International Land Acquisitions in the Global South:

Patterns, Drivers, and Impacts

Inaugural dissertation
of the Faculty of Science
University of Bern

presented by

Johannes Marcus Giger

from Sevelen SG

Supervisor of the doctoral thesis:
Professor Dr. Peter Messerli

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Prof. Dr. Marco Herwegh

Summary

The main goal of this dissertation is to analyse the process and impacts of international land acquisitions taking place in the global South since 2012. Through data collection at different levels and with different methods, the present dissertation bridges the gap between case studies of individual projects and analysis of global data. The research results contribute to land system science by providing a better understanding of important contemporary telecoupling processes that link socio-ecological systems in the global North and the South.

The core research first consisted in participation in a coordinated effort by a research consortium to develop a dataset on large scale land acquisitions (LSLAs), or “land deals”. Building on this data set, the analysis then aimed to assess the extent and dynamics of these acquisitions at the global level, as well as the actors and countries of origin behind them.

To provide more insights into LSLA processes, the present research analysed business models of commercial farms in Kenya and the drivers that influence these business models. Finally, based on interdisciplinary work in Kenya, Mozambique, and Madagascar, the diverse different socio-economic, food security, and environmental impacts, and the reasons why these may differ between different countries were analysed.

The results show that from 2008 to 2020 approximately 30 million hectares of agricultural land was acquired by investors legally registered in the West, the Gulf states, and a range of emerging economic powers, in particular China. The data highlight the persistent opaqueness of the origin of the true “beneficial owner” in many cases, as investor networks often use tax havens and offshore destinations to conceal the ultimate beneficiaries of the investments. In addition, the research points to a glaring lack of transparency regarding some of the most important information on LSLAs themselves, including contract terms, tax arrangements, social and environmental assessments, monitoring, exact locations, and implementation progress.

The cluster analysis of business models further highlights the importance of the production and technical models in differentiating outcomes rather than the types of actors or financial structures involved per se. The main drivers influencing these business models include market demands as well as government policies that ensure relatively secure land rights and simultaneously limit the land that can be acquired. The importance of a cluster effect related to enabling access to human resources and access to inputs was equally evident when comparing the case of Kenya to Mozambique and Madagascar.

The results on impacts point to limited overall benefits of LSLAs in terms of employment and income for local populations, yet considerable risks for local livelihoods and the environment, including threats to biodiversity, forest, and water resources. At the global level, we found that 87% of domestic and international agricultural land acquisitions are occurring in regions of medium-to-high terrestrial bio-diversity. Additionally, 54% of deals recorded in the Land Matrix database were geared towards production of water-intensive crops, including cotton, oil palm, rubber, and sugarcane. Importantly, 34% of these deals take place in dryland zones, where the intensive production increases pressure on scarce water resources. Comparative analysis in Kenya, Mozambique, and Madagascar showed that the local context, government policies, and production models give rise to four distinctive impact patterns, ranging from widespread adverse impacts to moderate impacts.

Acknowledgements

This dissertation is based on research carried out at the Centre for Development and Environment (CDE), University of Bern. It is based on research conducted in the framework of two projects, the “African Food, Agriculture, Land and Natural Resource Dynamics, in the context of global agro-food-energy system changes” (Afgroland) Project and the Land Matrix Initiative (LMI). The Afgroland Project was funded by Agence Nationale de la Recherche (ANR), France, the Swiss National Science Foundation (SNSF), and the National Research Foundation (NRF), South Africa. The Land Matrix Initiative is funded by the Swiss Agency for Development and Cooperation (SDC), the German Federal Ministry of Economic Cooperation and Development, and the European Commission.

Further, the present dissertation has also benefitted from many additional collaborations and discussions with other research teams at CDE, other units at the University of Bern, and other partners.

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Finally, I would like to thank my wife Beatrice, who has supported me throughout this time and has made it possible in many ways to keep focussed on the topic of this dissertation.

Contents

Part I: Background and Overview

1. Introduction

During the financial crisis of 2007/2008, prices of agricultural commodities skyrocketed to an unprecedented peak, leading to food crises, protests, and riots in many countries (McMichael, 2009). Prices for fuel similarly increased dramatically, exacerbating the economic shock for poorer segments of the world population (Von Braun, 2008). This shock (Ghosh, 2011), also dubbed the "Triple F" (food, fuel, and finance) crisis (Samuels et al., 2011) – in combination with a global population growth, changing consumption patterns such as increasing demand for meat and biofuels (Jarosz, 2009), increasing financialization of the agricultural sector (Ducastel and Anseeuw, 2017) – led to an explosion of demand for land in countries of the global South. Reports of huge land purchases and leases appeared in the global news, sparking interest both from the public at large and from policymakers (Margulis et al., 2013). Land suddenly appeared to be an attractive investment opportunity for investors. Fearing future food shortages, governments sought reliable sources of food imports. In one case, a South Korean company tried to lease one million hectares of land in Madagascar, leading to widespread protests and finally contributing to the fall of a government (Burnod et al., 2013). This and other cases have been cited in connection with the term of "land grabbing", which has been widely used in academic and media articles (Anseeuw et al., 2012) to refer to illegal and unjust processes of alienating land users from their land. Various detailed case studies were published illustrating how the benefits of land acquisitions are often captured by local elites and outside investors, and do not meaningfully profit the local community (German et al., 2013; Oberlack et al., 2016). Meanwhile, reports by international donors suggested that several countries in the global South had large reserves of potentially productive land that was underutilized by the local population (Deininger and Byerlee, 2011). These contrasting views evident from policy reports and scientific literature led to my own engagement with the topic of LSLAs.

The **main goal** of the present dissertation is to analyse the wave, ebb and flow of international land acquisitions in the global South so as to gain a better understanding of where and how they are happening and what impacts they entail.

Through data collection at different levels and with different methods, this dissertation bridges the gap between case studies of individual projects and analysis of global data on land deals. The corresponding research was conducted within two distinct, but thematically closely related research initiatives:

First, together with other partners, I took a leading role in the Land Matrix Initiative (LMI), beginning at its inception in 2012. The LMI has grown into a strong international consortium of research organizations, partnered with a coalition of development organizations and NGOs. The LMI collects data on LSLAs, and over the years it has become the most widely used open database on LSLAs. Based on this resource, I have co-authored multiple analytical reports examining its data. All have been widely reviewed and cited in the research community. The latest of these, published as book, forms a portion of the present dissertation. Another paper and another book chapter use this global data to contribute to current scientific debates by shedding light on LSLA-driven processes of land use change and related societal impacts.

Second, in addition to looking at the global patterns of implementation of LSLAs, I assumed a leading role in acquiring and developing the project "*African Food, Agriculture, Land and Natural Resource Dynamics, in the Context of Global Agro-Food-Energy System Changes*" (Afgroland). The project focussed on comparing the drivers and the impacts of LSLAs at the local and national levels in Kenya, Mozambique, and Madagascar. It provided me with the opportunity to conduct in-depth research in Kenya and to contribute to comparative research across three countries. I co-led the development of a synthesis of results from the various thematic work packages to explain the varied socio-economic, food security, and environmental impacts of LSLAs.

2. Overview of Research Publications

The present dissertation consists of four individual peer-reviewed papers (three published, one accepted), one book, one book contribution, and one commentary in a scientific journal. I am the first author of four of these publications.

Publication I uses data from the Land Matrix Initiative (LMI) to analyse global and regional patterns of LSLA extent, acquisition dynamics, implementation, and the origins of investments from different angles. It also provides an analysis of impacts of LSLAs based on the data in the global database, including a comparison to other contemporary research. I co-authored the book and took the lead in the chapter on environmental impacts.

Publication II investigates the business models of commercial agricultural investments and the drivers that influence these business models. Taking a close look at the Nanyuki area in Kenya, the paper investigates a region marked by the high presence of large-scale commercial farms that produce goods for national and international markets.

Publication III, based on global data, relates LSLAs to renewed interest in the emergence of zoonotic diseases, highlighting the finding that LSLAs often target biodiversity-rich areas and contribute to advancing agricultural frontiers. Publication IV, a book chapter, analyses the impacts of LSLAs on common-pool resources, providing a frame for the presentation of case studies in the other chapters of that book.

Publications V, VI, and VII focus on LSLA impacts in Eastern Africa, a hotspot of land deals, and compare patterns of impacts in three countries. Publication V, a comparative study, contributes to a growing body of research evidence enabling a nuanced picture of LSLA impacts. Publication VI deepens this comparative analysis concerning impacts on smallholders and land use, based on data on farmer perceptions and analysis of remote sensing data. Publication VII analyses the status and evolution of livelihood profiles of smallholders in the presence of commercial farms in the case study area in Kenya.

Table 1. Overview of publications building the core of the dissertation.

No.	Title	Authors	Publisher/Peer-reviewed journal	Current state
Global patterns and dynamics of Large Scale Land Acquisitions				
I	Taking stock of the global land rush: Few development benefits, many human and environmental risks. Analytical Report III.	Jann Lay, Ward Anseeuw, Sandra Eckert, Insa Flachsbarth, Christoph Kubitza, Kerstin Nolte, & Markus Giger	Book publication: CDE/CIRAD/GIGA/University of Pretoria ISBN (print): 978-3-03917-028-9	Published (2021)
Drivers of investments and business models: Case study Kenya				
II	Large agricultural investments in Kenya's Nanyuki Area: Inventory and analysis of business models.	Markus Giger, Emily Mutea, Boniface Kiteme, Sandra Eckert, Ward Anseeuw, & Julie G Zaehringer	Peer-reviewed paper: *Land use policy*, 99, 104833	Published (2020)
Impacts of Large Scale Land Acquisitions				
III	Large-scale land acquisitions, agricultural trade, and zoonotic diseases: overlooked links. One Earth May, 2021	Markus Giger, Sandra Eckert, & Jann Lay	Commentary: *One Earth*. Volume 4, Issue 5, 21 May 2021, Pages 605-608 https://doi.org/10.1016/j.oneear.2021.04.020	Published (2021)
IV	Impacts of large-scale land acquisitions on common-pool resources.	Markus Giger, Kerstin Nolte, Ward Anseeuw, Thomas Breu, Wytske Chamberlain *et al.*	Book Chapter: In: The Commons in a Glocal World: Global Connections and Local Responses (2019): 257. edited by Tobias Haller, Thomas Breu, Tine De Moor, Christian Rohr, Heinzpeter Znoj. Routledge.	Published (2019)
V	Why do large-scale agricultural investments induce different socio-economic, food security, and environmental impacts? Evidence from Kenya, Madagascar, and Mozambique	Christoph Oberlack, Markus Giger, Ward Anseeuw, Camilla Adelle, Magalie Bourblanc *et al.*	Peer-reviewed paper: *Ecology and Society* 26, no. 4 (2021): 18	Published (2021)
VI	Large-scale agricultural investments in Eastern Africa: consequences for small-scale farmers and the environment	Julie Gwendolin Zaehringer, Peter Messerli, Markus Giger, Boniface Kiteme, Ali Atumane *et al.*	Peer-reviewed paper: *Ecosystems and people*, *17*(1), 342-357.	Published (2021)
VII	Smallholders' livelihoods in the presence of commercial farms in Central Kenya.	Markus Giger, Aurélien Reys, Emily Mutea, Ward Anseeuw, & Boniface Kiteme	Peer-reviewed paper: Journal of Rural Studies	Accepted (2022)

3. Conceptual Background

Telecoupling and LSLAs

Globalization has vastly increased and intensified social and economic connections between countries worldwide in recent decades (Yu et al., 2013). The emergence of global value chains has shaped land use and food regimes in many countries of the global South (Zoomers, 2010). Policies stimulating international trade and aiming at securing food security – driven by countries of North America, Europe, the Middle East, and East Asia – appear to have significant impacts on land use changes in the global South (Hess et al., 2016; Liberti, 2013; Meyfroidt et al., 2013). Climate policies by the EU have contributed to major demand for biofuels and the land needed to produce these fuels (Banse et al., 2011; Jumbe et al., 2009; Muscat et al., 2020). At the same time, development actors such as the World Bank and FAO have suggested a need for additional investment in the agriculture sector of the global South, based on a perception of large available reserves of "unused land" and the imperative of stimulating production to combat food insecurity and poverty in those countries (Deininger and Byerlee, 2011).

This interconnectedness of the global economic system, its rapid evolution, and the need to analyse the impact of policies that influence distant systems, have also attracted the interest of land systems scientists. Flows and processes in the socio-economic (trade, finance, access to resources) and environmental (biodiversity destruction, greenhouse gas emissions, nutrients) spheres tie together socio-environmental systems in distant places. Analyses have increasingly showed that the speed and extent of changes in land use systems – induced by distal drivers – is unprecedented (Liu et al., 2007). To study the effects of globalization on land use systems in the global South, the analytical concept of telecoupling has been developed (Friis et al., 2016; Kapsar et al., 2019; Yu et al., 2013) with the aim of understanding how distant socio-environmental systems interact and influence each other. Proponents of the telecoupling concept advocate for increased research on the effects of these interactions between socio-environmental systems on land use changes and their impacts on local stakeholders (Eakin et al., 2014). Telecoupling analysis investigates distant interactions, feedback loops and multidirectional flows in and among coupled human and natural systems (Friis et al., 2016; Kapsar et al., 2019).

Operationalization of the telecoupling framework is challenging due to the complexity of corresponding processes and the comprehensive scope of the framework (Friis and Nielsen, 2017). Fries et al. (2016) suggest that scientists incorporate theories from other disciplines, for instance economic geography, in particular on global production networks (Coe et al., 2008; Henderson et al., 2002) and global value chains (Bair, 2005; Gereffi et al., 2005). Global value chain analysis focusses on the different actors in the value chain, their value addition and their degree of power over the value chain and is deemed very relevant for trade related analysis (Friis et al., 2016).

Our analytical focus therefore responds to these recommendations by focussing on the LSLA as a contemporary telecoupling process. Through the process of international land acquisitions, specific forms of interaction between distant actors are created or, in other words, "actors can skip scale" (Eakin et al., 2014). LSLAs go beyond the influence of demand for commodities on land systems. They can alter land systems directly by giving new actors access to land, enabling them immediate control over its use. LSLAs bear the potential to increase the flow of funds, technology, information and commodities over long distances and in different directions. Specific feedback loops are created within the financial and business networks, between different levels of public governance, within private–public partnerships, between civil society actors at different levels, and amongst these groups (Eakin et al., 2014). LSLAs extend and increase the influence of powerful economic and financial actors in often distant places – places that were previously at the margins of the dominant economic system.

Notably, when examining these new dynamics of land acquisition, it is important to remember that pushing for access to land and its products across borders and on distant continents is not a new process (Alden Wily, 2012; Giger and Rist, 2019; Guldi, 2022; Margulis et al., 2013). In their initial periods of world exploration and colonialization, European countries strove to gain access to the goods of foreign lands and sought to appropriate land overseas. This appropriation involved the use of armed forces and the forceful suppression of local resistance. In many countries, the colonial rulers handed over large swaths of land to white settlers, with local land users being coerced into the role of cheap labour (Edelman and León, 2013; Ki-Zerbo, 1978). Following independence, the many of the newly independent countries continued to promote the production of export crops. In the late 20th century, falling prices for commodities rendered acquisition of land for commercial agriculture less attractive for international investors in many places. However, when commodity prices began to rise again around the turn of the 21st century, new incentives for investment in land were suddenly created, and a process of new land acquisitions was set in motion. A wide range of investors from various regions, both private and public, started to acquire land for agricultural production and other purposes in less-developed countries. The new resulting links in telecoupled land systems are the focus of the present dissertation.

Access to land and impacts of LSLAs

LSLAs are by definition about access to land. Acquisition of land includes purchase of land, acquiring access through concessions for exploitation, or leases of land for a specified period of time (Anseeuw and Boche, 2012; Cotula et al., 2011). Consequently, LSLAs have the potential to severely harm local people and their livelihoods by restricting their access to land (Oberlack et al., 2016). Land held by communities is often not protected through formal land tenure rights (Giger et al., 2019a; Haller et al., 2016; Peters, 2009) in many countries of the global South. Hence, LSLAs often threaten to dispossess local communities of their land – land they need for farming, grazing animals, hunting, fishing, gathering, and a range of other activities. The acquired lands is frequently fenced-off or otherwise restricted from access for other land users. This can lead to loss of income, food security or cultural services, and can lead to open conflict and even displacement. Further, related environmental harms such as overuse of groundwater or river water or pesticide contamination can affect adjacent areas and secondary land uses for hunting or gathering can be lost (Haller, 2010).

Additionally, by pushing people off their land, LSLAs can fuel or exacerbate rising global land inequality (Anseeuw and Baldinelli, 2020; Guereña, 2016), further exposing marginalized groups to economic shocks, food insecurity, and forced migration. Unlike other types of investment, agricultural investments often only create a small number of relatively insecure jobs in a given area, thus failing to compensate for the livelihoods that are lost. This is particularly the case when the implemented business model favours large, mechanized production with low labour intensity (Lay et al., 2021; Nolte and Ostermeier, 2017).

For the above reasons, many NGOs (GRAIN, 2008) and a portion of the research community prefer to frame these type of land deals as “land grabs”, a term originally coined by Karl Marx (White et al., 2013). The term implies that these deals are either unlawful or based on acquisition of land against the will, legal rights, and/or intentions of local land users.

At the same time, others have made strong arguments for the sale, concession, or lease of land in order to promote foreign direct investment, innovation, and job and income creation in the global South (Collier and Venables, 2012; Cotula et al., 2011). According to this perspective, lack of investment in developing countries has been the main cause of slow growth of income and well-being (World Bank, 2007), stagnation, and food insecurity (Hallam, 2011). These were the reasons given when governments and international donors originally developed and launched policies aimed at promoting such land investments.

Considering these opposing perspectives, for the present dissertation a deliberate choice was made to gather data under the more neutral term LSLA, or land deal, rather than “land grab”. Of course, the conditions and processes leading to these acquisitions, and their impacts, were key focuses of the research. For scientific purposes, it does not make sense to an adopt an a priori negative framing, as implied by land grabbing, when seeking to uncover the facts of different cases. It is also important to collect data on more positive examples of land acquisitions and to identify potential best practices.

Definition of LSLAs

LSLAs are a complex, multi-dimensional issue. Two key documents offer useful guidance on the definition of LSLAs, criteria for data collection, and information that should be collected:

The *Voluntary Guidelines on the Responsible Governance of Tenure of Land Fisheries and Forests*, or VGGTs (FAO, 2012), endorsed by the Committee on World Food Security at global level, provide a framework that guides stakeholders with regard to land tenure issues. While it addresses various issues related to land tenure, it deals with land acquisitions using the term “investments”. It highlights several important topics relevant to LSLAs such as “free, prior and informed consent”, respect of customary land tenure systems, consultations with local stakeholders, compensation, and transparency regarding investments.

The *Tirana Declaration* from the International Land Coalition (2012) defines land grabbing as acquisitions or concessions that are one or more of the following:

> *“(i) in violation of human rights, particularly the equal rights of women; (ii) not based on free, prior and informed consent of the affected land users; (iii) not based on a thorough assessment, or are in disregard of social, economic and environmental impacts, including the way they are gendered; (iv) not based on transparent contracts that specify clear and binding commitments about activities, employment and benefits sharing, and; (v) not based on effective democratic planning, independent oversight and meaningful participation. “ (ILC, 2012)*

The formulation of the Tirana Declaration is very comprehensive. It includes not only unlawful actions and actions against the will of local land users, but also other characteristics of the process and practice of land acquisitions that might qualify them as land grabs.

While the VGGTs and the Tirana Declaration do not precisely match in their definitions, they both informed the type of information that was collected for the present research. It was not only important to collect data on the areas affected, but also on the following: precise investment locations, main production envisaged, water use (all deemed important to understand potential impacts); the terms and the process of acquisitions, consultations, participation, compensations, conflicts; promised and actual benefits of investments; and the investors involved. The definition of the type of data collected can be found in the chapter on methodology 4.2.1.

Interdisciplinary research at the global, regional, and local level

To illuminate the telecoupled system of LSLAs, it was necessary to study LSLAs and all the relevant actors at different levels – local, regional, and global – including not only LSLA target regions, but also the countries in which the investments originate.

In order to provide a more detailed understanding of impacts at the local level, the present dissertation also includes focussed research in Kenya, with a specific emphasis on the business models of investors, as well as the livelihood profiles of households engaged, or not engaged, with LSLAs.

In an effort to go beyond individual case studies (Adler et al., 2018; Gallati and Wiesmann, 2011) and contribute to the generalization of findings from individual case studies, comparative studies were carried out in three countries. To better capture the diversity of LSLAs, 16 large land deals in three countries were studied. In this endeavour – eventually resulting in a comparative assessment at the regional level – we were also inspired by ongoing efforts to develop a method for generalizing findings through archetype analysis (Oberlack et al., 2019; Oberlack et al., 2016).

Further, the possible impacts of LSLAs introduced above make it clear that research on LSLAs must deal with a wide range of social, economic, and environmental topics in order to assess impacts in a comprehensive manner from the perspective of sustainability. A multi-disciplinary research approach is required, in line with concepts developed and implemented by CDE over the course of many years (Messerli et al., 2013; Wiesmann, 1998). Such an approach was explicitly applied in the Afgroland project. It included a large interdisciplinary team of experts, and invested considerable efforts in creating a joint research agenda and elaborating a joint synthesis (Giger et al., 2019b; Oberlack et al., 2021), while also enabling disciplinary research to be conducted.

4. Research Objectives and Approach

4.1. Research Objectives and Questions

The overall objective of this research is to better understand the continuing trends of international land acquisitions, the target countries and contexts, the origin of investors, as well as the impacts of these developments. Robust data on these aspects has not been readily available to date, so it was necessary to invest in data collection at global scale. Moreover, up to now, relatively little research has been conducted to understand the rationale of investors behind LSLAs (Abeygunawardane et al., 2022). As a result, we wanted to better understand business models and the drivers behind them. Finally, we sought to obtain differentiated insights into the diverse socio-economic and environmental impacts of LSLAs, and why these might differ from one country to another.

Three main research questions and three sub-questions are addressed in the present dissertation:

1. **What are the global patterns of LSLAs since the year 2007/8?**
    a. What dynamics of land acquisitions and implementation can be observed?
    b. What is the origin of LSLA investors and what type of investors play a role?
    c. What are the most affected target countries and regions?

2. **What are the key drivers of LSLAs in a given context: Kenya case study**
    a. What different business models of commercial farms exist and how do they evolve?
    b. What is the role of global markets as a driver of local commercial investment?
    c. What role do national policies play and how do they influence commercial business models?

3. **What are the impacts of LSLAs?**
    a. What is the evidence on impacts of LSLAs emerging from global data collection?
    b. How and why does the impact of LSLAs differ between three countries in Eastern Africa?
    c. How do smallholders' livelihoods evolve in a context marked by the presence of LSLAs?

These research questions deal with a range of issues related to socio-environmental systems at different scales, demanding application of research methods from different disciplines. The following section describes the methods applied in this dissertation.

4.2. Research Approach and Methods

4.2.1. Development and analysis of a global data platform on LSLAs

The lack of data on LSLAs

The dissertation builds on the global dataset of LSLAs collected by the Land Matrix Initiative. As initially very little robust data on the new wave of LSLAs was available, and widely conflicting figures were circulating, we launched an intensive effort towards data collection in 2012. We developed the corresponding methodology and approach, aimed at effectively capturing the different dimensions and qualities of land acquisitions (Anseeuw et al., 2013). In contrast to efforts by others – such as the NGO GRAIN – that take a more activist approach, we adopted a more neutral stance to allow for collection not only of data on perceived negative impacts, but also perceived positive results. Therefore, following other researchers (Andrianirina Ratsialonana et al., 2011; German et al., 2011), we used the term “Large Scale Land Acquisition” and not “land grabbing”.

We defined several **criteria** to define the scope of data collection:

- Focus on development-relevant issues: this led us to focus on low- and middle-income countries.
- Focus on international acquisition – in particular because of the perceived dominance of large international actors and the need to intervene via coordinated policy at the global level. We perceived a need to investigate whether, and to what extent, land investments could be traced to wealthier areas in the global North, the Gulf Region, or China, etc. As we continued to deepen our work with partners from the global South who collected information on the ground, more and more cases of domestic investors were reported, such that we gradually began to include such domestic data in the database. This was due to the perceived importance of domestic investors (for instance in countries like Brazil or Indonesia) and the gradual realization that, in many cases, it is exceedingly difficult to distinguish between domestic and international investors given the complex financial structures behind such investments in land. However, the default criteria for most of the analysis at global level include only international acquisitions.
- Focus on agricultural land deals: this was seen as important to keep the data comparable. Pure logging concessions, for example, while frequently important in terms of size, often do not permanently change land use away from forestry, as is the case for agricultural acquisitions. Mining concessions are equally different in their impacts and are also monitored by other initiatives, so the LMI would run the risk of duplicating these efforts.
- Focus on land acquisitions that imply a conversion of previously communally held land, or smallholder land (farmers, pastoralists etc), into commercial use at large scale. This excludes purely commercial land transactions between large land owners.
- In view of focussing on the most-relevant deals first, we fixed a minimum threshold of 200 hectares for inclusion in the database – although many local partners also believe that, taken together, numerous smaller deals do create significant changes in many contexts.

Stages of land acquisitions: An additional significant step was to define and monitor different stages of the negotiation process (from a simple announcement to a signed contract and even to cancellation) and different stages of implementation. Other questions concerned the completeness of the data: Can a deal be reported as a deal when only fragmentary data are published? How much detail is needed to report a deal? Data on compensations, participation or gender impacts are often lacking or incomplete at best. And what should be considered reliable sources and sufficient verification? What proof is necessary to make information public? All these questions were agreed upon and condensed into a data manual and explanation in the form of FAQs published on the LMI website.

Spatial data on land deals were also collected. Somewhat surprisingly, however, such data is often hard to find or obtain. General lack of transparency means that contracts and land use maps are often not made public at all. Field visits to travel to these distant places are often too costly to implement. However, earlier research shows that such spatial data are very valuable to identify the type of land targeted, the implementation status, and the potential impact of these land acquisitions (Messerli et al., 2014).

Limitations

LMI data have also been subject to criticism. For example, Oya (2013) highlighted tendencies in the scientific and public debate to emphasize the importance of quantitative figures (e.g. the size of land deals), and he called them part of a syndrome of “false precision”. At the same time, Oya acknowledged that the LMI clearly flagged some of its data as not verified on the ground, and thus not to be taken as simple “facts”. Nevertheless, in the Oya’s view, making such data open access runs the risk of it being used superficially, to quickly produce “killer facts” (Oya, 2013). This and other critiques have led the LMI to refrain from labelling its information as “verified”, instead documenting the information with the data sources, and indicating the type of data source, enabling users to judge the reliability of the data themselves.

Some selection biases remain. An attention bias could lead to overreporting of cases in Africa (since they are newer compared to Asia and Latin America). The same could happen due to extra public attention given to new Chinese or Gulf investors compared to investors from the former “colonial powers”. Another could arise from the higher freedom of the press and the strength of research and NGO networks in particular target countries, increasing the likelihood that deals there are reported. These biases are difficult to estimate. Nevertheless, the LMI regional networks and informants enable us to consider possible over- and underreporting to some extent, and take them into account when producing LMI analytical reports.

Analysis of global data on LSLAs

As of November 2020, the LMI has documented a total of 2,485 (concluded) large-scale agricultural deals (>200 hectares), both domestic and international, encompassing over 43 million hectares of land. Data on LSLAs at the global level was analysed in the latest analytical report of the Land Matrix Initiative (Publication I). The reports summarized the pace of land acquisitions and their implementation over a period of 20 years. We used detailed descriptive analysis to explore the data and present a corresponding global and regional breakdown. We also investigate the dynamics of LSLAs, their implementation and economic, social, and environmental impacts. We then compared our findings with results from the literature. In our environmental chapter, we used spatial data and data on crop types from the Land Matrix to analyse the location and water needs of land deals in dryland areas. Further, we assessed the deforestation impacts of LSLAs.

Finally, we used the global data set and GIS to investigate spatial overlaps between biodiversity rich areas and land deals, in order to explore the possible role of LSLAs in increasing risks of zoonotic diseases (Publication III), as well as to investigate the potential impacts of LSLAs on common pool resources (Publication IV).

History of the Land Matrix Initiative (LMI)

With the sudden surge of LSLAs over a decade ago, the topic began receiving increased attention at the Centre for Development (CDE) as elsewhere. As CDE's activities were long focussed on land use change, local livelihoods, and governance of land systems in countries of the global South, it was immediately evident to CDE researchers that this new LSLA trend could have major impacts on CDE's partners countries. We also immediately recognized that to better understand this trend, it would be necessary to look beyond the local level and additionally investigate flows of investment capital, its origin, and the actors and business models shaping investment in land.

Meanwhile, new approaches and ideas for open data and data collection were innovated and tested. Use of social media platforms and crowdsourcing information from local citizens and activists were applied in different contexts such as disaster relief, monitoring of elections, and citizen-science initiatives (Albrecht et al., 2013; Bott and Young, 2012; Gigler et al., 2011). Global networks of NGOs and interest groups on land issues created new opportunities for collaboration and linking of science with activist movements as well as with policy networks and think tanks. Together with the International Land Coalition (a global alliance of civil society and intergovernmental organizations), CDE and other research organizations and NGOs began to collect data on LSLAs in 2010 and founded the LMI in 2012. The objective of the LMI has been to increase the transparency of LSLAs and ultimately to promote more equitable decisions regarding land.

One key issue from the beginning was the impossibility of monitoring the process of LSLAs everywhere in sufficient detail. A narrower focus was necessary. After discussions with our partners, a few criteria were elaborated and subsequently applied (see above). At the same time, the LMI underwent a process of decentralization, leading to adjustments to its priorities. These, in turn, then led to modification of some of the inclusion and analysis criteria, for instance regarding mining, forestry, or commercial transactions, in particular countries where these were perceived as important. Nevertheless, importantly, these data modifications are filtered out when the LMI presents global data.

4.2.2. Analysis of business models of commercial farms in Central Kenya

In this study, we initially established a complete inventory of all large-scale investments in our study area around Nanyuki, Central Kenya. Based on this inventory, we conducted in-depth interviews with 33 farm managers and owners. The interviews covered the main production activities, investments, land and water use, land access, employment, contract farming, markets, CSR strategies, and the policy environment. A cluster analysis was conducted – by first performing a principal component analysis and subsequent hierarchical clustering (Murtagh and Legendre, 2014) – in order to analyse key variables of the business models. The key variables were defined based on our literature review on business models (Chamberlain and Anseeuw, 2019; Di Matteo and Schoneveld, 2016) and covered the organizational structure, production model, and place and function in the value chain (Table 2). We further analysed the results by investigating the main determinants of these different business models.

Table 2. Analytical framework for investigation of business models.

Main dimensions of business models	Specific elements contained in analytical framework
(1) Organizational structure	Actors, juridical structure, network of funding, certification, compliance, and taxes
(2) Production model	Investment size, ownership and access to land, labour, outgrowing and contract farming, main products, technical agricultural model
(3) Place and function in value chain	Main markets, place and function in value chain

4.2.3. Comparative assessment of impacts of land acquisitions in Eastern Africa

The Afgroland Project provided the opportunity for a comparative and interdisciplinary assessment, based on a careful and intentional design. I was the coordinator on the Swiss side and responsible for two work packages (Business Models, Synthesis) of what was an international research project with multiple partners (CIRAD, University of Pretoria, CETRAD, Observatoire Foncier, and CDE).

The objective was to generate more nuanced knowledge on the impacts of LSLAs based on well-grounded research. In each country, we sought to explore a cluster of cases of land investments, which would all be investigated according to an agreed approach. Through joint design workshops and field visits, a diagnostic framework was agreed upon and joint study sites were defined. Some of the data collection (household surveys) was coordinated and carried out jointly, other data collection efforts were performed by different project teams. A synthesis workshop enabled agreement on a method to jointly analyse and describe the results and elaborate the key points for the synthesis paper. The final synthesis applied a set-theoretic approach (Schneider and Wagemann, 2012) and was supported by a formal concept analysis (Ganter and Wille, 2012) to investigate recurrent impacts and their associated conditions. The data synthesized was generated by diverse research teams and included information from specialists in food security, land science, agronomy, life-cycle analysis, economics, and policy analysis.

The case studies in Kenya, Mozambique, and Madagascar

The Afgroland project selected three countries as case study sites for comparative assessment: Kenya, Madagascar and Mozambique. Africa is a key target of large-scale land acquisitions (Nolte et al., 2016), and the three countries promised new insights into three different trajectories of LSLAs. The three countries enabled a high degree of diversity, providing the opportunity to identify and assess the factors shaping the rush for land, its impacts, and governance. The most important sources of variation between the case sites were: (1) one Anglophone, one Lusophone, and one Francophone country, each with different socio-historical, institutional, and legal frameworks; (2) despite being in the same region of Africa, the three countries display interesting differences in implementation of LAIs and their impacts: Kenya is a well-integrated economy with a relatively mature commercial agriculture sector in certain areas. Mozambique, with an intermediately developed agrarian sector (compared to Kenya and Madagascar) has recently been the site of many agricultural and land investments, particularly thanks to the implementation of “development corridors” (Beira corridor, Naccala corridor). Madagascar features a comparatively fragile governance system with a relatively easily influenced political-economic situation; it became known for many attempted land deals, most of which eventually failed.

In each country, we focussed on a specific study area (Figure 1): In Kenya, the Nanyuki area was chosen (see description above), based on its high number of investments and the good availability of economic and biophysical data. In Mozambique, the Nacala Corridor was chosen which covers three provinces and was reportedly the largest agricultural investment zone in the country, notably due to the Pro Savannah programme jointly funded by the Mozambican, Japanese, and Brazilian governments. Three locations were purposefully selected due to the presence of large-scale agricultural investments in the area (Reys et al., 2018). These locations feature good climatic and agronomical conditions and reflect the diversity of private agricultural companies' progress in the field. In Madagascar, 82 companies announced plans to develop large-scale farms between 2005 and 2014. However, 95% of these projects did not materialize or collapsed (Burnod et al., 2018). The few remaining companies were scattered around the country. For the present research, we finally selected one company operating large-scale maize production in a plantation model (associated with other crops in smaller areas), one contract-farming scheme producing barley, and one jatropha plantation.

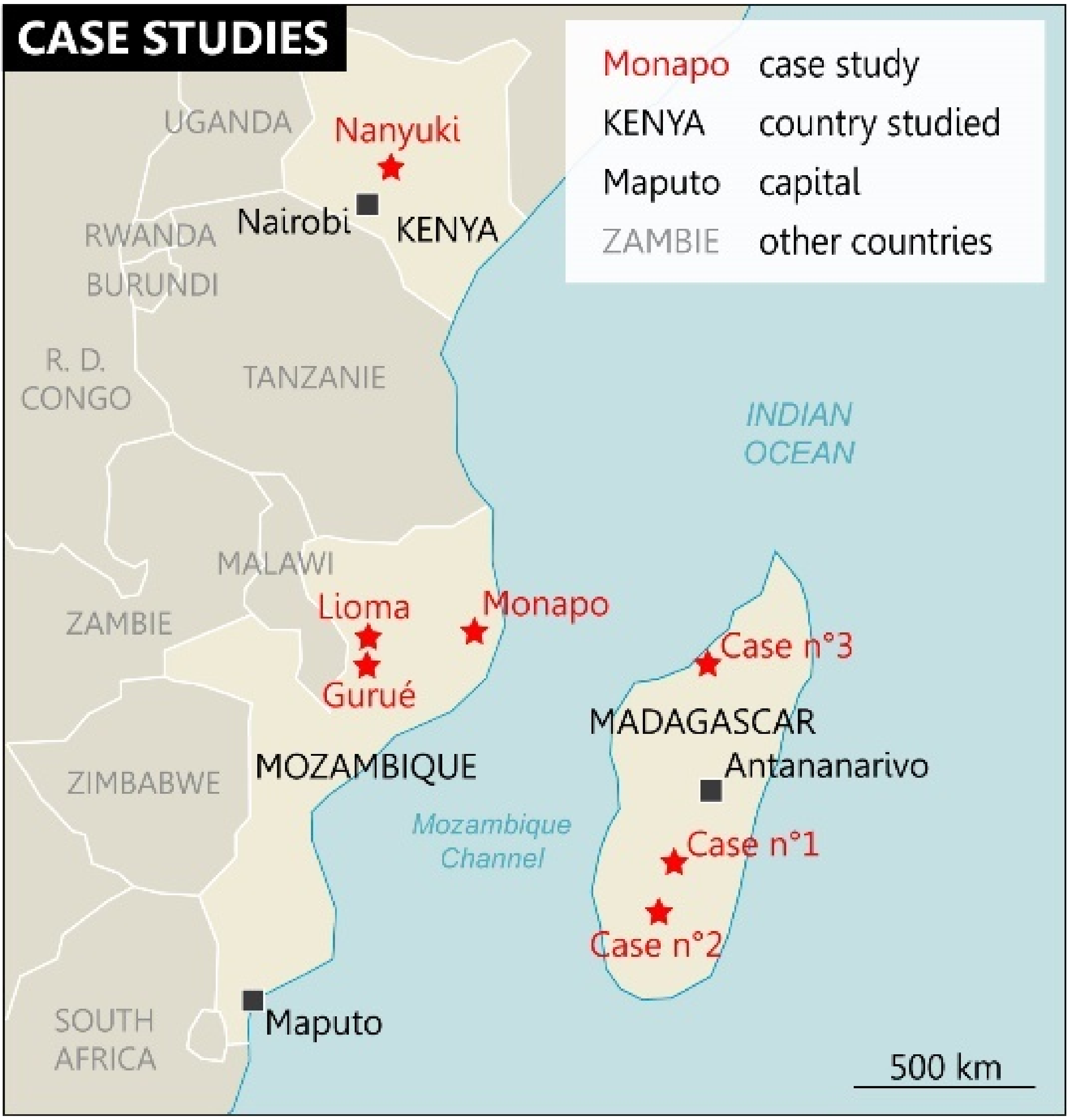


Figure 1: Overview of study areas in Kenya, Madagascar, and Mozambique. (Giger et al., 2019b)

4.2.4. Analysis of status and evolution of smallholders' livelihoods in Central Kenya

A second case study involved the analysis of household data collected through the Afgroland survey. The randomized survey of 375 smallholder households enabled estimation of the percentage of smallholder households working on commercial farms and the level of wages received in comparison to other sources of wage labour. We compared demographic and household statistics of the households grouped into different categories (with/without employment on the farms; contract farmers). For this purpose, we constructed a livelihood index and compared the livelihood assets of different groups with the help of the index. This enabled us to compare the findings to data from previous research dating all the way back to 1989/1990 (Ulrich et al., 2012). The data support conclusions regarding the status of the different groups and the evolution of livelihood over the long-term in a study area characterized by the presence of large investments. However, the available data did not enable a more detailed statistical analysis of causal relations regarding the impact of incomes from farms on the livelihoods of households, as the group of households with household members working on the commercial farms turned out to be very small in the sample from the Afgroland survey. However, the information from the household survey can be complemented with the results from Publication VI, based on a targeted survey with smallholders in the immediate vicinity of large farms.

5. Key Insights

5.1. Global patterns and dynamics of LSLAs

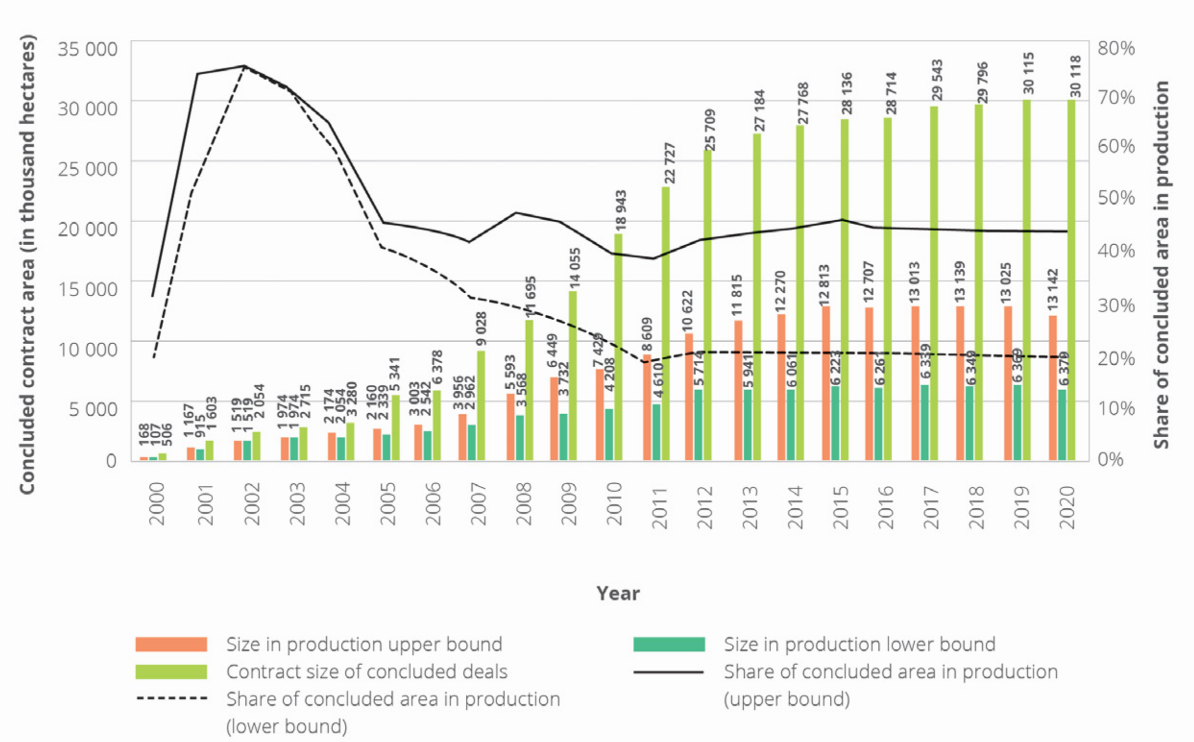
Patterns and dynamics of LSLAs

The results of the global analysis (Publication I) show the largest increase of new LSLAs took place from 2007/2008 until around 2012. Since then, the trend has slowed significantly (refer to Figure 2). About 30 million hectares of concluded international agricultural deals are documented in the Land Matrix up until 2020. Beyond the absolute amount of acquisitions, one ongoing, reoccurring dynamic is interesting: While new deals are recorded, other deals are cancelled. Further, many deals are not yet implemented, or only implemented in part: The estimated implementation of existing deals is around 25%, showing that much of the land will still come into production.

After prices spiked for agricultural commodities in 2007/2008, more moderate prices prevailed for much of the next decade, contributing to a slowdown of LSLAs in the late 2010s. At the same time, LSLA-related government policies changed in some countries: These changes included announced moratoriums on LSLAs in certain key target countries (Cambodia, Indonesia, Kazakhstan, Niger, and Ukraine), as well as dwindling support for first-generation biofuels, for instance, in the EU. Policymakers in some countries realized that the apparent promise of LSLAs faced serious obstacles, for instance, lack of real investment and job creation by investors, conflicts triggered by LSLAs, and complaints by local populations due to lack of compensation for lost land.

Among investors, reports of LSLA failures (especially jatropha plantations), underestimation of costs, and difficulties implementing commercial production contributed to declining interest in land deals. Land investment failures often resulted from mistakes and misconceptions in planning and management (Nolte, 2020). One crop stands out as susceptible to such problems: 50% of the deals intended to cultivate Jatropha – again mostly located in sub-Saharan Africa – have failed to date. However, based on rising prices for agricultural products since 2021, the trend could be reversed yet again and implementation may progress further at a higher speed.

