would assume that it is more likely for investors to allocate more land to these crops. Further research based on more detailed data would be required to test this hypothesis.

Finally, we have attempted to assess the potential local impacts of LSLA based on characteristics of the regions where they occur. Due to the lack of exact coordinates available for all deals, this was done using averages and majority filters within a 10Km buffer and at district level. These results are also dependent on the accuracy of the ready-made products used (population density, land cover and accessibility).

6. Conclusion

We have developed a framework to identify the priority food security needs of 38 African countries that could be used to guide food security related investments in each studied country, as well as others. We have analyzed the types of Large-Scale Land Acquisition deals for the studied African countries and found that the countries' food security needs rarely matched the types of LSLA in place. Moreover, we also find that LSLA generally lead to negative local impacts even in the countries where they do not oppose food security needs. By targeting previous croplands and densely populated agricultural areas, mostly for the production of flex crops, while food crops are allocated to more marginal lands, LSLA oftentimes risk population displacement, loss of livelihood and increase the potential of land related conflicts, further aggravating food insecurity. We also found that LSLAs can lead to deforestation, potentially contributing to land degradation and carbon emissions in large areas across the continent. While our analysis does not allow for a large scale assessment of potential positive impacts from LSLAs in terms of job creation and increased income, previous studies have highlighted that when such opportunities are created – and not only expected or presumed – the number of people accessing them is relatively small. Moreover, these benefits often take the form of very tedious seasonal job or target few skilled workers. But oftentimes, such benefits hardly make up for the negative impacts in terms of health and environment. Therefore, in practice, we show that LSLAs often fail to serve a food security agenda, and hypothesize that they may instead serve economic and financial gains for investors and national elites at the expense of poor and marginalized groups.

This study thus suggests that current LSLAs are not appropriate to serve food security in the continent. Instead, they follow a neo-extractivist logic prioritizing financial gain over socio-ecological benefits. In this study our findings conclude that food security needs have not been properly addressed. Therefore, in order to better serve this purpose, agricultural investments should be tailored to the priorities of each country, and developed together with current farming communities to ensure they are implemented in a responsible, sustainable, pro-poor, gender-sensitive manner and inclusive of marginalized communities so as to support the socio-ecological systems in which they occur. Furthermore, large deals targeting forest lands, as well as those displacing large agricultural communities should be avoided, particularly when they are meant for export markets in countries with already high prevalence of undernourishment.

Insuring food security should not arbitrarily equate increasing unsustainable LSLA, but rather needs to explicitly address the multidimensionality of food security and the systemic failures to achieving it in any given context.

CRediT authorship contribution statement

Altaaf Mechiche-Alami: Conceptualization, Methodology, Software; Analysis, Investigation, Visualization, Writing - original draft. **Jihad Yagoubi:** Conceptualization, Methodology, Investigation, Writing - original draft. **Kimberly A. Nicholas:** Conceptualization, Methodology, Writing - review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

We are grateful to LUCID, a Linnaeus Centre of Excellence at Lund University funded by the Swedish Research Council Formas (Grant 259-2008-1718) for supporting this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.worlddev.2020.105384.

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