LSLAs often produce for global commodity markets. Already, oil palm-related international LSLAs (if fully implemented) could account for over 20% of the global area currently cultivated with this crop. This share is well above the 10% for rubber and sugar beet, and above the 5% for sugarcane. Indeed, LSLAs concluded since the 2000s have already added and will continue to add significantly to the global production of these commodity crops (Lay et al., 2021). Under current conditions – e.g. Ukraine crisis, energy crisis, climate crisis – monitoring LSLA trends will continue to be crucial in order to alert and inform policymakers and civil society on any changes in these trends.



Note: the lines show the upper and lower bound of the share of contract size (excl. failed deals) in production. The bars show the absolute size per negotiation status per year. Note that in addition to the accumulative size in production by 2020 there is an additional size in production without year information between 1.6 (lower bound) and 8.2 (upper bound) million hectares.

Figure 2: Cumulative global contract size of concluded deals over time and size in production.
Source: (Lay et al., 2021)

The actors behind LSLAs remain often obscure

The global dataset also reveals that LSLA are a worldwide phenomenon. Investors are diverse and include actors from the global North and South. Top investor countries include developing countries with competitive agricultural sectors, for example, Malaysia and Brazil, and high-income countries like the United States, the Netherlands, and Great Britain. In recent years, China moved up to third place among the most-important investor countries. Investors from China are especially active in Southeast Asia, but, contrary to initial expectations, less so in Africa: 54% of the deals with Chinese involvement are located in either Myanmar, Laos or Cambodia.

The “real” beneficial owners of investments often remain obscure, for example, when parent companies set up intermediaries in financial hubs and tax havens: The top 10 countries of investment origin include Cyprus, Singapore, the British Virgin Islands, and Hongkong. Across all regions, the majority of investors are private actors, including private companies (35%), stock-exchange listed companies (17%), investment funds (10%), and individual entrepreneurs (5%). Governments, state-/government-owned companies, and semi-state-owned companies make up just 9% of the investors. For 24% of the investments in the database, no information on the investor is available (Lay et al., 2021). Well-known data leaks such as the Panama Papers have drawn public attention to the lack of transparency characterizing international finance networks (De Sanctis, 2017; Obermayer and Obermaier, 2016). Opaque networks used to conceal beneficial ownership elsewhere (Radon and Achuthan, 2017) are also used in financing LSLAs, such that LSLAs could also be used for money laundering or in tax evasion schemes.

Continuing and glaring lack of transparency surrounding LSLAs

Indeed, another key insight is that transparency around land acquisitions is still largely absent. Additional analysis of LMI data showed that for Africa, 78% of all deals assessed show unsatisfactory levels of VGGT uptake and implementation (Anseeuw et al., 2022). This is a remarkable finding, since ten years ago the global community almost unanimously adopted the VGGTs (FAO, 2012; Munro-Faure and Palmer, 2012), which call for transparency over investments in land. Our findings show that it is still common practice in many countries to shield land deals between governments and foreign investors public scrutiny. Information on contracts, consultations, impact studies, taxed incomes, and monitoring often remains hidden or inaccessible.

Publication I: Taking stock of the global land rush: Few development benefits, many human and environmental risks

In this report, we summarize and interpret the global dataset of the Land Matrix. In the first chapter, we trace the evolution of the global land rush, including the pace of implementation and regional breakdowns of these figures. Results regarding type of land affected can also be found.

The subsequent chapters focus on the impact of land acquisitions on people, livelihoods, land tenure, and the environment. Overall, the results of the analysis of the global dataset and complementary analyses are sobering – and at times alarming. Very significant risks occur at the local level, in particular uncompensated loss of land in affected communities and deforestation. Meanwhile, also at the local level, the LSLAs generate very few benefits in terms of employment, productivity spillovers or infrastructure.

Our results point to insufficient consultation with affected communities and only rare cases of compliance with principles of responsible business conduct. Despite efforts by large producers of food and agricultural products to gain a reputation for more sustainable and responsible production, our findings largely point to ongoing "business-as-usual" operations that continue to destroy rainforests and natural habitats at new and old agricultural frontiers, in the Amazon, in Southeast Asia, and in the Congo Basin.

Notwithstanding the progress made concerning land governance, a general lack of turning policy into actual practice is evident. This book also reviews application of the VGGTs at the country level and examines the transparency of land acquisitions. Recommendations for policy changes in five priority areas are also formulated.

5.2. Drivers of investments and business models

Publication II examines a unique inventory of large agricultural investments in Kenya's Nanyuki area, using a cluster analysis of business models. The study pointed to a high diversity of these commercial farms. The cluster analysis reveals that they can be divided into four main groups: *farms with field crops, flower farms, vegetable producing farms, and large mixed farms.* However, these are not fixed categories. The interviews showed that the farms are evolving, for instance from producing field crops to more intensive vegetable farming or specialized flower farms. Economic competition is fierce: smaller flower farms struggle to survive and are frequently bought by large companies that own multiple farms.

Our study showed that the main element structuring these business models is the *production model* (based especially on the crops or livestock produced as well as the *technical model of production*) rather than the types of actors or financial structures involved per se, as earlier research had suggested (Boche and Anseeuw, 2013). A total of 88% of the investors were of Kenyan nationality. A total of 52% of the farms were private companies with shareholding, 27% were private companies without shareholding, and 21% were individually owned by entrepreneurs or farmers.

The presence (or lack) of secure land tenure rights have a direct influence on business models. As land in our study area could only be leased or bought from private owners – as no more government owned land could be accessed – only business models requiring smaller land sizes currently could be launched. The data clearly showed that in the last 20 years nearly all the farms established in the study area had surface areas well under 100 hectares, clearly distinguishing them from the sort of megadeals seen in other countries in the last decade. Much larger LSLAs have occurred elsewhere in Kenya, but they took place in areas of the country where state and communal land tenure prevails. In those areas, the resulting problems and conflicts mirrored some of those found in Madagascar and Mozambique. Indeed, land tenure may be considered a key driver that shapes the size of land investments. Further, the demands of the market, in particular the European market, have a significant influence on the type of agricultural products invested in (i.e. high-value crops such as flowers and vegetables) as well on the technical model. For example, the European market demands enforcement of relatively high environmental, social, and sanitary standards compared to Kenya's own legal requirements. Comparing these examples with other study sites of the Afgroland project also clearly points to a cluster effect (Porter, 2000) occurring in the region. The emergence of specialized human resources at different levels, formed and trained via the different commercial farms, clearly represents an important comparative advantage on the part of Kenya. New agribusiness investors can recruit from this existing pool of talent. These and other cluster effects drive down costs for investors, for instance also by reducing the cost of access to inputs, specialized machinery and construction material and other services. Moreover, these clusters were also supported by the relative liberal economic policy of the government.

Publication II: Large Agricultural Investments in Kenya's Nanyuki Area: Inventory and Analysis of Business Models

This paper contributes to the literature on large agricultural investments and corresponding business models by inventorying and analysing such investments in Kenya's Nanyuki area. The main dimensions of business models were conceptualized as (1) organizational structure; (2) production model; and (3) place and function in the value chain. We identify four clusters of business models that differ primarily by the type of production. Other distinct determinants identified were: demand from markets; access to land; land tenure regime and colonial history; actors involved; biophysical context; labour availability; and governance of the value chain via private standards. The study results shed light on the factors that help or hinder the implementation of large agricultural investments and shape their impacts in the context of African land use systems. The way land is accessed represents one of the most-decisive factors determining the risks and opportunities associated with such projects. We found that most investments in the Nanyuki area occur on land bought or leased from private owners. This aspect has reduced the risks of losing land among smallholders. Governance of land and water, therefore, are important mechanisms that can mitigate potential conflicts between investors and the local population. However, we also found that relatively few commercial farms (15%) engage with smallholders in contract-farming arrangements, and these arrangements are declining in importance.

5.3. Impacts of LSLAs

The present dissertation investigates the impacts of LSLAs at the global, regional, and local level. All the publications contribute to a different degree to the analysis. Publication I, Publication III, and Publication IV investigate impacts at the global level, looking at different issues. Publication V and Publication VI deepen the analysis at the regional level by looking at Kenya, Mozambique, and Madagascar. Publication VII is a case study in Kenya on the livelihoods of smallholders near commercial farms, providing insights into the potential impacts of wages and contract farming on the status and evolution of smallholder livelihoods.

Results from global analysis: significant social and environmental risks

Small or moderate benefits vs. high risks for local populations: Our research based on the global dataset of the Land Matrix points to significant LSLA-related risks for local populations, and only moderate benefits in terms of job opportunities and decent incomes. Exceptions are few: among them are the relatively rare cases of investment in labour-intensive high value crops. Also palm oil concessions in Indonesia have created many jobs, but these concessions also have come at significant costs to the environment in terms of deforestation. Publication I provides detailed analysis of economic impacts in terms of estimated job creation, contribution to global production, and a range of social impacts.

LSLAs impact forested areas and hotspots of biodiversity: LSLAs' impacts on forest are considerable, as many are directly located in forested areas: Looking at data from 964 geo-located land deals in tropical regions, we estimated that forest have been reduced in these areas by 1.9 million hectares (20%) in 10 years. Further implementation of these deals will invariably lead to further deforestation and loss of biodiversity (Publication I). Given the very negative impacts of deforestation on climate, biodiversity, we argue from a sustainability perspective that LSLAs targeting tropical forest areas should be halted entirely, and investors from the global North should be held accountable to avoid the further destruction of such forests.

During the pandemic, the risks of emergence of zoonotic diseases came to global attention. Land use change has been highlighted as one of the risk factors for emergence of new zoonotic diseases and even global pandemics (Dobson et al., 2020; Jones et al., 2008). Until recently, however, this risk was mainly discussed among experts. Indeed, LSLAs are one of the important drivers of land use change and affect many biodiverse rich areas. Yet the risk of zoonotic diseases has scarcely been considered when weighing the benefits and costs of LSLAs. For instance, in the last three conferences convened by the World Bank on "Land and Poverty", the topic was barely mentioned in written or oral contributions.

Our spatial analysis of Land Matrix data (Publication III) confirmed the close proximity and/or overlap of LSLAs with many biodiversity hotspot areas. Taken together, 87% of domestic and international agricultural land acquisitions are occurring in regions of medium-to-high terrestrial biodiversity (i.e. areas with over 314 species per 10 km^2), largely corresponding with areas of high probability for emerging zoonotic diseases (Allen et al., 2017). The map overlays concerning biodiversity richness, risk of disease emergence, and the presence of LSLAs showed that several regions (Southeast Asia, Western and Eastern Africa, and parts of Latin America) bear major risks for disease spillover (Figure 3). These regions display high rates of land use change and a propensity for many interactions between humans and wildlife in biodiversity-rich areas.

There are several possible mechanisms through which LSLAs can increase the risks of new zoonotic diseases and pandemics. In particular, related expansion of the agricultural frontier puts more people in close contact with possible pathogen hosts (e.g. via consumption of bush meat) (Dobson et al., 2020).

There are also research findings suggesting that specialized monocultures could change zoonotic host diversity, increasing the share of host species in these environments (Gibb et al., 2020). The analysis of the Land Matrix shows that this type of ecological and, ultimately, health impact needs to be factored in when analysing the benefits and costs of LSLAs.

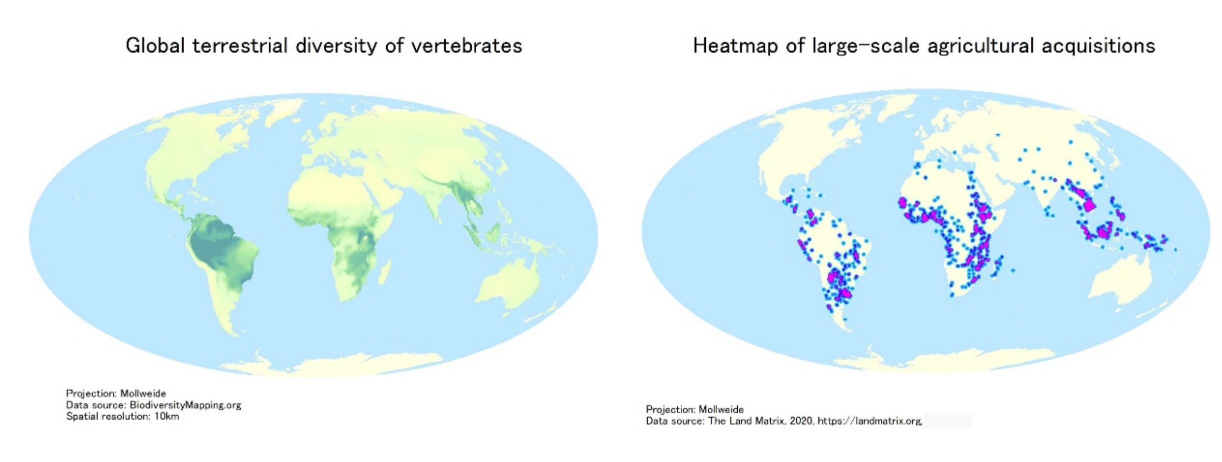


Figure 3: Global terrestrial vertebrate biodiversity (left) versus hotspots of large-scale agricultural land deals (right). Source: Giger M, Eckert S, Lay J. (2021). "Large-scale land acquisitions, agricultural trade, and zoonotic diseases: Overlooked links", One Earth.

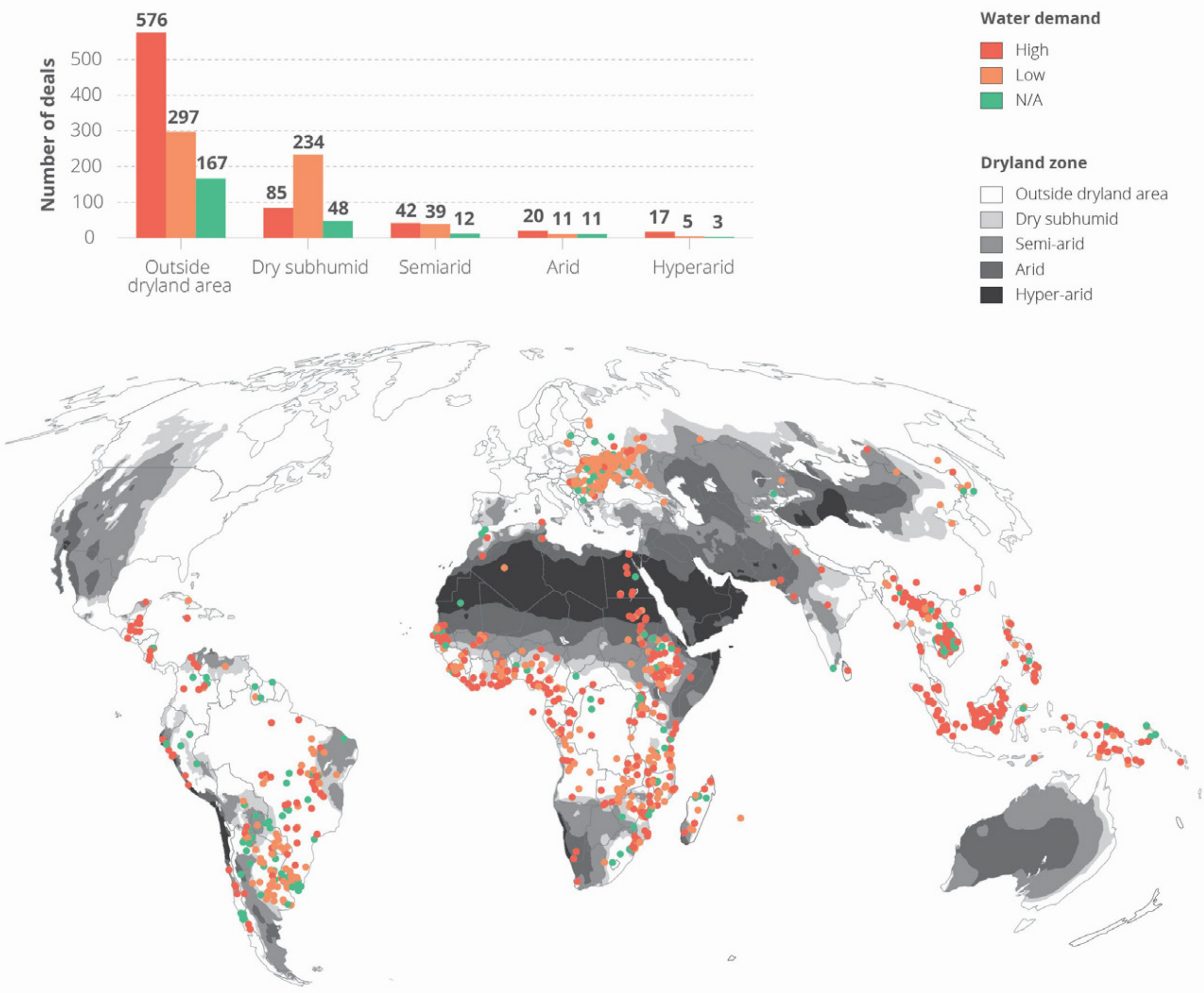
Publication III: Large-scale land acquisitions, agricultural trade, and zoonotic diseases: Overlooked links in research and practice

Land use change, especially deforestation, is associated with the emergence of zoonotic disease outbreaks and subsequent pandemics. Deforestation and destruction of natural habitats, in turn, are frequently driven by LSLAs for export-oriented commercial agriculture, often promoted by governments and international donors. Research on land acquisitions reveals that such deals often occur in or near areas of comparatively high terrestrial biodiversity.

Using the LMI data on domestic and transnational agricultural land acquisitions, we created a global heatmap enabling the comparison of investment locations with local terrestrial biodiversity. The resulting maps reveal that numerous agricultural land acquisitions are occurring in or near areas of comparatively high terrestrial biodiversity.

However, with few exceptions, mainstream debates on agricultural trade and land acquisitions have failed to highlight the likely ties of these activities with emerging zoonotic diseases. Agricultural and trade policies, as well as spatial planning measures, need to be altered and strengthened to prevent forest fragmentation and the further intrusion of land investments into biodiverse ecosystems. Increasing the transparency of land acquisitions is instrumental to better understand their implications for zoonotic disease emergence, but also to monitor and, where possible, prevent further social and environmental harms.

Increased pressure on water resources is another threat of LSLAs (Breu et al., 2016; Johansson et al., 2016). We found that 54% of all deals recorded in the Land Matrix database are intended to produce water-intensive crops, including cotton, oil palm, rubber, and sugarcane. Importantly, 34% of deals take place in dryland zones, 10% use high water-demanding crops (about 31% of those in dryland areas are producing crops that require large amounts of water) (see Figure 4, taken from Publication I). This impact on water resources will also increase pressure on common pool resources such as wetlands, rivers, and lakes, and are especially relevant for marginalized groups such as nomads, fisherfolk, women, and others (see also Publication IV).



Notes: Water demand categories based on Johansson et al. (2016) (High: > 8 500 m3/ha; Low: <= 8 500 m3/ha; NA: Crop demand not classified). Map background showing different dryland zones (in grey). LSLAs: n=1 568.

Figure 4: Water demand categories of crops cultivated in LSLAs. Source: (Lay et al., 2021)

LSLAs and impacts on common pool resources

Another scientific and policy contribution was made in our chapter of a book (Publication IV) focussing on common-pool resources (CPR). In the chapter, I and my colleagues put LSLAs in the context of previous land acquisitions by colonial powers and post-colonial elites, presenting the latest wave as a further step in the history of eroding customary practices of land governance (White et al., 2012). In the 2016 Land Matrix dataset, community (32%) and state ownership (27%) accounted for over half (59%) of acquired land. Land in these areas of the global South is more likely to be managed as CPRs. Consequently, we argue that LSLAs may affect the use and management of such CPRs, as others have found (Dell'Angelo et al., 2017). Of course, communal ownership can take different forms, and we cannot assume that all of this land is managed by CPR institutions. In this contribution, we acknowledge the paucity of explicit LMI data on land use tenure, especially regarding CPRs, constraining detailed assessment at the global level. More insights can be generated once more case studies have been conducted and the results have been shared with the LMI. Unfortunately, however, land use tenure assessments are seldom published when LSLAs are announced.

Publication IV: Impacts of large-scale land acquisitions on common-pool resources: Evidence from the Land Matrix

In this contribution, we discuss the relevance of the data on LSLAs for the study of CPRs. We posit that expansions of large-scale agriculture often impact areas formerly used as CPRs, for instance by small-holders and pastoralists. We describe four mechanisms through which LSLAs affect CPRs and common-property regimes. First, capital-intensive and rationalized agricultural production systems are typically fenced off, depriving CPR users of access and thus of key livelihood components. Second, impacts can be related to indirect externalities, as the change in land ownership often comes with changes in the mode and techniques of production – affecting offsite CPRs through contamination or changes in groundwater levels. Third, impacts can affect secondary land uses, which are often not immediately evident or only temporarily, such as for grazing or collecting various land products. Fourth, LSLAs can include water use rights, which can then directly affect water resources offsite or further downstream.

CPR regimes have been weakened throughout colonial history, and we argue that LSLAs are a further step in the marginalization of these customary practices. Existing power imbalances in traditional systems can be exacerbated by the impact of LSLAs and the loss of resources they entail. Indeed, the impact of LSLAs on CPRs may be even higher than the mere quantity of land affected would suggest. To illustrate our findings, we discuss four case studies documented in the LM database. We conclude by discussing ways of increasing the relevance of LM data for the study of the commons.

Three different trajectories and impact patterns in Kenya, Mozambique, and Madagascar

The comparative assessment (Publication V) showed that we had done well in choosing these research countries. While the three countries come from the same sub-region in Africa, they present highly diverse situations encompassing many issues, all relevant to LSLAs (in this study we also include spatially smaller-scale investments, which are nevertheless large-scale in financial terms). In a nutshell, they illustrate three different possible trajectories of LSLAs. In Kenya, we found relatively well-established commercial farms enabling us to study the processes and impacts triggered by these business models, and the policies leading to these outcomes. Notably, in other regions of Kenya with different local contexts – especially concerning land tenure – the situation is much different. On the other extreme, in Madagascar, a country that was initially reported to be a hotspot of land acquisitions, we found very few operations that were still active. Here we studied two of the few remaining operational cases. Mozambique, on the other hand, has been the object of many LSLAs and many of them were implemented.

The analysis allowed us to identify four distinct patterns of impacts. Two of them are patterns that do not involve loss of land to local communities, since the land was originally accessed by earlier large landowners. However, conflicts around water arise in one of them (four cases in Kenya) – though these conflicts have been mitigated by policies aimed at restricting water use by large-scale farms. As they reflect intensive production models, the environmental impacts were also especially pronounced in this the second pattern. In the two other patterns, land is lost by local communities – albeit to varying degrees. In one of these latter two patterns (six cases in Mozambique and one in Madagascar), this loss of land creates acute conflicts and widespread hostility towards investors. In the other (two cases in Mozambique), however, this loss of land is at least partly compensated by job creation.

Overall, we found that the variations in impact patterns are associated a number of factors, in particular prior land use, operational farm size, labour intensity and main production type, employment levels, the experience in local agriculture or domestic origin of investors, accountability of government, land tenure security, and civil society capacity. By contrast, the destination market and juridical structure appeared to play less of a role. Notably, efforts stemming from global governance initiatives such as the VGGT did not make a difference in the impact patterns.

Two points merit special emphasis: First, our comparative assessment clearly shows the decisive role of land tenure. LSLAs are less likely to occur in places where local land rights are secure for smallholders, and are generally limited to areas where large landowners are transferring land rights to commercial investors. This was the situation found in Kenya, where the colonial government originally stripped local communities of their land and transferred it large land owners – namely, Europeans and later Kenyans. this land. In such contexts, smallholders find it difficult to obtain access to *new* land for their children or to enlarge their small plots, but their *existing* land rights are protected by legal titles. By contrast, in Madagascar or Mozambique – where land officially remains in the hands of the government while being used by traditional communities – acquisition of land by investors can strip locals of their land access.

Second, we found that the type of production plays a decisive role. Large-scale mechanized production models replace more livelihoods than the jobs they create. By contrast, business models requiring labour-intensive production – such as greenhouse production for export markets – create many jobs, but they tend to be low-paid. This should be considered when commercial agriculture and LSLAs are promoted in countries where job creation should be a priority.

Publication V: Why do large-scale agricultural investments induce different socio-economic, food security, and environmental impacts? Evidence from Kenya, Madagascar, and Mozambique

Large-scale agricultural investments transform land use systems worldwide. There is, however, limited understanding of how the common global drivers of land use change spur different forms of agricultural investment and produce different impacts on the ground. This article provides a cross-country comparative analysis of how differences in business models, land use changes, and governance systems explain differences in land investment-related socio-economic, food security, and environmental impacts in Kenya, Madagascar, and Mozambique. It synthesizes results from the Afgroland project that collected data in a multi-method approach via household surveys, business model surveys, semi-structured household interviews, life-cycle assessments of farm production, analysis of remote-sensing data, key informant interviews, and document analysis. For the project synthesis, we combined a collaborative expert workshop with a comparative analysis of 16 cases. The results show that the cases follow four distinctive impact patterns, ranging from widespread adverse impacts to moderate impacts. The results indicate that commercial agriculture can be a component of sustainable development strategies under certain conditions, but that these strategies will fail without substantial, sustained increases in the economic viability and inclusiveness of smallholder agriculture, as well as improved land tenure security, agro-ecological land management, and support for broader patterns of endogenous agrarian transformation.

Impacts on smallholders and the environment in the vicinity of large-scale agricultural investments

In one of the underlying studies for Publication V, we investigated the impacts of large-scale agricultural investments on nearby smallholders, land use, and the environment in the three countries. Many studies on such investments focus on the impacts directly on-site. Studies exploring off-site effects are relatively scarce. Our study was relatively unique in combining land-related interviews with smallholders in the vicinity of investments – on perceived changes to land use, land management, and tree-cover –

together with interviews on changes in the general environment and people's health, as well as on employment opportunities, infrastructure, and conflicts. These additional questions were designed to assess the general attitude of the smallholders towards investments and what they contribute (or not) to regional development. We used remote-sensing methods to generate complementary data to compare with the responses about land use changes occurring in the previous 15 years. Interpretation of the results showed a differentiated picture, highlighting distinctions between countries and between cases within individual countries. Interview responses suggested that changes in land use and land management are on-going in all the cases, especially regarding water management. A varying portion of households directly attributed these changes to the investments. Overall 38% of respondents reported changes in cropland management, and, of these, 41% believed that land investments were responsible for these perceived changes (including 87% of those respondents who reporting a change in Case 3).

Overall, the majority of impacts were perceived as negative. Perceived positive impacts included employment opportunities and increased security. Notably, despite the perceived negative impacts of LAIs (air and water pollution, water use, negative health impacts), the majority of respondents (55%) still preferred that the nearby LAI remain operational – though this differed greatly from case to case. Overall, the research showed clearly that the impacts of investments can differ greatly from one place to another.

Publication VI: Large-scale agricultural investments in Eastern Africa: consequences for small-scale farmers and the environment

Empirical evidence about the impacts of large-scale agricultural investments (LAI) in low-income countries is typically skewed towards assessment of economic benefits. How these investments affect land use and the environment is less understood. This study (Zaehringer et al., 2021) assesses how small-scale farmers living close to LAIs in Kenya, Mozambique, and Madagascar perceive their impacts on land use, land management, and tree cover. It also investigates their perceptions regarding LAI impacts on the general environment and people's health, as well as on employment opportunities, infrastructure, and conflicts. A total of 271 small-scale farmers were interviewed and their perceptions were complemented with remote-sensing-based analysis of land use and land cover changes. Results showed that LAIs contributed both directly and indirectly to deforestation in Mozambique, triggered changes in small-scale farmers' agricultural land management in Kenya (mainly due to less water availability), and caused pastoralists to lose access to grazing land in Madagascar. Despite some benefits from employment opportunities and infrastructure improvement, the majority of respondents perceived the overall impacts of LAIs as negative, highlighting reduced access to land and water, pollution, health issues, and unsatisfactory working conditions. We urgently need to invest in devising concrete transformative options to improve the contribution of LAIs to sustainable development in host countries.

Limited potential of LSLAs to improve the status and evolution of smallholder livelihoods

Publication VII focuses on the status and evolution of smallholder livelihoods in the case study area in Kenya, which is marked by an impressive cluster of commercial farms. The results show that even in this region characterized by numerous commercial agricultural investments and around 8,000 corresponding jobs (Giger et al., 2020), only a small fraction of local households (15%) actually have household members working on such farms. Contract farming was even less common (2%). Additionally, there are clear indications that both types of engagement with the commercial farms are frequently transitory and unstable, as the labour conditions and pay are not seen as sufficiently rewarding by local smallholders. Employed households tend to be younger, are more likely to be married, and have more children than those households that are not engaged with commercial farms. While these and certain other differences are statistically significant, they do not imply a causal relationship. For instance, we find that contract farmers have more livelihood capital: This may be a factor that enables them to work as contract farmers (more land, more livestock, better access to irrigation); or it could be an outcome of engagement in contract farming.

Overall, with the exception of the small group of contract farmers, the differences in household capital are relatively small. This is an interesting result: one explanation may be that the wages paid on the commercial farms are only slightly above minimum wage. This means they are better than some of the most precarious wages earned by households by other means, but remain well below other more attractive employment opportunities existing elsewhere. This explains why, in personal interviews, smallholders often portrayed commercial-farm employment as an option for younger people, as a safety net, or for those needing cash for particular purposes – for example, to earn school fees for children. In other words, employment on the commercial farms may not be a way out of poverty, but it provides a safety net that prevents some from falling into deeper poverty.

Our longitudinal comparison with household data from the same area showed that precarious livelihoods persist in the region, with only modest improvements occurring over the last 30 years. In addition, household land holdings are shrinking due to lack of access to new land and increasing population density. Further, we found only modest evidence of a transfer of technology from commercial farms to smallholders, aside from the production of selected horticulture crops and use of certain irrigation equipment. Agricultural inputs such as fertilizers and pesticides were purchased and used by all farmers; however, this cannot be attributed solely to the presence of commercial farms, but rather to the general liberalization of agricultural input markets in Kenya (Käser, 2018)

Publication VII: Smallholders' livelihoods in the presence of commercial farms in Central Kenya

We studied smallholder households in central Kenya in an area characterized by the presence of many large commercial farms. Our findings improve understanding of the potential impacts of strategies to promote commercial farming as a means to alleviate poverty in smallholder farming systems. We surveyed 375 smallholder households, compared them according to three categories (employed, contract farmers, households non-engaged with commercial farms), and constructed a livelihood index. The results show that contract farmers and households employed on farms only make up a small fraction of all smallholders in the area. Employed and non-employed households display little difference in overall livelihood levels. Results suggest that employment on large commercial farms is mainly a coping strategy for younger households or in times of need. Contract farmers were found only in a specific location and had better access to irrigation water and higher livestock holdings. Comparison with earlier data points to the persistence of precarious livelihood levels and household strategies aiming at diversification of activities, with little evolution over the last 20 years despite the presence of commercial farms. Overall, there is little evidence that proximity to commercial farms offers a way out of poverty for nearby smallholder farmers.

6. Synthesis and Outlook

Methodological considerations

The methodological work underlying the present collection and analysis of data at global level has significantly contributed to the creation of a more robust empirical basis for understanding of LSLAs. Though not exhaustive, the data are now used as a basis by numerous researchers working on this topic. It serves as a reference point to put more detailed investigations into perspective and is used as a frame to help target new research locations.

While global-level analysis using this dataset is a necessary and important step towards understanding the phenomenon of international land acquisitions, there are also constraints in terms of possible data biases, incompleteness of the data, as well as the persisting opaqueness of the sector and its possible distorting effects.

To address these challenges in the global dataset and to better understand the realities on the ground – including a multitude of local factors that can influence the process and outcomes of land acquisitions – it is indispensable to investigate the issue more locally. Insights from such local-level investigations can then be taken up in the global dataset. While this is currently done wherever possible, detailed research results on individual cases are currently – and will probably always – be lacking in many areas.

Therefore, the research for the present dissertation also aimed at investigating LSLAs at the local level. The approach of selecting three case study areas in three different countries, all belonging to the same continental sub-region (East Africa), proved useful and productive. It enabled understanding of the impacts of LSLAs taking into account a wide array of parameters (colonial history, land governance, bio-physical and social context, distance to global markets), while avoiding comparing cases from totally different contexts, which can preclude meaningful analysis of the factors shaping particular impacts. Further, having several case studies in each country proved useful in offering rich insights and avoiding simple conclusions based on single case studies. Admittedly, it is a challenge to investigate enough cases in each country applying the same study framework, especially with teams comprising different disciplines and different research organizations. The organizational and managerial demands on the research teams involved were quite high.

The present dissertation has tested and successfully applied a method to generalize insights beyond individual case studies. Formal concept analysis made it possible to capture a wide range of quantitative and qualitative data from diverse disciplines and teams and enabled identification of broad patterns of impacts and the drivers behind them (Oberlack et al., 2021). The study is part of an effort by a small but growing research community (Eisenack et al., 2021; Oberlack et al., 2019) aimed at developing methods to overcome limitations in generalizing impacts from individual case studies. In the present case, the approach proved suited to research topics that are multi-disciplinary in nature.

Nevertheless, measuring the impacts of LSLAs remains challenging. The complexity of socio-economic systems, and the absence of time-series data for many parameters preclude identification of causal relationships beyond the most direct effects such as conversion of land use, levels of water use, number of jobs created, or wages paid. Other equally important topics such as offsite impacts on food security, health, land management, livelihood assets, etc. depend on many other variables. At the same time, interviewing affected actors about their perceptions proved to be a very valuable method for exploring possible causal relationships. Response data could then be complemented or reinforced with data from land use monitoring via remote sensing or more quantitative data on household characteristics.

Thematic contributions

The present dissertation offers new insights for land science and other disciplines seeking to better grasp the phenomenon of LSLAs in the global South. Global analysis of LSLAs contributes to better and more detailed understanding of LSLA extent, regional patterns, trends in new acquisitions, implementation, and drivers of these phenomenon that link land systems in the global North and South. Notably, it has been shown that not only the pace of new acquisitions is important, but also the progress in LSLA implementation can have important impacts.

Our analysis revealed that LSLAs are important drivers of land use changes globally, and have major impacts on forests, biodiversity, water resources, land used by smallholders, and common pool resources. These land use changes are expected to increase as rising amounts of acquired land are put into production.

Regional comparison in Eastern Africa – between Kenya, Mozambique, and Madagascar – enabled more detailed analysis of the local context and different trajectories and impacts of LSLAs in the three countries. It shows clearly that LSLA patterns, drivers, and impacts can be very diverse even between three countries belonging to the same sub-region in Africa, and also between cases within one country. This should be considered in further research activities on LSLAs. Analysis of the nuanced patterns of impacts also suggests that there is a scope for improving LSLAs by enhancing their positive impacts and reducing negative ones.

The studies belonging to this suggest that LSLA benefits like job creation are not sufficient to overcome poverty in rural areas. Even near clusters of investments in Kenya that require a relatively high amount of labour, only a limited number of households are employed on commercial farms, as the number of jobs created is still small in comparison with the overall supply of labour. In addition, the salaries and work conditions are not attractive to many. Nevertheless, there are indications that the jobs created can act as safety net in times of need, enabling some households to avoid falling into deep poverty and food insecurity. Our study in Kenya showed that livelihood conditions in the vicinity of commercial farms were not substantially transformed over the course of three decades. We found some evidence of limited technology transfer with respect to water conservation – but many technologies used on commercial farms are not applicable or affordable for farmers without access to capital, skills, or larger landholdings. We conclude that government efforts to promote LSLAs are unlikely to improve conditions for smallholders in the region on their own. They need to be complemented with other programmes that can effectively reach smallholder households.

Reduced access to land and water caused partly by the LSLAs has been a persistent topic, leading to latent or acute conflicts. The present research shows that increasing the security of land tenure for smallholders is key to mitigate the adverse impacts of LSLAs. Our comparative assessment revealed that security of land tenure makes a crucial difference with regard to land acquisitions and their impacts. However, this also begs the question of how these land use rights can be better guaranteed where they are presently not secured. Additional research is needed to answer this question.

Household surveys and personal interviews with land users during the pilot studies enabled insights into local livelihoods and the perceptions of local actors regarding commercial investments. They revealed significant ambivalence towards commercial investors: while conflicts and constraints created by the presence of large investments are often clearly articulated, new income opportunities – as modest as they may be – are often seen as important either for households themselves or the community at large.

Our research on business models in Kenya focussed on an area marked by the dynamic development of commercial agriculture. It aids understanding of commercial investments and the determinants that shape these investments. The corresponding cluster of highly intensive farms is found in an area benefitting from excellent conditions for this type of production, in particular good climate, availability of water, infrastructure, and abundance of cheap labour. Comparative assessment with Mozambique and Madagascar showed that this type of setting found in Kenya cannot be easily replicated, due to different economic, social, and geographic conditions. The corresponding agricultural production in Kenya is mostly oriented towards consumers in Europe and the Gulf. Kenya is uniquely positioned for these markets with good air transport links and the possibility to produce during European winter. These ideal conditions are not found in Mozambique or Madagascar. Further, it would be a difficult, long process to create similar clusters of highly commercial farms in other countries, where such trajectories of commercial development have not taken place over decades.

Overall, the investors and business models behind LSLAs have received relatively little attention from researchers. Our investigation into the business models of commercial investment has provided a more detailed understanding of how these processes unfold and what local drivers influence the business models applied. In contrast to earlier findings (Boche and Anseeuw, 2013), the present research found that *technical* and *production*-related elements have a greater impact on the business model established, whereas institutional and financial arrangements play less of a determining role (Giger et al., 2020).

Contributions to policymaking

The key role of land rights in determining outcomes for local land users has been clearly shown in the different articles comprising the present dissertation. Safeguarding and reforming land rights continues to be highly relevant for policymaking. While the VGGTs are already celebrating their tenth anniversary in 2022, these guidelines have yet to be put into practice on the ground in most settings. Further, transparency regarding LSLAs is still largely absent on the side of investors and governments in the global North and South. The Land Matrix database is one of the tools to monitor the implementation of the VGGTs (Anseeuw et al., 2022).

The present research found that LSLA-related global frameworks are not having much impact at the local level, and they are scarcely known by local actors. Therefore, more efforts are needed to translate global frameworks like the VGGTs (*Voluntary Guidelines on the Responsible Governance of Tenure of Land Fisheries and Forests)* and PRAI principles (*Principles for responsible investment in agriculture and food systems*) (CFS-RAI, 2014; Cole, 2022) into tangible instruments that create real change. Researchers can facilitate such efforts by providing topical inputs and access to tools that can support training and capacity building.

Overall, we recommend that policies aiming at promoting agricultural investment prioritize investments that are labour-intensive, environmentally sustainable, and require only modest land resources. However, it must be understood that creating clusters of highly specialized commercial farms is a long-term process, in which many enabling factors need to present. The necessary conditions cannot be easily reproduced, as or examples of Mozambique and Madagascar have shown, and the pre-conditions and necessary policy instruments must be carefully assessed and implemented.

In all corresponding policies, the following elements should be guaranteed: respect for the land rights of local and indigenous people; free, prior, and informed consent (FPIC); respect for human rights; transparency over contracts and procedures; clear and binding agreements on employment; benefit sharing and compensation; participation of local stakeholders; and effective oversight and monitoring. It is my sincere hope that the activities of the Land Matrix Initiative, as well as those of other members of the research community dedicated to investigating LSLAs, will continue to make meaningful contributions towards greater transparency, enabling participation, and securing land users' rights.

Finally, while our results have revealed nuanced patterns of LSLA impacts on the ground, the global analysis has also shown that many deals take place in tropical forest areas. Considering the corresponding harms of deforestation with regards to our climate and biodiversity, LSLAs targeting tropical forest areas should be stopped entirely from the perspective of sustainable development.

Outlook

Stronger global governance and addressing the responsibility of investors from the global North are crucial elements of improved policies on LSLAs. However, better governance is also needed in the target countries where the land deals are implemented. Meanwhile, many of the target countries still perceive economic growth and reduction of poverty as their most important development goals, and see investments in commercial agriculture as important to achieve these goals – often even at the expense of indigenous people's land and remaining forests. A more balanced global economic regime providing other ways of increasing incomes for developing countries would go a long way towards enabling other political priorities. The necessary changes in the global economy and the global governance of trade and financial flows go far beyond the governance of LSLAs and are outside the scope of this dissertation. The problem ultimately needs to be addressed through a transformation of the global economy and society, thereby limiting the ever-growing demands for land and water. This would imply major changes in the global food system, in particular.

Overcoming poverty and supporting transformations to sustainable development simultaneously represent a comprehensive agenda. Addressing issues of land governance and land acquisitions remain key to this agenda.

Unfortunately, the research goal pursued by the present dissertation continues to be as relevant as ever in policymaking at the global and national level. The recent steep rise in commodity prices caused by the Russian invasion of Ukraine, and its effects on global food and energy markets, could trigger a replay of the land rush of 2008–2012. As a result, it will be necessary to continue to monitor the process of land acquisitions in this new context.

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LAND MATRIX

Few development benefits, many human and environmental risks

Taking stock of the global land rush

Analytical Report III | 2021

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The Land Matrix Initiative's parters are:

UNIVERSITÄT BERN
CDE CENTRE FOR DEVELOPMENT AND ENVIRONMENT

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

GIGA German Institute of Global and Area Studies
Leibniz-Institut für Globale und Regionale Studien

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

INTERNATIONAL LAND COALITION

Asian Farmers' Association for Sustainable Rural Development AFA

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Acronyms

AFA	Asian Farmers' Association for Sustainable Rural Development
ASEAN	Association of Southeast Asian Nations
CDE	Centre for Development and Environment
CED	Centre for Environment and Development
CIRAD	Centre de cooperation Internationale en Recherche Agronomique pour le Développement
CFS	Committee on World Food Security
CSO	Civil society organisation
DFI	Development finance institution
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FDI	Foreign direct investment
FPIC	Free, prior, and informed consent
FSC	Forestry Stewardship Certification
FUNDAPAZ	Fundación para el Desarrollo en Justicia y Paz
GC-LTS	Global Index of the Governance Context for Land Tenure Security
GIGA	German Institute for Global and Area Studies
GIS	Geographic information system
GIZ	Gesellschaft für Internationale Zusammenarbeit
HCV	High Conservation Value
ILC	International Land Coalition
ILO	International Labour Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
LMI	Land Matrix Initiative
LSLA	Large-scale land acquisition
MENA	Middle East and North Africa
MODIS	Moderate Resolution Imaging Spectroradiometer
NGO	Non-governmental organisation
NLO	National Land Observatories
RAI	Principles for Responsible Investment in Agriculture and Food Systems
RFP	Regional Focal Point
RSPO	Roundtable on Sustainable Palm Oil
RTRS	Roundtable for Responsible Soy
TLIC	"Turning Land into Capital" policy
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure

The Land Matrix Initiative and the scope of this report

The Land Matrix Initiative (LMI) is a partnership between the Centre for Development and Environment (CDE) at the University of Bern, Centre de cooperation Internationale en Recherche Agronomique pour le Développement (CIRAD), German Institute for Global and Area Studies (GIGA), Gesellschaft für Internationale Zusammenarbeit (GIZ), and International Land Coalition (ILC) at global level, and the Asian Farmers' Association for Sustainable Rural Development (AFA), Centre for Environmental Initiatives Ecoaction, Fundación para el Desarrollo en Justicia y Paz (FUNDAPAZ), and University of Pretoria at regional level.

Established in 2009[1] to address the gap in robust data on the real extent and nature of the "global land rush", the LMI has evolved into an independent land monitoring initiative that promotes transparency and accountability in decisions over large-scale land acquisitions (LSLAs) in low- and middle-income countries in response to the need to monitor such complex investment flows. We do this by collecting, capturing, and sharing data about LSLAs at global, regional, and national level on our online open access platform. Our four Regional Focal Points (RFPs), located in Africa, in Asia, Eastern Europe, and Latin America, as well as our National Land Observatories (NLOs) in Argentina, Cameroon, Philippines, Senegal, and Uganda are responsible for data collection in their respective regions. Generally, we collect data for deals targeting agricultural production, timber plantations and extraction, carbon trading, industry, renewable energy production, conservation, and tourism in low- and middle-income countries. Specifically, we record transactions that entail a transfer of rights to use, control, or own land through sale, lease, or concession; that cover 200 hectares or more; and that have been concluded since the year 2000. We also mostly consider land deals that imply the potential conversion of land from smallholder production, local community use, or important ecosystem service provision to commercial use. In this report, however, we also include those deals targeting land formerly used for commercial agriculture in order to ensure that LSLAs in Eastern Europe and parts of Latin America are not under-represented. To allow for meaningful comparisons across regions, we focus on transnational deals in the agricultural sector. While there has been an increase in the number of domestic and non-agricultural deals recorded in the database, the coverage of these data are not yet sufficiently developed. In addition, as intended and failed deals are inherently difficult to verify, unless specified otherwise, most numbers presented in this report only refer to concluded deals, given their high level of reliability. Concluded deals are defined as deals where we have credible reports about an oral agreement or a signed contract. Nevertheless, since other stages of the negotiation process do impact communities and have socio-economic and environmental effects, we dedicate certain parts of the report to the analysis of the evolution of LSLAs, including intended and failed deals.

Finally, deals are only included in our public database if the country is listed and there is information on at least one investor name, one data source, and either the intended, contracted, or operational size. This explains why our database is not exhaustive, although we strive to get much more precise and complete data on each deal where possible. We discuss data coverage limitations further in Chapter 1, Box 1.

This report is based on a snapshot of the data available in our database taken on 20 August 2020. Since the database is continuously updated and data quality improved, the exact numbers and information available in this report will differ from the information available on the website currently. Our data is open-access and can be accessed through www.landmatrix.org. Please refer to our frequently asked questions at www.landmatrix.org/faq for a list of the countries we actively monitor, or to find out more about how we capture, analyse, verify, and use the data.

[1] *The first version of the database was launched in 2012.*

EXECUTIVE SUMMARY

More than 10 years after the surge in large-scale land acquisitions (LSLAs) in developing countries following the spike in agricultural commodity prices in the late 2000s, the Land Matrix Initiative has taken stock of the "global land rush" and its socio-economic and environmental impacts. Our findings draw on evidence from the Land Matrix database as well as a literature review in order to analyse and better understand the wide-ranging effects of LSLAs.

The results of our review and complementary analyses are sobering, in part alarming. Compliance with the principles of responsible business conduct is rare, and scant consultation with the affected communities is common. The non-consensual and uncompensated loss of land often comes with only little socio-economic benefits – be they employment, positive productivity spillovers, or infrastructure. "Business-as-usual" continues to destroy rainforests, natural habitats, and biodiversity on the agricultural frontiers of the Amazon, Southeast Asia, and the Congo Basin. Although progress has been made with regard to land governance, a lack of policy implementation in this area is evident. This is particularly apparent from our assessment of the application of the Voluntary Guidelines on the Responsible Governance of Tenure (VGGTs) and the transparency of land acquisitions.

While the development community has different views on desirable or feasible patterns of rural development and which instruments, policies, and priorities are required to achieve this in a sustainable way – views which are echoed within the Land Matrix Initiative and among the authors of this report, based on the evidence we have collected, we have reached a consensus that, by and large, LSLAs have not delivered on their promises for rural development.
As the ongoing implementation of LSLAs continues to pose significant threats to rural livelihoods and natural habitats, swift and decisive action is needed to protect both. To address the failings of LSLAs to date, we recommend policy changes in five priority areas:

1. Land governance reforms and their effective implementation, based on the VGGTs, should be pursued and fast-tracked by governments. Implementation of and follow-up on the VGGTs should be made a prerequisite imposed by all donors and investor countries for land- and agricultural-related financial support or investments. In this way, key risks associated with LSLAs can be addressed and effective land policy reform assured. Policy compliance and effective implementation should be secured through national and local multi-stakeholder engagement platforms. Importantly, these platforms need to be strengthened and supported by governments and donors.

2. Local development should take centre stage, with a focus on spillovers to and the inclusion of smallholder farmers. Not only do LSLAs need to comply with the principles of Responsible Investment in Agriculture and Food Systems (RAI), but host governments also need to develop and implement a strategic approach to rural development that pays more attention to local endogenous growth patterns and to positive spillovers for broad-based rural development. In particular, targeted measures should enhance benefits for smallholder farmers, and local development in affected areas should be prioritised.

3. International investment treaties must integrate human rights and environmental provisions, and human rights due diligence should be mandatory. To change the conduct of businesses, human rights and environmental provisions that reflect the specific risks of LSLAs should be included in international investment treaties. Further, we support the introduction of mandatory sustainability due diligence legislation. However, such legislation can only lead to more responsible land-based investments if the affected populations are able to use it effectively in the context of LSLAs. Relatedly, it is of the utmost importance that the participation of citizens, parliaments, and civil society in discussions about the treaties and frameworks that concern human and other basic rights in LSLA contractual arrangements is supported and encouraged.

4. LSLAs that lead to deforestation, the conversion of other valuable natural habitats, or damage important carbon stores such as peatlands need to be stopped. Host governments must develop comprehensive landscape plans that address the trade-offs between environmental, economic, and social objectives. Drastic action is urgently required – for example, through moratoria. Such measures can be incentivised by the international community with benefits such as climate funding. Environmental governance around the risks associated with LSLAs, including the emergence of zoonotic diseases and declining water resources, also needs to be improved through stricter environmental impact assessments, broader planning approaches, and new methodologies.

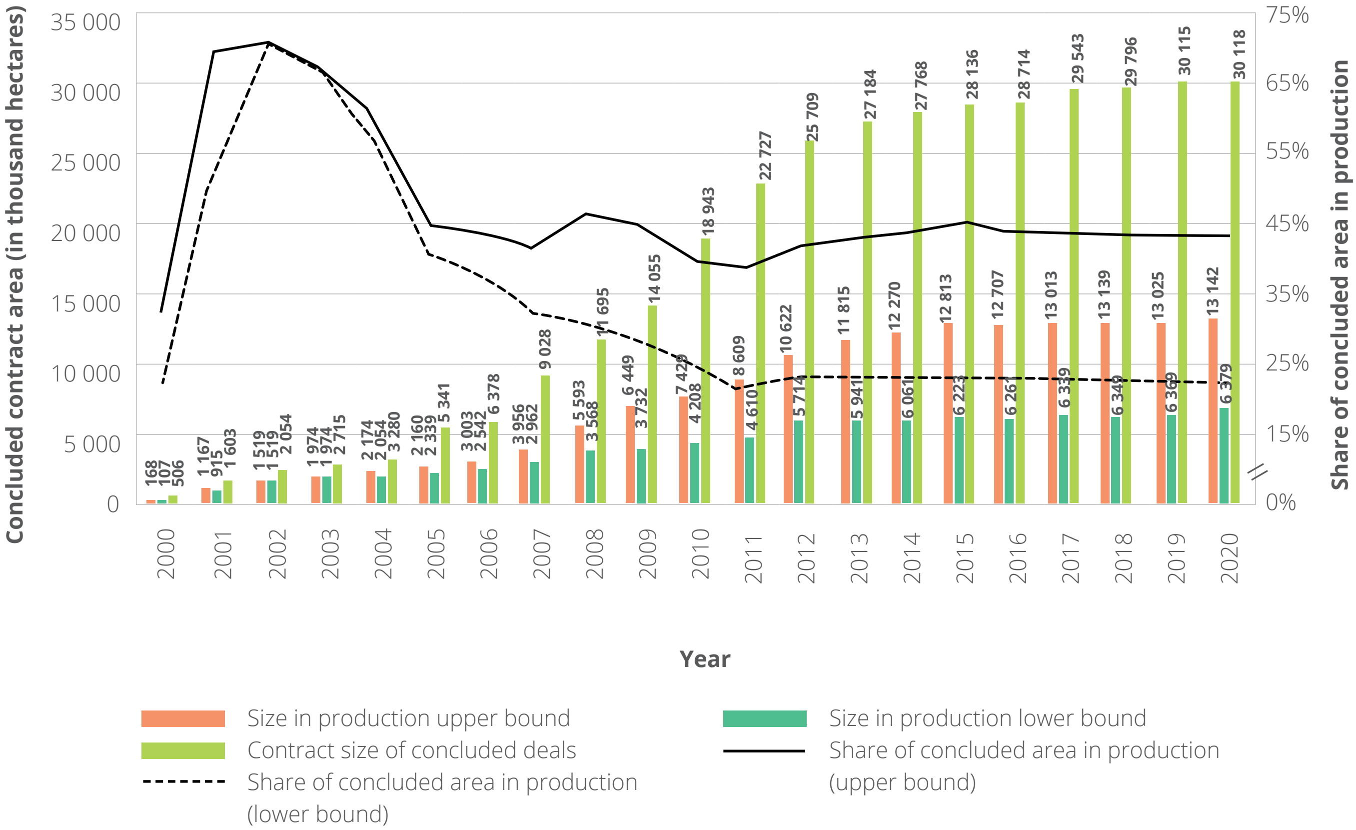
5. Binding commitments to increase transparency are needed, for all stakeholders. Transparency should be increased by, firstly, making it mandatory if public capital is involved; secondly, supporting independent transparency and monitoring initiatives; and thirdly, monitoring land ownership, land transactions, and land-use change at the local level. We call on all stakeholders to step up their efforts. Target countries should draw up transparent land-based contracts guided by the VGGTs and RAIs; commodity fora should apply transparency requirements to their members; and donor countries should support independent transparency and monitoring initiatives, including those at the local level.

Main findings of the report

After a decade of gradually declining LSLAs, is a new land rush in the making? The analysis of the Land Matrix data presented in this report clearly reflects a surge in LSLAs in the wake of the commodity price hike of 2007/08, which saw investors hastening to secure land worldwide. This rush for land plateaued after 2010, and since 2013, deals totalling approximately 3 million hectares (ha) have been captured in the database compared to the total volume of 33 million ha for the 1 865 deals recorded by 2020 (of which 1 560 deals with 30 million ha are concluded). More moderate price expectations could be one reason for the slowdown in additional LSLAs after 2013, but policies have also changed. These include land moratoria in important target countries, dwindling support for first-generation biofuels, and restrictions on selling land to foreign investors in some cases.

However, the pendulum may well swing back again as economies try to recover from the pandemic-induced economic crisis. Restrictions could be lifted and more favourable economic conditions – possibly a new "commodity super-cycle" driven by the post-COVID economic recovery – could once more accelerate global LSLAs. Indeed, some countries, including Indonesia and India, have already liberalised their land markets to attract foreign investments.

Figure 0.1: Cumulative global contract size of concluded deals over time and size under production (left axis) and share of concluded size under production (right axis)



Notes: Calculations based on Land Matrix data. The lines show the upper and lower bound of the share of contract size (excl. failed deals) in production. The bars show the absolute size per negotiation status per year. Note that in addition to the accumulative size in production by 2020 there is an additional size in production without year information between 1.6 (lower bound) and 8.2 (upper bound) million hectares.

The slow but steady implementation of land deals can be observed, with many also being (re)negotiated, transferred, or abandoned. The report has also uncovered **huge regional variation** in implementation rates. Since 2012 – taking into consideration an upper- and lower-bound estimate due to incomplete information on the exact size of the area under production and the additional area under production without year information – we estimate that between 30% and 73% of the contracted land has been put into production. These figures show that the LSLAs documented by the Land Matrix since the year 2000 had, by 2020, put an area of somewhere between 8 million ha, comparable in size to Sierra Leone or Austria, and 21 million ha, equivalent in size to Ghana or Great Britain, into agricultural production. They also imply that between 9 million and 22 million ha of the 30 million ha of land currently acquired by investors have not yet been used for production. In many world regions, especially sub-Saharan Africa, the Asia-Pacific region, Europe and Central Asia, deal implementation has been slow in the 10 years following the global land rush.

Delays in land deals often result from long negotiation phases, while deal implementation proceeds quickly following deal conclusion. Although land deals remain in the negotiation phase for 6.6 years on average, once a deal is concluded, investors (in 64% of the cases) generally start production in the same year. The effects of the different timing and trajectories of land deals are not known, and the reasons for the delays are not always clear. In some cases, delays occur because careful consultation with local communities draws out the process, but in others, they are due to technical and management challenges on the part of investors.

Deal failures are significant and grounded in the jatropha hype and other ill-conceived investments. The hasty acquisition of land (often that which is used by local farmers and pastoralists) for ill-planned projects in the aftermath of price spikes led to a significant number of project failures, particularly in sub-Saharan Africa, which accounted for half of all failed deals. Failed deals may cause lasting harm, especially if they involve conflicts over land. The reasons for failed deals vary, from miscalculations and misconceptions in planning and management to "realities on the ground", which include financing problems, the underestimation of set-up costs, and agronomic difficulties. However, one crop stands out as "attracting" such problems: 50% of the deals intended for jatropha cultivation, again mostly in sub-Saharan Africa, have failed to date.

LSLAs are related to big global business that focuses on international commodity markets. Oil palm-related LSLAs recorded in the Land Matrix database account for more than 20% of the area currently cultivated with this crop worldwide, a share which is also well above the 10% (of currently cultivated area) for rubber and sugar beet and the 5% for sugar cane. This demonstrates how substantially LSLAs have already added or will add to the global production of these crops. For staple crops, on the other hand, the shares are much lower. Estimates reveal, for example, that fully implemented LSLAs for maize, rice, or wheat would make up less than 1% of the globally cultivated area. However, in absolute terms these crops still cover large tracts of land – approximately 2 million ha each for maize and wheat.

Investors are diverse and truly global, originating from the North, the South, and tax havens. In addition to hailing from both the global North and the global South, many investors operate through investment hubs, many of them tax havens, thus obscuring their "real" origin. This explains why the top-10 investor origins include countries such as Cyprus (in fourth place), Singapore (seventh place), the British Virgin Islands (eighth place) and Hong Kong (ninth place). Other top investor countries are developing countries with competitive agricultural sectors, like Brazil and Malaysia, and high-income countries such as Great Britain, the Netherlands, and the United States. China also features, having climbed up the ladder to third place among the top investor nations over the last few years. However, contrary to the widely held belief that sub-Saharan Africa is the primary target for investors from China, only 23% of deals with Chinese investors actually occurred in this region. In fact, Chinese investors are far more active in neighbouring countries such as Cambodia, Laos, and Myanmar, with 54% of deals with Chinese involvement taking place in one of these three countries.

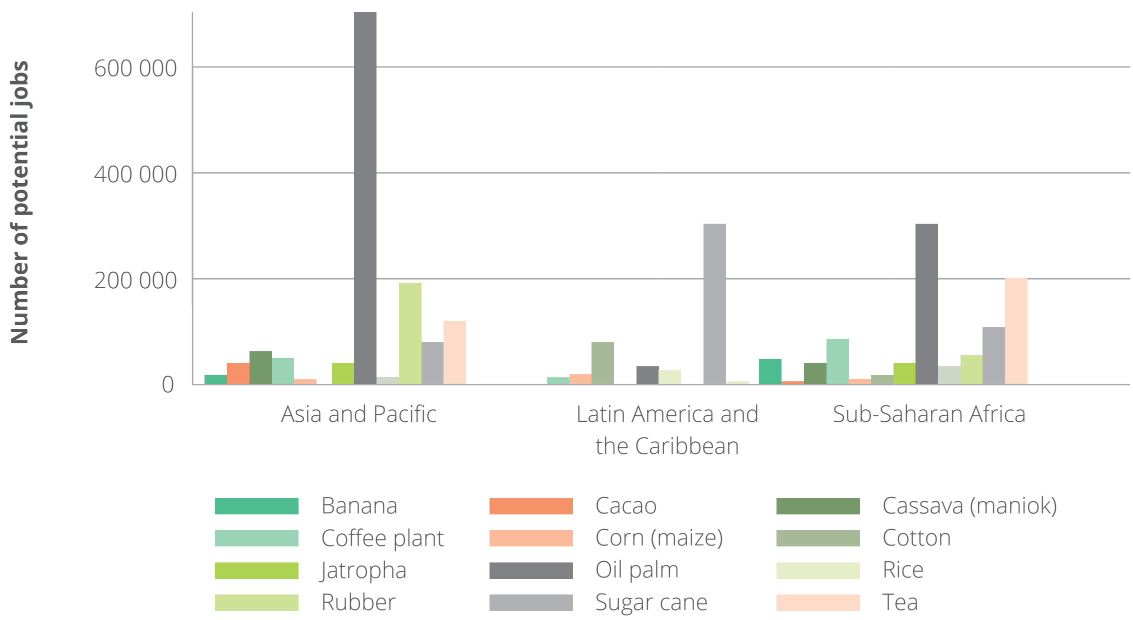
LSLAs occur regardless of the degree of land tenure security. While the literature confirms that land tenure security clearly plays a role in investors' interest in specific deals, no linear relationship exists between the locational choice of investors and land tenure systems at the country level. In contrast to the case for other forms of foreign investment, land-based investments can frequently be found in countries with weak institutions. Indeed, in such contexts, LSLAs may lead to increased corruption and competition for land, particularly with locals whose land rights are less protected.

The land targeted by investors is often already used by smallholders, leading to competition over land and displacement without consultation or compensation. According to current Land Matrix data, in at least 18% of concluded deals, the land (or part of the land) was previously or is currently used for smallholder agriculture, pastoralism, or shifting cultivation. When combined with weak tenure security, this frequently leads to one of the most adverse outcomes of LSLAs: the displacement of local communities. Such displacement, as well as other forms of conflict, could be avoided through proper consultation. However, as the report shows, consultation on LSLAs is inadequate in most cases. Indeed, for the more than 250 deals globally for which the Land Matrix has information on consultation, only 15% report that free, prior, and informed consent (FPIC) was given, while almost 45% report no consultation whatsoever.

LSLAs often exacerbate the weaknesses of land governance systems since they affect tenure security and the perception of it, particularly with regard to customary land and collective land rights. Indeed, the exclusion of local communities from their land, as well as from the decision-making processes and institutions governing the land, are putting enormous strain on land rights and governance systems. In many countries in Africa, for example, customary rights will be lost permanently, often leaving institutional voids. LSLAs can also induce institutional, structural, and practice-based changes, such as contract farming or tenure formalisation, which may reinforce pre-existing inequalities that fuel land insecurity and conflicts.
The emerging evidence on the socio-economic development impacts of LSLAs suggests that **the rural development expectations have remained largely unfulfilled** and that the promises of jobs, rural infrastructure, and positive spillovers to smallholders have been broken, particularly in sub-Saharan Africa. **There is only limited employment creation due to the low labour intensity of production on most large-scale farms.** Depending on the crops and locations, our assessment of the effect of LSLAs on the quantity of rural jobs highlights that the net employment effects of large farms may be relatively small, or even negative, when LSLAs replace smallholder farms. Only highly labour-intensive crops, such as vegetables and roses, can replicate the labour intensity of smallholder farms (estimated at two permanent jobs per ha) at scale. In contrast, highly mechanised production – for example, in South America – employs one worker on approximately 100 ha, while semi-mechanised production in India employs one worker on approximately 7 ha.

Only a few crops generate significant employment. One such crop is oil palm, the cultivation of which is relatively labour intensive. Since this crop covers large tracts of land in Southeast Asia in particular, and increasingly in sub-Saharan Africa, it could potentially create close to one million jobs worldwide if the LSLAs are fully implemented. Rubber, another relatively labour-intensive crop, could generate up to 200 000 jobs in Southeast Asia, while in Latin America, sugar cane

Figure 0.2: Potential employment creation through LSLAs by crop type



Notes: Calculations based on Land Matrix data. For the selected crops and regions, the total area is 13 168 545 ha.
Only concluded deals are included, with the exception of abandoned deals. We only show data for crops with a potential employment creation larger than 50 000 and not less than 15 concluded deals in the selected regions.

could create a further 300 000 potential jobs. The employment impact of other crops is generally lower at the country or global level, either due to the relatively small area, as is the case for cocoa, coffee, and tea, or due to low labour intensity, as is the case for most staple crops such as barley, sorghum, teff, and wheat. Most rural labour markets will therefore not benefit significantly from transnational LSLAs, except in some less densely populated countries – for instance, the Democratic Republic of Congo, Gabon, Laos, Namibia, and Papua New Guinea – where LSLAs hold some promise because the job creation potential relative to the labour force is high. On average, though, less than 0.5% of the national workforce will be employed on acquired land in most countries.

LSLAs are not a remedy for precarious labour markets since temporary and underpaid jobs prevail. The limited evidence focusing on LSLA job quality indicates a trend towards less permanent salaried work, except for the few management positions, and a greater reliance on casual temporary work. While these temporary jobs may help diversify the income portfolio of the local population, they can only serve as an additional source of income alongside other permanent sources of income. Nevertheless, exceptions to this rather bleak assessment have been documented, including formal work in Kenya's horticultural sector and in selected soya production projects in Mozambique. It is important to note that there is often a gender dimension to LSLA labour demand. For example, while horticultural production in Kenya and Ethiopia predominantly uses unskilled female labour, oil palm (Indonesia) and sugar cane production (Liberia) is more male labour intensive.

Positive spillovers to smallholders are rare due to the inadaptability of capital intensive and scale-dependent new technologies. Evidence on spillovers from newly established large-scale farms for grains and staples in sub-Saharan Africa suggests that they are extremely limited, and only moderately positive overall. This holds in particular for crops with larger yield gaps between smallholders and large-scale farms, such as maize production in Zambia where smallholder yields increased by 20% if farms were located near large-scale farms. In the oil palm sector on the other hand, smallholders, particularly in Southeast Asia, quickly took up the newly introduced oil palm, given that it is highly profitable even on a small scale. In Indonesia, smallholders currently account for over 40% of the total oil palm area. However, in many cases, new technologies are not adaptable to the small plots, limited budgets, and traditional skillsets of smallholder farmers. Although contract farming arrangements can help overcome some of these constraints, such arrangements are only found in 15% of the concluded deals captured in the database. Moreover, contract farming may not always be beneficial for smallholder farmers because of unequal risk-sharing and high costs. There is also very little evidence on spillovers through local land, labour, and product markets, such as the depression of local crop prices for staples such as maize. Indeed, there is some evidence from West Africa on potentially adverse impacts on local smallholder farmers through the labour market due to increased wages for hired labour.

The expectation that large-scale land-based investment would improve social and physical infrastructure has remained unfulfilled. Just 15% of the concluded deals recorded in the Land Matrix have information on the benefits promised in terms of infrastructure development, and of these, in only half of the cases have these benefits actually materialised on the ground. Even so, these data should be interpreted with caution due to potential under-reporting. Furthermore, LSLAs bring little to no tax revenue. Companies are often exempted from customs duties, income, and excise taxes, and sometimes even receive subsidies. If at all, tax revenue comes from the one-off sale of licenses and concessions. In fact, some companies even "optimise" taxes, for example, in Ukraine, where Land Matrix data reveals that countries such as Cyprus and Luxemburg, which are known for low corporate taxes, are the primary location of investors.

Under specific conditions, LSLAs can lead to poverty reduction, but the bulk of them do not. In sub-Saharan Africa, the evidence suggests that the effects of LSLAs on poverty will be very limited, if not poverty-augmenting. In Asia, however, empirical evidence suggests that the oil palm sector, the primary target of investments according to the Land Matrix, has lifted millions of Indonesians out of poverty, while in Laos, LSLAs focused on various crops have contributed to poverty reduction. Both cases suggest that LSLAs are associated with poverty reduction when smallholders are included, farmers in the target region have the skillset to adopt the newly introduced crops and technologies, , and LSLAs do not compete for smallholder and pastoral lands. The latter, however, often means that LSLAs encroach on non-agricultural land, such as forests, as has been widely documented with respect to the oil palm sector.

Local elites often control the redistribution of land, thereby reinforcing inequality. LSLAs have, to date, received little attention in terms of their inequality effects. On the one hand, there is some evidence that local elites can take advantage of the redistribution of land or compensation, thus reinforcing pre-existing inequalities. On the other hand, recent research indicates that employment and labour market effects could favour relatively poor households with little land, which may have positive distributional effects.

LSLAs have a limited impact on food security and cause competition for land to increase. Export-oriented LSLAs, particularly when related to biofuel production, have often been associated with threats to food security in target countries as they compete with food production for scarce resources. The empirical evidence on such effects is, however, ambiguous. For example, at the household level, the effect of specialised cash crop production on local dietary diversity is negative, but the effect tends to be small in size. In addition, positive income effects, such as income from cash crops or wage employment, partly counteract the potential losses in dietary diversity. Still, in certain settings where food markets are not easily accessible and income-generating activities are rare, on-farm production diversity may remain important for local food security.

LSLAs continue to be a key deforestation threat. LSLAs are a core driver of land-use change, contribute substantially to deforestation, habitat destruction, and land degradation, and, consequently, are associated with massive losses of biodiversity and high carbon emissions, particularly when tropical rainforests are affected. This grim assessment is supported by our own analysis, which combines Land Matrix data on international LSLAs with data on forest cover. Looking at data from 964 geo-located land deals in tropical regions with a total contract area of 19 million ha, we have found, for example, that whereas approximately 9.4 million ha were still forested in 2000, this area had been reduced by 20.2% (1.9 million ha) by 2019.

East Asia shows continued forest loss, tropical rainforests are at risk in sub-Saharan Africa, and old and new agricultural frontiers have emerged in Latin America. Some LSLA target countries, including Brazil and Indonesia, have been hotspots for deforestation for decades, but LSLAs have also created new deforestation frontiers worldwide. In East Asia and the Pacific, for instance, approximately 74% of the area around the location of the deals was still forested in 2000, a share which has declined by 16 percentage points over the past 20 years (mainly through oil palm expansions in Malaysia and Indonesia, but also through new agricultural frontiers in Cambodia, China, Laos, and Vietnam). Although deforestation rates have generally been lower in sub-Saharan Africa to date, partly due to the slower pace of LSLA implementation, tropical rainforests in Africa are presently also at risk. This is particularly the case at new frontiers, with huge deforestation threats in the Congo Basin and West Africa (specifically in Côte d'Ivoire, Liberia, and Sierra Leone) – often supported by deliberate government policies.

Of grave concern, many deforestation impacts from LSLAs are still expected. Our spatial analysis shows that, based on a 50% tree-cover threshold, approximately 39% of the total LSLA area was still forested in 2019; however, as many LSLAs begin to move into implementation, an imminent threat for remaining forests looms. **With increasing deforestation and damage to other ecosystems, biodiversity is equally affected.** Our data shows that 87% of LSLAs are located in regions of medium-to-high terrestrial biodiversity, of which 39% fall, at least partially, within biodiversity hotspot areas. The current pattern of LSLAs, which generally sees deals concentrated in tropical areas (where endemic diversity is higher), is harming global biodiversity far more than if these deals were located in more temperate climates. **The link between LSLAs and pandemic risks is another reason for concern.** Several mechanisms accompanying agricultural deals may contribute to the emergence of zoonotic diseases, and whole outbreaks of these diseases are seldom, if ever, factored in when assessing the benefits and costs of agricultural investments. Initial estimates indicate that the costs of a change in policies by creating incentives that reduce deforestation and wildlife trade – and thus the risk of pandemics – could be low compared to the cost of a pandemic.

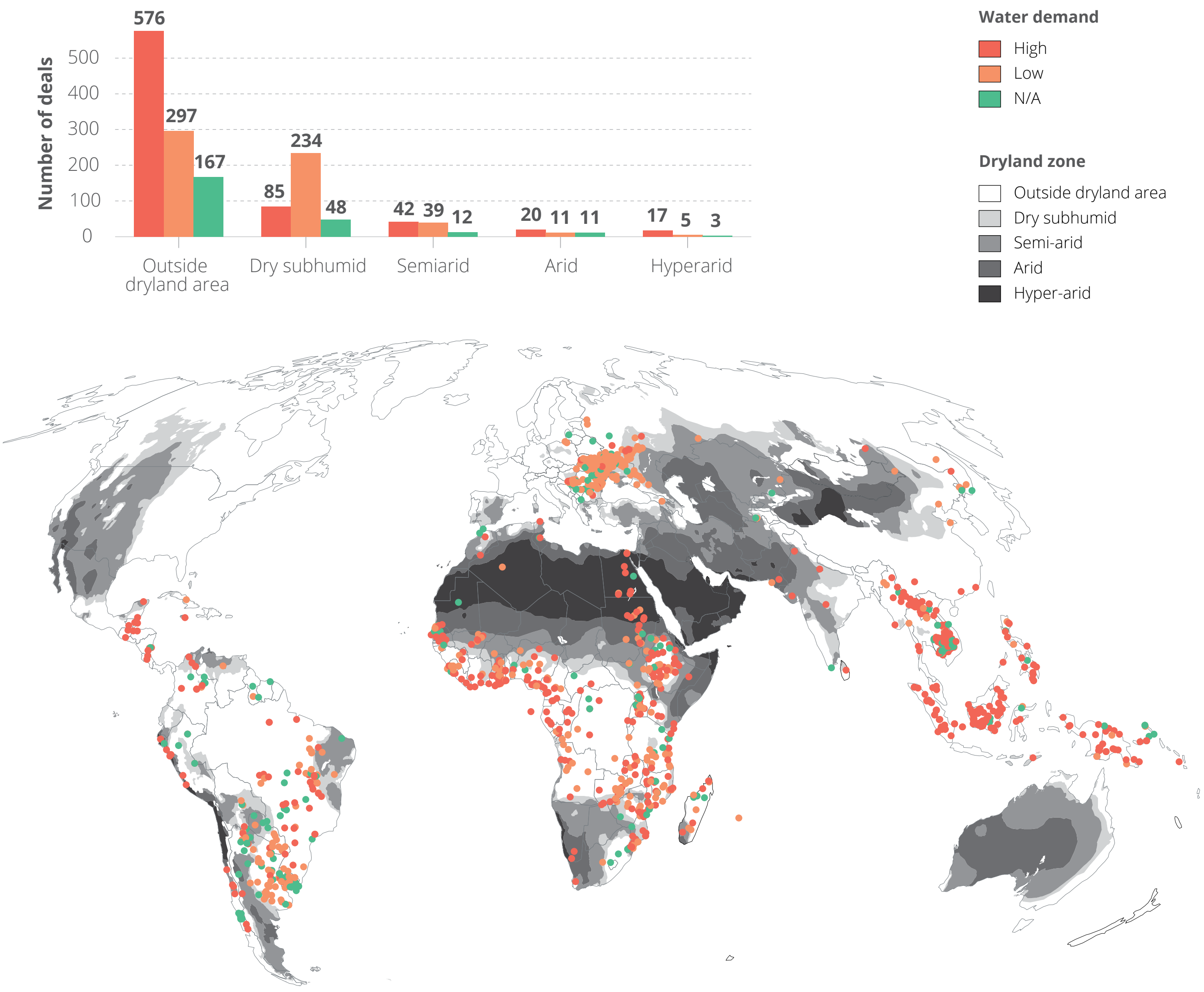
LSLAs frequently produce crops requiring a large amount of water – even in dryland zones. Water resources are an important dimension of the potential environmental consequences of land acquisitions, as starkly illustrated by the fact that 54% of all deals recorded in the Land Matrix database are intended to produce water-intensive crops, including cotton, oil palm, rubber, and sugar cane. Worse yet, 34% of these deals take place in dryland zones, with 10% of them producing crops that require large amounts of water. The intensive use of water for LSLAs can also have negative environmental impacts in humid areas due to significant changes in the hydrological cycle through the conversion of rainforests to agricultural land. However, in many dryland areas, such as the Nile region, water-intensive crops like cotton, fodder, potatoes, and sugarcane have the added issue of being likely to cause increased competition and conflict between different users, sectors, and even countries.

This report clearly shows the urgent need to rethink LSLAs. The current practices of large-scale agricultural investments need to be transformed into responsible and sustainable contributions to economic and social development that respect human rights and the environment. In addition, our report shows the necessity of promoting broad-based rural development and endogenous growth patterns with clear priority given to smallholder development. In order to achieve these goals, fundamental changes in the conduct of both domestic and international businesses, as well as dedicated and targeted efforts by investor and host-country governments, are required. Although progress has been made with the VGGTS and RAIs, much remains to be done at all levels, from global to local, to effectively ensure that land rights are protected, social development in target regions is enhanced, and the environment is respected.

The implementation of the VGGTs and associated principles at the country and deal level remains low. Our analysis shows that in Africa, for instance, almost one-third of the deals assessed do not comply with the VGGT guidelines and standards at all, and only 25% are considered to have achieved the minimum compliance. Additional analyses on the transparency of land deals in other regions show a similar picture.

LSLAs remain opaque due to the lack of information emanating from the local level in target regions, as well as investors, including those from the bigger and

Figure 0.3: Water demand categories of crops cultivated in LSLAs and dryland zones



Notes: Water demand categories based on Johansson et al. (2016) (High: > 8 500 m3/ha; Low: <= 8 500 m3/ha; NA: Crop demand not classified). Map background showing different dryland zones (in grey). LSLAs: n=1 568.

most developed countries, failing on transparency. Even though some publicly accessible information regarding LSLAs is provided by companies and governments from G20 member states, detailed analysis of Land Matrix data shows that the operating company is known in less than 20% of deals, the exact location of the land investments is communicated to the public in only 15% of all G20 deals, and less than 10% of investors publish the purchase price or leasing fee. Regardless of prior efforts by the G20, to date its member states are no more transparent on average than non-G20 investing and target regions. Indeed, despite the continuous and rigorous efforts of the Land Matrix Initiative over the last 10 years, the persistent shortcomings in the data confirm that there is a dearth of reliable information around the processes of LSLAs, in all countries.

Our report provides 11 specific policy recommendations for the road ahead.

Policy recommendations

Recommendation 1:
All governments need to pursue and fast-track land governance reforms and their effective implementation based on the VGGTs.

Recommendation 2:
Governments should utilise national and local multi-stakeholder engagement platforms to ensure policy compliance with regard to land management and investment.

Recommendation 3:
Land deals and their related projects need to comply with RAI principles and put local development centre stage.

Recommendation 4:
Governments need to develop and implement a strategic approach for land-based investments that pays more attention to positive spillovers for broad-based rural development, particularly through spillovers to and inclusion of smallholder farmers.

Recommendation 5:
Human and other basic rights (right to food, right to water, right to land), as well as aspects related to the environment, need to be included in international investment treaties.

Recommendation 6:
Mandatory human and other basic rights due diligence legislation should be introduced and affected populations should be empowered to effectively use such legislation in the context of LSLAs.

Recommendation 7:
LSLAs that lead to (or might lead to if implemented) deforestation, the destruction of other valuable natural resources or habitats, or damage to important carbon stores need to be stopped.

Recommendation 8:
Governments should develop comprehensive landscape plans that address the trade-offs between environmental, economic, and social objectives, and in which the purpose, role, and dimensions of LSLAs are clarified.

Recommendation 9:
All actors engaged in large-scale agricultural investment projects must increase transparency; indeed, when public capital is involved, it should be made compulsory.

Recommendation 10:
Donor countries should provide a mandate to and support independent transparency and monitoring initiatives.

Recommendation 11:
All countries should, at the local level, continuously monitor land ownership and control, land transactions, and land-use change.

4

Environmental impacts of LSLAs:
The looming threat to forests and water resources

LSLAs are commonly justified on the grounds that they establish 'modern', highly productive agricultural systems based on intensive – usually year-round – cultivation in contrast to more traditional production systems (Giger et al., 2019). However, these systems – typically monocultures – often also result in land conversion from natural habitats, either directly caused by the land deal itself or indirectly by pushing local people or bringing migrants to frontier areas – and are associated with a number of environmental changes and potentially negative impacts (Haggblade et al., 2017; IARC, 2017; Sharma et al., 2019; WHO & IPCS, 2010). These range from land use change, deforestation, and biodiversity loss, to greenhouse gas emissions, local climate change, and impacts on water resources (Zaehringer et al., 2021). In this chapter, we discuss these environmental impacts, focusing on land use changes and deforestation, as well as the related effects on water resources.

4.1. Land conversion, biodiversity loss and climate change

Land conversion is associated with massive losses of biodiversity, in particular when tropical rainforests are affected (Drescher et al., 2016; Giam, 2017). Davis et al., (2021) for example, suggest that if all concluded agricultural deals registered in the Land Matrix database were fully implemented, relative species richness, an important biodiversity indicator, would experience substantial declines, with losses being markedly prominent in Africa and Asia. In line with these findings, the study also hints at considerable overlap of contracted production areas of LSLAs with areas defined as biodiversity hotspots or critical habitat: 39% of agricultural LSLAs fall at least partially within biodiversity hotspot areas, while a smaller percentage (13%) partly overlaps with at least 40% of the contracted size with likely critical habitat. Our own analysis of the data also shows that 87% of these LSLAs are occurring in regions of medium-to-high biodiversity (Giger et al., 2021).

39% of agricultural LSLAs fall at least partially within biodiversity hotspot areas

In addition to biodiversity losses, the conversion of forests can contribute to climate change by directly releasing a large amount of carbon into the atmosphere (Liao et al., 2020), an effect that is particularly pronounced when forests or peatland are being burnt.[27] Moreover, LSLAs impact – mostly negatively – water, soils, the local climate, and biogeochemical cycles, as well as energy and nutrient fluxes. The impact of LSLAs on water has received notable attention, even being referred to as "water grabs" – rather than "land grabs", highlighting the increased appropriation of freshwater resources (Rulli et al., 2013; Tejada & Rist, 2017).

While it is widely acknowledged that agricultural expansion has long been an important driver of deforestation, we argue in this chapter that this threat to natural habitats remains highly relevant now and for the future, particularly since many of the concessions and areas under contract have not yet been converted or put under cultivation (see Chapter 1). However, as some studies tend to underscore, the establishment of highly productive agricultural systems resulting from LSLAs may also reduce pressure on environmental resources. Higher productivity could as such have a land sparing effect, by requiring potentially less land to be cultivated for the same amount of production. Through this effect, remaining natural ecosystems could be saved from conversion into agricultural land (Feniuk et al., 2019; Folberth et al., 2020; Grau et al., 2013; Phalan et al., 2014; Villoria, 2019). It is also important to note that not all unfavourable land use practices with negative external impacts, such as soil erosion, nutrient mining, or carbon emissions, are connected to LSLAs. Many of these, such as slash-and-burn practices with short fallow periods in between, are pre-existing and unrelated.

Since many species are endemic to regional environments, biodiversity in one region cannot be offset with higher levels of biodiversity in another region

As recognised in the literature on land sparing, however, there are some caveats to this line of argument. First, agricultural productivity on or within close proximity to LSLAs might not necessarily be substantially higher compared to regions without LSLAs. Furthermore, they may not be able to sustain higher productivity in the long run due to soil depletion or over-use of water (see Section 4.4). Second, much of the literature on land sparing (Folberth et al., 2020) relates to increasing productivity on existing cropland, and not to

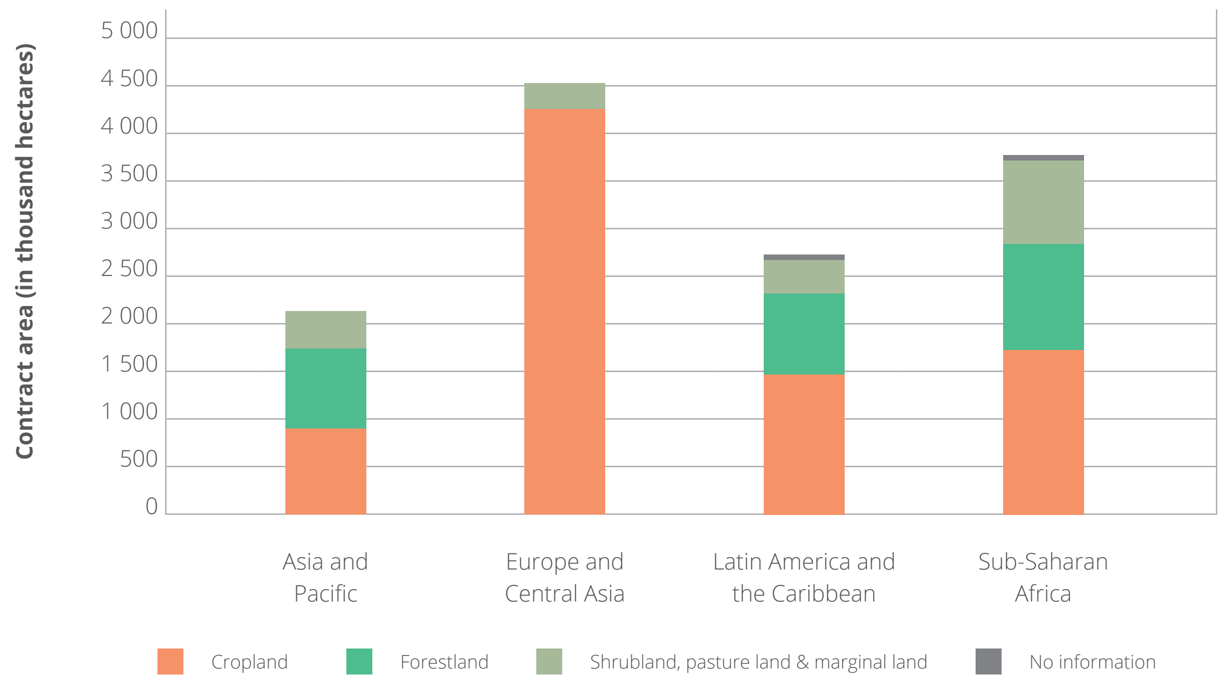
[27] Liao et al. (2020) find a total of 18.9 million ha of forest being at threat of being cleared because of LSLAs which would lead to 3.5 Gt of additional CO2 emissions as a result of direct and indirect land use changes. This would account for about 10% of the global energy-related CO2 emissions in 2019.

opening new cropland on previously uncultivated land, as is the case for an important fraction of LSLAs. Third, global land sparing is complex when it comes to biodiversity (Carrasco et al., 2014; Grau et al., 2013), and, since many species are endemic to regional environments, biodiversity in one region cannot be offset with higher levels of biodiversity in another region (Carrasco et al., 2014). For example, sparing land in regions with relatively low biodiversity, such as rapeseed in Germany, by expanding production with higher land productivity in regions with higher biodiversity, such as palm oil in Liberia, does not necessarily save biodiversity. These considerations highlight the importance of understanding the role of LSLAs as a direct and indirect driver of land use change and deforestation, which we address next.

4.2. LSLAs persist as a key deforestation threat

LSLAs are a key driver of land use change, thus contributing substantially to deforestation, habitat destruction, and land degradation (Davis et al., 2015, 2020; D'Odorico et al., 2017; Magliocca et al., 2019; Zaehringer, Wambugu, et al., 2018), as reflected in Land Matrix data on former land cover of acquired land. For example, globally, as Figure 4.1 shows, the majority of LSLAs (63%) are implemented on existing cropland, often leading to intensified land use, as is the case in Europe and Central Asia, while in the other regions, there is considerable cropland expansion which eats away at forests and natural vegetation cover, such as shrub, pasture, and marginal land.

Figure 4.1: Primary land cover type targeted by land deals and region (share by aggregate contract size)



Notes: Individual deals list up to four different types of former land covers. The Land Matrix does not provide information on the share of area for each type of former land cover; hence, for this analysis, we have divided the area under contract and attributed equal shares to each former land cover. N (deals) = 620, N (former land cover) = 1 560.
Calculations based on Land Matrix data.

In particular, LSLAs threaten tropical forests and their extraordinary biodiversity, and there is overwhelming evidence that LSLA-related agricultural expansion is a major determinant of large-scale deforestation in the humid tropics (Curtis et al., 2018; DeFries et al., 2010; Gibbs et al., 2010; Meyfroidt et al., 2014). For instance, Pendrill et al. (2019) demonstrate that in the period from 2005 to 2013, 62% (corresponding to 5.5 million ha per year) of forest loss could be attributed to expanding commercial cropland, pastures, and tree plantations. Henders et al. (2015) likewise show that the production of beef, soya bean, palm oil, and wood products in seven countries with high deforestation rates

(Argentina, Bolivia, Indonesia, Malaysia, Papua New Guinea, and Paraguay) account for 40% of total global tropical deforestation observed between 2000 and 2011. In Brazil, home to the world's largest tropical rainforest, deforestation has accelerated considerably under the Bolsonaro administration (Escobar, 2020) and it may well be that the – increasingly intensive – cattle ranching and soy production are the key economic drivers of frontier deforestation (Schielein & Börner, 2018). Similarly, in Indonesia, which has the world's third largest area of rainforest after the Amazon and Africa's Congo Basin, massive deforestation continued throughout the 2010s, driven by large-scale oil palm and timber plantations, in particular at the new frontiers on Kalimantan.

There is overwhelming evidence that LSLA-related agricultural expansion is a major determinant of large-scale deforestation in the humid tropics

While some of the countries mentioned have been hotspots for deforestation for decades, global land investments have, in the past 15 years, opened new deforestation frontiers worldwide. This grim assessment is supported by our own analysis that combines Land Matrix data on international LSLAs with Hansen's forest data. Specifically, we use the geographic point location of the LSLA registered in the Land Matrix and draw circular buffers around each deals' location corresponding to the respective contract size. Data on forest cover is derived from Hansen's tree cover in the year 2000 using two different thresholds of initial forest cover set to 25-100% and 50-100%, respectively, and the reported yearly losses until 2019 (Hansen et al., 2013).

Table 4.1: Loss of forest within LSLAs between 2000 and 2019

REGIONS	NUMBER OF DEALS	SIZE OF CONTRACT AREA OF LSLA (HA)	SIZE OF FOREST COVER IN 2000 WITHIN LSLA (HA)	SIZE OF FOREST COVER IN 2019 WITHIN LSLA (HA)	SIZE OF FOREST LOSS BETWEEN 2000-2019 (HA)	SHARE OF FOREST WITHIN LSLA IN 2000 (%)	SHARE OF FOREST WITHIN LSLA IN 2019 (%)
50% tree cover threshold							
Sub-Saharan Africa	390	6 396 817	2 145 056	1 798 447	346 609	33.53	28.11
Latin America and Caribbean	161	4 722 053	1 267 715	1 049 453	218 262	26.85	22.22
Asia and Pacific	414	8 150 117	5 993 934	4 713 072	1 280 867	73.54	57.83
Total	**965**	**19 268 987**	**9 406 704**	**7 560 972**	**1 845 738**	**48.82**	**39.24**
25% tree cover threshold							
Sub-Saharan Africa	390	6 396 817	3 631 400	3 130 189	501 211	56.77	48.93
Latin America and Caribbean	161	4 722 053	1 836 054	1 513 049	323 005	38.88	32.04
Asia and Pacific	414	8 150 117	6 348 887	5 015 229	1 333 658	77.90	61.54
Total	**965**	**19 268 987**	**11 816 341**	**9 658 467**	**2 157 874**	**61.32**	**50.12**

Notes: Calculations based on Land Matrix data and Hansen (2013). Concluded international deals within the tropical humid, moist or dry forest and tropical mountain regions. Deals with location precision only at country level were excluded.

Looking at data from 964 geo-located land deals in tropical regions with a total contract area of 19 million ha, the first half of Table 4.1, which uses a 50% tree cover threshold, shows that, about 9.4 million ha were still covered with forest in 2000. With a lower tree cover threshold, as used in the second half of Table 4.1, it is almost 12 million ha. However, there is significant regional variation, which is important to note: In Asia and the Pacific (with almost all selected deals being located in East Asia), about 74% of the area around the location of the deals was still covered with forest in 2000, which is considerably larger than the 26% and 33% in Latin America and sub-Saharan Africa, respectively.[28]

East Asia shows continued forest loss

Nevertheless, East Asia is also the region with the highest loss of forest cover. According to our estimates, about 1.3 million ha were lost between 2000 and 2019 within the contract area of LSLAs, corresponding to a loss of 16 percentage points. In a previous, very similar study, zooming in to the country level, Davis et al., (2020) show that forest loss within LSLAs was particularly high in Cambodia, Indonesia, and Malaysia. Looking at the specific case of Cambodia, Magliocca et al., (2019) found that between 2000 and 2016, the country lost roughly 1.6 million ha of forest, corresponding to 22% of the country's total forest cover. Worth mentioning, 30% of these deforested areas are located within economic land concessions granted by the state to foreign and national investors.

East Asia is also the region with the highest loss of forest cover. According to our estimates, about 1.3 million ha were lost between 2000 and 2019 within the contract area of LSLAs

In Southeast Asia, these developments are largely driven by rubber and oil palm plantations (Austin et al., 2017; Chiarelli et al., 2018; Rulli et al., 2019), as shown by the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), which reveals that the area cultivated with rubber in this region increased from 5.7 to 9.5 million ha (66%) between 2000 and 2019 (FAOSTAT 2021). Hurni and Fox (2018) further found that rubber plantations increased by 8%, covering an area of 7.5 million ha, in the mainland Southeast Asia countries alone between 2003 and 2014. Of note, 70% of this expansion came at the expense of natural forests, with deforestation greatest in Cambodia and Laos, but also significant in parts of China and Vietnam. However, Indonesia and Malaysia host the vastest area of oil palm plantations, at about 18 million ha collectively (Index Mundi, 2021), much of which has likewise been established to the detriment of primary and secondary forests (Austin et al., 2017; Hunt, 2010). In fact, between 2001 and 2016, oil palm expansion directly caused 23% of the nationwide deforestation in Indonesia (Austin et al., 2019). Furthermore, a significant share has been implemented on carbon-rich peat swamp forest, which has considerable implications for global climate change (Fuller et al., 2011).

Tropical rainforests are at risk in sub-Saharan Africa

In contrast to East Asia, deforestation in the proximity to LSLAs in sub-Saharan Africa was substantially slower, covering just 350 000 ha between 2000 and 2019 (Table 4.1) with a decline in forest cover of only about 5%, from 33.53% to 28.11%.[29] This concurs with the slow implementation of LSLAs in the region, as discussed in more detail in Chapter 1. It may also mean that the temporal patterns of forest loss and agricultural expansion are different. Deforestation within African LSLAs appears to frequently occur several years before the deals are concluded (Davis et al., 2021), suggesting that land deals in this region may have benefitted from previous land clearing (such as for pasture or smallholder farming).

Even with these caveats, tropical forests in Africa are under risk. Partly drawing on Land Matrix data and extrapolating recent trends in commodity production, Ordway et al., (2017) analysed the risk of agricultural expansion at the cost of forests in sub-Saharan Africa and found that it is undeniably increasing pressure on tropical forests, in particular in four Congo Basin countries as well as in Côte d'Ivoire, Liberia, and Sierra Leone. In these countries, high forest cover coincides with low proportions of potentially available cropland outside forest areas, but the authors also hint at an important role played by foreign large-scale investment in selected commodities, most notably palm oil, even though, overall, agricultural expansion is driven mainly by small-

[28]This is in line with evidence presented by Davis et al. (2021), who used a smaller sample of deals in the Land Matrix database (with a contract size of 4 million ha).
[29]Note that lowering the threshold for tree cover to 25% considerably elevates the LSLA-area covered (although more sparsely) by trees in 2000 to more than 56%.

and medium-scale farms rather than industrial plantations (Jayne et al., 2016). This is borne out by Gasparri et al. (2016), who show that there are indeed initiatives to facilitate and increase foreign investment, which typically come in the form of large-scale projects. A case in point is Cameroon, where the government's goal is to triple cocoa production (230 000 tonnes in 2010) and double oil palm production (600 000 tonnes in 2010) by 2035 (Ordway et al., 2017). The threat these plans entail for tropical forests, with approximately 17.3 million ha (68%) of land suitable for agriculture currently still being covered by dense tropical forest (Chamberlin et al., 2014) is cause for grave concern.

Old and new agricultural frontiers in Latin America

The data from Latin America gives mixed signals. On the one hand, Table 4.1 suggests that about 39% of the LSLA area was forest in 2000 (25% tree cover threshold), which is less than in other regions. Deforestation within the contract size-buffered deal locations also appears relatively slow, albeit with a 7% loss in forest cover. On the other hand, these findings are at odds with the evidence that shows substantial deforestation linked to agricultural expansion in the region (Curtis et al., 2018). These apparent contradictions are not easily reconciled, however, partial data coverage of LSLAs, in particular of domestic investors – which are more important in Latin America than elsewhere but have received less attention than international deals – may be one reason for this.[30] Yet, for them to bias the percentages presented in Table 4.1, the non-covered deals would need to target more forested areas, which is not necessarily the case. In fact, we surmise that the data on LSLAs for Latin America is likely more partial than it is for other regions, in light of domestic investors not being the main focus of the Land Matrix to date (see Chapter 1).

In Africa, the large share of yet-to-be implemented deals foreshadows a significant threat, in particular to the Central African rainforests

Partial data coverage[31] is also likely to explain why we underestimate – when using Land Matrix data – deforestation in the Gran Chaco, which hosts the largest dry forest in South America. This area has seen rapid deforestation since 2000, with 7.8 million ha of the Chaco's forests converted into farmland or grazing land for soy and livestock production between 2001 and 2012, according to Fehlenberg et al. (2017). The soya bean area alone increased by 126%, from 2.3 million ha to 5.2 million ha, during the same period, and while livestock farming and feedstock production can of course be complementary, at the same time, displacement effects can occur when the expansion of soy production pushes livestock farmers to seek new grazing land at the frontier. This behaviour has frequently been observed in Brazil, where rangeland is converted to cropland by large-scale investments, resulting in livestock farmers converting surrounding forest into new grazing land in turn (Cohn et al., 2016; Hermele, 2013).

In addition, the Land Matrix data clearly reveals – in line with other studies – that there are "new" threats to forests on the horizon, such as oil palm plantations, which until recently have not been a common driver of deforestation in the region. Indeed, as suitable land for new oil palm plantations in Southeast Asia is depleting, companies have begun to look to new production frontiers, such as Colombia and Peru, which have experienced the highest growth rates in recent years. In the Peruvian Amazon, for example, oil palm has become an important strategy for development, which Vijay et al. (2018) warn is a major deforestation risk. This is supported by the findings of Bennett et al. (2018), which show that between 2000 and 2015, 40 000 ha of primary forest were cleared for large oil palm plantations in Peru alone.

These examples clearly illustrate that LSLAs – notwithstanding some regional variation – pose a major threat for further destruction of the world's remaining natural habitats. Whereas in Africa, the large share of yet-to-be implemented deals foreshadows a significant threat, in particular to the Central African rainforests, massive deforestation has never really slowed down in Southeast Asia, and LSLAs are now even targeting new frontier regions. Similarly, in Latin America, LSLAs have been adding new frontiers to the unresolved problems of deforestation in the Amazon for some time. Distressing as this is, perhaps what is most sobering is the fact that, overall, our own analysis (Table 4.1) is likely significantly underestimating (potential) LSLA-induced forest loss – at least in relative terms (share of land previously covered by forest), and certainly in absolute terms.

[30]Domestic deals represent almost 60% of all land deals and almost 40% of the acquired area in the complete Land Matrix database for Latin America.
[31]Among the countries with agricultural expansion at scale with many investors, Indonesia stands out in terms of publicly reporting single projects.

4.3. Indirect land use change and the loss of remaining fragments

There are two other mechanisms that drive LSLA-related land use change that bear mentioning. First, there is growing evidence that LSLAs are also responsible for indirect land use change, adding to the observed direct land use change (Oberlack et al., 2021). Indirect land use change is considered a spillover effect whereby former small-scale land users, displaced by the implementation of the LSLA, make new land arable, mostly through small-scale deforestation, elsewhere. This has been observed in Africa, Southeast Asia, and South America. For example, in their study on deforestation in and around land concessions in Cambodia, Magliocca et al., (2019) find that an additional 49 000-174 000 ha (depending on low or high estimates) of forest are lost around the concessions due to indirect land use change (3-10.7% of all forest lost in Cambodia by 2016). Similar observations were made in case studies from Mozambique, where small-scale mosaic croplands were acquired by LSLAs, forcing the affected small-scale farmers to clear forest for new arable land (Zaehringer, Atumane, et al., 2018).

LSLAs not only escalate deforestation, but also contribute to forest fragmentation – with potentially strong negative effects on biodiversity of remaining forest patches

Second, LSLAs not only escalate deforestation, but also contribute to forest fragmentation – with potentially strong negative effects on biodiversity of remaining forest patches (Davis et al., 2021; Zaehringer, Wambugu, et al., 2018). Beyond that, Hansen et al. (2020) recently pointed out that the remaining forest fragments decrease at a greater rate compared to large forest blocks, with clearing for agricultural production as a critical factor. This calls for as much attention to be paid to forests that are being fragmented as those that are being cleared.

4.4. The building pressure on water resources

The potential impact on water resources is an important dimension of the environmental consequences of land acquisitions. Since increasing land-based production is generally achieved through greater use of water, if the water demand cannot be met by rainfall, irrigation of "blue water" (see below) becomes necessary. Indeed, the link between LSLAs and increased water demand becomes patently clear when viewed in light of the fact that 54% of the land deals recorded in the Land Matrix database are intended to produce crops with high water use, such as oil palm, sugar cane, jatropha, cotton, and rubber.[32]

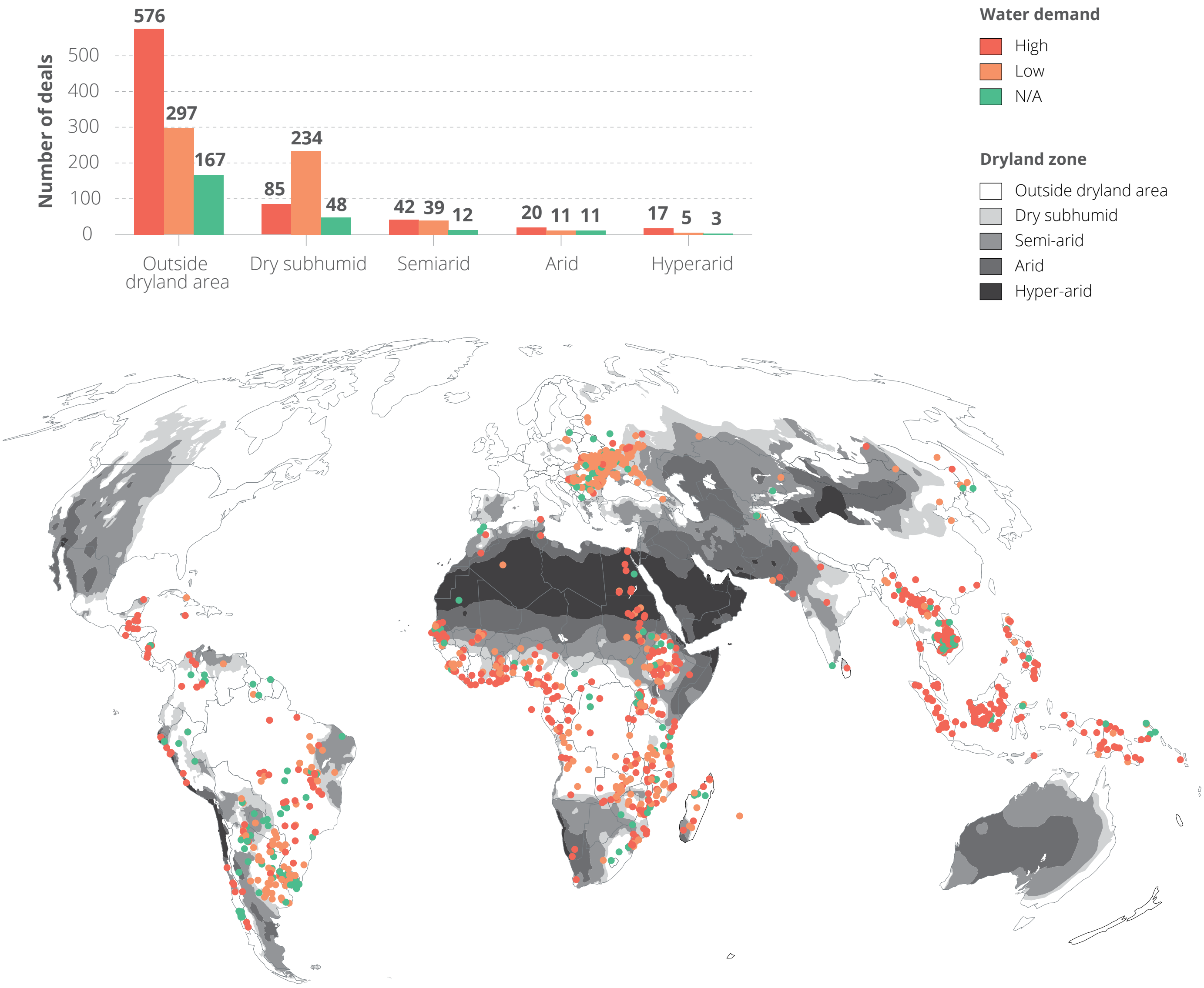
54% of the land deals recorded in the Land Matrix database are intended to produce crops with high water use

Another important potential effect of increased water use is that it can reduce the availability of water for the surrounding areas and downstream users (Chiarelli et al., 2018; Dell'Angelo et al., 2018; D'Odorico et al., 2017), which has implications for their livelihoods and food security. LSLAs can also impact water quality through increased run-off of nutrients and pesticides in the surrounding water bodies and environment (Giger et al., 2019; Muriithi & Yu, 2015; Oberlack et al., 2016; Zaehringer, Wambugu, et al., 2018).

Looking at Figure 4.2, which illustrates different water demand categories (high and low) in relation to global dryland zones, we note that water demand and availability according to the climate does not coincide everywhere. In Southeast Asia, for example, oil palm – a crop with high water demand – is produced in a region with mostly abundant rainfall. Conversely, for instance, in the Nile region but also in other places, other high water demanding crops (fodder, cotton, sugarcane, potatoes, and vegetables) are produced in an extremely dry area, requiring intensive irrigation. Our data show that 34% of deals take place in dryland zones where water resources are scarce by definition, with 10% of them producing crops that require large amounts of water. Crops with low water demand, like cereal, are often found in areas that are outside drylands and have sufficient water to produce these crops, such as those found in high concentration in Eastern Europe and parts of Latin America and Africa.

[32]Tn=1 568. Categories based on Johansson et al. (2016). High: > 8 500 m3/ha; Low: <= 8 500 m3/ha; NA: Crop demand not classified.

Figure 4.2: Water demand categories of crops cultivated in LSLAs and dryland zones



Notes: Water demand categories based on Johansson et al. (2016) (High: > 8 500 m3/ha; Low: <= 8 500 m3/ha; NA: Crop demand not classified). Map background showing different dryland zones (in grey). LSLAs: n=1 568.

In the absence of publicly available project documents, let alone environmental impact studies, data around water and irrigation is generally difficult to obtain. However, the Land Matrix database does have some information on water abstraction for a limited subset of 269 land deals, which account for an area of about 5.7 million ha and may be interpreted as a lower-bound estimate to the number of deals associated with water abstraction and corresponding adverse socio-environmental impacts. Surface water (water that comes from above the ground, including rivers, lakes, streams, wetlands, and reservoirs), is the most cited source of water (46% of deals), but groundwater (water that is found below the ground) is also mentioned (12% of deals). Both these sources of water are known as "blue water", as opposed to "green water", defined as rainfall that is subsequently stored in soils and consumed by plants (Falkenmark & Rockström, 2006; Johansson et al., 2016). Blue water thus represents the amount of water needed to meet production ends in addition to the water provided by rainfall. While green water is considered better or less problematic in the context of LSLAs, using blue water is not necessarily "bad" if it does not increase water demand beyond the capacity of the agro-ecological[33] environment. In reality, however, there are many LSLAs that do cause blue water demand to increase substantially, placing considerable pressure on already water-stressed areas. Examples of land deals that have a very high proportion of blue water demand and take place in severely water-scarce areas can be found in Egypt, Namibia, and Sudan, for instance.

Using Land Matrix data for Africa in a crop-modelling exercise, Johansson et al. (2016) demonstrate that, based on current national irrigation efficiencies, 35% of all deals would take place in blue water use hotspots (that is, areas where their blue water demand is more than 50% of their total water demand). Furthermore, they found that even under more efficient sprinkler or drip irrigation technologies, up to 20% of the total deals in production would still fall in such hotspot areas.

BOX 10:
Blue water use in stressed contexts

One extreme example of the use of blue water in a water-stressed context (Deal #1172 covering 42 000 ha) comes from Egypt, where Gulf companies (from different countries) have invested in the country's Western Desert in Toska, transforming the desert land to agricultural land by diverted water from the Nile to produce alfalfa. This animal feed, requiring extremely high amounts of water to grow, is partly for domestic use, but is also exported to the Gulf, including to Saudi Arabia which imports fodder to produce milk and meat due to a production ban on animal feed that has been in place since 2017. The project has attracted much criticism regarding its contractual agreements (below market prices for water and land) and low number of jobs created. Moreover, the strategy of reclaiming desert land for high water demanding crops has been slated for reducing the availability of water for Egyptian farmers in the Nile valley to produce rice, wheat, and fruits, which are profitable and more water efficient crops, but currently need to be imported (Arafat and El Nour, 2020). Another example of blue water irrigation that causes adverse local impacts has been reported from Sierra Leone (deal #1798). Here, intensive sugar cane production has necessitated the installation of large irrigation structures, with the water being pumped from a local river flowing through the concession area and subsequently resulting in the nearby swamps falling dry. These swamps were previously used for rice production by the community, and especially by women farmers to produce vegetables during the dry season. The project's large-scale monoculture has also destroyed a highly diverse cultural landscape, significantly changing the quality of and access to land, water, and non-timber forest products which were of specific importance for marginal groups, including women and land users not originally from this region (Bottazzi et al., 2018; Marfurt et al., 2016).

While blue water matters for some crops and contexts, D'Odorico et al., (2017) point out the important fact that only a tiny fraction of total water used by LSLAs is from surface water or groundwater. Green water is thus likely to remain the major water source for most LSLAs. Nevertheless, the increased use of green water can create equally negative environmental impacts, depending on the context in which this water use arises. In Southeast Asia, for example, oil palm plantations, which are typically rain-fed, alter hydrological cycles with the conversion of rainforests to agricultural land (Merten et al., 2016), as young plantations increase run-off and temperatures, while established plantations increase evapotranspiration compared to natural forests. These combined effects, found in crop-modelling studies (Manoli et al., 2018), confirm perceptions of oil palm being a "water greedy" crop. However, some of these effects can be mitigated through current best practices using cover crops during the establishment phase.

Analysing the hydrological consequences of rubber expansion in Southeast Asia, which also relies on green water, Chiarelli et al. (2020) found evidence that the higher evapotranspiration of rubber plantations compared to shrubs, pastures, or less water-demanding crops, could reduce run-off, especially in dry seasons, and negatively impact water availability for downstream farmland. Chiarelli et al. (2020) also point to

[33]Some irrigation systems in selected tropical areas, although using large amounts of water (paddy rice), are considered water management systems (regulating inundation and dry periods) for optimal crop management and are less likely to critically limit water available of adjacent areas.

the "grey water consumption" – the amount of water that is required to dilute to below acceptable standards the concentration of pollutants – used in the production of rubber. Rubber plantations using fertilisers and pesticides contribute to downstream water pollution as well. Indeed, this is true for most LSLAs: increased economic activity through intensified agricultural production and processing of goods will create the possibility of increased pollution of water resources, which needs to be prevented or mitigated. The exact terms of the water rights granted with land concessions or purchases are rarely made public, which makes is difficult to assess the impact on water. It is nevertheless important to take into consideration not only the quantity of the water consumed by LSLAs, but also the many other factors involved, including the local context and availability of water sources. Conducting environmental impact studies is therefore critical, as is making the results of the studies available to the public and concerned stakeholders.

BOX 11:
LSLAs and pandemic risk

A recent report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2020) has drawn attention to the complex – sometimes ambiguous – relationship between biodiversity loss and pandemic risk (Dobson et al., 2020; Gibb et al., 2020; IPBES, 2020; Jones et al., 2013; Tollefson, 2020). For instance, deforestation in tropical regions is considered among the most important factors leading to the emergence of zoonotic diseases. While such a link has been discussed by specialists for decades (Borsky et al., 2020; Jones et al., 2013; Perrings et al., 2018; Wallace, 2016; Wallace et al., 2014), mainstream debates on land acquisitions have so far neglected to address this.

Based on the IPBES report, several mechanisms accompanying agricultural deals may contribute to increased risk of zoonotic disease outbreaks. First, continued expansion of the agricultural frontier and associated loss of biodiversity could reduce the buffering effect of biodiverse ecosystem niches by decimating the variety of animals that act as buffering species, slowing or stopping pathogen transmission (Keesing et al., 2006, 2010). Second, monocultures could modify zoonotic host diversity, increasing the share of host species. Third, implementation of LSLAs and related infrastructure in or near highly biodiverse natural habitats could increase forest fragmentation and bring more people in close contact with potential hosts of pathogens. Fourth, displacement could push people deeper into more remote areas, bringing them into contact with new reservoirs of pathogens. Fifth, conversely, risks of zoonosis might be mitigated if people's livelihoods change in ways that reduce hazardous human-wildlife interactions, for example, by increasing people's incomes and reducing their reliance on consumption of bushmeat.

To date, the risks of zoonotic disease emergence are seldom, if ever, factored in when assessing the benefits and costs of agricultural investments. However, initial estimates indicate that the costs of a change in policies by creating incentives that reduce deforestation and wildlife trade – and thus the risk of pandemics – could be low compared to the cost of a pandemic (Dobson et al., 2020).

Until now, zoonosis risks have not been taken into account by any of the mainstream global guidelines on responsible agricultural investment and land governance either (FAO, 2012; FAO et al., 2010). The call by the authors of the IPBES report for developing and incorporating pandemic and emerging disease risk health impact assessments in major land-use projects should therefore certainly apply to land acquisitions as well. Furthermore, agricultural policies should be reviewed along with LSLAs in view of preventing forest fragmentation and the further intrusion of land investments into biodiverse ecosystems. Importantly, avoidance of competition of land and displacement of people needs to be addressed even more urgently.

Finally, increased transparency on land acquisitions will be instrumental in advancing investigations into their relationship with zoonotic disease emergence.

Source: The box is based on a commentary published in One Earth, May 2021. Giger Markus, Eckert S., Lay J. (2021). Large-scale land acquisitions, agricultural trade, and zoonotic diseases: overlooked links. One Earth, 4(5), 605-608.

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Large Agricultural Investments in Kenya's Nanyuki Area: Inventory and Analysis of Business Models

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Abstract

Many experts agree that more agricultural investment is needed in the global South to improve local food security and reduce poverty. However, there is a lack of consensus about the *types* of investment needed to achieve these goals. This paper contributes to the literature on large agricultural investments and corresponding business models by inventorying and analysing such investments in Kenya's Nanyuki area. We identify four clusters of business models that differ primarily by type of production and other distinct determinants, namely: demand from markets; access to land; land tenure regime and colonial history; actors involved; biophysical context; labour availability; and governance of the value chain via private standards. The study results shed light on the factors that help or hinder implementation of large agricultural investments and shape their impacts in the context of African land use systems. The way land is accessed represents one of the most-decisive factors determining the risks and opportunities associated with such projects. We find that most investments in the Nanyuki area occur on land bought or leased from private owners.

1. Introduction and objectives

Increasing agricultural investment in the global South has long been seen as crucial to improving local food security and reducing poverty (World Bank, 2007). However, there is a lack of consensus about the *types* of investment needed to achieve these goals (Hall et al., 2017). Some researchers see the future in large-scale mechanized, high-input commercial agriculture (Collier and Dercon, 2014; Deininger and Byerlee, 2011). Others emphasize the continuing importance of small-scale family agriculture for the livelihoods of rural populations (Holden and Otsuka, 2014; McIntyre, 2009), and highlight the threat of displacement and other negative impacts posed by agricultural commercialization in the global South (Henderson and Isaac, 2017; White et al., 2012). A growing body of research evidence is shedding light on the social, economic, and environmental impacts of large-scale international land acquisitions (Alden Wily, 2012; Anseeuw et al., 2012; Borras Jr and Franco, 2012; Bottazzi et al., 2016; Cotula, 2009; Nolte et al., 2016; Oberlack et al., 2016; Peluso and Lund, 2011; Schoneveld, 2014; Schoneveld, 2017; Schoneveld et al., 2011; Voget-Kleschin and Ott, 2013).

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At the same time, observers also emphasize the need for more nuanced understanding of the different *models* of commercial agricultural investments as well as their corresponding impacts (Cotula et al., 2011; Cramb et al., 2017; Glover and Jones, 2019; Hall et al., 2017). Vital questions include whether, and to what extent, particular models of commercial investment support broader agrarian change and sustainable rural development (Kleemann and Thiele, 2015; Messerli et al., 2013; Oya, 2013). Answering such questions can also aid understanding of how local land use changes are shaped by distant drivers (Lambin and Meyfroidt, 2011; Meyfroidt et al., 2013).

The present article contributes to the emerging literature on commercial investment models, outlined below in section 2.1, and builds a new conceptual framework for analysis upon it (Anseeuw and Ducastel, 2012; Chamberlain and Anseeuw, 2019; Cramb et al., 2017; Vermeulen and Cotula, 2010).

In Kenya, investments in commercial agriculture have been significant and are viewed by many as an economic success story. In particular, horticulture in Kenya has experienced strong growth since the 1980s, reaching a domestic value of KES 236.45 billion (USD 2.36 billion) in 2017 (Government of Kenya, undated). The value of Kenya's horticultural *exports* reached KES 115.3 billion (USD 1.15 billion) in 2017, and is Kenya's second biggest source of foreign exchange earnings (Government of Kenya, 2018). At the same time, the sector has undergone major shifts in the structure of production, moving away from smallholder models and towards large-scale production types (Dolan and Humphrey, 2000; Humphrey et al., 2004). Dolan and Humphrey (2004) describe the rise of tightly knit value chains aimed at horticulture exports to the UK especially. According to Neven et al. (2009a), most small farmers in Kenya have found it difficult to link up directly with modern supermarket-oriented value chains, but new opportunities for contract-farming and new labour markets have afforded them some benefits from increasing commercialization. Rao and Qaim (2016) point to particular opportunities and potential benefits for women workers in Kenya, but emphasize remaining barriers to entry that must be overcome. Some observers express concern that large commercial actors – in combination with more stringent standards – will gradually put local smallholders and contract farmers out of business (Dolan and Humphrey, 2000; Gachukia, 2016; Henson and Humphrey, 2010; MacGregor et al., 2014; Neven et al., 2009; Obidzinski et al., 2013; Ouma, 2010; Tallontire et al., 2014). Nevertheless, Dolan (2002) has emphasized the likelihood of positive employment effects based on the shift from smallholder production to larger commercial units. Several researchers have studied the working conditions of employees on horticultural farms in Kenya (Dolan and Sutherland, 2002; Peter et al., 2018). Kuiper (2019b) found that horticultural farms in Naivasha, Kenya, offer an increasing number of more permanent, secure jobs – in addition to many temporary, precarious jobs – but usually under strongly hierarchical conditions. Using household survey data in Kenya, Muriithi & Matz (2015) found consistently positive associations between export markets and people's incomes – but not their assets.

Agricultural investments and their impacts are intrinsically linked to land access (Oberlack et al., 2015). In Kenya, land plays an essential role both politically and socio-economically (FIAN, 2010). During the period of British colonial rule (1920–1963), many indigenous communities across Kenya's central uplands were dispossessed of their land. These areas in the "White Highlands" and adjacent rangelands were subsequently transferred to European settlers. All told, 20% of Kenya's land – including prime agriculture areas – was seized in the process. Following Kenyan independence, political leaders played a key role in maintaining systems of land patronage (Duvail et al, (2012). Land in Kenya is categorized as either public, private, or community (Government of Kenya, Land Act 2012). These categories shape the patterns of large agricultural investments in different regions of the country. Most of Kenya's intensively farmed central and western provinces were gradually subdivided and privatized after independence (Smalley and Corbera, 2012). In other areas, public land was – and still is – used as a form of patronage and a means to maintain control and power. This explains the centralized nature of Kenya's post-independence land administration, which in turn enabled the spread of "land grabbing". In recent years, land grabbing has extended to areas of great ecological importance and has acquired a new dimension in contestations over global trends of large-scale land deals (Anseeuw et al., 2012). To date, the majority of land grabbing has occurred in Kenya's Tana region where public land prevails, but is used by local communities (Arevalo et al., 2014; Duvail et al., 2012; Smalley and Corbera, 2012). Overall, land grabbing by elites has enriched politically connected individuals and companies at the expense of the public since at least the 1980s (Manji, 2012).

The present study sought to empirically analyse large agricultural investments (hereinafter LAIs) and corresponding business models in Kenya's Nanyuki area, enabling better understanding of the implications of these business models regarding land use and spatial planning. The research sheds light on how LAIs are embedded in given agrarian structures, which can contribute to better governance of LAIs and eventually sustainable development.

This article deepens the relevant literature by analysing a comprehensive inventory of agricultural businesses in a study area that is a preferred target for large commercial investments in Kenyan land. In contrast to other studies that focus on individual case examples, we sought to identify relevant patterns at the *regional* level by taking into consideration all LAIs in the area. The findings, in turn, are relevant at the national level in Kenya, since similar investments are occurring across the country, as well as throughout Africa, since various countries on the continent have sought to attract LAIs to promote hubs or corridors of commercial agricultural growth.

In particular, we sought to answer the following research questions:

(1) What are characteristics and typical patterns of business models of LAIs in the study area and how have they changed over time?

(2) What are the determinants of these patterns of business models?

(3) What can we learn regarding general land use policies that govern LAIs and agricultural investments in tropical land use systems?

2. Conceptual framework

2.1. Conceptual framework for assessing business models of LAIs

Referring to the organization of commercial enterprises, the term "business model" is frequently used throughout the scientific literature. Nevertheless, there is no single agreed-upon definition that is applied by all researchers. Morris et al. (2005) have identified over 30 scholarly definitions of the term. Further, it is often used interchangeably with terms like "business concept", "revenue model", or "economic model" (Morris et al., 2006). However, Magretta (2002) offers a concise definition: "Business models describe, as a system, how the pieces of a business fit together". In addition, Morris, Schindehutte et al. (2005) propose that business models can be analysed on strategic, operational, or economic levels. Finally, Camisón &Villar-López (2010) suggest distinguishing business models according three basic dimensions: (1) organizational structure, (2) degree of diversification (product/market sector), and (3) management of value chain activities (vertical integration vs. cooperation).

With regard to agricultural investments in Africa, analysis of business models is an emerging field that aims to uncover the dynamics of growing commercialization of agriculture (Anseeuw and Boche, 2012; Anseeuw and Ducastel, 2012; Boche and Anseeuw, 2013). The present authors previously investigated business models of current investments in commercial farms, showing how they are shaped by complex interactions of resource flows, decisions made at different levels, and competitive pressures. Boche and Anseeuw (2013) identified six very different land acquisition-related business models, based on research in four southern African countries. These models spanned independent farmers, cooperatives, contracting arrangements, and various types of commercial business actors. Their typology, based on empirical data, was created using three sets of variables: the set-up and organizational characteristics of the business model; the results, outcome, and sustainability of the business model; and the inclusiveness and direct implications of the model for local populations and development (Boche & Anseeuw, 2013). Di Matteo and Schoneveld (2016) analysed an inventory of land investments in Mozambique and characteristics of their impacts. They found that most investments aim at domestic food markets, and stem from investors in South Africa, Zimbabwe, and northern countries. Finally, research by Hall et al. (2017) in Ghana, Kenya, and Zambia has identified advantages of commercial farming areas and contract-farming business models in creating many local economic linkages. Further, they found that larger plantations/estates create more jobs, but these tend to be of lower quality and favour casual employment conditions. Our review of business models in agriculture is limited to land-based investments, therefore we do not include commercial investments in input supplies or mechanization, for example (Houssou et al., 2013).

Another strain of relevant research focuses on the "inclusiveness" of business models (Cotula, 2009; Cramb et al., 2017; Vermeulen and Cotula, 2010). Vermeulen and Cotula (2010) assess inclusiveness according to four dimensions: *ownership* (of the business itself and key project assets); *voice* (the ability to influence key business decisions; and the presence of arrangements for review or lodging of grievances); *risk* (commercial, but also more broadly) and *reward* (economic costs/benefits, but also nonmonetary rewards). Based on this methodology, Chamberlain and Anseeuw (2019; 2018) have analysed the impact of more inclusive business models particularly in terms of the integration of smallholders into commercial value chains, highlighting weaknesses of these models such as power asymmetries between investors and farmers leading to limited empowerment and financial benefits among participating farmers. German et al. (2016) studied inclusiveness models in Mozambique and found little contribution to poverty reduction or building of community–investor relations.

Drawing on this literature on business models and our own prior research and policy engagement regarding LAIs in Africa, we developed an adapted analytical framework for interviews conducted in the present study. The resulting framework focuses mainly on the operational level, and less on the strategic or economic level (Morris, Schindehutte et al. 2006). While the management and governance of value chains (Gereffi et al., 2005; Lee et al., 2012; Peterson et al., 2001; Williamson, 2007) were not the focus of the investigation, we nevertheless identify the *position* of our studied LAIs in the value chain and the *type* of value chains they are embedded in. Our analytical framework covers the organizational structure, agricultural production model, and place and function in value chain (Table 1).

Main dimensions of business models	**Specific elements contained in analytical framework**

(1) Organizational structure	Actors, juridical structure, network of funding, certification, compliance, and taxes
(2) Production model	Investment size, ownership and access to land, labour, outgrowing and contract farming, main products, technical agricultural model
(3) Place and function in value chain	Main markets, place and function in value chain

Table 1: Analytical framework for investigation of business models

3. Methods and data

3.1. Study area

Our analysis focused on Kenya's Nanyuki area, where numerous LAIs specialized in horticulture have developed over the last 20 years (Jacobi et al., 2018; Ngigi et al., 2007; Peter et al., 2018), as shown in Figure 1. Nanyuki is one of the most important areas in Kenya for export-oriented horticulture farms. At the same time, there many large cereal and livestock farms and ranches in the area. In total, we identified 48 ranches and farms in the study area. This area of 249,147 hectares (ha) is situated in the north-western foothills of Mount Kenya, approximately 200 km north of Nairobi, and includes parts of Laikipia, Meru, and Nyeri counties. The area was chosen because it enables investigation of a cluster of LAIs already in operation that have evolved in recent decades.

While not always large by surface area (typically around 40–200 ha), the commercial farms in the study area tend to be large in terms of capital invested and labour force involved. According to our interviews, approximately 8,200 workers are employed by the 33 LAIs investigated. Unlike other regions in Kenya, most land is titled and land tenure is generally considered secure in Nanyuki. Land tenure in the area has been strongly shaped by history – especially colonial-era land grabs and post-colonial control by national elites. Many large farms in the area were subdivided and sold to smallholders during the post-colonial period, supported by government programmes and international donors. However, some farms were not subdivided, and continue to exist or were sold to new investors (Käser, 2018). Notably, there are strong competing interests regarding use of water resources in the area (Dell'Angelo et al., 2016; Eckert et al., 2017; Ngigi et al., 2007; Zaehringer et al., 2018). Using remote-sensing methods, Eckert et al. (2017) found that between 1987 and 2016, the area covered by greenhouses increased by 624 ha (from zero) and waterbodies (reservoirs) increased by 96 ha. They also found that intensified field crops increased significantly in the area (irrigated cropland increased by 18,315 ha or 7.4%), cultivated both by commercial farmers and smallholders.

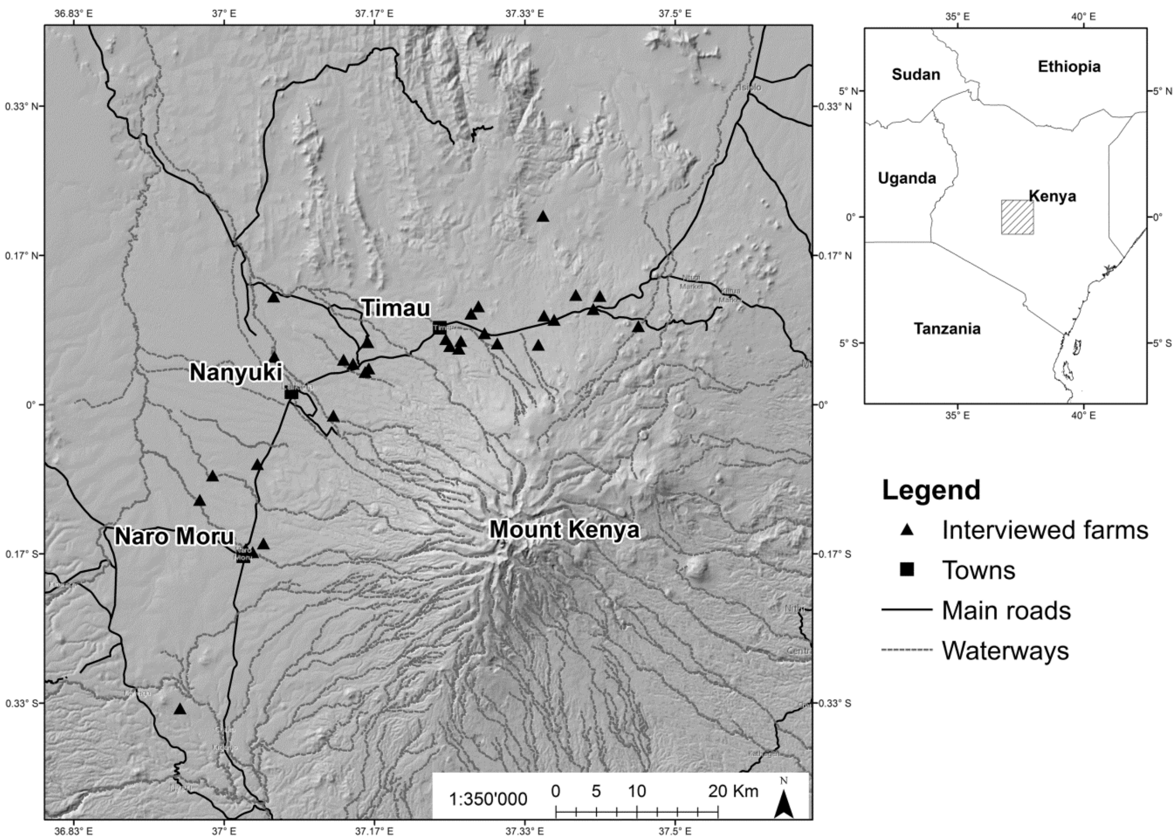

Figure 1: Map of the study area

3.2. Data collection

Our initial data sets derived from wider inventories of farms and ranches collected in 1996 (Kiteme, 1996) and 2013 (Lanari et al., 2018). By combining these two data sources, and excluding those not falling in the chosen study area, we arrived at an initial count of 59 farms and ranches. Additional LAIs were identified in exploratory field research, undertaken in January 2016. We eventually settled on a final count of 48 active farms and ranches, which we consider a complete inventory of LAIs in the study area (Mutea & Giger 2016).

To be included on the list of LAIs, the investments had to fulfil all of the following criteria: (1) featuring land-based agricultural production; (2) involving private business-oriented management and possessing an accounting system; (3) large by area (>20 ha) or capital (no precise benchmark was used regarding capital, as the available data were not robust). Investments purely focused on processing activities were not included.

We initially sought to interview representatives from every LAI. Ultimately, we conducted 41 preliminary semi-structured interviews (85% response rate) between February and April 2016. In a second round, we were able to carry out 33 in-depth interviews between June and September 2016. Overall, we consider the sample to be representative, as no systematic bias was found in terms of the distance to road, main type of production, or the size of the corresponding LAIs. The reason cited for rejection of second interviews by relevant respondents was lack of time. The 33 in-depth interview subjects included seven LAI owners, six directors of LAIs, 18 medium-level managers, one accountant, and one supervisor of operations of respective LAIs.

We developed the questionnaires for the in-depth interviews (see Appendix A) based on literature review of business models, our prior empirical research on the topic, as well as the exploratory field visits. Interviews lasting 150–180 minutes were conducted/recorded by the second author and subsequently transcribed (Mutea & Giger, 2016).

Thanks to the long-time involvement of some of our Kenyan research partners in the study area, it was possible to obtain access to the LAIs and collect first-hand information. However, the respondents were typically reluctant to share certain information for fear of giving away business secrets, worries about possible misuse, or concerns about attracting unwanted attention from fiscal/financial authorities. As such, the researchers were not given access to business plans, profit or loss statements, audits or tax reports. In particular, it was not possible to verify data on levels of investment. Data on employment could be cross-checked with survey data in the same area (Reys et al., 2018). The perceived incidence of conflicts and local people's views/attitudes towards five specific LAIs were analysed by Zaehringer et al. (2018).

3.3. Data analysis

The questionnaire data were coded and assessed by means of descriptive statistical analysis of the most important variables. We selected a total of 20 key variables that captured the main characteristics of business models according to the analytical framework: type of actor; degree of integration; model of investment; juridical form; organization of agricultural production model; technical agricultural model; ways of accessing land; size of investment; and area used (Appendix Table A). We then evaluated correlations among all variables and eliminated those that were highly correlated. This gave rise to a final selection of ten not normally distributed variables, four quantitative variables, and six ordinal variables.

In order to further reduce the number of variables and achieve a normal distribution of data, we first performed a principal component analysis (PCA) using an approach that can handle mixed data (i.e. quantitative and qualitative variables). As part of this approach, for the qualitative variables, squared loadings are correlation ratios between the variable and the principal components, while for the quantitative variables, squared loadings are the squared correlations between the variable and the principal components (Chavent et al., 2014).

Afterwards, the resulting normally distributed principal components were used to perform a hierarchical clustering. We selected a clustering approach that performs a multiscale bootstrap resampling of the data (i.e. the individuals) using 10,000 bootstrap replications. This enables computation of approximately unbiased (AU) probability values (p-values) for each cluster. Clusters with an AU>95% are considered strongly supported by the data. We used ten PCAs to perform the clustering. They explained 87% of the data variance. The clustering was performed based on Euclidean distances and according to Ward's D2 method (Murtagh and Legendre, 2014), in which dissimilarities are squared before clustering. Ward's D2 provided the best separation of clusters and highest AU. These calculations were done using R software (Team, 2017). The pcamix package was used for PCA (Chavent et al., 2017), and the pvclust package was used for clustering (Suzuki and Shimodaira, 2013).

4. Results

4.1. Characteristics of business models of LAIs in Kenya's Nanyuki area

4.1.1. Organizational structure

Most LAIs in the study area were undertaken by domestic *actors*: 88% of the investors (n=33) were citizens of Kenya (see SI2 for an overview of key data). Five investors were from the UK, Ireland, France, South Africa, and Zimbabwe, but partnered with local investors in order to register a company, obtain access to land, and/or benefit from local technical know-how. The investors came from different sectors, but the majority (78%) had many years of experience (10–40 years) in commercial agriculture – often in Nanyuki itself. Hence, most were familiar with local agricultural dynamics and risks.

In total, 52% of the farms were private companies with shareholding, 27% were private companies without shareholding, and 21% were individually owned by entrepreneurs or farmers.

Shareholding company structures enable commercial farms to raise necessary capital. Investments are often very high, up to a total of USD 5–9 million[5] for individual farms in the last ten years. Overall, this legal structure eases the entry of new investors into Kenya. Foreign investors are simply required to partner with locals to register a company. In this way, foreign capital may be invested in local companies (Republic of Kenya, Companies Act 2015). In addition, Kenya's Companies Act 2015 stipulates that foreign companies registering in Kenya must demonstrate that at least 30% of the company's shares are held by Kenyan citizens born in the country. The private companies with shareholding in the study sample were described by respondents as independent businesses – except for in two cases, in which respondents mentioned formal links to a multinational company, on the one hand, and to an unnamed investor in Ireland, on the other. The LAIs in this business/legal category include many flower and vegetable producers, as well as ranches and wheat farms. Eight of the LAIs with shareholding were established after the year 2000, and required major investments. Nevertheless, some newer investments have opted for other business/legal structures.

Our sample also included nine private *companies without shareholding*, which is also possible under Kenya's Company Act.[6] All had Kenyan owners, with the exception of one large French cooperative that invested in an LAI to produce seeds. Two others were affiliated with larger companies, but claimed Kenyan ownership. Six of these companies produced goods primarily for export, while the remaining three were focused on local markets (avocados, cattle, sheep, cereals). Four of these LAIs were established after 2000, and the investment levels ranged between USD 0.3 million and USD 1.7 million.

Overall, these private companies typically employed management staff with long-running experience, including many of Kenyan origin, while some newer LAIs, especially horticulture farms, featured different management levels, such as boards of directors, general managers, human resources managers, farm managers, etc.

[5] KES 100 = USD 0.97423 as of 1 June 2016
[6] A company which does not have shares but limits liabilities by guarantee (Art 7, Company Act).

Finally, several farms in the sample were run by *individual entrepreneurs and farmers*, which are not legally registered as companies. These were all run by Kenyans, and involved cultivation on open fields (dairy, hay, horticulture) – not in greenhouses. The farms ranged from small to medium size, with the majority measuring around 20 ha. Only two such investments amounted to over USD 0.2 million in the previous ten years. This form of business is more appropriate for smaller operations. The individual owners must personally assume all risks and liabilities, which tends to constrain their access to large amounts of capital. Three were established after the year 2000. Two of these LAIs operated as outgrowers for other large companies (horticulture).

A combination of companies' own capital (including shareholding) and bank loans were the main source of funding for investors (42% of LAIs). A total of 49% of the LAIs mainly depended on short-term bank loans, while 9% declared other types of mixed funding. According to respondents, bank loans are very accessible and – despite high interest rates and service charges – used regularly to expand business operations more rapidly, with banks refraining from steering the precise use of funds. By contrast, companies' own capital – including funds from shareholders, parent companies, and savings – were described as long-term and subject to steering by investors who exert control over company decisions. Some companies changed ownership when growth was perceived to be too slow and more investments were seen as necessary. Specific sources of funds mentioned were national and international banks as well as other specific companies[7] (agricultural cooperatives, horticulture traders, and investment funds). Several LAIs gradually expanded and invested in different farms, generating more income for the parent company. Some of the LAIs invested in other farms in the study area, in other areas of Kenya, or in another African country (Ethiopia).

The LAIs operated according to diverse international and domestic *production standards* (Aschinger 2017). Overall, 23 LAIs (56%; n=41) obeyed at least one standard, with 21 farms (91%) following between two and five standards. The remaining two farms (9%) only mentioned one standard. In total, 18 different standards were used. In particular, 14 farms (61%) produced according to GLOBALG.A.P. guidelines. If we combine several standards considered roughly equal by observers (KenyaGAP, KenyaFlower Council, MPS-GAP), then a total of 18 farms (78%) followed similar standards. Another 16% produced according to Fair Trade standards, with four farms following a combination of GLOBALG.A.P. and Fair Trade standards.

Taken together, 45% (n=33) of respondents stated that EU standards and regulations made no difference to their business, since they either produce for local markets, have stopped horticulture, or believe other standards are more stringent and follow them instead. A total of 33% acknowledged the impact of particular pesticide standards and social norms – also highlighting corresponding costs of implementation to accommodate them. A small minority (12%) of respondents explicitly viewed such standards as negative and burdensome, while 3% reported both negative and positive aspects. Organic production was mentioned as a potential market, though only two farms produced organically and were specialized in herbs, oils, and seeds.

The *government of Kenya* has not assumed a direct role in determining the pricing or physical operations of horticultural marketing. Its role has been rather limited, mainly confined to regulatory and facilitative functions. Nevertheless, many respondents expressed criticism about governance issues, including perceived corruption, political interference, overly strict labour laws, and more. A total of 88% (n=33) of respondents described regular government inspections. Environmental rules, conditions on water use, health inspections, labour management reviews, and tax audits were mentioned most frequently. In

[7] World Bank, Standard Bank, AFC, Kenya Commercial Bank, Barclays, Standard Bank HM Clause, Wealmore and KHE

total, 70% of the LAIs declared they paid annual taxes, however we could not obtain details on the amount and type of tax in most cases.

4.1.2. Production model

Commercial investments in agriculture encompass a range of significant costs, including those for accessing land; purchasing farm equipment; building farm infrastructure such as greenhouses, water ponds and pumps, warehouses, and cooling equipment; buying inputs such as fertilizers and pesticides; employing workers; applying for various licenses and certifications; and more. We were able to obtain total cost/investment estimates from respondents with respect to 23 LAIs. For the remaining LAIs, we estimated overall costs based on comparable LAIs (type/size) in the study area and data pool. A total of 16 LAIs indicated investments totalling over USD 1 million, while three LAIs indicated investments of more than USD 10 million. The five LAIs with the highest levels of investments were flower and vegetable farms, as well as one mixed cereal/livestock farm (SI2). Average investments per hectare were highest for flower farms, followed by investments in horticulture farms (Table 2).

Our data from eleven flower farms revealed a cost range of USD 3/m^2 to USD 60/m^2 for construction of greenhouses, with differences attributable to application of different production standards – but also due to incomplete information provided by managers. One senior manager offered an estimate of USD 30/m^2 the average cost of building a modern greenhouse for production of roses. Altogether, 624 ha of greenhouses were constructed in the study area between 1987 and 2016 (Eckert et al., 2017). Taken together, total greenhouse investments in the study area during this period could be as high as USD 190 million.

Type of Production	**Number of LAIs**	**Investment**	**Area Used**	**Total Labour**	**Labour Intensity**	**Capital Intensity**
		Millions of USD in ten years	**in hectares (ha)**	**Employees/ farm**	**Total employees/ ha**	**1000 USD/ha in last ten years**
Dairy	**1**	**0.02**	**8**	**7**	**0.88**	**2**
Field crops	**3**	**2**	**829**	**34**	**0.04**	**3**

Mixed cereals/livestock	**7**	**4**	**787**	**106**	**0.13**	**5**
Vegetables	**8**	**1**	**25**	**230**	**9.31**	**39**
Vegetable seeds	**1**	**2**	**3**	**85**	**28.33**	**567**
Flowers	**11**	**4**	**25**	**467**	**18.76**	**169**
Organic herbs, oils	**2**	**0.5**	**55**	**148**	**2.68**	**9**

Table 2: Average investment, area cultivated, employees, and labour and capital intensity per type of production

When asked about future investments, most respondents had concrete plans (85%). A total of 42% mentioned expanding operations (mainly adding greenhouses), while 27% planned to upgrade technology (new machinery, solar panels, etc.). Diversification and acquisition of land were each mentioned twice.

The majority of LAIs (67%, n=33) *owned their land*, while 27% *leased* and 6% *rented*. Leasing conditions varied from three-year renewable up to 50 and 999 years (for a very large farm of over 400 ha). Renting refers to one- or two-year contracts.

The majority of privately owned land was purchased. Only three LAIs were inherited, and all three were owned by individual farmers. Investors typically find suitable land for purchase either via word of mouth; real estate agencies; networks/ties with friends, relatives, etc.; gifts; or inheritance. In most cases, remaining land available for purchase is owned by foreigners, especially British or American elites or a few influential, politically well-connected local individuals who own thousands of acres of land. From a legal point of view, purchasing or leasing land is relatively easily done through an established legal process, evidenced by the fact that land in Nanyuki is largely titled and privately owned. In practice, however, farmland is not easy to acquire because there are very few willing sellers remaining and such land is in high demand. Most new farms acquired their land from a single previous owner who possessed a sufficient amount of contiguous land (source: own survey).

Corruption at the land registry and *land fragmentation* (causing lack of contiguous plots) were the main constraints to *accessing land* mentioned by local farmers. These difficulties were not cited as influencing business models or causing project failures. According to the respondents, authorities usually welcome investments because they provide employment to locals and contribute to government revenues via payment of taxes and fees. In addition, thanks to enforcement of strict land laws, no communities have been displaced by any of the LAIs in study area. This was confirmed by all respondents as well as interviews and surveys conducted with around 400 land users living near the LAIs (Zaehringer et al. 2018; Reys et al. 2018).

Overall, land access is an important factor influencing the type of production**.** Five LAIs were established prior to 1980 when larger continuous plots were easier to obtain: all are larger than 200 ha and produce cereals or cereals/livestock. Indeed, the biggest large-scale farms in the area were mainly created in the colonial era. Newer farms are much smaller: in the last 20 years, only four LAIs larger than 80 ha have been founded in the study area. As land access is now constrained and largely limited to purchase or lease (apart from the occasional inheritance), the situation precludes establishment of additional geographically large-scale operations.

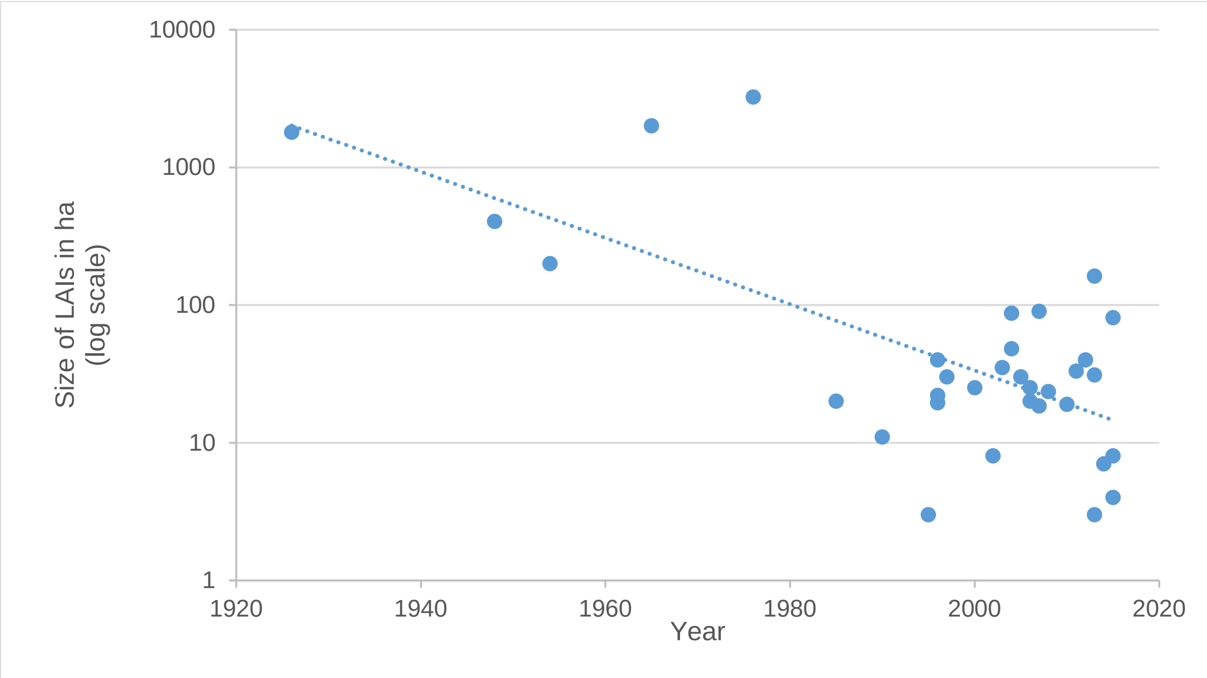

Figure 2: Size of LAIs (ha) and year of start of production of LAI

Interestingly, the data suggest that the total investment value does not show a clear trend when compared with the establishment date of firms. Older LAIs, frequently specialized in more extensive production over larger areas, generally correspond with large cost of investments, commensurate with their large size. Newer LAIs, however, which encompass a number of smaller farms displaying very different levels of investments, do not exhibit a clear trend (see Figure 3: Investments and year of production start of LAI). A closer look at more 27 recently established LAIs (since 1990) confirms this result.

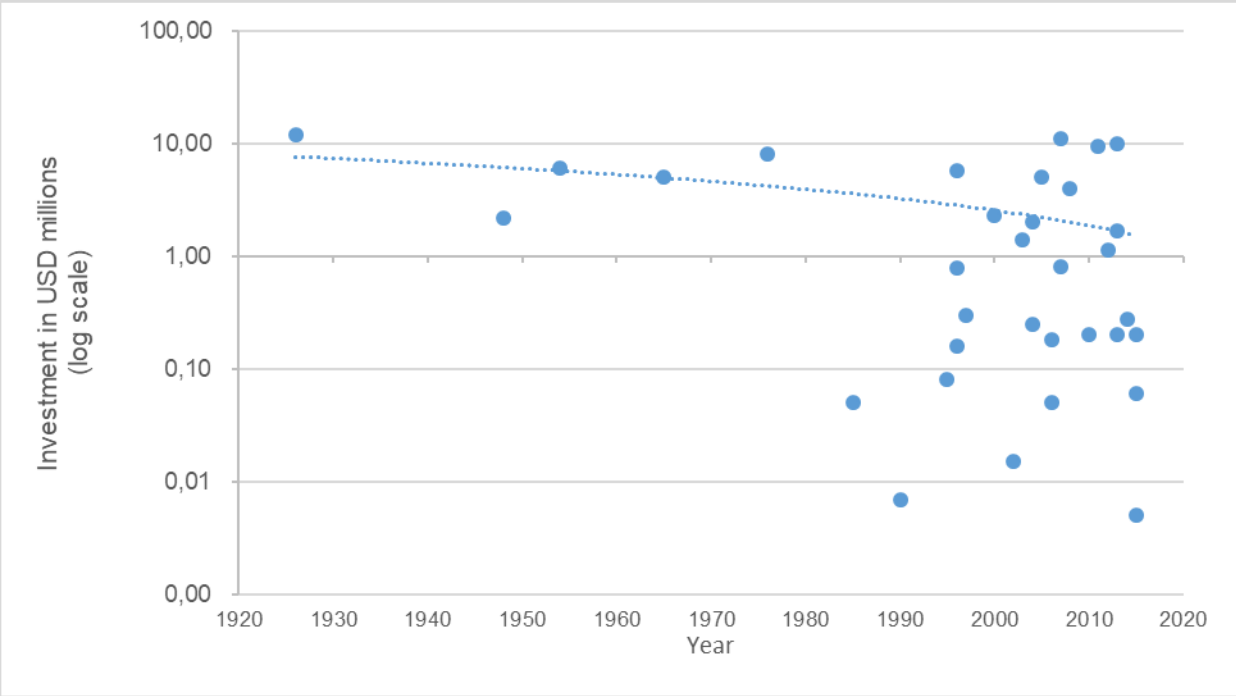

Figure 3: Recent investments and year of production start of LAI (n=33). Note that the y-axis indicates recent investments (in the last ten years), whereas the x-axis indicates the production start date.

In terms of *area owned*, the majority of LAIs (48%, n=33) in the study area were relatively small, i.e. 1–50 ha (mostly flower farms). Another 30% were 51–200 ha (mostly vegetable farms), while 21% were over 200 ha (mostly cereal farms). Notably, many LAIs did not utilize all of their land. Indeed, 36% (n=33) of the LAIs used less than 50% of their land for crop production. Some were still developing and set aside part of their land for grazing, while others had land with forest cover. Water scarcity also deterred some LAIs from cultivating all of their land, though most invested heavily in water-harvesting structures. Finally, a variety of other operational, financial, logistical, and technical issues precluded LAIs from using all of their land for production.

The 33 LAIs in the study employed 8,200 *workers* in total – 70% on permanent contracts (Mutea et al 2017). Notably, 49% of the permanent workers and 62% of the seasonal workers were women. The majority worked on horticulture farms. The extensive cereal farms and ranches employed very few people, but almost all were permanent. LAIs had a big pool of labour to draw on in terms of unskilled and skilled workers because of the large local population and high unemployment rate. General workers (seasonal and casual) were usually recruited based on prior experience; the remainder received on-the-job training. Managers and technicians were required to have a degree or diploma in relevant fields as well as professional experience.

Labour intensities were mainly dependent on the type of production. As seen in Table 1, flower farms exhibited the most labour-intensive production models by far, employing many seasonal workers. Vegetable production displayed intermediate labour intensity. Cereal farms and other field production had the lowest labour intensity. Livestock or mixed production on large farms was also relatively low in labour demand.

According to the respondents, labour laws requiring benefits such as pensions, health insurance, and social security funds disincentivized some farms from employing large numbers of permanent workers. The LAI wages, salaries, and transaction costs were very low compared to Kenya's national standards, but workers still sought after the jobs due to their dependability (payment on time and in full). In interviews, the managers and owners were very enthusiastic about the employment benefits of the investments.

All 33 farms were *plantations (production on own farm*), with only six farms – mainly vegetable producers – contracting out some of their activities. The advantages they cited included increased production and better distributing risks. According to some respondents, however, contract farming often fails because contract farmers cannot meet certain standards. Several LAIs reported using fewer contract farmers more recently, opting solely for those capable of producing at a larger scale while meeting necessary standards. Six of the LAIs themselves became outgrowers to larger businesses.

Only five respondents reported contract-farming arrangements with smallholders (15%; n=33). One LAI engaged nine groups each consisting of 25–50 farmers. Another respondent said they had contracts with 1,000 farmers. Notably, however, several specialized contract-farming businesses in the study area bought directly from smallholders and had no production of their own (Hakizimana et al., 2017). Flower farms do not contract out production at all because of their high production standards and the required greenhouse infrastructure.

Table 3 specifies the *main products* cultivated by the farms. As shown, the LAIs were highly specialized on a narrow range of products.

Table 3: Main products of LAIs

Type of Production	**Number of LAIs**	**Area used** (ha/LAI)	**Total Labour** (employees/ LAI)	**Specific products**	**Comments**
Dairy	1	8	7	Milk	Small, individual farm
Field crops	3	829	34	Wheat, barley, canola	Large farms that were all established before 1980
Mixed cereals/livestock	7	787	106	Wheat, canola, milk and meat	Large farms that were all established before 1980
Vegetable seeds	1	3	85	Tomato seeds	Highly specialized producer
Organic herbs, oils	2	55	148	Herbs, oils	Greenhouses and open fields
Vegetables	8	25	230	Peas, beans, cabbages, broccoli	These farms usually have both greenhouses and open-field crops

Flowers	11	25	467	Roses, other flowers	Specialized producers, all in greenhouses

Many of the farms utilized advanced *technical agricultural models*. In the semi-arid Nanyuki area, irrigation is needed to produce vegetables. A total of 82% of LAIs – producing flower, herbs, and vegetables – used irrigation. The remaining 18% that did not use irrigation were focused on producing grains, fodder, oil plants, and barley. Drip irrigation was employed by 54% (n=33). Kiteme and Gikonyo (2002) have shown how the horticulture industry increased water demand in the area. Horticulture farms are required to have a 90-day water-storage facility before being issued a water license to abstract water from the river. Local farms have invested heavily in water-harvesting infrastructure. Eckert et al (2017) found that 97 ha of water ponds were installed in the last 20 years, which fill with harvested rainwater from the greenhouses during the rainy season. All the managers in the study area stressed that they have policies in place to minimize water use. Government regulations and water resource user associations (WRUAs) have been relatively successful at mitigating water problems to date (Lanari et al., 2018), as was confirmed by virtually all respondents. Service providers and dealers for machinery and equipment used on the LAIs can be found easily, especially due to the presence of numerous similar investments. The horticulture farms employed various specialized technologies such as drip irrigation, fertigation systems, greenhouse ventilation systems, net shading, pre-cooling, cold-storage facilities, grading, bouquet makers, fertilizer recycling systems to prevent wastage, wetlands for wastewater treatment, artificial lighting to increase daylight hours, grading/packaging sheds, and refrigerated trucks. A total of 36% of the LAIs use greenhouses (n=33). The rest of the LAIs – producing grains, such as canola and wheat, barley, hay and vegetables – practise minimum tillage, open-field farming, semi-mechanization, or precision cultivation.

4.1.3. Place and function in the value chain

The majority of farms claimed to be independent businesses, but ten (30%) declared affiliations with another company or the status of belonging to another company. The following links to larger businesses or funders were identified: *Kevian Kenya Limited* (Kenya-based fruit and beverage company), *Sunripe Limited* (South African, with several farms in Kenya), *Agri-Vie* (South African and international private-equity investment fund focused on food and agribusiness in Sub-Saharan Africa), *Groupe Limargrain* (Clause Vegetable Seed, French, a large cooperative), *AAA Growers* (Kenyan company that owns four farms, two of them in the study area). One of the LAIs studied was an outgrower for *Kenya Fresh* (a Kenyan grower and exporter of fresh vegetables and fruits). We did not systematically investigate the degree of independence of affiliated/subsidiary LAIs in operational and strategic decision-making. However, according to managers, parent companies of relevant LAIs controlled major decisions, for example, regarding wages, crop schedules, or infrastructure (e.g. pack house for its branches). Managers of affected LAIs were solely responsible for decisions on an operational level, such as hiring or firing of workers, provision of trainings, work plans, or supervision.

All the LAIs in the study area were engaged in production, with some also involved in packaging, distribution, and retail. Independent farms were directly engaged in production and distribution (transport and selling) of their own produce, while farms belonging to a parent company tended to focus on production and were less involved in packaging.

Some of LAIs had direct *access to markets* in specific countries, others brought their produce to auctions in Europe, and still others produced for both. Auctions enable farms to market their flowers and sometimes fetch better prices than selling directly, as well as offering flexibility. "*The auction market is flexible because one does not have to meet certain market demand, you just sell what you have produced*" (interview Farm 3), stated one respondent. But there are also downsides to auctions, as illustrated by this statement: "*We used to sell to the Dutch auction system and this made us almost bankrupt, and so we decided to maintain a direct connection with the wholesalers and this has translated into big profit margins"* (interview Farm 11). Direct marketing enables investors to sell their produce at a defined price, but is not without complications: *"Direct marketing is complex in terms of logistics involved to secure a market and meet a certain market demand, as opposed to the auction market"* (interview Farm 25).

Overall, LAIs in the study area were able to access different markets for their products. Many were exclusively focused on exports (58%; n=33), especially to the EU/UK as well as the Middle East. Another 39% sold nationally, while 12% sold both nationally and internationally. Flowers were produced solely for export, as well as most herbs and vegetables. Finally, grains, oil plants, barley, fodder, milk, and some vegetables and herbs were produced for local and national markets.

Several LAIs also aimed at *diversification of business*. Among the private companies featuring shareholding, seven out of 17 owned multiple businesses – four LAIs had over three other businesses. Among the private companies without shareholding, a few owned one additional farm or other business (e.g. construction, hotel) and one company owned several businesses. By contrast, among lone entrepreneurs and individual farm owner/operators, only one claimed to have an additional business. Individual farmers tend to lack enough capital to acquire and run additional businesses. Overall, only private companies with shareholding have the means to invest in multiple businesses, and they typically do so when it supports a wider strategy of expansive growth.

4.2. Principal component and cluster analysis of business models

The results of the principal component analysis showed that a high number (i.e. 10) of principal components (PCs) were required to explain more than 75% of the variance in the data. As seen in Figure 4, PC9 and PC10 contributed substantially to the explanation of the variability of the ten variables. Out of these ten variables, the qualitative variable *main production* explained most of the variability, followed by the three qualitative variables *access to land*, *investor origin*, and *juridical structure*. Out of the quantitative variables, *number of employees* was the most important variable and *production area* the least important.

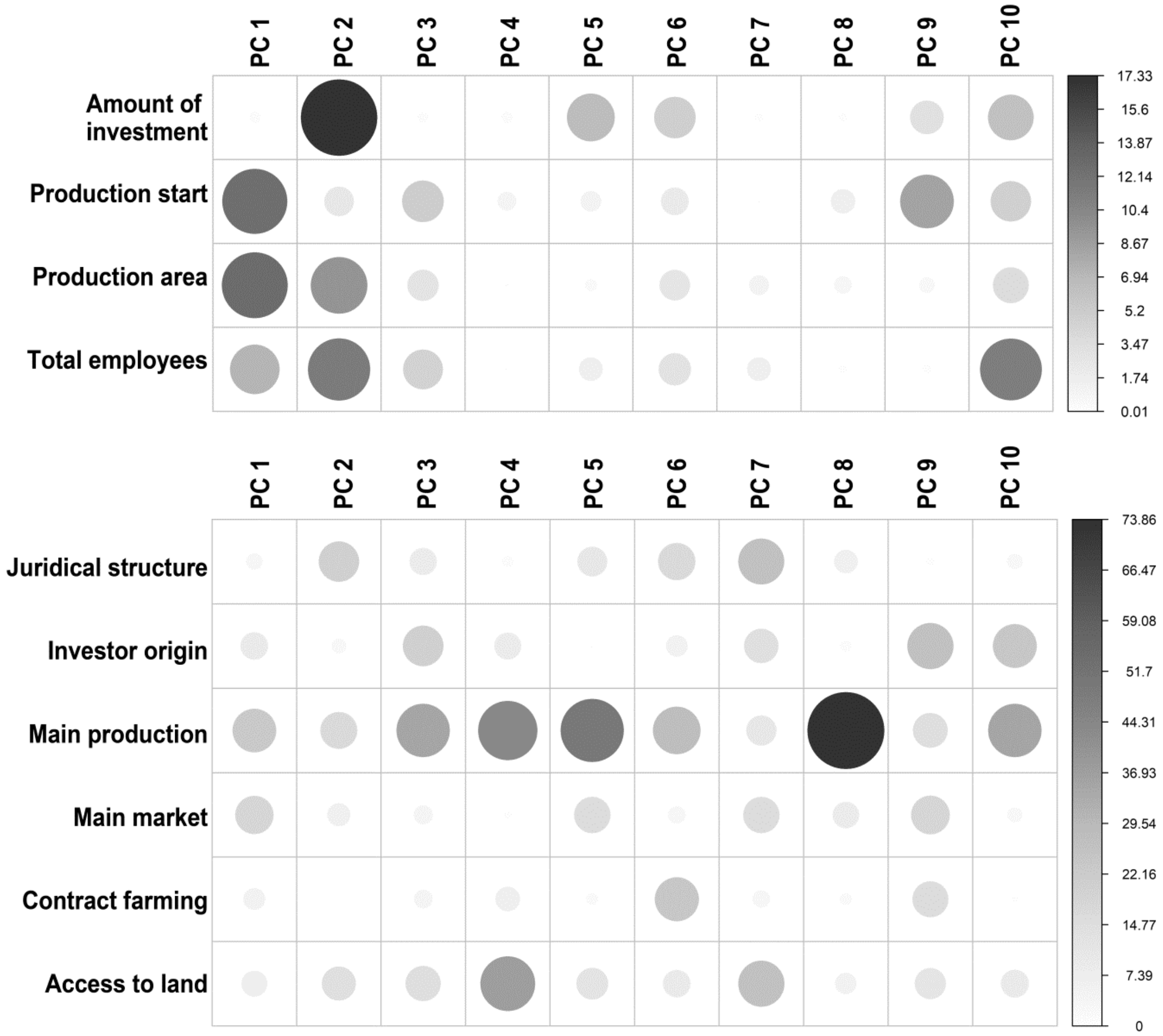

Figure 4: Correlation plots of the relative contribution of the first ten principal components (PCs), or dimensions, in explaining the variability of the six qualitative variables (bottom) and the four quantitative variables (top).

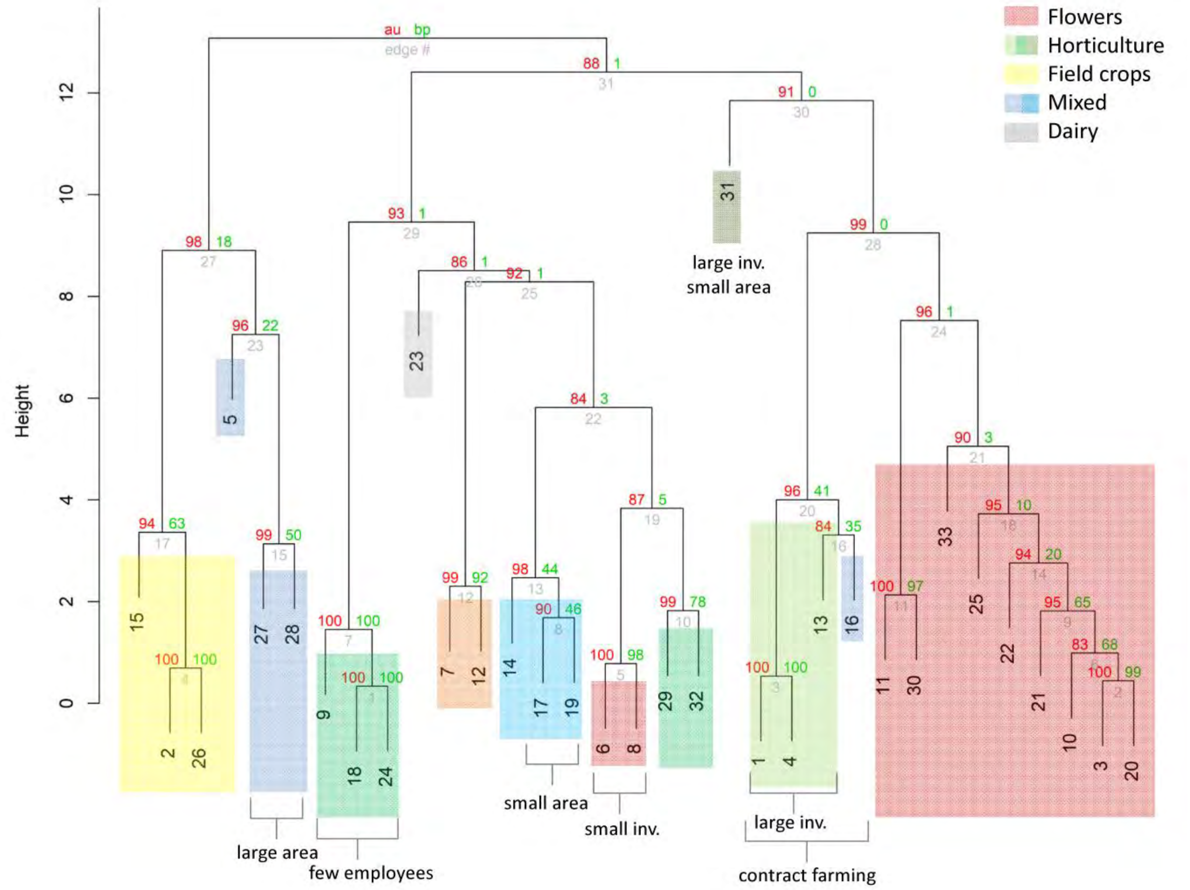

Figure 5: Dendrogram with the approximately unbiased (AU) probability values in percent (i.e. p-values) indicated in red, and the bootstrap probability indicated in green. The individual LAIs are identified with a number (and a symbol indicating their main production type). Additional information on particular characteristics which contribute to the clustering are also indicated. Two-thirds of the clusters reached an AU of 90% while one-third reached AUs between 80% and 89%.

The dendrogram in Figure 5 illustrates the main clusters and business models that were identified:

As seen in the figure, the nine flower farms appear to the far right of the dendrogram, whereas the three field-crop farms appear to the left – these two types of LAIs constitute the two most distinct business models.

The three *farms with field crops* cluster together to the far left of the dendrogram mainly due to a combination of large area, low number of employees, and national market destination. They are linked very closely, clearly showing that these farms are distinct – especially vis-à-vis the other extreme, i.e. flower farms.

The business model of *flower farms* is characterized by a combination of moderate area, high numbers of employees, and international sales. Nine such farms cluster close together to the far right of the dendrogram. Two other flower farms constituting a different subgroup cluster in the middle of the dendrogram. These are the smallest flower farms with the lowest investment levels.

Vegetable producing farms are the third clear business model, which may be further clustered into three distinct subgroups:

(1) One subgroup of three LAIs is distinguished by a combination of work with contract farmers, rather large areas, and high investments. (Another LAI producing mixed cereals and livestock also fits into this cluster, as it, too, uses contract farmers and is similarly sized).[8] These are all very commercially oriented, highly capitalized private companies both with shareholding and without it.

(2) Another subgroup consists of minimally capitalized vegetable farms with relatively few employees. All are owned by individual farmers (farms 9, 18, 24).

(3) Two other vegetable farms display intermediate characteristics (farms 29, 32).

A fourth identifiable business model clustered to the far left consists of three *large mixed farms*. These farms are highly capitalized, very large, have many employees, and were founded over 40 years ago. They are similar to the first cluster.

Another group of mixed farms is situated slightly to the left of the middle of the dendrogram (farms 14, 17, 19). These are younger and smaller than the three large mixed farms, and much less capitalized.

Two more *specialized farms* (herbs, oils; farms 7, 12) and one *dairy farm* (farm 23) are situated in the middle of the dendrogram – they do not belong to any particular cluster, but the dendrogram still indicates where they fit in most closely.

Overall, we find that the *type of goods produced* and the *technical model of production* are the most important distinguishing factors between business models. However, factors such as land area, investment level, age, and number of employees also aid distinction. Finally, factors such as actor type, juridical structure, main market destination, and presence of contract farming are of secondary importance.

4.3. Determinants of business models

As shown above, *type of goods produced* and the *technical model of production* are the main factors distinguishing different clusters of business models, with various other factors characterizing particular subgroups.

This choice between producing flowers or vegetable horticulture, and particular technical models for doing so, is largely determined by market demand and economic incentives. This emerges clearly from the interviews. We found a tendency towards more intensive production types, especially horticulture aimed at international markets. Nanyuki is ideally located for exporting vegetables and flowers to Europe and the Middle East by air. Investors identified the area as an ideal location for growing high value crops for Europe during the winter. Relatively low airfreight costs, in particular, have enabled a lucrative business opportunity. Notably, however, many of the farms in our sample

[8] One LAI (farm 31), featuring a very small operational size, is also near this cluster, but it produces very high value seeds for the international market. Its position on top of the dendrogram highlights the distinctness of this case.

also produced goods for Kenya's national market (cereals, milk, meat), for which strong demand also exists.

In addition, the two distinct clusters of vegetable horticulture LAIs and flower horticulture LAIs are undoubtedly driven, in part, by Nanyuki's ideal biophysical conditions and geographic location. Its altitude, climate, water availability, and relatively good access to the international airport present competitive advantages for commercial horticulture. In this way, the biophysical context, geographic location, and market demand – especially from Europe and the Middle East – are additional key drivers of the business models observed.

The conditions of access to land are another important factor. As our results have shown, newer farms are typically midsized (under 100 ha), reflecting the relative scarcity of available land. At the same time, Nanyuki's strong land tenure regime provides stability. This combination of high tenure security and relative scarcity of land has also driven the recently established intensive farming business models. By contrast, we found many older LAIs (cereal farms and ranches) that continue to produce on large areas and apply extensive production models thanks to their ongoing access to large tracts of land.

Our investigation and cluster analysis also show that the choice of goods produced and the technical model are correlated with the labour intensity of the farms. Local abundance of relatively cheap labour was another factor cited by many respondents as a key explanation for the presence of horticulture farms. Nevertheless, large colonial-era farms also remain that practise more extensive forms of production and require relatively few labourers. For these large farms, thanks to the existing land tenure structure, land remains cheap enough for extensive production to be profitable.

Finally, analysis also showed that businesses in the study area are mostly owned by actors with long-running experience in agriculture and in this region in particular. When occasional newcomers enter the field, they can obtain access to experienced, professional management staff. We did not find evidence of short-term speculative investments, but rather of investors who understand the risk profile and time horizons of commercial investments in agriculture.

4.4. Evolution of business models over the past twenty years

In addition, we sought to trace the recent evolution of LAIs in the research area. Comparison of inventory lists from 1996, 2013, and 2016 showed that 15 LAIs had closed down or undergone changes, such as being leased out to other farms, while new LAIs had emerged. Notably, five LAIs were subdivided among individual smallholders in this period. This shows that commercial development in the Nanyuki area is a dynamic process.

We also found evidence that smaller flower farms may no longer be viable in the long term. As the owner of one such farm put it: *"This farm is probably the last privately financed farm [likely to be] set up in the region, as now you need big money to set them up. You could previously start with around two hectares and build up, but now you need to start with at least ten hectares and build up to twenty hectares (the minimum to be financially viable)"* (interview Farm 33). Indeed, this subgroup may vanish as market pressures further consolidate the sector, reducing the competition to a handful of larger, highly capitalized farms.

The evolution of production models also displays a trend towards higher value crops that offer a better price per unit/weight ratio, which is important for airfreight. All the flower farms remained flower farms during the period examined. By contrast, vegetable production appears to be undergoing market pressure: four LAIs switched from lower-value vegetable horticulture to higher-value flower production. In two cases, vegetable production was abandoned in favour of livestock/agriculture production. In addition, five LAIs began specializing in higher-value vegetable crops including herbs and oils. Nevertheless, three LAIs were converted from livestock/agriculture production into horticulture businesses. The respondents attributed these shifts towards higher value crops to the high standards set in the vegetable market of the EU in particular. In addition, our data confirm a trend towards less contract farming, which can be partly attributed to rising standards in export markets, as well as to the benefits of economies of scale and the extra costs associated with management of contract-farming arrangements.

Some of the LAIs’ strategies for the future consist of upgrading and expanding operations – including on uncultivated land they already own (42% of the farms have less than 50% of their land under crop production) – and diversification of business.

5. Discussion

Analysis of the results enabled us to identify distinct types of business models. The main element structuring these business models was found to be the *production model* (based especially on the *crops* or *livestock* produced as well as the *technical* model of production) rather than the types of actors or financial structures involved per se. In addition, a number of other important factors that shape these business models could be identified, including: demand for horticultural products, access to land, types of investors, labour creation, and integration and governance of the value chain.

First, demand for horticultural products in Europe and the Middle East is a key factor that has profoundly shaped agricultural business models in the study area over the last 20 years. This demand enabled establishment of a horticulture industry in the study area, and it determines the types of crops grown and the conditions of production. The business models implemented by investors in the study area respond to this demand. At the same time, local conditions shape the configuration of their investments.

Second, access to land and water strongly influences the “where” and “how” of production. Access to land is deeply conditioned by the historical context and current land tenure system. It has created a tri-faced landscape featuring some very large ranches and farms remaining from the colonial era, a number of medium-sized commercial vegetable and flower companies – most of them established after 1990 – as well as a substantial smallholder and family-farm sector coexisting alongside them. Access to land for new commercial farms is limited, and this is pushing the sector towards more intensive production of higher-value goods. Water access is also essential for horticulture especially in the semi-arid environment of Nanyuki. Conflict over water use has arisen in the past and remains a risk, as smallholders and downstream users depend on the same water resources used by commercial farms. Water harvesting and storing are increasingly practised, and this has helped to mitigate conflicts to some extent. In the mid- and long-term, however, competition for land and water is bound to intensify, as the local population continues growing and the horticulture industry develops further. Additional strengthening of integrated water and land management is needed.

Third, the findings enable identification of three broad types of investors active in the study area. Above all, we find Kenyan entrepreneurs who have prior/long-term experience in the sector. Next, we find several international investors with strong experience in commercial agriculture, who partner with local actors and focus on high-value crops using relatively advanced horticultural production methods. This latter group is small, and different means of affiliation were found with no common pattern emerging. Finally, we observe a small group of individual farmers who inherited their land and are continuing their family tradition, and have been around since the colonial/post-colonial era when land was still plentiful in the area. This type of agriculture is under increasing market pressure, especially when the farms are small and not professionally managed. Notably, our study did not find evidence of speculative, short-term focused agricultural investors. At the same time, our research did not investigate commercial actors operating at even smaller scale in the study area, including mid-sized milk producers, smaller horticulture producers, etc. Further, we did not interview actors related to investments that were sold or closed down.

Fourth, labour availability characterizes the various business models observed. Our findings confirm research in another region of Kenya (Kuiper, 2019a) showing that horticulture employs high numbers of workers, both on a permanent basis and as temporary or casual labour. Interviewees considered these jobs to be highly beneficial to the region and the local population. Intensive ethnographic research in the area (Käser, 2018) found that off-farm income – earned on LAIs and via other non-farm activities – is important for many families to support their own smallholder production and cover livelihood needs. As these family farmers have only small landholdings, they depend on external inputs to sustain their primarily subsistence-oriented production which generates little cash income (Käser, 2018). Indeed, despite competition over water, Zaehringer et al. (2018) found that most respondents in areas near LAIs favoured their presence, believing that they contribute to local economic development. At the same time, other research (Peter et al., 2018; Reys et al., 2018) suggests that many workers earn very little and their household livelihoods are often no better than those of the unemployed (Mutea et al., 2019; Reys et al., 2018). The jobs of temporary and seasonal workers, in particular, are not secure. At the time of the interviews in early 2016, several vegetable farms had to scale back their operations and dismissed workers due to a drought in the area. Existing jobs on extensive cereal farms and ranges are somewhat more secure, but fewer in number. The distinction can be explained by differing market pressures impacting these LAIs, since cereals and livestock do not need to be sold immediately and can be withheld in cases of low prices on spot markets. Overall, the many jobs created by LAIs represent an important contribution to the local labour market, helping to sustain local livelihoods and aiding economic development in the study area.

Notably, we found only a few cases of contract-farming arrangements in vegetable production, but no such arrangements in the production of flowers or field crops. The results confirm earlier findings on Kenya’s horticulture sector showing that contract farming is under pressure, especially due to difficulties fulfilling the standards and guidelines set by importers. However, if and when the organization of contract-farming systems improves, the horticulture sector could eventually be developed more in this direction, especially as long as individual commercial farms continue to have difficulty accessing or purchasing additional land. One interviewee indicated this possibility, citing the relationship of their international parent company with firms in countries such as Chile, where conditions were more appropriate for contract-farming arrangements.

Sixth, horticulture farms in the study area are shaped by global value chains including input and output markets. However, very few appear to be incorporated in a vertically integrated business structure. Instead, our findings indicate that Kenya’s flower and vegetable farms are integrated in a typical buyer-driven value chain (Lee et al., 2012). At the same time, the farms do not appear to be “captive” to a particular value chain, i.e. they are not totally dependent on one or two buyers (Gereffi and Fernandez-Stark, 2011). Since the goods they produce (e.g. cut flowers) are highly standardized and codified, they also can be brought to daily auctions in Europe – more in line with a true “market” value chain (Gereffi and Fernandez-Stark, 2011). Nevertheless, many farms also reported direct links to specific large-scale buyers, and described the strong impacts of their regulations and standards on the business. Overall, we found examples of various forms of vertical coordination in the study area (Peterson et al., 2001), ranging from spot markets (auctions) to specified contracts (for large retailers), equity-based alliances, and full vertical integration. However, we did not investigate these different forms of coordination in detail to understand why different LAIs operate at different positions along the coordination continuum (Peterson et al., 2001).

Finally, the LAIs are regulated and controlled by government agencies – such as the Kenya Investment Authority (KenInvest) and the Kenya Plant Health Inspectorate Services (KEPHIS) under various laws (Investment Promotion Act, 2004, Employment Act, 2007) – and by private standards and guidelines, although effective implementation and enforcement are not always given (Kiteme et al., 2019). The respondents stressed that these laws and regulations have an important impact on their business practices.

6. Conclusions

The findings of the present study make three important contributions to the literature on business models.

Firstly, comparing our results to the business models identified by Boche and Anseeuw (2014), the study area exhibits two types of models similar to those they described as “independent farmers” and “agribusiness estates”. However, our findings lead us to different conclusions about the importance of particular actors and investment structures. We found that *technical* and *production*-related elements have a greater impact on the business model established, and institutional and financial arrangements play less of a determining role. As such, there is more business homogeneity within technical production (i.e. business models seem to be more determined by the sector – for example labour-intensive highly mechanized models in the flower sector) than by financial structures and institutional frameworks. Investment in flower farms necessitates access to land, labour, specialized equipment, skilled management, and significant funds invested over a number of years; our results show that this is being done in similar way irrespective of the investment network or the type of actors behind it. We attribute this finding mainly to the relative mature stage of the sector in the study region. We postulate that market pressures, highly conditioned by the specific agrarian structures prevailing in the study region, have been advancing a very specific type of “modern” agriculture that obeys the dominant standards of commercial practices for specific products. In addition, this development is shaped by the geographic context, the abundance of cheap labour, and land tenure rules that enable transactions of land and relatively secure investment conditions.

Secondly, we find that access to land, in particular, greatly determines the prevailing business models: where large land areas are still available, investments aim at extensive agriculture and ranching; where land resources are limited, but other biophysical conditions are suitable, investments aim at intensive horticulture. Land access is also one of the most decisive factors determining the risks and opportunities associated with such projects. Many studies highlighting conflicts and negative impacts on local communities refer to cases in which contradicting and overlapping land tenure systems co-exist. The present case study focused on an area in which land rights are relatively clearly defined, and importantly, large plots of land are privately owned and can be bought or leased from a handful of owners. The data show clearly that the majority of LAIs occur on purchased or leased land, made available and accessed by means of a well-functioning local land market. Unlike land used for coffee production, which cannot be alienated for other purposes under Kenyan law, the relevant land in the study area was used for ranching or cereal farming, and was not subject to restrictions on transforming land use. For investors, these conditions greatly reduced the difficulty and costs of accessing land, as it was not necessary to reach an agreement with numerous smallholders or a community with customary rights over the land. The active involvement of land administration services was also not necessary, further easing the process. Importantly, the strong land tenure laws also protect smallholders and pastoralists from dispossession via land acquisitions by LAIs. Our results show that most of the recent investments took place on relative small land areas, unlike the large-scale land deals that often harm local communities elsewhere (Oberlack et al., 2016; Schoneveld, 2014; Schoneveld, 2017)). At the same time, access to water is a highly relevant concern in the study area. Strong governance efforts to improve water use efficiency and water storage have helped to mitigate water conflicts in the area, at least somewhat. However, this remains a challenge in view of population growth and increasing local economic activity. A special concern is management of groundwater, which is increasingly used but poorly monitored to ensure sustainable supplies. Efforts are increasing to better control and monitor this additional water use, with a new levy imposed on groundwater pumping.

Thirdly, a "cluster effect" (Ketels and Memedovic, 2008; Martin and Sunley, 2003; Porter, 2000) appears to have reinforced the success of commercial agriculture investments in the study area. The emergence of specialized human resources at different levels, formed and trained via the LAIs, clearly represents an important comparative advantage for Kenya. New agribusiness investors can and do recruit from this existing pool of talent. These and other cluster effects drive down costs for investors, helping to build forward and backward linkages (Hakizimana et al., 2017; Hall et al., 2017), and provide opportunities to influence governance mechanisms in favour of the sector. The remarkable performance of the industry in the study area can also be ascribed to government policies that have enabled autonomy in production and marketing decisions, thus fostering significant local private initiatives and dynamism in the industry. We have not investigated the cluster effect in detail, but it represents a promising avenue for future research – as well as comparison with similar case studies in Africa.

Overall, Kenya has maintained a relative stable, liberal macroeconomic environment in recent decades, in which government policy has favoured foreign investment and international trade. This has enabled its commercial agriculture sector to grow and advance technologically. At the same time, local governance and land tenure have shaped the sector, promoting long-term investments and more intensive land use. There are many challenges ahead, however, which may limit future development of the sector, in particular regarding the environmental costs of intensification, increasing land and water scarcity, and the external costs of airfreight upon which export business depends.

Our results also give rise to several *recommendations regarding land use policy*:

Clear land tenure rights and mechanisms for accessing land should be given priority in policies on agricultural investment. In Kenya, the policies aiming at devolution of responsibilities from national to county level are not yet fully implemented, creating overlaps and frictions between the different levels and unclear regulatory and fiscal requirements on the part of the LAIs. This has been cited as a problem by many respondents. These inconsistencies will need to be further harmonized. To enable long-term investments in agriculture, commercial farmers and investors must be able to access land relatively easily and obtain sound ownership or leasing rights. Transparent, reliable, and effective legal processes are indispensable. At the same time, the land tenure of smallholders and communities must also be fully secured. These conditions were fulfilled in our study area, enabling co-existence between diverse types of farmers and commercial farm enterprises. This co-existence should be possible to replicate in other regions of Kenya and Africa more broadly, though additional tenure challenges must be carefully negotiated in places where land is largely publicly or community owned.

Further, we recommend that policies aiming at promoting agricultural investment prioritize investments that are capital and labour intensive, environmentally sustainable, and require only modest land resources. In our study area, intensive horticultural production has created positive spillovers, especially for a large local workforce seeking employment. At the same time, strong governance is needed to uphold good labour conditions and protect the health of workers. It is also crucial to strengthen policies and regulations on the environmental impacts of LAIs, in particular with regard to impacts on water resources and pesticide use. The present study also highlights the reluctance of LAIs to involve smallholder farmers via contract farming arrangements, with the standards imposed by private labels and import regulations in target markets representing barriers to such models. New ways of overcoming these barriers should be sought.

Finally, policymakers should be aware that creating a cluster of highly specialized commercial farms is not an easy process and cannot be easily reproduced in other countries or regions where certain preconditions are not met. Policies aiming at creating a similar pattern of investment would need to be carefully prepared and sustained over a long period of time, including significant public investment and appropriate governance mechanisms. In particular, regional integration through well-functioning infrastructure (roads, electricity) is necessary, together with links to national and international markets.

Appendices

Appendix A: Questionnaire

Appendix Table A: Data used for cluster analysis

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Pre-Print 4.4.2021 Markus Giger, Sandra Eckert, Jann Lay

Large-scale land acquisitions, agricultural trade, and zoonotic diseases: Overlooked links in research and practice

Land use change is associated with the emergence of zoonotic disease outbreaks and subsequent pandemics. Commodity production-related deforestation and agricultural expansion are especially relevant (1-6). Besides the trade of wildlife, deforestation is one of the most important drivers of emerging zoonotic diseases (1). This deforestation, in turn, is frequently driven by large-scale land acquisitions for export-oriented commercial agriculture, often promoted by governments and international donors (6-11). With few exceptions, however, mainstream debates on agricultural trade and land acquisitions have failed to highlight the likely ties of these activities to emerging zoonotic diseases. Indeed, more focus is needed on prevailing agricultural and economic strategies and how these may be linked to risky biological and social processes. We contribute to this debate from the perspective of the Land Matrix Initiative[1].

Large-scale land acquisitions for commercial agriculture

Large-scale land acquisitions for commercial agriculture, typically fuelled by foreign investors, have become a central topic in debates on rural development in the global South (12). Many land deals are struck to produce tradable goods for export, such as palm oil, rubber, soy, beef, wood, and a range of other commodities (13). These deals raise complex issues spanning various dimensions – legal, economic, social, environmental, ethical, and cultural. Some observers welcome them as a source of urgently needed investment in land, infrastructure, and (previously neglected) agricultural development (14). Others raise important questions about the possible social, economic, and environmental harms of land acquisitions (15). In the meantime, the international community has sought to formulate detailed guidelines for promotion of "responsible" land investments (16).

Many large-scale agricultural investment projects were initiated in just the last 15 years, and are expanding to produce a wide range of commercial crops such as palm oil, rubber, soy, sugarcane, maize, tea, wheat, and rice. In this way, they are making a large and growing contribution to global land use change (6, 11, 13, 17, 18). Evidence of their (primarily negative) environmental impacts continues to accumulate, including rising carbon emissions (7), increasing water consumption and pressure on water resources (19), and pollution from pesticides and fertilizer use. Above all, however, large-scale land acquisitions are major drivers of deforestation. And a significant share of them is located in or near biodiversity-rich ecosystems – for example, in Indonesia and Papua New Guinea, the Congo Basin, the Gran Chaco and the Amazon (12). Lots of rainforest and other natural habitats have already been lost, and even more remain under threat.

Land use change and the emergence of zoonoses

The COVID-19 pandemic has prompted researchers to take a closer look at the connections between agricultural encroachment, deforestation, biodiversity loss, and the likelihood of future pandemics.

[1] The Land Matrix Initiative (LMI) represents a partnership between the Centre for Development and Environment (CDE) at the University of Bern, the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), the German Institute for Global and Area Studies (GIGA), the German Agency for International Cooperation (GIZ), AFA (Asian Farmers' organization for Sustainable Rural development), UP (University of Pretoria), Ecoaction (Centre for Environmental Initiatives), FUNDAPAZ (Fundacion para el Desarrollo en Justicia y Paz), and the International Land Coalition (ILC). The LMI systematically collects and seeks to verify information on large-scale land acquisitions. Its database on large-scale land acquisitions is considered the most comprehensive such database on large-scale land acquisitions in the world.

A report by Intergovernmental Platform on Biodiversity and Ecosystem Services (4) has drawn attention to the complex – sometimes ambiguous – relationship between biodiversity loss and pandemics. One specific mechanism through which land use change may impact the emergence of zoonotic diseases is the “dilution effect”(4). Biodiverse ecosystem niches may have a variety of animals that act as *buffering species*, slowing or stopping pathogen transmission (20). Since commercial agriculture usually reduces biodiversity, it may trigger increased pathogen transmission by hastening the demise of local buffering species. Further, Gibb et a. 2019 show that human-dominated ecosystems feature greater *zoonotic host* diversity, suggesting that land use change towards such systems creates fertile ground for hazardous interfaces between humans, livestock, and wildlife susceptible to zoonotic diseases (2). Finally, transmission may also be facilitated by zoonotic and anthropogenic pathogen exchange when certain species are forced into atypical ecological interactions (21). This effect could occur, for example, when new crops are introduced in a particular ecosystem.

Land acquisitions fuel land use changes in biodiversity-rich areas

Since 2012, the Land Matrix Initiative (LMI) has collected data on the pattern and extent of large-scale land acquisitions in low- and middle-income countries. As of November 2020, the LMI has documented a total of 2,485 (concluded) large-scale agricultural deals (>200 hectares), both domestic and international, comprising over 43 million hectares of land. Over 70% of them are fully or partly aimed at the international market. While these data do not provide a full inventory of all land transactions, their coverage of recent large-scale agricultural projects – in particular by foreign investors – is fairly comprehensive for several countries in Africa, Latin America, and Southeast Asia. They provide a detailed portrait of land deal trends and composition in these areas.

Using the LMI data on domestic and transnational agricultural land acquisitions, we created a global heatmap enabling comparison of investment locations with local terrestrial biodiversity (Figure 1). The resulting maps reveal that numerous agricultural land acquisitions are occurring in or near areas of comparatively high terrestrial biodiversity. Previous studies using LMI data have shown that major portions of these land deals fall in forested areas (9, 12).

Figure 1: Terrestrial vertebrate biodiversity and a global heatmap of large-scale agricultural investments.

Note: Terrestrial vertebrate biodiversity (left) and a heatmap of large-scale agricultural investments (right) point to an overlap of the two in several regions of the world. We generated the two maps using existing geospatial datasets without performing additional analyses (e.g. geospatial correlation analysis). To generate the map of terrestrial vertebrate biodiversity, we summed existing geospatial datasets of bird, mammal, and amphibian richness (Jenkins et al. 2013, Pimm et al. 2014), available for download at the Biodiversity Mapping website (BiodiversityMapping.org, 2020). Based on the geospatial information of each investment contained in the database, we generated a heatmap using ArcGIS software (ESRI, 2017). Deals in Eastern Europe were excluded, as they take place mainly agricultural land (N=2034).

Conclusions

The proximity and overlap of many biodiversity hotspots with large-scale land raises the question of how and to what extent corresponding agricultural investments may contribute to ongoing and future risks of zoonotic disease outbreaks. The urgency of the question is heightened by the fact that many already-concluded deals have yet to be implemented on the ground, but will ultimately also be brought into production. There are several ways in which agricultural deals may contribute to increased risks of zoonotic disease outbreaks: first, continued expansion of the agricultural frontier and associated loss of biodiversity could disrupt the protective "dilution effect" mentioned above. Second, specialized monocultures could modify zoonotic host diversity, increasing the share of host species. Third, establishment of plantations, roads and human settlements in or near highly biodiverse natural habitats could cause more hazardous interfaces between wildlife, livestock, and humans, by contributing to forest fragmentation and bringing more people in close contact with potential hosts of pathogens. Related clusters of disease emergence could more quickly make the jump to national and global levels via road networks created to access land deals, thus increasing the risks of pandemics. Fourth, investment-related population displacement and land competition could push people deeper into more remote areas, bringing them into contact with new reservoirs of pathogens. Fifth, conversely, risks of zoonosis might be mitigated if people's livelihoods change in ways that reduce hazardous human–wildlife interactions, for example by reducing consumption of bushmeat.

Overall, we still have only limited scientific knowledge of the links between expansion of commercial agriculture and zoonosis risks and mechanisms. Importantly, the risks of zoonotic disease emergence are seldom, if ever, factored in when assessing the benefits and costs of agricultural investments, or when considering the role of trade-related agricultural production in displacing crop-growing into ever more remote areas. Initial estimates indicate that the costs of new policies to disincentivize deforestation and wildlife trade – and thus the risk of pandemics – would be low compared to the costs of another pandemic (1). To our knowledge, zoonosis risks are not presently taken into account by any of the mainstream global guidelines on responsible agricultural investment and land governance (16, 22).In our view, land acquisitions for commodity production should be subjected to health impact assessments that incorporate pandemic and emerging disease risks, as called for by the authors of the recent IPBES regarding other major land use projects (4).

In light of the massive health and economic costs of the current pandemic, we see the possible link between zoonotic diseases and large-scale land acquisitions (and agricultural expansion more generally) as a pressing research gap. Addressing this gap will require close collaboration between epidemiological, public health, land use, and agricultural experts. Specifically, future research should examine the pathways of pathogen transmission in agriculturally transformed landscapes that border natural habitats.

Yet even without extensive additional knowledge on such questions, the likely link between agricultural expansion and zoonotic diseases may demand swift preventive action in policy and practice – especially if the costs of such actions are relatively low and they are accompanied by co-benefits, such as nature conservation. First, agricultural and trade policies as well as spatial planning measures need to be altered and strengthened to prevent forest fragmentation and the further intrusion of land investments into biodiverse ecosystems. Second, persistent concerns regarding displacement of people through investments should be addressed with even greater urgency. Third, policies and interventions should target changes in the nutritional patterns of concerned households, incentivizing them to access less risky sources of food. Fourth, international guidelines and principles, social and environmental standards, and due diligence practices in value chains should be adapted in view of addressing zoonotic disease risks. Fifth, many of these policies and interventions require more transparency on agricultural investments, especially with regard to the scale, pace, geographical location, and type of such investments. In particular, governments should make land contracts publicly available, and require companies to provide data on large-scale land conversions. Increasing the transparency of land acquisitions is instrumental to better understand their implications for zoonotic disease emergence, but also to monitor and, where possible, prevent other social and environmental harms.

The current pandemic has once more shown that health is a global issue that is interlinked with other major global environmental and social problems. The COVID-19 pandemic provides yet another compelling reason to rethink mainstream policies shaping global agriculture and food systems – namely, to better understand and prevent zoonosis risks. It will require enormous shifts in priorities, incentives, and resource flows to change the current agricultural production and trade regime, which is at the root of deforestation and environmental destruction in many parts of the world. Financial institutions and governments must reassess their policies concerning agricultural investments and trade, reforming those that contribute to current deforestation trends.

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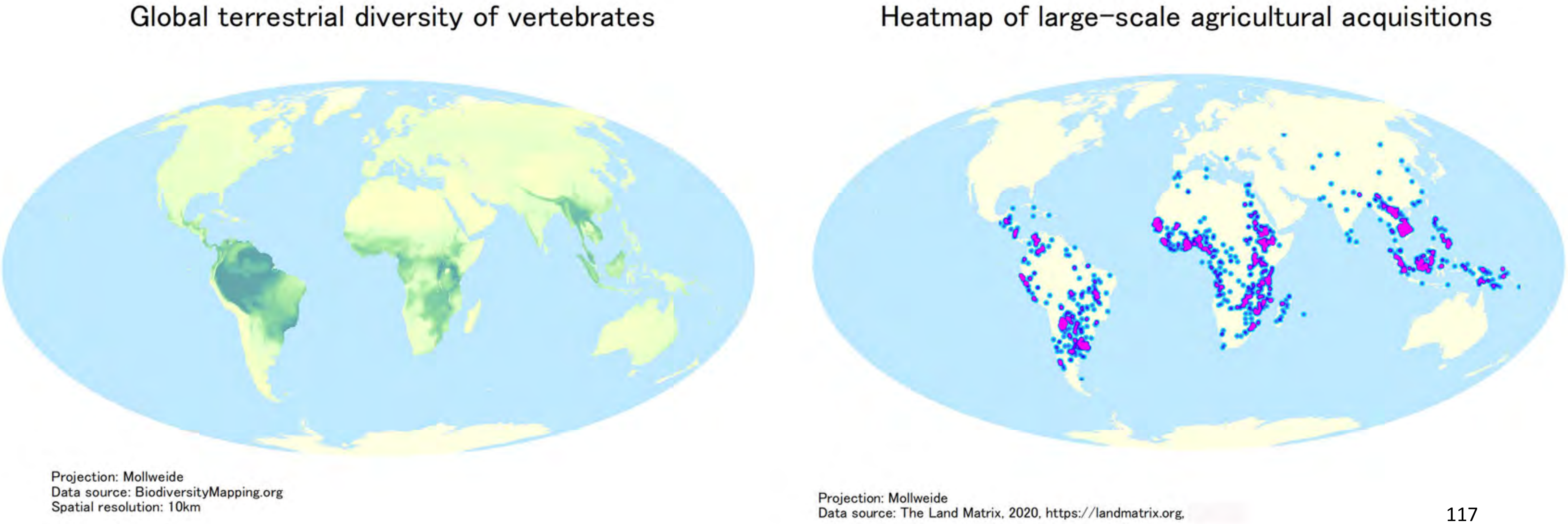
Figure 1


Global terrestrial diversity of vertebrates
Heatmap of large-scale agricultural acquisitions
Projection: Mollweide
Data source: BiodiversityMapping.org
Spatial resolution: 10km
Projection: Mollweide
Data source: The Land Matrix, 2020, https://landmatrix.org,

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13 Impacts of large-scale land acquisitions on common-pool resources

Evidence from the Land Matrix

Markus Giger, Kerstin Nolte, Ward Anseeuw, Thomas Breu, Wytske Chamberlain, Peter Messerli, Christoph Oberlack and Tobias Haller

Introduction

When prices for agricultural commodities reached record highs in 2008 and again in 2011, reports about a rush for land made headlines in news media around the world. Observers and analysts explained this phenomenon – which we refer to as large-scale land acquisition (LSLA) – by pointing to factors like the expectation of continued high commodity prices, fear of food shortages in the face of an increasing (and increasingly better-off) global population, agrofuel production, speculation, and the quest for finding new investment opportunities. Reports about large land-based deals made in secrecy and without involving affected land users raised concerns about a wave of "land grabbing" happening to the detriment of smallholders, pastoralists, forest dwellers, and other poor land users with low land tenure security and little political voice.

At the same time, the debate about the best model for agricultural development is still far from resolved (Deininger and Byerlee, 2011a; Byerlee, 2014). For instance, the World Bank Report 2008 (Bank, 2007) as well as IAASTD 2009 (McIntyre, 2009) argued for smallholder-based development as the right model for rural development, based on both theoretical and empirical evidence. However, others highlighted the limited success of promoting small-scale agriculture in Sub-Saharan Africa (Collier and Dercon, 2014) and argued in favour of large-scale, modern and resource-intensive agriculture. The perceived urgency to achieve food security lead both important donors and governments in the South to opt for large scale agricultural production in the global South (Deininger and Byerlee, 2011b, Fouilleux et al., 2017).

This debate is of high relevance also for the study of the commons. We posit that expansions of large-scale agriculture often affect areas formerly used as common-pool resources (CPRs), for instance, by smallholders and pastoralists. CPRs such as water, pasture, fisheries, wildlife, forests, and veldt products are resources linked and related to land and are central for food security and sustainability as an extensive body of research shows (see McKean, 2000; Haller, 2007; Haller et al., 2013 for summaries). The question whether or how CPRs are impacted by LSLA is of high interest in this article, as they have formerly been neglected in the debate on land investments (Adams et al., 2019).

CPRs are defined by a number of characteristics, in particular the difficulty to exclude users and the subtractability[1] of their use (Haller et al., 2013). They may comprise a wide range of natural resources, including forested land, grassland, so-called "wasteland", wetlands, and water bodies. Such resources often require flexible and seasonally adapted use, for example in the form of pastoralist migration between lower and higher altitudes. CPRs provide a wide range of goods and services, such as wood for construction and fuel, edible and medicinal plants, fodder, bush meat and fisheries products and many more. In so-called mosaic landscapes dominated by cropland, access to commons can be crucial in helping local people meet their food and income needs, which they might not be able to cover fully based on privately owned land. Social anthropology research shows that CPRs not only play an important role in ensuring food security but also provide cash resources relevant for securing livelihoods, especially among marginalized groups and women (Haller, 2010b, 2010c, 2013).

CPRs can exist in the context of common property, private property, or state property regimes, or a mixture of these (Netting, 1993; Haller, 2010b). In many cases they have been – and continue to be – managed under customary rules that define a common property regime. Many such systems have been significantly weakened or transformed, with negative effects; reasons for this include contradictions between government regulations and customary rules (Stücklin and Frei, 2010, Haller et al., 2016). Fox et al. (2009) listed several factors contributing to a decline in CPR-based livelihoods, among them the rise of conservation, commoditization of land, and promotion of industrial agriculture. Customary management systems are frequently overlooked, or their benefits for users are underestimated or considered outdated and irrational (Lavers, 2012, Haller et al., 2016).

Land titling has been proposed as a strategy addressing the existing or perceived weaknesses of CPRs, creating more land tenure security and paving the way for increased productivity and incomes by creating better incentives for investments in developing countries (Lawry et al., 2017). However, these outcomes are not certain (Sitko et al., 2014) or can vary widely depending on the context (Chimhowu, 2019). Furthermore, an important question is whether land titling of customary land is a way to prevent negative consequences of LSLAs also because CPRs often cut across land boundaries (Haller, 2010b). For instance, in Cambodia this is not the case (Dwyer, 2015).

Two recent meta-analyses of the scientific literature indicate that LSLAs frequently impact on CPRs and common property regimes. Oberlack et al. (2016) investigated the livelihood impacts reported in scientific case studies of LSLAs and found that common property regimes were affected in 38 out of the 44 cases in the sample. Loss of access to land and natural resources was the most frequent of all adverse livelihood impacts. In more than 70 per cent of the cases investigated, the land acquired had previously been held as common property or as a mosaic of common and private property. A small number of archetypical processes explained the adverse impacts: enclosure of livelihood assets based on privatization of land rights; elite capture by local and state elites; selective marginalization of people already living in difficult conditions; and polarization of development discourses. Dell'Angelo et al. (2017) systematically reviewed case studies of LSLAs and found that these took place in the context of common-property regimes in 55 per cent of the 56 cases investigated.

In this chapter, we analyse the database of the Land Matrix (LM) to find out more about the impacts of LSLAs on CPRs and common property regimes. The LM database covers a comparably large number of cases and contains information not only from scientific studies but also from other sources such as media, governments, the private sector, and NGOs. Although this information is often incomplete and partly derives from secondary sources, it nonetheless provides an overview of patterns and trends characterizing the recent wave of land appropriation. We exploit the LM data in light of what they tell us about impacts on CPRs and address the following questions:

- What general patterns and processes characterize LSLA in the global South?
- How do LSLAs impact CPRs and common property regimes?
- To what extent are CPRs affected by LSLAs, and what impacts have been observed?

In the following section, we present the LM database and describe what information it contains about recent trends in LSLA in the global South. We then discuss how LSLAs impact CPRs and common property regimes. Further, we analyse empirical evidence of these impacts in the LM database and illustrate them with brief descriptions of individual cases. We conclude with a discussion of our overall findings.

What general patterns and processes characterize LSLA in the global South?

Our source of information: the Land Matrix database

As the phenomenon of LSLA grew, several initiatives started to collect data on as many cases as possible. Among them was the Land Matrix Initiative (LMI), which is widely considered to maintain the most comprehensive database on LSLAs in the global South. An international partnership of research organizations and regional land-focused organizations, the LMI continues to collect data on international LSLAs in low- and middle-income countries and provides open access to these data. The aim is to increase transparency in the context of LSLAs and contribute to more balanced and equitable decision-making on land.

The LMI collects data from a wide range of sources, including governments, the private sector, academia, civil society, and the media. All contents of the LM database are open access and are frequently used in research, media coverage, lobbying, and policymaking. Besides collecting data and making them widely accessible, the LMI also engages in research and analysis, with the aim of supporting multi-stakeholder processes and enabling informed participation in decision-making around land governance. The fact that all data are accessible through the database or via the primary source facilitates research into individual cases.

The LM database focuses on international LSLAs that entail "a transfer of rights to use, control or ownership of land through sale, lease or concession" (Anseeuw et al., 2012). Other criteria for inclusion of cases are a minimum area of 200 hectares, conclusion of the deal in 2000 or later, and implication of potential conversion of land from smallholder production, local community use, or important ecosystem service provision to commercial use. The focus is mainly on LSLAs by international investors for the purpose of agricultural production, although the database is also beginning to include domestic LSLAs and LSLAs for non-agricultural purposes (timber extraction, carbon trading, industry, renewable energy production, conservation, and tourism). Data collection is restricted to deals in low- and middle-income countries.

The LMI acknowledges that LM data are incomplete and subject to potential biases (Nolte et al., 2016). Governments often choose not to document deals publicly, and official figures are sometimes contradictory. Where possible, data on an individual deal are collected from multiple sources, enabling triangulation of information. Currently almost 80 per cent of cases are based on two or more sources, and 40 per cent on three to seven sources (Nolte et al., 2016). Biases can result from different effects. The level of presence of land-focused media coverage, NGO activities, and researcher networks may differ from country to country, which can lead to under- or over-reporting in certain countries. In addition, the LMI network is not equally strong in each country. Finally, media attention may be focusing on certain sectors (e.g. agrofuels), regions (e.g. Africa), or types of investors (e.g. state companies from emerging countries) (Nolte et al., 2016). But although the data in the LM database are neither complete nor free of errors and omissions, they nonetheless offer valuable insights into current trends in international LSLA.

Insights into broad patterns and frequent processes

The analyses presented in this chapter refer to the data set used in the LMI's second analytical report (Nolte et al., 2016), which contained 1,004 concluded deals for agricultural purposes covering 26.7 million hectares.

These deals focus mainly on the production of food crops (38 per cent of total area), unspecified agricultural products and non-food commodities (32 per cent), agrofuels (21 per cent), and livestock (9 per cent). The most important crop types across all continents are oilseed, including oil palm and jatropha (44 per cent), cereals (20 per cent), and sugar crops (10 per cent).

Investors come from all regions of the world. However, investors from Western Europe (the UK, the Netherlands, France, Jersey, Cyprus, and others) are involved in 315 concluded deals, which makes this the biggest investor region. The second most important investor region is Southeast Asia. The top individual investor countries are Malaysia, the USA, the UK, Singapore, and Saudi Arabia. Non-listed and listed private companies account for more than 70 per cent of deals. Investment funds and state-owned entities together are involved in as little as 15 per cent of deals.

Taken together, these findings nuance and contradict widely held perceptions by the media that state investors from emerging countries (Gulf States, China) are the main investor category. On the contrary: private-sector actors from developed countries in the global North – especially the USA and Europe – are key players behind LSLA worldwide.

Figure 13.1 shows a global heat map of LSLA target areas based on the LM data set. The higher the density of deals affecting a region, the darker the shading.

Africa is the most important target region of deals in the LM data set. LSLAs occur in many countries across the continent. Overall, 422 concluded agricultural deals (42 per cent of all deals) covering 10 million hectares (37 per cent of total area) targeted land in Africa. Many LSLAs are found along major rivers and in Eastern Africa. Eastern Europe is the second most targeted region in terms of area, and accounts for 96 concluded deals on 5.1 million hectares. Comparison of data from 2012 and 2016 shows that although a number of deals failed, the overall trend points towards increased implementation.

Nolte et al. (2016) analysed the location of acquired land with regard to climatic zones and found tropical savannahs (38 per cent of all land deals) and tropical rainforest (18 per cent) to be the two most targeted zones. In Eastern Africa, temperate zones in highland areas are targeted as well. Land in arid areas is less frequently acquired, except along major rivers and waterbodies. This points to the importance of water availability for agricultural production (Breu et al., 2016) and to potential externalities.

Looking at how strongly LSLA affects individual countries, Indonesia, Ukraine, Russia, Papua New Guinea, and Brazil emerge as the five most targeted states in the LM dataset. In the context of CPR, it is important to note that a number of major LSLA target countries also appear to have weak land tenure security (e.g. Cambodia, Ethiopia, Madagascar, Laos, or Ghana). Some studies suggest a strong correlation between poor tenure security and a high occurrence of LSLAs (Deininger, 2013; Nolte et al., 2016) – although a more recent study confirms this relationship only with regard to smaller-sized LSLAs (Lay and Nolte, 2018).

How do LSLAs impact on CPRs and common property regimes?

Having outlined the overall patterns in the geographical distribution of LSLA target areas and investor origins, in this section we proceed to investigate how LSLAs affect CPRs and common property regimes. Any discussion of impacts of recent LSLAs on commons needs to consider the historical background of commons appropriation by settlers and colonial states. In this process, much of the land traditionally managed as common property was placed under the ownership of private settlers or of the state (Peluso and Lund, 2011; Alden Wily, 2012; Haller et al., 2016). In the postcolonial era, common property regimes were additionally

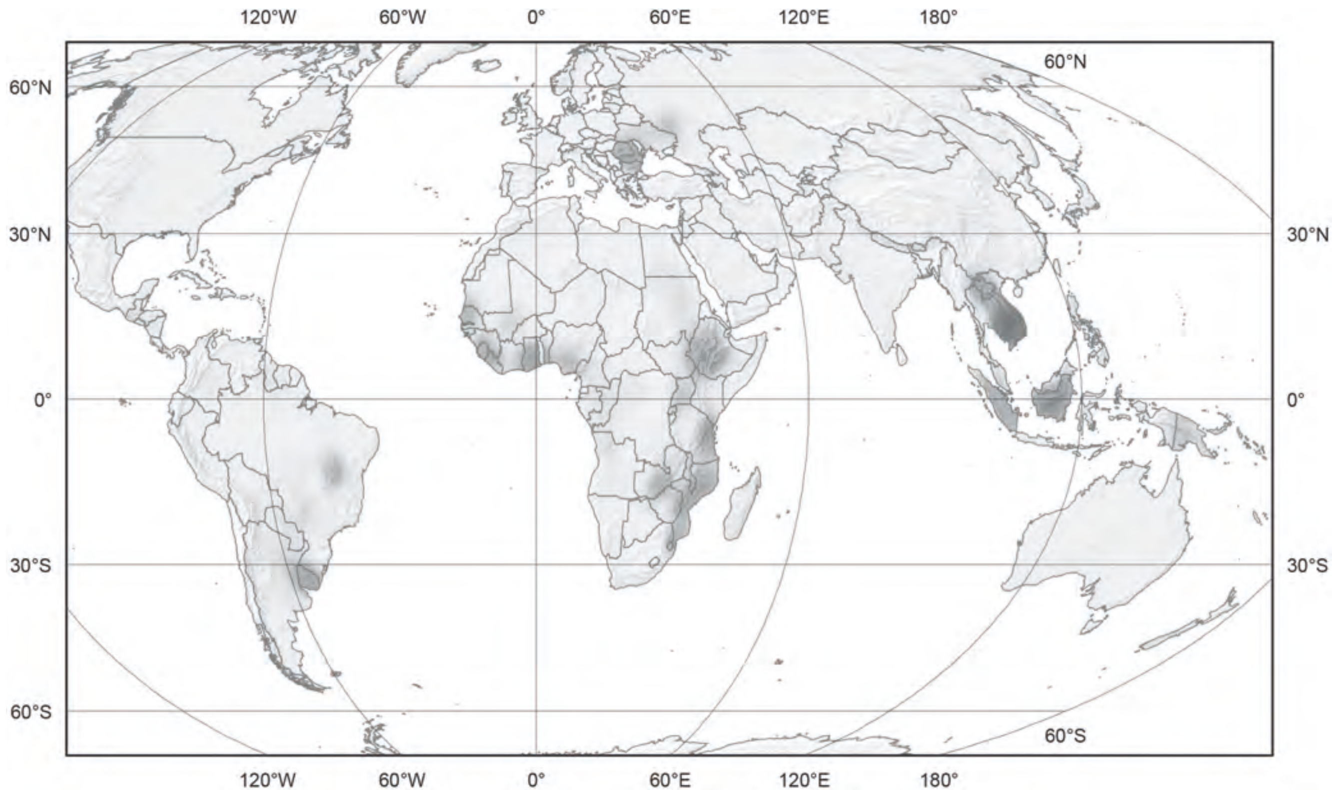

Figure 13.1 Global heat map of LSLA target areas (Nolte et al., 2016).
Source: Land Matrix, 2016.

weakened by the establishment of nature reserves and increasing division and fragmentation of land into land designated for forestry, agriculture, or rangeland (Alden Wily, 2011, 2012). Most states created separate management entities for specific types of resources (e.g. animal husbandry, forestry, or fisheries), further weakening and sometimes even destroying common property management systems by separating responsibilities for different components of interlinked socio-ecological systems (Haller et al., 2013, 2016).

Common property regimes in formerly colonized countries are particularly susceptible to continued destruction in the contemporary global land rush, as these countries disproportionately attract private investors from their former colonial powers (Arezki et al., 2013). Furthermore, postcolonial state structures facilitate the expropriation of customary land users (Alden Wily, 2011; German et al., 2013).

LSLAs may thus be a further step in the history of the progressive weakening of such customary practices (White et al., 2012). If corporate actors acquire large tracts of land for commercial use, this can damage CPRs and common property regimes in various ways. At least four mechanisms are crucial to understanding how LSLAs affect CPRs and common property regimes.

First, the rationale behind such deals is often to establish "modern", highly productive agricultural systems based on intensive, often year-round cultivation and high usage of water and chemicals compared to more traditional production systems. Such plantation style production systems were already established during colonial times, due to perceived and partly real economic advantages for certain crops, but also ideologies and beliefs on the part of the colonial powers (Byerlee, 2014). The current wave of large-scale investments could be a resurgence of this tendency, fuelled by high commodity prices and easy access to land (Byerlee, 2014). The high degree of mechanization, new agricultural technologies and the large amounts of inputs required make such intensive systems capital-intensive to establish. Accordingly, the premises are frequently fenced off to protect expensive equipment. However, this also cuts off access to CPRs on the premises for other users. This can cause locals to be displaced from the land on which they have built their house and grow their crops, or which they use collectively for herding, gathering firewood, and other activities. Land rights under common property regimes often allow powerful traditional or government leaders to reallocate rights from community members to investors (German et al., 2013; Nolte and Väth, 2015).

Second, establishment of a mechanized and rationalized production system often comes with externalities that affect CPRs. For example, adjacent water bodies may suffer from increased abstraction of water, contamination, or other off-site effects, such as the loss of important landscape elements like hedges, small streams and ponds, trees, and bushes (Tejada and Rist, 2017; Lanz et al., 2018). Such biotopes frequently generate products that local users consider to be common property and that constitute important elements of subsistence and household resilience. This type of environmental impact has been reported for LSLAs in Kenya that involved substantial intensification of horticulture and floriculture production (Zaehringer et al., 2018). Furthermore, CPRs may also be overexploited and degraded, when communities lose access to land and subsequently resource users concentrate more on the remaining land (Haller, 2010b).

Third, CPRs are frequently overlooked because their use may constitute a secondary use of land – even if this secondary use is also very important. For example, even if an area's land use is indicated as smallholder farming, in addition to growing crops, smallholder farmers and other inhabitants may also be using that land to collect and hunt a range of products which are communally managed (Haller, 2010b; Lavers, 2012; Marfurt et al., 2016). Such secondary uses are affected, for example, when an LSLA cuts off access to water points or blocks pastoralists' migration routes. This situation is particularly frequent in areas characterized by seasonal water shortages and droughts, such as floodplains or other types of pastoral lands, where herders frequently move to wetlands in the dry season, and drylands in the rainy season. Moreover, drylands are not only used by pastoralists, but often also serve for grazing poor farming households' small ruminants, collecting firewood, and hunting and gathering. When such land is transformed for large-scale commercial production, it is frequently enclosed (Oberlack et al., 2016), depriving farmers of access to its CPRs. Loss of such resources is not readily visible to outsiders. Often it takes an in-depth anthropological study of the socio-ecological systems involved to detect it.

Fourth, water use rights usually form an integral part of investment contracts (Breu et al., 2016). The implementation of these contracts often comes with increased water resource appropriation, altering the local availability of freshwater and thereby directly affecting local livelihoods and CPRs in downstream areas outside the perimeter of acquired land (Breu et al., 2016). Thus, water resource appropriation by investors can impact on ecological and hydrological cycles in a larger area, for instance by cutting off seasonal river flows through dams (Haller, 2010c; Haller et al., 2016; Kamski, 2016). It can reduce the practicability of traditional irrigation patterns or make them entirely obsolete (Tejada and Rist, 2017), negatively affect local fisheries (Haller and Merten, 2008) and wildlife (Chabwela and Haller, 2010), impede seasonal migration by pastoralist groups (Haller et al., 2013, 2016), raise the groundwater table, damaging activities such as brick production (Tejada and Rist, 2017), or restrict access to swamps used by women for off-season vegetable production (Marfurt et al., 2016).

To what extent are CPRs affected by LSLA, and what impacts have been observed?

Evidence in the Land Matrix data that points to adverse impacts on CPRs

In this section, we review available data on the context in which LSLAs occur and present information on previous uses, covers, and ownership of the acquired land. This gives an indication of what types of land are targeted; and it enables conclusions regarding the potential extent of LSLA impacts on CPRs.

Research based on the LM data (Messerli et al., 2014) showed that the local surroundings of these LSLAs had a considerable average population density of 81 people per square kilometre; and most cases were located in relatively accessible areas with fairly well-developed infrastructure. This resonates with concerns about competition for scarce land, other natural resources, and infrastructure between investors and local communities (Anseeuw et al., 2012). However, these observations did not apply to all cases; many LSLAs targeted areas that had a low population density (47 per cent of the deals were in areas with a population density below 25 persons per square kilometre) and were relatively remote (43 per cent of the deals were in areas with more than six hours travelling time to the nearest city with 50,000 or more inhabitants). The land cover types of LSLA target areas ranged broadly: cropland mosaics, forested landscapes, as well as grass, shrubs, and other cover types were targeted by around one third of deals each. Looking at these characteristics together, three distinct socio-ecological contexts (Messerli et al., 2014) were identified:

1. **Densely populated and easily accessible areas with cropland mosaics.** These areas are well suited for agriculture, and strong competition for land is to be expected.
2. **Moderately accessible and moderately populated shrub- or grassland.** This type of land corresponds broadly to what the LM database refers to as "marginal land".[2] However, such land may be highly important to local land users and can be very productive, especially when it includes wetlands (Haller, 2010b).
3. **Largely remote and sparsely populated forestland.** Forest-related land use systems are often targeted by LSLAs intended for producing crops like oil palm, rubber, soy, and many others (Nolte et al., 2016). Large areas of the forest/agriculture frontier are still partially or entirely used for shifting cultivation (Van Vliet et al., 2012, Heinimann et al., 2017).

Each context pose different challenges for local populations and CPR management. In the next sessions we conduct an analysis of more data contained in the LM to further investigate the context in which LSLA take place.

Type of land acquired: previous landowners, land covers, and land uses

Three variables describe the types of land that investors are acquiring: previous landownership, previous land cover, and previous land use. Data on these variables can be used to examine the links between CPRs and LSLAs.

Previous landownership

Communal landownership is found in many parts of Africa, Asia, and Latin America. Under communal landownership, a traditional authority regulates and manages individual and communal land use rights. In many regions state ownership coexists with customary land tenure, which may be either individual or communal. Historical research has shown that, in many cases, land and corresponding CPRs have been transferred to state property (Haller et al., 2013). Allocation of such land to large-scale investors will further dispossess local populations of these resources, to which they may still have had access, albeit with limited control (Haller et al., 2013). Therefore, we investigate whether LSLA actually targets such land within state property or land held by communities.

The LM distinguishes between community-owned, state-owned, and privately owned (by large landowners or smallholders) land. Nolte et al. (2016) report that previous ownership of the land acquired in the 336 deals for which information on this variable was available[3] was attributed to communities (32 per cent of total acquired area), the state (27 per cent), private smallholders (13 per cent), and private large-scale farmers (28 per cent) (Nolte et al., 2016).

Together, community and state ownership indeed account for more than half (59 per cent) of the acquired land. This strongly suggests that CPRs are widely affected by LSLA. Of course, communal ownership can take different forms, and we cannot assume that all of this land is managed by common property institutions. Communal ownership can also entail that members of the local community de facto hold the land as private, though in many cases they will face restrictions on sale, lease, or inheritance.

Previous land cover

All land cover categories may be important in the context of CPRs, although each may concern different types of CPRs and present different challenges. Of high interest to local communities are rangelands in pastoral systems, which are often managed as a CPR (Haller et al., 2013; Messerli et al., 2014). Haller et al. (2013) discuss this with respect to African pastoralist regimes and conclude that common property regimes are still important in many regions, despite having been strongly affected by both colonial and postcolonial state interventions. Floodplains in seasonally flooded areas, often categorized as "marginal" land, frequently contain CPRs (e.g. water, dry-season pasture, fisheries) that are managed by locally developed common property institutions (Haller, 2010b). Forested landscapes are likewise used and managed as CPRs by people living near or in the forests (Agrawal and Gibson, 1999; Nagendra and Ostrom, 2012). But common property institutions may also apply on croplands in traditional land-use systems, particularly when it comes to rules on the right of way for humans, grazing of cattle and small ruminants during off-season periods, gathering and hunting, migration of herds, gathering of firewood, and other activities.

In the LM data, cropland proved to be the most frequently reported land cover type found on acquired land prior to its acquisition, with almost half of all deals (49 per cent) implemented (at least partially) on former cropland. Another 32 per cent of deals targeted forestland, 18 per cent "marginal" land (a category which is not clearly defined, but most likely is often used to describe pastoral land and also floodplains[4]), and 2 per cent land reported as "grass and shrubs". As noted earlier, the two categories of "marginal" land and "grass and shrubs" largely overlap and relate to similar underlying perceptions of land less suitable for intensive production.

Previous land use

The previous use of acquired land reveals information about former livelihood activities. Smallholder agriculture and pastoralism are particularly important land-use categories with regard to CPRs, but forestry and conservation may also point to former uses of CPRs.

Among the deals in the LM data set, the most dominant previous land use is agriculture: 43 per cent of the total area acquired was used for commercial agriculture and another 31 per cent for smallholder agriculture. The high percentage of commercial agriculture requires an explanation. Although such land may have been used commercially prior to the most recent acquisition, it was also used by local communities,[5] for example if the former owner at some point neglected a plantation and local communities replanted it. A detailed analysis from Mozambique shows that a number of these cases concern land that was at one time colonized by European settlers, then nationalized, and subsequently sold or leased to private investors (Adalima, 2017). However, this land was also used by local people, and the recent LSLA led to the dispossession and eviction of local land users, creating land tenure insecurity and conflict (Reys et al., 2018). Similar cases have been recorded in the LM database for Ethiopia and Tanzania, among others. Cases with previous private ownership are not included in our further analysis, however, as they do not directly relate to land as a CPR, despite their potentially negative impact on local communities.

Smallholders previously used 31 per cent of the total area acquired for agriculture, that is about 8.3 million hectares. If we assume an average farm size of 2 hectares (Lowder et al., 2016), it becomes evident that LSLA may have affected a very substantial number of smallholders. Further land uses were less targeted: 16 per cent of the total acquired area was previously used for forestry and 5 per cent each for pastoralism and conservation.

Combining information about previous land use and landownership and previous land use and land cover

In a next step of analysis, we compared the available data on previous land use and previous landownership. Our assumption is that the combination of state or community landownership with land uses that are likely to occur under CPR regulations will provide a better indication of how frequently LSLAs risk affecting CPRs. In Table 13.1, we display these combinations that potentially reflect an impact of LSLAs on CPRs. We therefore do not show the combinations

Table 13.1 Comparison of previous land use and previous land landownership for areas potentially managed communally

		Previous landowner					
		State		*Community*		*Total*	
		Number of deals	*Size in 1,000 ha*	*Number of deals*	*Size in 1,000ha*	*Number of deals*	*Size in 1,000 ha*
Previous land use	Smallholder agriculture	67	578	93	957	**160**	**1,535**
	Pastoralism	11	43	13	71	**24**	**114**
	Forestry	8	433	42	1,107	**50**	**1,541**
	Conservation	9	269	22	105	**31**	**375**
	Total	**95**	**1,324**	**170**	**2,241**	**265**	**3,566**

Source: LM database, 25 April 2016; analysis by the authors.

Note: LM records may indicate more than one previous land use and more than one previous landowner, but the LM does not provide any information on the shares of area relating to each former land use or landowner. For this analysis, we have we have attributed equal shares of the area under contract to each land use or landowner and divided the deals in order to count each combination separately. As a result, the original sample of 297 records that include information on both the previous land use and the previous landowner increased to 537 cases. Of these, 265 fall into the categories taken into account in this table. The numbers of deals indicated show in how many deals a specific combination occurs, but it may concur with other combinations in the same deal.

for previous private land owners (smallholders or large scale) with the different previous land uses – albeit these may also include CPR regulated land.

The data clearly show that most of the land previously owned by the state or by communities was used for smallholder agriculture and forestry (1.5 million hectares each). However, some of it was also used for pastoralism and for conservation.

In 67 cases, land previously used for smallholder agriculture was owned by the state. Most of these cases are located in Southeast Asia and Eastern Africa. In another 93 cases where the land acquired was previously used by smallholders, it was community-owned. Most of these are located in Eastern or Western Africa and in Southeast Asia. Pastoralists who used land previously owned by the state (11 deals) or communities (13 deals) are reported to have lost access to land in Eastern and Western Africa and in Southeast Asia.

In all of these regions, governments legally own most of the land. In Cambodia, for example, the government grants land titles to individuals and in some cases to local communities, but it also grants concessions on state land (Dwyer, 2015). This is a case of a legal pluralism, which is observed in many other countries as well (Haller, 2010a, 2010c).

Finally, we compared data on previous land use and previous land cover (Table 13.2). We did so based on the assumption that the land cover of land potentially used under common property regimes can give an indication of what types of CPRs are affected, and where.

Table 13.2 Comparison of previous land use and previous land cover for areas potentially managed communally

		Previous land cover							
		Cropland		*Forest*		*Shrubland and marginal land*		*Total*	
		Number of deals	*Size in 1,000 ha*	*Number of deals*	*Size in 1,000 ha*	*Number of deals*	*Size in 1,000 ha*	*Number of deals*	*Size in 1,000 ha*
Previous land use	Smallholder agriculture	173	1,713	30	174	64	769	**267**	**2,657**
	Pastoralism	9	17	29	67	31	359	**69**	**44**
	Forestry	11	141	60	1,652	20	24	**91**	**1,818**
	Conservation	5	24	27	383	50	30	**37**	**438**
	Total	**198**	**1,897**	**146**	**2,277**	**120**	**1,184**	**464**	**5,359**

Source: LM database, 25 April 2016; analysis by the authors.

Note: LM records may indicate more than one previous land use and more than one previous land cover, but the LM does not provide any information on the shares of area relating to each former land use or land cover. For this analysis, we have we have attributed equal shares of the area under contract to each land use or land cover and divided the deals in order to count each combination separately. As a result, the original sample of 277 records that include information on both the previous land use and the previous land cover increased to 612 cases. Of these, 464 fall into the categories taken into account in this table. The numbers of deals indicated show in how many deals a specific combination occurs, but it may concur with other combinations in the same deal.

Table 13.2 gives a nuanced view of how previous land covers relate to previous land uses. In terms of area, former cropland was clearly most frequently used for smallholder agriculture, and former forests were most frequently used for forestry. However, this provides no additional indication of whether acquisition of this land by investors may have affected CPRs. It is important to recall that the information in the LM regarding previous land cover and land use is often incomplete and not fully able to capture the details of how smallholders use resources in a highly diverse manner. Nevertheless, it is interesting to note that, in many deals, previous forests, shrubland, or marginal land had been used by smallholders and pastoralists. The likelihood that this land was used as CPRs is high. For example, in cases where the previous land cover is indicated as forest and the previous land use as smallholder farming, the land may have been used for shifting cultivation or for collecting forest products. It is important to mention that even if forest is indicated as the previous land cover and forest as the previous land use, CPRs may still have been affected; in addition to forestry, the land may have also been used for various purposes by people living in or around the forest. The same is true of areas previously used for conservation. They may still have been used by local people, even though they might already have lost the right to manage these resources. Loss of access to such land particularly affects marginalized groups and women, as they typically base their livelihoods on CPRs (Johnson, 2004).

Insights into potential LSLA impacts from case studies reported in the LM database

In this section, we present four short case studies of LSLA impacts on CPRs. All four cases are included in the LM data set analysed above. However, they provide deeper insights into the impacts of LSLA on CPRs than analyses of entire data sets can. The cases are located in Senegal, Sierra Leone, Ethiopia, and Kenya and are related to European or North American investments and actors. We would like to underline that these cases are not representative of the general impact of LSLA on CPRs; we selected them because they are relatively well-documented. For each case, we briefly describe its main features, the CPRs concerned, and how these are affected by the LSLA.

Senhuile in Senegal (Case ID in LM database: #3433)

The case shows how land used for grazing, growing crops and collecting timber, as well as access to water collection points was lost – all of it relevant for CPRs. The main mechanism for the loss of these CPRs was the loss of access to land.

This deal covers 10,000 hectares in the Ndiael nature reserve and was undertaken by private investors, including one from Italy. Initially, the Senegalese government allocated land to this company in the area around Fanaye. Strong community protests against the project forced the government to find alternative land. A first lease of 20,000 hectares was granted in 2012 for a period of 50 years. This land, owned by communities and the state, was previously used by local communities for smallholder agriculture. Since the first lease was signed, 10,000 hectares have been revoked by the government as the lessor. A subsequent lease for an additional 5,000 hectares has also been revoked.

The project has affected a total of around 9,000 community members from 40 villages. None have been displaced, but people have lost access to land. The community was only consulted during the social impact assessment in 2013, when the land had already been acquired. Villagers living in close proximity to the project are constantly threatened with eviction by company representatives and the local police.

In an effort to improve working relations between the company and the community, an agreement was signed in 2014 outlining the compensation and benefits that the communities would receive. This stipulates that Senhuile will provide 0.3 hectares of land per family for grazing and cultivation; so far, 189 hectares have been allocated to families. The memorandum also promises other community benefits, such as the construction of classrooms and the creation of community gardens for women, but these have not yet materialized. However, Senhuile has delivered fodder to affected community members to compensate them for the loss of grazing land (Franchi and Manes, 2012; GRAIN, 2013; Action Aid, 2014a, 2014b, 2016; Harding, 2016).

Addax Bioenergy Ltd in Sierra Leone (Case ID in LM database: #1798)

The case shows the loss of land managed under a traditional community system – to which not all community members have equal access – impacting disproportionally families not originating from the region and women who depend on swamps for their specific crops. The main mechanisms are the loss of land, externalities created by the LSLA (abstraction of water) and the loss of secondary uses (such as swamps for horticulture production in off-season).

This project was initiated in 2008 by a Swiss-based company to produce sugar cane in Sierra Leone. The lease originally covered 54,000 hectares, but was later downscaled to about 23,000 hectares. Partly as a result of the Ebola crisis, implementation of the project came to a stop in 2015. The project was then sold to another company, Sunbird Bioenergy Africa Ltd, and production started again. The case was the subject of detailed anthropological field research and a large socio-economic survey, whose findings inform this case study.

The research showed that the project's large-scale monoculture has destroyed a highly diverse cultural landscape, significantly changing the quality of and access to land, water, and grassland products, especially for the more marginalized groups such as women, youth, tenants, and migrants, and reducing the resilience of local livelihoods to external shocks. Many land users have been excluded from accessing CPRs (land for production, swamps) and have thus lost previous access rights based on common property institutions. The average area of land a family uses for agriculture is much smaller within the project area than outside the project area (2.53 hectares versus 9.16 hectares). Those who have no land of their own – because they are originally not from the area – are more seriously affected by this land scarcity than landowners.

Payments for the land lease are low and have been made only to landowners, who make up about 50 per cent of the people living on agriculture. The compensation scheme has exacerbated existing tendencies towards elite capture of the project's economic benefits, further intensifying tensions and conflicts among different groups within the *Temne* society.

In the beginning, local people welcomed the project as they anticipated it would bring development and salaried work to the area. Failure of these expectations to materialize triggered various responses. Local elites as well as the younger generation have activated both old and new ways of resistance, resorting to old institutions of resistance (secret societies) and to a combination of old and new tenure institutions and international legal rights. With the help of a local NGO they are aiming to win back control over the commons (Bottazzi et al., 2016; Marfurt et al., 2016; Nolte et al., 2016; SiLNoRF and BFA, 2017).

Kuraz Sugar Development Project in Ethiopia (Case ID in LM database: #4623)

The Kuraz Sugar Development Project exemplifies how the use of, and access to, water can be jeopardized by an LSLA and pasture managed as CPRs can be destroyed by these changes in the hydrological cycle. It provides insight into the cumulative effects of hydropower infrastructure and land acquisition on local people, which creates huge externalities in terms of changes in water and pastoral resources.

This case is located in the lower Omo Valley in Ethiopia. The Gibe III dam was inaugurated 2016 and constitutes the biggest hydroelectric dam in the country. Construction of the dam is intrinsically linked to a huge irrigation scheme which was meant to enable ESC (Ethiopia Sugar Corporation) to irrigate 175,000 hectares of land allocated to them by the Ethiopian government. Plans included five factories and several sugar cane estates and the creation of 700,000 jobs as well as five urban centres and 42 villages; however, these plans have recently been downscaled.

NGOs and UNESCO (2011) raised concerns about the project's environmental and social impacts on people living downstream of the dam. Their livelihoods rely on flood-recession agriculture and pastoralist activities and will likely be severely damaged or even destroyed. The pastures of the Mursi and Bodi – two of the ethnic groups affected (Stevenson and Buffavand, 2018) – are managed as common property and controlled by local groups (Turton, 1995). But "the permanent alteration of the hydrological cycle has also ruled out the continuation of flood-recession agriculture, which is the most reliable component of local agro-pastoralist livelihoods" (Kamski, 2016). Government plans foresee the villagization of 45,000 people. But while the dam has been constructed, the establishment of the sugar cane estates has been severely lagging. Kamski (2016) reports that mitigating measures such as watering points for livestock have been implemented. But in February 2016, sugar cane had been planted only on about 10,600 hectares. As a result, people are deprived of their traditional livelihoods with no alternative income sources available, and their traditional way of life cannot continue in the new settlements (The Land Matrix Global Observatory, Salini Impregilo, Stevenson and Buffavand, 2018).

Dominion Farms Ltd in Kenya (Case ID in LM database: #1374)

This case shows the impact of a LSLA through blocking the access to land. In this case, land had multiple uses including fishing, collecting wild products, grazing and small-scale agricultural production. These uses are of importance for a large number of people under CPR regimes.

The Yala Swamp in Kenya is a wetland region of more than 200 km^2 in Kenya. Kenya's legal pluralism, dating back to colonial times, provided a legal basis for a US investor to lease 6,900 hectares of swampland, primarily to produce rice. The lease was agreed with local county councils in the name of development, and as such was welcomed by political leaders. However, reclamation of the swamp affects the resilience of local communities by blocking access to CPRs. It is estimated that indirectly many more people benefitted from the swamp's resources than those who benefit directly from employment created by the investment. The loss of a major livelihood basis combined with a lack of employment opportunities limits the diversification of livelihood strategies.

An area of 182 hectares was allocated as compensation for the loss of resources. But after Dominion Farms Ltd drained the land, local institutions were ignored and no further steps were taken to distribute the land to local people. Some wealthy community members, using paid labour, rushed to clear this land in order to lease it to others themselves. Vulnerable people, including elderly women and poor peasant farmers, were unable to continue using the land as they had before.

Currently, local newspapers report that the investor is preparing to leave the country. Whether the project will be continued by a new investor remains unclear (Schubiger, 2015; Schubinger and von Sury, 2016; von Sury, 2016; Kamau, 2017; Odhiambo, 2017).

Conclusions

This contribution discussed impacts of LSLAs on CPRs and common property regimes. We considered multiple ways in which land deals may affect CPRs. First, capital-intensive and rationalized agricultural production systems are generally fenced off, blocking access, and eliminating important components of CPR users' livelihoods. Second, impacts might also be related to indirect externalities, as the change in landownership often comes with changes in the production mode and techniques – affecting off-site CPRs like adjacent water bodies, biodiversity, landscape components, and others. Third, impacts can affect secondary land uses. Many forms of CPR use, such as collecting and hunting communally managed products, are often "hidden" and therefore frequently overlooked when assessing potential impacts. LSLAs nonetheless restrict these uses. Lastly, LSLAs can directly affect natural resources on- and off-site: for example, water use rights are often part of investment contracts, affecting downstream areas and users.

We assess the extent to which LSLA may be impacting CPRs and provide deeper insights into the nature of these impacts. Our review of LM data indicates that LSLA may be impacting widely on CPRs. As LSLAs target a wide variety of socio-ecological contexts, potential impacts will likewise range widely, and challenges will differ by context. Based on a subset of LM data we show that acquired land was previously owned by communities or the state in 59 per cent of cases. The importance of this finding becomes apparent when we consider that in Africa, and in other regions of the global South, land officially owned by the government is very often de facto used by local land users. Against this background, the high percentage of previously community- or state-owned land affected by LSLAs indicates that land appropriation by commercial users may be having profound effects on local populations in more than half of the cases contained in the LM database.

We further describe four case studies that provide deeper insights into how LSLAs can affect CPRs. In the four cases, CPR users indeed lose access to grazing land, water, and timber as a result of LSLA. In this context it is important to consider that this will likely lead to exclusion of weaker groups within the local setting, such as immigrants, women, or poor households.

We have not investigated to what extent new options and income opportunities arising from LSLA may counterbalance losses due to enclosure and reduced availability of, and access to, CPRs with other benefits, or how these benefits are distributed. However, the fact that elite capture, selective marginalization, and discourse polarization are widely observed in the context of LSLA (Oberlack et al., 2016) raises serious doubts about the prospects LSLA providing sizable benefits for marginalized groups.

Customary institutions for the management of commons very often include rules and mechanisms that lead to a certain level of balance between powerful and marginalized groups. Institutions for customary management of CPRs also often include ways and means to mitigate risks of climate variability and extreme events. Common property regimes have been weakened throughout colonial history, and LSLAs are a further step in the marginalization of such customary practices. Existing power imbalances in traditional systems (for instance between gender, or with regard to actors not originating from the area or same ethnic group) can be exacerbated under the impact of LSLA and the loss of resources they entail. New mechanisms that could compensate for this loss are often absent or not sufficiently implemented when commercial actors start using the land. The impact of LSLA on CPRs may therefore be even higher than the mere quantity of land affected suggests.

We would like to conclude this chapter by discussing how the relevance of LM data for the study of the commons might be increased. We have shown that LSLAs have tremendous impacts on the commons; however, LM data only indirectly cover the topic of CPRs and common property regimes. In the upcoming process of decentralizing the LM database, a greater focus of the LMI on these aspects would therefore be welcomed. Great potential lies in the establishment of national land observatories. In regions where CPRs are important, these observatories could focus on impacts of LSLAs on the commons. Ideally, researchers and practitioners investigating these impacts would share their insights with the LMI in general and with relevant national land observatories in particular. The LMI is currently also reaching out to other data initiatives, including LandMark,[6] which focuses on mapping lands that are collectively held and used by indigenous peoples and local communities. The national land observatories, data sharing, and new alliances could advance research and practice alike and ultimately benefit the communities depending on CPRs.

Notes

1 Subtractability means that CPR users compete for CPRs; if one user benefits from use of a CPR, this reduces other users' potential benefits from that CPR. See chapter by Haller et al. in first section of this book.
2 Note that the land cover typology (GlobCover 2009) used in the study by Messerli et al. does not contain a category of "marginal land"; instead, it contains land cover types such as "closed to open shrublands", "grasslands", and "sparse vegetation".
3 Individual deals list up to three different previous owners. The LM does not provide any information on the share of area owned by each previous owner; for the present analysis, we have attributed equal shares of the area under contract to each previous landowner and divided the deals in order to count each combination separately. N (deals) = 336; N (previous landowners) = 386.
4 According the LM guidelines "land of poor quality with regard to agricultural use, and unsuitable for housing and other uses. OECD 2001: Glossary of statistical terms" LMI Draft 2015.
5 Although the LM's criteria for inclusion of deals in the database exclude transfers from commercial large-scale owners to other large-scale owners, some deals include land that was originally owned by communities or smallholders and acquired by a large-scale investor, but has been resold from one private actor to another after it was first recorded in the database. In such cases, the previous land use is listed as large-scale agriculture, but the deal is retained in the LM database, as the land was originally lost by the local community (Nolte, et al., 2016).
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Research

Why do large-scale agricultural investments induce different socio-economic, food security, and environmental impacts? Evidence from Kenya, Madagascar, and Mozambique

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ABSTRACT. Large-scale agricultural investments (LAIs) transform land use systems worldwide. There is, however, limited understanding about how the common global drivers of land use change induce different forms of agricultural investment and produce different impacts on the ground. This article provides a cross-country comparative analysis of how differences in business models, land use changes, and governance systems explain differences in socio-economic, food security, and environmental impacts of LAIs in Kenya, Madagascar, and Mozambique. It brings together results on these aspects generated in the AFGROLAND project that collected data in a multi-method approach via household surveys, business model surveys, semi-structured household interviews, life-cycle assessments of farm production, analysis of remote-sensing data, key informant interviews, and document analysis. For the present project synthesis, we combined a collaborative expert workshop with a comparative analysis of 16 LAIs. The results show that the LAIs follow four distinctive impact patterns, ranging from widespread adverse impacts to moderate impacts. Results demonstrate how the following conditions influence how the global drivers of land use change translate into different LAIs and different impacts on the ground: labor intensity, prior land use, utilization of land, farm size, type of production, experience in local agriculture, land tenure security, accountability of state and local elites, the mobilization capacity of civil society, expansion of resource frontiers, agricultural intensification, and indirect land use change. The results indicate that commercial agriculture can be a component in sustainable development strategies under certain conditions, but that these strategies will fail without substantial, sustained increases in the economic viability and inclusiveness of smallholder agriculture, land tenure security, agro-ecological land management, and support for broader patterns of endogenous agrarian transformation.

Key Words: *agricultural investments; business models; environment; food security; governance; land use change; livelihoods*

INTRODUCTION

Large-scale investments in agriculture (LAIs) are transforming land use and food systems in their targeted regions worldwide. The long-term global drivers of these social-ecological transformations persist: global population growth, changing diets and recurrent national food shortages (Zoomers 2010, Nolte et al. 2016), energy system transitions (Scheidel and Sorman 2012, Antonelli et al. 2015), climate change responses (Davis et al. 2015), private capital in search of investment opportunities (Ceddia 2019), national development strategies (Cotula 2012), and geopolitics (Oliveira 2016). They have given rise to a rush of large-scale agricultural investments (LAIs) across Africa, Asia, Latin America, and Eastern Europe over the last decade (Anseeuw et al. 2012, Nolte et al. 2016), leading to major concerns for global sustainable development (Deininger and Byerlee 2012, Dell'Angelo et al. 2017a).

Large-scale agricultural investments affect livelihoods, food security, and the environment in their target regions in diverse ways (German et al. 2011, Oberlack et al. 2016). Some studies found positive effects on employment and rural welfare (Petrick et al. 2013). Other studies showed that LAIs displace land users, undermine resilience, disrupt customary land tenure institutions, and lead to livelihood destruction, deforestation, environmental degradation, and increased conflict (e.g., Ahrends et al. 2015, Bottazzi et al. 2016, Haller et al. 2019). Therefore, the socio-economic, food security, and environmental impacts of LAIs differ markedly from one setting to another (Hall et al. 2015a).

However, there is limited understanding about how the common global drivers of land use change generate different forms of agricultural investment and different impacts on the ground. Such understanding would be important to identify entry points and levers for policy action at national and international scales. These limitations are partly due to dominant methodologies that investigate LAIs either by means of isolated case studies or national/global inventories (Oya 2013). More cross-country comparative analyses of LAIs are needed to close this knowledge gap (Cotula et al. 2014, Schoneveld 2014, Hall et al. 2015a, Breu et al. 2016, Dell'Angelo et al. 2017b, Haller et al. 2019).

This study provides a cross-country comparative analysis of the social-ecological dynamics associated with LAIs. Specifically, this study analyzes how differences in business models, land use

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changes, and governance systems explain differences in LAIs' socio-economic, food security, and environmental impacts. It brings together results on these aspects generated in the AFGROLAND project. We studied LAIs in Kenya, Madagascar, and Mozambique. Primary data were collected using a mixed-methods approach combining large-scale household surveys, a survey of business models, semi-structured interviews, life-cycle assessment, remote-sensing data, and document analysis. The present synthesis of the AFGROLAND project was conducted through a collaborative expert workshop in combination with a set-theoretic methodology for case-based comparative analysis. Our study thus responds to calls for use of robust empirical methodologies to provide reliable evidence on the impacts of LAIs (Oya 2013, Scoones et al. 2013), as well as to calls for use of comparative methods to attribute LAI impacts to particular conditions (Purdon 2013, Meyfroidt 2016).

Two research questions guided our study. First, do LAIs in Kenya, Madagascar, and Mozambique exhibit recurring patterns of socio-economic, food security, and environmental impacts? Second, how are differences in business models, land use changes, and governance systems associated with variations in LAI impacts?

We find that the LAIs in our sample follow four distinctive impact patterns, ranging from widespread adverse impacts and hostility to moderate impacts. The following conditions jointly shape how common global drivers of land use change translate into different forms of LAIs and diverse impacts: labor intensity, prior land use, utilization of land, farm size, type of production, experience in local agriculture, land tenure security, accountability of state and local elites, the mobilization capacity of civil society, expansion of agricultural resource frontiers, agricultural intensification, and indirect land use change.

CURRENT CONTROVERSIES AROUND LARGE-SCALE AGRICULTURAL INVESTMENTS

Debates on LAIs have evolved over the past decade (Cotula 2009, Borras et al. 2011, De Schutter 2011, Borras and Franco 2012, White et al. 2012, D'Odorico et al. 2017). This section reviews current controversies that focus on LAI impacts, land use changes, business models, and governance. Large-scale agricultural investments include large-scale land acquisitions (LSLA) as well as capital-intensive agricultural investments. Large-scale land acquisitions encompass transfers of rights to use, control, or own land from smallholder households or communities to commercial actors (e.g., corporations, public investment funds) through sale, lease, or concession of areas larger than 200 ha (Anseeuw et al. 2013). Here, we extend this focus on LSLA by incorporating LAIs that are smaller in farm size, but large in invested capital, such as horticulture farms. This allows us to compare a broader range of farm sizes associated with corporate land investments.

Socio-economic Impacts of Large-scale Agricultural Investments

Large-scale agricultural investments are commonly justified using development narratives that emphasize new opportunities for employment, agricultural productivity, and infrastructure in targeted regions (German et al. 2016, Zoomers and Otsuki 2017). Empirical case studies, by contrast, point to numerous adverse impacts of LAIs. Meta-analysis of case studies show that livelihood benefits for beneficiary households can indeed occur if LAIs generate decent employment (Oberlack et al. 2016, Hufe and Heuermann 2017). However, dominant narratives in Africa contend that LAIs rarely realize the employment effects initially anticipated (Li 2011, Deininger and Byerlee 2012, Palliere and Cochet, 2018). Labor conditions are criticized for low wages, poor working conditions, and short-term contracts (Li 2011). Evidence shows that levels of job creation and quality vary according to agricultural model, previous land use, and institutional contexts (Smalley 2013, Hakizimana et al. 2017, Hall et al. 2017, Nolte and Ostermeier 2017).

Loss of access to land and water is the most frequently reported adverse impact of LAIs on rural livelihoods (Oberlack et al. 2016). It occurs most directly when smallholders, pastoralists, or other land users are displaced by land concessions, leases, or purchases (Borras and Franco 2012). Land tenure insecurity is fueling these effects (Haller et al. 2019). Pro-LAI discourses often mobilize narratives of vacant, fallow, or unproductively used lands (Li 2014, Scoones et al. 2019). However, global and local scientific evidence shows that land targeted for investment is already used by smallholders, pastoralists, or local entrepreneurs in the majority of cases (Alden Wily 2012, Messerli et al. 2014, Schoneveld and German 2014). Large-scale agricultural investments often exacerbate conflicts in target regions (Hufe and Heuermann 2017), not only between communities and investors but also between villages, families, and generations (Bottazzi et al. 2016, Millar 2016).

Thereby, LAIs can contribute to undermine resilience. Haller et al. (2020) introduced the notion of "resilience grabbing" to refer to processes in which LAIs reduce the resilience of local communities as a consequence of displacing them from access to food and non-food resources held as commons (Boillat and Bottazzi 2020).

Another subject of controversy is the distribution of LAI impacts, i.e., who bears the costs and who enjoys the benefits of such development (Peters 2013). Large-scale agricultural investments often marginalize already vulnerable groups, most frequently according to categories such as gender, ethnicity, prior poverty, and age (Schoneveld et al. 2011, Oberlack et al. 2016, Hall et al. 2017, Adams et al. 2018, Hajjar et al. 2019). Large-scale agricultural investment farms may employ vulnerable populations, but some of them may be too poor to decline low wages (Maertens and Swinnen 2009, Marfurt et al. 2016, Burnod et al. 2018). Finally, LAIs may be socio-economically harmful if jobs are transient, projects fail, or elites capture disproportionate shares of benefits (German et al. 2013, Nolte and Ostermeier 2017, Lanz et al. 2018).

Food Security Impacts of Large-scale Agricultural Investments

Food security concerns are both a driver and an impact of LAIs. Here, we focus on the impacts of LAIs on the food security of households in LAI target regions. Limited empirical evidence exists on how LAIs impact household food security in Africa. Hufe and Heuermann's (2017) review of LAIs in Africa found that only four of 60 case studies (comprising 146 acquisition projects in 22 countries) exhibited harms to food security; however, the authors note that the cases fail to provide sufficient insight into the underlying mechanisms behind the effects of LAIs on food security. Large-scale agricultural investments may impact food security via changes in employment and land access.

On the one hand, LAIs can improve food security by generating income opportunities in the agricultural, non-agricultural, and service sectors, based on new contracting or outgrower prospects, land leasing opportunities, increased local food supplies, or improved market access in remote areas (von Braun and Meinzen-Dick 2009, De Schutter 2011, Cotula et al. 2014). However, this presupposes that households have good and stable access to local food markets and are sufficiently resilient to price shocks (Bottazzi et al. 2018). Notably, the productivity of large farms has been found to be lower than that of smaller farms in Ethiopia (Ali et al. 2017) and Malawi (Deininger and Xia 2018), possibly indicating fewer income opportunities on larger farms.

On the other hand, LAI-related loss of land access can undermine food security for households who rely on agriculture for subsistence or income (Cotula 2009, 2011, Ronald 2014, Shete and Rutten 2015). Large-scale agricultural investments can increase commercial pressures on land, raising the cost per unit and constraining or barring access to communal areas used for grazing of livestock, fishing, and foraging (De Schutter 2011, Hall et al. 2015a).

Environmental Impacts of Large-scale Agricultural Investments

Several environmental impacts are associated with LAIs. They are often seen as harming water resources (Zaehringer et al. 2018b). Aims of securing water resources have been suggested as key drivers of LAIs (Breu et al. 2016, Dell'Angelo et al. 2018), thereby reducing water access for small-scale farmers (Tejada and Rist 2018). Large-scale agricultural investments can increase greenhouse gas emissions via deforestation and use of fertilizers and pesticides (Intergovernmental Panel on Climate Change (IPPC) 2006). If cultivation and other management practices are unsustainable, soils may degrade until profits disappear and production must expand elsewhere (Shete et al. 2016). Other important, but understudied, environmental impacts include on- and off-site loss of natural vegetation and biodiversity, as well as chemical pollution of water and air resources (Dell'Angelo et al. 2017a). There is general concern that LAI-related practices of intensification—such as monoculture, irrigation, and agrochemical use—can amplify environmental degradation (Mekonnen et al. 2012, Muriithi and Yu 2015, Lanari et al. 2016, Di Matteo and Schoneveld 2016).

Agricultural Investments, Resource Frontiers, and the Transformation of Land Systems

Large-scale agricultural investments drive transformations in social-ecological systems when they transform the land use systems in targeted areas. This can happen in at least three key ways: expansion of agricultural resource frontiers; agricultural intensification; and indirect land use change (Eckert et al. 2018, Ingalls et al. 2018, Zaehringer et al. 2018a, Magliocca et al. 2019).

Expansion of agricultural resource frontiers refers to situations in which demand for resource appropriation and associated capital inflows drive growth of agricultural land use at the expense of forests, grasslands, and shrublands (Peluso and Lund 2011, Meyfroidt et al. 2018, Barbier 2020). Large-scale agricultural investments may drive frontier expansion by facilitating capital inflows and triggering conversion of forests, shrublands, or grasslands into plantations. Davis et al. (2015) identified LAIs as a key driver of deforestation in Cambodia. Global estimates suggest that 32–60% of LAIs between 2000 and 2015 targeted forestlands, shrublands, and grasslands, indicating trends of agricultural frontier expansion (Messerli et al. 2014, Nolte et al. 2016). Indeed, agricultural expansion remains the most important proximate driver of deforestation (Hosonuma et al. 2012, Ceddia et al. 2014), and expansion of large commercial farms often displaces prior land users (Meyfroidt et al. 2018).

Large-scale agricultural investments may foster agricultural intensification by increasing inputs per land unit, (monocrop) yields per land unit, or the density of a resource system (Eckert et al. 2018, Meyfroidt et al. 2018). Such intensification can trigger additional agricultural expansion, especially if effective environmental governance is absent (Ceddia et al. 2014). Large-scale agricultural investments often create large-scale capitalized agriculture in areas where smallholders previously dominated agrarian sectors. Yet most assessments of agricultural intensification fail to ask: "Intensification for whom?" Displaced smallholders may either out-migrate, relocate land use to adjacent areas, or accept employment on LAI farms (Tejada and Rist 2018).

Large-scale agricultural investments lead to indirect land use changes (iLUC) by displacing land uses elsewhere at the cost of other land cover or land use in these areas (Bergtold et al. 2017, Zaehringer et al. 2018a, Magliocca et al. 2019). Large-scale agricultural investments can trigger iLUCs in several ways. First, displaced smallholders seeking cheaper or forested land in an LAI's target region can induce additional, off-site agricultural expansion (Meyfroidt et al. 2018). Second, LAIs may trigger iLUC via transfer of knowledge and technologies from LAI farms to small-scale farms. One example is adoption of agricultural practices on small farms neighboring LAI farms. Nevertheless, evidence of such spillovers is limited (Deininger and Xia 2016). Finally, LAIs may induce iLUC when seasonal workers on LAI farms encroach on adjacent areas seeking additional livelihood options beyond on-farm employment (Tejada and Rist 2018).

The Organization of Agricultural Investment and Production through Large-scale Agricultural Investments

Business models are the organizational strategies and governance structures that determine how a firm organizes its agricultural investment, production, and trade activities (Chamberlain and Anseeuw 2018). Boche and Anseeuw (2014) identified independent farmers, cooperatives, speculative enterprises, contract farming, and agribusiness as the main business models active in southern African LAI contexts. Common trends include high investment failure rates, tendencies to increase value-chain integration, and lacking inclusiveness of local populations. Poor operational performance of LAIs has been repeatedly observed in different parts of the world, including Laos (Schoenweger and Messerli 2015), Madagascar (Burnod and Andriamanalina 2017), and across Africa (Cotula et al. 2014, Hall et al. 2015a).

Earlier research has identified the following business-model features as key to LAI evolution and impact: (1) type of actor, (2) degree of vertical integration, (3) origin of capital, (4) juridical form, (5) main production, (6) organization of agricultural production mode, (7) technical agricultural model, and (8) ways of accessing land (Camisón and Villar-López 2010, Boche and Anseeuw 2014, Chamberlain and Anseeuw 2017).

Although many LAIs commodify land and labor (D'Odorico et al. 2017), certain inclusive business models may comprise more decommodified forms of social exchange (Haller et al. 2016, Gerber and Gerber 2017). Inclusive business models are possible alternatives for structuring agricultural investments. Instead of land acquisitions, they may rely on collaborative arrangements between capitalized investors and small-scale farmers and communities (Vermeulen and Cotula 2010). No single model, however, has been identified as the best option for smallholders in all circumstances, and none reviewed can be said to be perfectly fair or offering a holistic solution to rural development at local and national levels (Lahiff et al. 2012, Cramb 2013, Chamberlain and Anseeuw 2017).

Governance of Large-scale Agricultural Investments

Governance of LAIs encompasses numerous actors spanning many different levels of activity, ranging from community-based collective action to state-based decision making and global governance (Margulis et al. 2013, Oberlack et al. 2018). Important mechanisms to regulate and shape LAIs include legal regulations and human rights provisions (Schoneveld and German 2014, Bürgi 2015, Nolte and Väth 2015, Schoneveld 2017), voluntary guidelines (Seufert 2013), transparency initiatives (Vijge et al. 2019), and social movements (Hall et al. 2015b). Here, we focus on how global/national agricultural policy and land policy mediate the influence of global drivers of LAIs, shaping implementation of LAIs and their impacts on the ground.

Globally, the agricultural policy debate has been marked by proliferation of multi-actor platforms, some of which promote LAIs in Africa (High Level Panel of Experts on Food Security and Nutrition (HLPE) 2018). The latter have fostered narratives of untapped land potential in Africa and the need to produce more food. These narratives point to the increasing role of transnational corporations in global food security (Fouilleux et al. 2017). In the aftermath of the global food price crisis of 2007–2008, the G8 heads of state/government made food security a priority in L'Aquila in 2009 (Margulis 2012). Several initiatives followed. For instance, the African Union Commission, the New Partnership for Africa's Development (NEPAD), and the World Economic Forum founded Grow Africa in 2011 with the aim of increasing private sector investment in agriculture. The New Alliance for Food Security and Nutrition (NAFSN), formally established in 2012, brings together 10 African governments, the African Union, private-sector actors, and donors to encourage private investment in agriculture (McKeon 2014).

In the global land policy field, diverse voluntary arrangements are meant to govern LAIs. The Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources (PRAI) were endorsed by the World Bank, the United Nations Conference on Trade and Development (UNCTAD), FAO, and International Fund for Agricultural Development (IFAD) in 2010–2011. The seven principles encompass all types of investment in agriculture, including between principal investors and contract farmers. They are intended to provide a framework without constraining power to guide and assess national regulations, international investment agreements, corporate social responsibility initiatives, and individual investor contracts. In response to pressure by international civil society organizations for tighter principles, the Committee on World Food Security endorsed the Voluntary Guidelines on the Governance of Tenure to Land, Forests and Fisheries (VGGT) in 2012 (Seufert 2013).

In countries under an aid regime like Madagascar, Mozambique, and, to a lesser extent, Kenya, external actors such as bi- and multi-lateral cooperation agencies, international non-governmental organizations (NGOs), and private foundations often shape the development of public policies (Lavigne Delville 2017). This external influence may operate, for instance, by conditioning national budget support, institution building, and public policy transfers. International actors often directly shape the policy discourse and instruments produced by national governments. Yet countries that are comparable in terms of aid dependency and history do not always make the same policy choices. Portrayals of top-down land grabs often overlook the agency of host states and domestic elites at the national and local level (Fairbairn 2013, Wolford et al. 2013, Lanz et al. 2018). Similarly, in countries with elaborate legal provisions to protect customary tenure, national/local enforcement of said rules remains key to safeguard land tenure and access effectively (German et al. 2013, Haller et al. 2016, Delaney et al. 2018). Indeed, the interplay of policy and legal frameworks with national/local human agency may be one of the most decisive factors shaping LAI implementation and impacts (Nolte and Väth 2015, Lundsgaard-Hansen et al. 2018).

Large-scale agricultural investments are frequently contested by NGOs and others on the ground (Temper et al. 2015). The mobilization capacities of local, national, and international NGOs vary. Some NGOs simply act as intermediaries informing and explaining the situation and possibilities to local communities, whereas others act as spokespersons and defend a specific cause in national or international arenas (Tafon and Saunders 2019). These strategies are more effective when they are echoed by traditional authorities, local groups, the media, and diplomatic actors (Allaverdian 2010, Rocheleau 2015, Lavers and Boamah 2016). The implementation of particular land and agriculture policies may depend on the mobilization capacity of local and national civil society as well as on the views of national elites influenced by their relationships with the donor community and past experiences with investors.

Taken together, one important frontier in the debate on LAIs relates to deeper understanding of the interactions and variations among the socio-economic, food security, and environmental impacts of LAIs. A second frontier calls to clarify the role and interactions of business models, governance, and land-use changes in translating common global drivers of land investments into varying impacts on the ground. Addressing these frontiers requires methodological approaches of cross-country comparative analyses of LAIs that use consistent interdisciplinary research instruments. The AFGROLAND project has set out to contribute to push these frontiers.

MATERIALS AND METHODS

Research Design

This paper combines a collaborative expert workshop with a case-based comparative analysis to synthesize results of the AFGROLAND project. It brings together the results of specialized research questions on land use change, business models, governance systems, as well as socio-economic, food security, and environmental impacts (Burnod and Andriamanalina 2017, Bourblanc and Belenfant 2018, Burnod et al. 2018, da Silva 2018, Eckert et al. 2018, Giger et al. 2018, 2020, Mawoko et al. 2018, Fitawek 2019; Adalima, *unpublished manuscript*; Burnod, *unpublished manuscript*; Masola et al., *unpublished manuscript*; Mutea et al., *unpublished manuscript*; Ralandison, *unpublished manuscript*, Reys et al., *unpublished manuscripts*) by examining the recurrent patterns and linkages between these aspects.

We chose a set-theoretic methodology for our comparative analysis (Schneider and Wagemann 2012). This methodology enabled integration of quantitative and qualitative data, matched our sample size, and fit our ambition of identifying context-sensitive generalizations that explain how particular outcomes/impacts of LAIs relate to different combinations of conditions (i.e., equifinality) (Magliocca et al. 2018, Oberlack et al. 2019, Eisenack et al. 2019).

Kenya, Madagascar, and Mozambique were selected as study countries because they: (1) experienced a rush of LAIs in the past two decades; (2) belong to the same regional economic community and bear similarities in regional trade and economic policies; and (3) vary in the degree of commercialization of their agrarian sectors. Mozambique features intermediate development of commercial agriculture (compared with Kenya and Madagascar) and has recently experienced many LAIs via the Beira and Nacala development corridors. Kenya is a well-integrated economy with a comparatively mature commercial agriculture sector. And Madagascar features a comparatively fragile governance system with a relatively easily influenced political-economic situation—it is known for many attempted land deals, most of which have failed.

In each country, we identified regional hotspots of LAIs in which to analyze LAI dynamics beyond individual cases: the Nanyuki area of Kenya (in Laikipia County), the highlands of Madagascar, and the Nacala Corridor of Mozambique (Monapo und Gurué districts). For the present synthesis, we included 16 LAIs according to the following criteria: (i) range of mature and recent investments; (ii) range of business models; and (iii) availability of data from multiple work packages for the project synthesis.[1] Five cases are in Kenya, three in Madagascar, and eight in Mozambique. In Kenya, we chose cases in an area that is typical for the relatively mature and intensive type of investments, which characterize an important part of the agricultural sector in Kenya (Eckert et al. 2018, Giger et al. 2020). In Mozambique, we chose relatively large-scale land acquisitions in the Nacala corridor, which is one of six corridors designated by the government as priority areas to foster agricultural growth through large-scale land investments (Ikegami 2015). In Madagascar—despite a wave of announced land acquisitions after 2005—by 2015, out of 85 cases, more than 90% had failed. We finally chose two of the very few remaining and operational cases in the country and one failed case, located in Central Madagascar (Burnod and Andriamanalina 2017).

Data Collection and Data Analysis

Using a mixed-methods approach, the AFGROLAND project combined six methods to collect primary data in 2015–2017 (Poteete et al. 2010). (1) Three rural household surveys using stratified random samples in Mozambique (n = 504), Kenya (n = 545), and Madagascar (n = 601)—i.e. 1,650 households in total—capture socio-economic and food security impacts of LAIs. To assess impacts, we compared engaged households (i.e., employed directly or contract farming), non-engaged households in a LAI target area, and households in counterfactual areas without LAIs (Reys et al., *unpublished manuscripts*). (2) We conducted 296 semi-structured household interviews with open-ended questions (99 in Kenya, 96 in Madagascar, and 101 in Mozambique) to record household perceptions of land use changes, environmental impacts, and conflicts (Zaehringer et al. 2018a, b). (3) We conducted 12 semi-structured interviews (four in Kenya, eight in Mozambique) with LAI representatives and 20 interviews with small-scale farmers (10 in Kenya, 10 in Mozambique), and completed life-cycle assessments, including water footprint assessments, to measure environmental impacts (da Silva 2018). (4) We analyzed remote-sensing data to quantify land uses and land use changes in the study areas (Eckert et al. 2018, Zaehringer et al. 2018a). (5) We conducted 68 semi-structured interviews with investors to survey business models (Adalima, 2016, *unpublished manuscript*, Burnod, 2017, *unpublished manuscript*, Mutea et al., 2017, *unpublished manuscript*). Finally, (6) we conducted key informant interviews with representatives from public and governmental organizations, development and finance organizations, project managers, farmer organizations, civil society and the private sector, and performed document analysis to collect data on governance systems (Burnod and Andriamanalina 2017, Bourblanc and Belenfant 2018; Ralandison, 2016, *unpublished manuscript*, Burnod, 2017, *unpublished manuscript*). For the present project synthesis, we used these data and analyses in a collaborative expert workshop and for the truth table of our set-theoretic comparative analysis. The research protocol of the present project synthesis followed six main steps (Fig. 1).

Step 1. Collaborative expert workshop

The expert workshop with 19 project members from six countries was held at the University of Pretoria, South Africa, in January 2018. Project members presented and discussed the results of the individual work packages; created a common understanding of the main results; identified the indicators for synthesis; and discussed the relationships between business models, land use changes, governance systems, as well as socio-economic, food security, and environmental impacts of LAIs.

Step 2. Identify indicators

We characterize the main categories of interest in this synthesis through 103 indicators, including 6 indicators for socioeconomic impacts, 7 for food security impact, 14 for environmental impacts, 21 for business models, 33 for land use changes, 17 for governance systems, and 5 for social-ecological contexts. Table A1 in the Append. 1 provides the details of their measurement scale and data sources. We decided that the main unit of analysis for the synthesis would be the scale of LAIs and their adjacent zones of influence (5 km around an LAI), as this is where most of the direct impacts occur.

Step 3. Compile database and truthtable

We compiled the data set for the present synthesis by characterizing each of the 16 included LAIs along the 103 indicators by merging data from the individual work packages of the AFGROLAND project. Next, we converted this data into a truth table, indicating the presence or absence of an attribute for

Fig. 1. Research protocol.

Step	Activity and method	Result
0. Primary data collection and analysis	Mixed-methods approach in four work packages of the AFGROLAND project, including: household surveys (n=1,650), semi-structured interviews with investors (n=68+12), semi-structured interviews with households (n=328+20), life-cycle assessment, remote-sensing data analysis, key-informant interviews and document analysis in Kenya, Madagascar, and Mozambique in 2015–2017.	In-depth results on business models, land use changes, governance systems, socio-economic, food security and environmental impacts (cf. references in text).
1. Collaborative expert workshop	A collaborative workshop of 19 project members from six countries was held at the University of Pretoria, South Africa, in January 2018. It enabled project members to present and discuss the results of the individual work packages; to create a common understanding of the main results; to begin identifying the indicators for overall synthesis; and to discuss relations between business models, land use changes, governance systems, as well as the socio-economic, food security, and environmental impacts of LAIs in a qualitative manner.	Shared understanding among project members of main results from the four work packages; co-design of synthesis work; indicators.
2. Indicator selection	At the collaborative expert workshop (University of Pretoria, Jan. 2018) and subsequent refinement, identifying the main indicators of each work package.	103 indicators in total
3. Common database	Compilation of primary data in common database and standardization of data into a truth table for Formal Concept Analysis.	Truth table with 103 indicators for 16 LAIs.
4. Identify impact patterns	Partitioning of impact profiles of the set of 16 LAIs. Criteria for partitioning: the resulting subsets are (1) consistent (i.e. assembling cases with similar configurations of impact values); (2) crisp (i.e. cases of one subset are as similar as possible among each other and as different as possible from other subsets); (3) parsimonious (i.e. number of subsets as small as possible); (4) recurrent (i.e. subsets observable in at least two cases); (5) and high coverage (the typology of subsets covers all cases).	▪ Four distinct and recurrent impact patterns identified. ▪ Quantitative and qualitative description of each impact pattern.
5. Identify conditions associated with each impact pattern	Using Formal Concept Analysis to identify the conditions of land use changes, business models, governance systems and social-ecological contexts that that are associated in a fully consistent (100%) and recurrent (n≥2) manner with each impact pattern.	▪ Consistent and recurrent conditions for each impact pattern identified. ▪ Quantitative and qualitative description of all conditions.
6. Verification and interpretation	Verification through cross-checking with results and expert knowledge of the contributing researchers. Interpretation of results in view of current controversies and hypotheses on LAIs.	▪ FCA results verified against primary sources and expert understanding. ▪ Implications of results for controversies on LAIs drawn.

each case. Table A1 and Append. 2 present the detailed methods used to compile the truth table (Append. 3). This truth table was the input for the set-theoretic comparative analysis (Rudel 2008, Schneider and Wagemann 2012).

Step 4. Data analysis: identify the impact patterns

To analyze this data, we applied Formal Concept Analysis (FCA) in search of recurrent impacts of LAIs and the associated conditions. Formal concept analysis is a tool for qualitative knowledge representation and inference (Ganter and Wille 2012). It is suited for set-theoretic comparative analyses as it identifies the multiple configurations of attributes present in the truth table. In contrast to qualitative comparative analysis (QCA) (Ragin 1987), FCA retains factors even if their presence and absence has led to the same outcome in different cases. We used the Concept Explorer software, with the truth table of cases and their attributes serving as our input. Formal concept analysis generates a concept lattice and compiles logical implications between attributes. "The concept lattice organizes the attributes in a hierarchical structure such that higher-tier attributes are logical implications of lower-tier attributes, while lower-tier items show distinct combinations with higher-tier attributes in the dataset" (Oberlack et al. 2016: 157). In this way, FCA is capable of visualizing multiple configurations of LAI impacts. To identify these patterns in the 27 indicators of socio-economic, environmental, and food security impacts, we identified distinct sets of impacts profiles among the 16 LAIs using the following criteria: the sets of impact profiles are (1) consistent (i.e., assembling cases with similar configurations of impact values); (2) crisp (where cases in one subset are as similar as possible to each other and as different as possible from cases in other subsets); (3) parsimonious (where the number of subsets is as small as possible); (4) recurrent (observable in at least two cases); (5) and have a high coverage (where the typology of subsets covers all cases). We first partitioned the cases based on the degree of households' losses of access to land, given the significance of land access for the impacts of LAI. This yielded subsets of cases with similar degrees of land access losses. Next, we noted all impacts that were consistently co-occurring in the cases of a given subset. Finally, we identified distinctive patterns within a subset, if more than two cases within this subset were similar on a particular impact indicator while being distinctively different to all other cases of the subset. This procedure resulted in four impact patterns.

Step 5. Identify the processes and conditions consistently associated with each impact pattern

We used FCA to identify the processes and conditions of land use changes, business models, governance systems, and social-ecological contexts that are associated in a fully consistent (100%) and recurrent ($n \geq 2$) manner with each of the four impact patterns. Furthermore, we identified those conditions that hold for all but one case per impact pattern to correct for possible loss of information via the conversion of primary data into our truth table (i.e., standardizing numerical into categorical data for indicators with numerical measurement scale). Solely in instances where the attribute values of the unrepresented case were close (+/- 20%) to the values of the represented cases, we added those conditions to the set of consistent attributes. We noted the precise numeric values rather than the values of standardized classes for all processes/conditions identified in this manner.

Step 6. Verification

Finally, we verified the FCA results by crosschecking them with the results of the research teams of the individual work packages.

Limitations

The following limitations must be considered when interpreting our results. First, the data set involves missing data, as we do not have full data on all 103 indicators for all 16 cases—mostly regarding the Mozambican cases. The set-theoretic methodology of FCA helps address such gaps, as FCA provides robust results regarding distinct patterns even when data are missing. Formal concept analysis identifies similarities across cases without the need to impute missing data. More complete data might have added empirical support for the four patterns we found, or it may have enabled identification of additional patterns or more detailed sub-patterns within the four patterns. The missing data do not compromise the existing similarities we found in the available data set.

Second, some prior residents of the LAI target areas under analysis may have already out-migrated and been missed by the livelihood and food security surveys and household interviews. The household surveys and interviews captured residents living in the study areas at the time of fieldwork in 2015–2017. We cannot rule out that some households who lost land access to LAIs left the targeted area before survey/interview data were collected. Current residents, including in-migrants, may not always report on displacements that affected previous land users.

Third, we used 14 indicators to assess environmental impacts. Half of our data on environmental impacts (indicators ENV1-7) are based on the perceptions of households at the time of research. Perceptions of environmental impacts can be biased according to personal experiences and values. The other half of our data on environmental impacts (indicators ENV11-17) is based on interviews with LAI and small-scale farmers, corresponding with life-cycle assessments and expert assessments. Measuring and comparing environmental impacts across such diverse landscapes is challenging. In our case, quantitative data on indicators ENV11-17 were very scarce, or LAIs were unwilling to share them. This forced us to work with limited data and to use expert knowledge to fill in gaps on environmental impacts ENV11-17 (see Append. 2).

Finally, our conflict indicator is based on semi-structured interviews with open-ended questions with households (Zaehringer et al. 2018a, b). Therefore, we were able to capture a range of different kinds of interpretations of conflicts. Respondents mainly referred to overt acts of resistance and individual negative feelings toward the LAI. By contrast, covert acts of resistance are not captured. Therefore, the level of conflicts might possibly be underestimated by our indicator.

RESULTS

Part one of the results shows that the 16 LAIs follow four patterns exhibiting distinct impact profiles. The patterns are: (1) moderate employment with no loss of smallholder land access, but high conflict incidence and large environmental impacts (termed "conflicted neighborhood"); (2) moderate employment with no loss of smallholder land access, low conflict incidence, and low environmental impacts ("moderate neighborhood"); (3) large employment effects but at considerable cost to smallholder land access and the environment ("land loss to main employer"); and (4) widespread loss of land access, high conflict incidence, and negative attitudes ("widespread hostility"). Table 1 presents the descriptive statistics for each pattern for all socio-economic, food security, and environmental impact indicators. Figure 2 visualizes these profiles, and Fig. 3 illustrates the differences across patterns.

The second part of the results shows how particular processes and conditions of land use change, business models, and governance are associated consistently and recurrently with each impact pattern (Table 2). Each pattern is described below.

Pattern 1: Conflicted Neighborhood: Moderate Employment, No Smallholder Land Access Loss, and High Conflict Incidence

Socio-economic, food security, and environmental impacts

Pattern 1 was exhibited by four LAIs, all in Kenya. Residents did not report any loss of access to land (0% of households), but 54% of households in the areas surrounding LAIs reported incidences of conflict. The reported tensions related to perceived air pollution (40–70% of households in all four LAIs), chemical exposure (35% of households affected by one LAI), and water pollution (25% affected by one LAI). Similarly, water consumption, energy consumption, pesticide use, eutrophication potential, acidification potential, and global warming potential are highest in the LAIs of Pattern 1 (out of all the LAIs in our sample). Additionally, conflicts with pastoralists are not uncommon in the Nanyuki area, as reported by LAI farm managers and other stakeholders. Although the farms engage in water resource user associations (WRUAs), not all WRUAs were able to regulate water access comprehensively, and commercial farms in the WRUAs were found to have more bargaining power to access water than smallholder farmers (Jacobi et al. 2018, Ngutu et al. 2018). Despite the conflicts, relatively few households (24% on average) expressed wishes for the farms to leave the area.

Table 1. Impacts of LAIs follow one of four patterns

Impacts [measurement scale]	Impact Pattern (1) Conflicted neighborhood	(2) Moderate neighborhood	(3) Land loss to main employer	(4) Widespread hostility
Socio-economic impacts	Means (range), median			
Land access loss [%] §, |	0 (0), 0	0 (0), 0	26 (22–29), 26	54 (25–79), 46
Employment on-site [%] §, |	15 (8–26), 12	8 (6–10), 8 †	65 (63–67), 65	28 (19–36), 28‡
Preference for LAIs to leave [%] §	24 (15–30), 25	10 (0–24), 5	-	60 (20–85), 65
Conflict incidence [%] §	54 (35–65), 58	11 (4–20), 8	-	68 (18–95), 80
Infrastructure establishment [%] §	15 (0–35), 13	53 (0–80), 80	-	44 (0–89), 29
Food security impacts	Comparison of engaged households (EN), non-engaged households (NE) and households in counterfactual areas (CF)			
Food consumption	EN > CF	≈≈ †	EN ≈ CF	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN > NE	EN > NE †	EN ≈ NE	≈≈ ‡
Household dietary diversity	EN ~ CF	≈≈ †	≈≈	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN > NE	EN > NE †	≈≈	≈≈ ‡
Women's dietary diversity	EN < CF	≈≈ †	≈≈	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN ↕ NE	≈≈ †	≈≈	≈≈ ‡
Assets	EN > CF	EN > CF †	EN > CF	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN > NE	EN > NE †	≈≈	≈≈ ‡
Food provision	EN > CF	EN > CF †	EN < CF	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN > NE	≈≈ †	≈≈	≈≈ ‡
Coping strategies	EN ↕ CF	≈≈ †	EN ≈ CF	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN ↕ NE	≈≈ †	EN ≈ NE	≈≈ ‡
Food security index	EN > CF	≈≈ †	≈≈	≈≈ ‡
[relation of EN/CF and EN/NE] |	EN > NE	EN > NE †	≈≈	≈≈ ‡
Environmental impacts	Means (range), median			
Perceived chemical exposure [%] §	13 (5–35), 5	9 (8–10), 9 †	-	4 (0–16), 0
Perceived deforestation [%] §	1 (0–5), 0	0 (0), 0 †	-	15 (0–27), 5
Perceived water over-extraction [%] §	9 (5–25), 5	12 (4–20), 12 †	-	2 (0–16), 0
Perceived water pollution [%] §	6 (0-–15), 5	0 (0), 0 †	-	3 (0–16), 0
Perceived air pollution [%] §	53 (40–70), 50	15 (0–30), 15 †	-	6 (0–28), 0
Perceived pest increase [%] §	13 (5–25), 10	3 (0–5), 3 †	-	0 (0), 0
Perceived water occupation [%] §	0 (0), 0	0 (0), 0 †	-	9 (0–17), 9
Pesticide use [1..4] ¶	3.8 (3–4), 4.0	2.0 (1–3), 2.0 †	1.5 (1–2), 1.5	2.4 (1–3), 3.0
Eutrophication potential [1..4] ¶	3.8 (3–4), 4.0	2.5 (2–3), 2.5 †	2.0 (1–3), 2.0	2.3 (1–3), 2.0
Acidification potential [1..4] ¶	3.8 (3–4), 4.0	2.5 (2–3), 2.5 †	2.0 (1–3), 2.0	2.6 (1–3), 3.0
Global warming potential [1..4] ¶	3.8 (3–4), 4.0	2.5 (2–3), 2.5 †	1.5 (1–2), 1.5	2.6 (1–3), 3.0
Energy consumption [1..4] ¶	3.8 (3–4), 4.0	2.0 (1–3), 2.0 †	2.0 (1–3), 2.0	2.6 (1–3), 3.0
Water consumption [1..4] ¶	3.8 (3–4), 4.0	2.0 (1–3), 2.0 †	1.5 (1–2), 1.5	2.4 (1–3), 3.0
Soil degradation [1..4] ¶	3.0 (3), 3.0	3.0 (3), 3.0 †	3.0 (2–4), 3.0	2.1 (1–3), 2.0
Number of LAI cases following this pattern	4	3	2	7

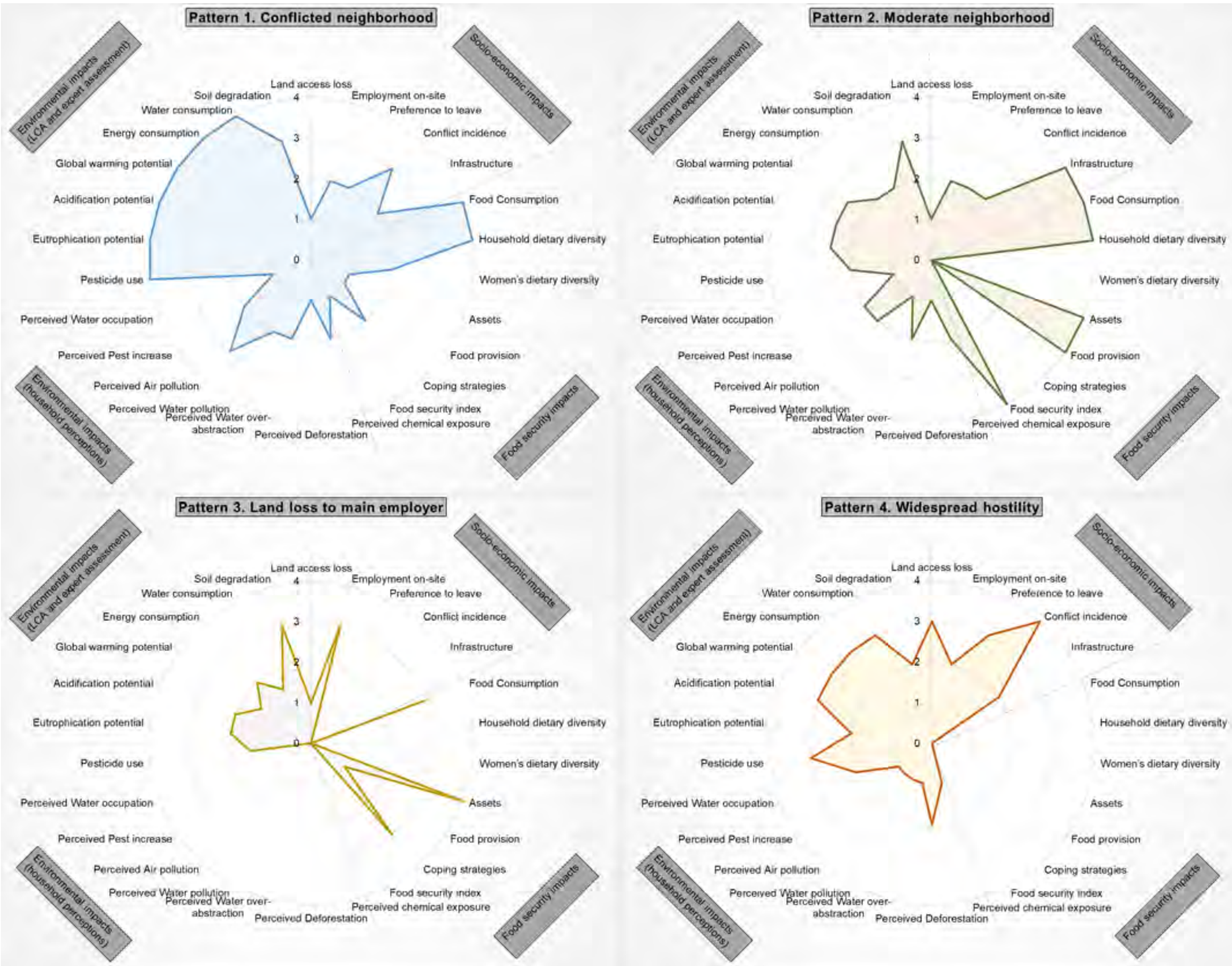
Notation: EN: engaged households, NE: non-engaged households, CF: counterfactual, > better than, < worse than, ↕ spreading (more most-food secure households and more most-food insecure households), ~ moderation (less most-food secure households and less most-food insecure households), ≈ no difference, ≈≈ inconclusive evidence across cases, - data not available, % percentage of households, † data available for two of three cases, ‡ data available for two of seven cases, § data source: household interviews of WP3 (*n* = 20 per case), | data source: household survey of WP4, ¶ data source: household interviews, life-cycle assessment, and expert assessment,

The four farms have generated moderate employment effects, as 15% of households in their surroundings have at least one member employed by them. Many households in the area have built livelihoods based on jobs with other employers (40–65%) as well as based on self-employment. This indicates that the four LAIs are but one livelihood option among several alternatives in the Nanyuki area. The food security situation of employed households tends to be slightly better than that of unemployed households in the LAI zones or households in the "counterfactual" zone. This is indicated by slightly better food consumption, better household dietary diversity, better assets, fewer months of inadequate food provision, and better food security index. However, the food security impacts are spreading in terms of women's dietary diversity and coping strategies. That means that, compared with both non-engaged households and households in the counterfactual area, more engaged households apply severe coping strategies such as skipping meals and more engaged households apply milder strategies such as borrowing food.

Associated features of business models, governance, and land use changes

All four LAIs of Pattern 1 share similar business model-related features. All are greenhouse-based horticulture farms in Kenya's Nanyuki area. At the time of research in 2017, they ranged in age from 4 to 17 years. Their operational farm size was moderately large—between 23 ha and 87 ha—and their acquired farm size ranged from 27 ha to 140 ha. Each created between 493 and 600 jobs. Their large labor intensity (6.9–20 jobs/ha) and land

Fig. 2. Profiles of the four impact patterns. Note: the scale denotes the strength of the impact from 1 (no impact) to 4 (strong impact), with 0 (no data). It does not denote a judgement as to whether this impact is “good” or “bad”.



utilization rate (62–100% of leased land actually used) were comparatively large. They recruited workers in adjacent areas and externally. Employment contracts were longer than 8 months for about 90% of workers, indicating low levels of daily/seasonal employment. Salaries were under USD $2/day for 8% of employees, between USD $2 and USD $5/day for 60%, and over USD $5/day for 31% of employees.

All four LAIs were established on land used previously by large farms. They were owned either by domestic investors or those with experience in Nanyuki’s local agricultural context.

All the LAIs intensified agricultural land use with high degrees of mechanization and input intensity. Three LAIs also involved agricultural expansion, but one did not. We found some evidence that LAIs triggered spillovers to land management on smallholder farms via extension services, outgrower contracts, and excessive extraction of water, spurring smallholders to modify their land management.

The governance system combines a policy discourse that is mildly favorable to LAIs with good mobilization capacity of civil society organizations (CSOs), strong land property rights, and high land tenure security for smallholders as well as a government whose accountability to smallholders is comparatively high.

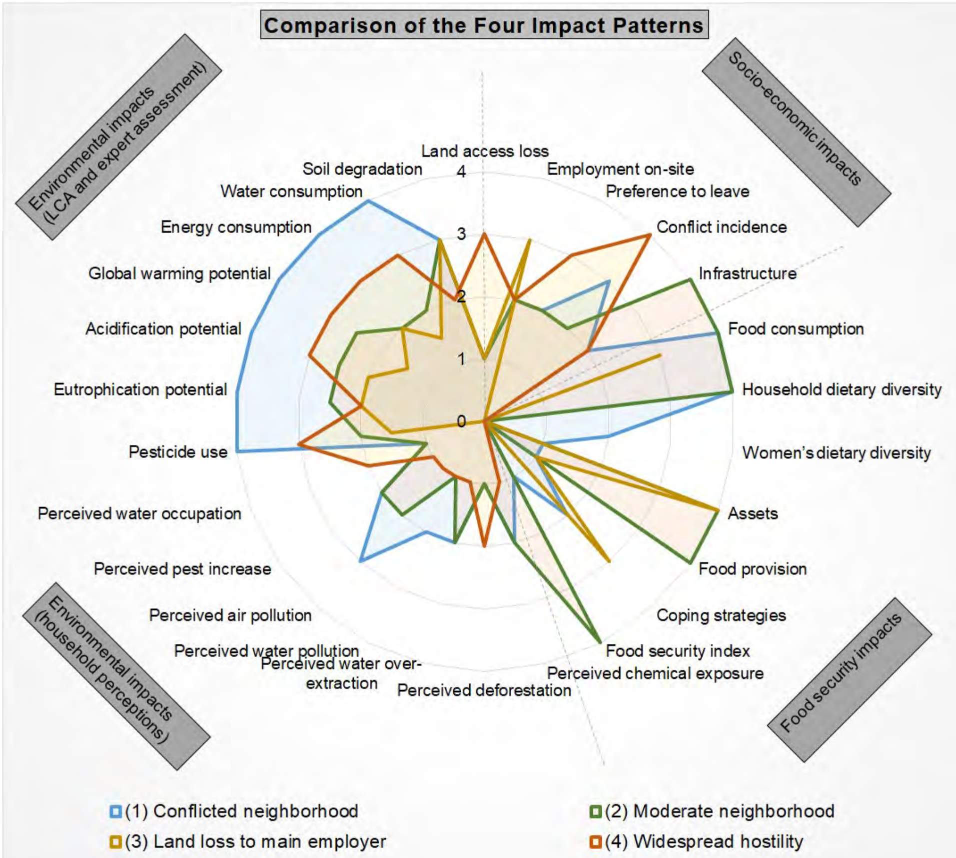
Pattern 2: Moderate Neighborhood: Moderate Employment, No Smallholder Land Access Loss, and Low Conflict Incidence

Socio-economic, food security, and environmental impacts

Similar to pattern 1, the three LAIs following Pattern 2—one in Kenya and two in Madagascar—involved no loss of smallholder land access (0% of households in adjacent areas) and featured moderate employment effects (6–10% of households in adjacent areas). They also generated slightly positive effects for engaged households according to most food security indicators, when compared with non-engaged households in LAI target areas.

In contrast to Pattern 1, however, the LAIs of Pattern 2 exhibit lower incidences of conflict (4%, 8%, and 20%, respectively). They

Fig. 3. Comparison of the four impact patterns.



also feature less extreme environmental impacts. Furthermore, two of three LAIs following Pattern 2 exhibit widely perceived infrastructure benefits (80% and 81% of affected households, respectively).

Associated features of business models, governance, and land use changes

The three LAIs following Impact Pattern 2 were characterized by two configurations of conditions. Two farms—one horticultural farm in Kenya and one barley contract-farming scheme in Madagascar—were moderate to large operational farm sizes (125 ha and 256 ha, respectively). The Kenyan farm was established 12 years prior to the time of research, whereas the Malagasy LAI farm was established 2 years prior. Both involved contract farming with smallholders, with the Kenyan farm also operating on its own fields. The two commercial farms engaged 850 and 2,636 persons, respectively (as employees or smallholders), making labor intensity comparatively high (6.8 and 10.3 jobs/ha).[2]

The third LAI featured different processes and conditions giving rise to a different impact pattern. It was a jatropha project in Madagascar that was abandoned shortly before the research. In 2008, it acquired 2,220 ha of land for implementation of a jatropha plantation. The investor was an international newcomer to the country's agricultural sector. The farm planted young jatropha trees on 600 ha of land previously used by pastoral communities as grazing land, substantially reducing available fodder for livestock. The project was abandoned in 2016, but the land is now legally registered in the name of the state. Beginning in 2017, we observed communities (via satellite imagery) resuming seasonal burning of their former grazing land, as was done for decades prior to arrival of the LAI.

Pattern 3: Land Loss to Main Employer: Large Employment Effects vs. Smallholder Land Loss

Socio-economic, food security, and environmental impacts

Impact Pattern 3 was displayed by two LAIs—both in Mozambique—that had become the main employer in their target region. Overall, 63% and 67% of nearby households, respectively, had at least one member employed by them. However, 22% and 29% of households, respectively, experienced loss of land access. Evidence on the food security situation was mixed. Compared with non-engaged and counterfactual households, the LAI-employed households had slightly better assets, similar food consumption and coping strategies, but worse food provision. Environmental impacts were moderate to high.

Associated features of business models, governance, and land use changes

The two LAIs operated large farms (2,500 ha and 3,000 ha, respectively). They included a sisal and a tea plantation with low degrees of mechanization and low-to-medium input intensity. They

Table 2. Processes and conditions of land use changes, business models, governance, and social-ecological contexts associated with each impact pattern

Process or condition [measurement scale]	Impact patterns			
	1 Conflicted neighborhood	2 Moderate neighborhood	3 Land loss to main employer	4 Widespread hostility
Business model				
Farm size operational [ha] †	43 † (23–87)	127 † (0–256)	2750 † (2,500–3,000)	1900 † (830–6,000)
Farm size acquired [ha] †	58 † (27–140)	1260 (300–2,220) ‡	5523 † (5,045–6,000)	3974 † (850–10,000)
Utilization of land [%] †	84 † (62–100)	21 (0–42) ‡	51 (42–60)	61 (15–98)
Workers total [number] †	536 † (493–600)	1162 † (0–2,636)	1101 † (800–1,401)	587 † (148–556)
Labor intensity [workers/ha] †	15.2 † (6.9–20)	5.7 † (0–10.3)	0.4 (0.4–0.5)	0.4 † (0.07–0.4; 1 outlier: 1.4)
Prior land use [small-scale farming, large-scale farming] †	Large-scale farming †	≈≈	Large-scale farming †	Small-scale farming †
Years since establishment [years] †	11.0 (4–17)	7.7 (2–12)	18.5 † (16–21)	6.3 † (4–8)
Experience of investor in local agriculture OR domestic investor [0/1] †	1 †	≈≈	1	≈≈ †
International investor and manager [0/1] †	≈≈	≈≈	≈≈	1 †
Juridical structure	≈≈	Private without shareholding	≈≈	≈≈
Vertical integration [1–4]	2	≈≈	≈≈	≈≈
Production [in-house, contract farming]	In-house	≈≈	In-house	In-house
Main market [local, national, international]	International	≈≈	-	≈≈
Irrigation [drip, overhead]	Drip	≈≈	-	-
Investor land access [lease, purchase, inheritance, rent]	≈≈	≈≈	≈≈	Lease
Status of irrigation [full operation, struggling, failed]	Full operation	≈≈	Full operation	Full operation
Certified production [0/1]	1	≈≈	≈≈	-
Land use change				
Agricultural intensification [0/1] †	1 †	≈≈	-	≈≈
Agricultural expansion [0/1]	≈≈	≈≈	-	1
ILUC: LAI drives smallholders into forest [0/1] †	0 †	0	-	≈≈
ILUC: LAI induce land management change on smallholder fields [0/1] †	1 †	1 †	-	-
LAI mechanization [low, medium, high]	High §	≈≈	Low	≈≈
LAI input intensity [low, medium, high]	High	-	≈≈	≈≈
Governance system				
Experience of policymakers with LAI [strong/weak]	Strong	≈≈	Strong	Strong
Agrifood policy discourse [Strongly, mildly, not favorable for LAI] †	Mildly favorable †	≈≈	Strongly favorable	Strongly favorable
Policy reform facilitates LAI [0/1]	1	1	1	1
Extraversion of policy making [weak, medium, strong]	Medium	≈≈	High	High
Development brokering [few/many] †	Few †	≈≈	Many	Many
Fragmentation of policy-making impacts LAI [0/1]	1	1	1	1
Civil society mobilization capacity [low/high] †	High †	≈≈	Low	Low
NGO financial independence [low/high]	Low	Low	Low	Low
Legal compensation systems with moderate compensation levels and mixed implementation [0/1]	1	1	1	1
Main land property rights system [type] †	Private †	≈≈	Leasehold and customary	≈≈
Investor land tenure security [low, high]	High	≈≈	High	High
Smallholder land tenure security [low, high] †	High (if private land) †	≈≈	Low †	Low †
Accountability of community leaders to land users [weak, strong]	Weak	Weak	Weak	Weak
Accountability of governments to land users [weak, strong] †	Strong †	≈≈	Weak †	Weak †
State authority in land governance [centralized, fragmented]	Fragmented	≈≈	Fragmented	≈≈
Access of smallholder to state authorities [weak, moderate, strong] †	Moderate †	≈≈	Weak †	≈≈
Social-ecological context				
Household employment elsewhere [%] †	52 (40–65) †	-	28 (24–32) †	-
Yield potential [low, medium, high]	Medium	≈≈	High	≈≈
Actual yields [low, medium, high]	High	≈≈	Low	≈≈
No. of growing days [classes]	240–269	≈≈	180–209	≈≈
Smallholder fertilizer use [rare, medium, frequent] †	Frequent †	≈≈	≈≈	Rare
Water source for irrigation	≈≈	Above ground	≈≈	≈≈
Number of cases following this pattern	4	3	2	7

Notes: The table reports those processes and conditions that are consistently associated with each impact pattern.
Notation: ≈≈ condition not consistently associated with impact pattern, - data not available, † conditions that (1) vary across patterns and (2) are plausible according to the theories presented in section 2, ‡ data available for two of three cases, § data available for three of four cases, Abbreviations: ILUC: indirect land use change,

were established 16 and 21 years prior to data collection, respectively. Even though land utilization rates (42% and 59% of acquired land used) were lower than those observed in the first two patterns, the corresponding LAIs remained, as noted, the main employer in their target region (63% and 67%). Only 24% and 32% of households sustained their livelihoods via jobs with other employers. However, most of the LAI employees (83% and 90%, respectively) earned less than USD $2/day, with scarcely anyone (0% and 3%) earning over USD $5/day. Furthermore, many jobs (41% and 67%) were only daily or seasonal, not long-term.

Land tenure in the target areas was previously in the hands of large state farms. However, the de facto prior land use involved smallholders as well. Both the LAI farms were led by international investors with a long-term record of experience in the agricultural system of the targeted region.

The governance system in the two cases exhibited low land tenure security for smallholders and weak government accountability. Civil society mobilization capacity was also low, whereas the dominant agri-food policy discourse was strongly favorable to LAIs as a development strategy.

Pattern 4: Widespread Hostility: Widespread Loss of Land Access, High Conflict Incidence, and Omnipresent Negative Attitudes

Socio-economic, food security, and environmental impacts

Finally, Impact Pattern 4 was exhibited by seven LAIs. Households in the corresponding target regions experienced widespread loss of land access (average 54%; range of 25–79%). The reported incidences of conflict between communities and LAIs were high (average 74%; range of 71–95% for five cases; two outliers at 18% and 33%). The majority of households (average 67%; range of 62–85% for five cases; two outliers at 20% and 42%) voiced wishes that investors would leave the area. In the Mozambican cases corresponding to Pattern 4, blocked footpaths to key water sources were an additional issue for small-scale land users. Data on food security and employment effects were available for only two of the seven LAIs; the relevant LAIs were more important employers in their area than those in Pattern 1 and Pattern 2 (28% vs. 15% and 8%, respectively), with differing impacts on food security. Perceived improvements in infrastructure varied widely (0–89%). Residents scarcely perceived any environmental impacts, although the LAIs moderately enhanced risks of acidification, global warming, and energy and water consumption.

Associated features of business models, governance, and land use changes

The seven farms—six in Mozambique and one in Madagascar—featured large-scale operational sizes (average 1,900 ha; range 700–6,000 ha). Aged between 4 and 9 years at the time of research, they produced cereals, oilseeds, cotton, and macadamia. Acquired farm sizes were decidedly large (850–10,000 ha) with varying rates of utilization (15–98%). However, labor intensities were much smaller (0.07–0.4 jobs/ha; one outlier at 1.4 jobs/ha) than those in the other patterns. Most of the jobs created (61–90%) were daily or seasonal.

Agricultural expansion was present in all seven LAIs of Pattern 4, fuelling the widespread hostility observed. In all cases, the land targeted for investment was previously used by smallholders. In six of the seven cases, establishment of the LAI triggered indirect land use change by driving smallholders to cut down adjacent forests in order to re-establish their livelihoods.

The governance systems in Pattern 4 consistently displayed strongly pro-LAI national policy discourses. Governance arrangements provided only minimal land tenure security to smallholders. The mobilization capacity of civil society and accountability of governments to land users were weak.

In summary, our results across the four patterns indicate that variation in impact patterns is associated with prior land use, operational farm size, labor intensity and main production type, employment levels, the experience in local agriculture or domestic origin of investors, accountability of government, land tenure security, and civil society capacity. Of less importance are, among other factors, the juridical structure of investments and their main markets. Global governance initiatives do not appear to shape impacts directly.

DISCUSSION: REVISITING CONTROVERSIES OVER LARGE-SCALE AGRICULTURAL INVESTMENTS

The results offer insights into the social-ecological transformations associated with LAIs. Specifically, this section first discusses why LAIs produce different socio-economic, food security, and environmental impacts. It then discusses the social-ecological transformations related to land use systems and the role of business models and governance changes, before reflecting on implications of LAIs for resilience and social-ecological transformations at regional scales.

Why do Large-scale Agricultural Investments Produce Different Socio-economic, Food Security, and Environmental Impacts?

Why do socio-economic impacts vary?

First, the LAIs in our sample displaced smallholders from grazing areas or farmland to much different extents. In nine of the 16 cases, LAI farms displaced between 5% and 79% of current neighboring households from grazing areas or farmland. In seven cases, survey and interview respondents perceived no LAI-related losses of land access. This variation is consistently associated with prior land use, farm size, and national/local governance systems. The LAIs that avoided displacing smallholders all targeted land that was previously used for large-scale farming.[3] Their operational farm sizes were moderate (23–256 ha). In contrast, the LAIs that displaced smallholders featured much larger operational farm sizes (830–6,000 ha) and consistently targeted land previously used by small-scale farmers. In contrast, in the LAIs without smallholder displacement in Pattern 1, investors accessed land previously used by agribusinesses. Stronger government accountability and mobilization capacity of civil society may have contributed to safeguard land access and tenure security among smallholders. These governance features were lacking among the LAIs exhibiting displacement (Patterns 3 and 4).

Second, the labor impacts of LAIs and the dependency of a region on particular farms are not solely a function of the number of jobs created, but also of the local availability of alternative livelihood options. The LAIs comprising Pattern 1 were just one among several livelihood options in Kenya's Nanyuki area. In contrast, the two Mozambican LAIs comprising Pattern 3 were the main employer in their region. The dependency of a region on one main employer (quasi-monopsony) is associated with lower wages and more short-term employment. Pattern 2 LAIs created 1,162 jobs on average, similar to the average of 1,101 jobs created by Pattern 3 LAIs. However, only 8% of Pattern 2 households worked for LAIs, compared with 65% of Pattern 3 households.

Third, all the LAIs in our sample caused conflicts and all but one triggered negative local attitudes toward investors—but again to varying degrees. Hostility rates were highest in Pattern 4 LAIs, smallest in Pattern 2, and moderate in Pattern 1. Agricultural expansion, loss of land access, and environmental impacts may explain these differences. In Pattern 4, agricultural expansion—i.e., the replacement of natural vegetation with cropland—and loss of land access appear to have contributed to conflict incidence and negative local attitudes. Agricultural expansion was also present in three of four Pattern 1 cases, but did not displace smallholders. Instead, conflicts in Pattern 1 were related to impacts on local environmental quality due to water over-extraction, air pollution, chemical exposure, and pest increases. Agricultural expansion, loss of land access, and impacts on local environmental quality are much lower in the low-conflict LAIs of Pattern 2.

Why do food security impacts vary?

Our findings suggest that LAIs influence household food security in two key ways: by creating livelihood options for engaged households (i.e., employed households or contract farmers) and by causing loss of land access. In other words, the results confirm that livelihood options and land access mediate the effects of LAIs on food security.

Pattern 1 and Pattern 2 LAIs were associated with slightly better food security—in terms of food consumption, household dietary diversity, assets, food provision—among engaged households, compared with non-engaged households in the target regions or households in counterfactual areas. Notably, in both patterns, smallholders did not lose land access to the LAIs and LAI-related employment or contract farming was just one of several livelihood options available.

However, in Pattern 1, the food security impacts are spreading in terms of women's dietary diversity and coping strategies, i.e., engaged households are more frequently identified both as most food secure as well as most food insecure along these two indicators. Counterfactual households applied fewer coping strategies than non-engaged households, especially immediately after the production season. However, food security levels might have appeared worse had interviews been conducted a few months earlier, prior to harvest. Our findings also suggest that female-headed households are disadvantaged in terms of access to employment and contracting opportunities, with implications for food security and dietary quality—especially in Madagascar.

Why do environmental impacts vary?

The on-site environmental impacts were highest among Pattern 1 LAIs. These LAIs consistently involved processes of agricultural intensification, such as implementation of monocultures, irrigation, and agrochemical use, and high levels of mechanization. The same was also true of LAIs of other patterns that exhibited high environmental impacts. Thus, we find evidence of a consistent association between agricultural intensification and on-site environmental degradation.

At the foot of the natural water tower of Mt. Kenya, Nanyuki's climatic and topographical features offer key ecological preconditions for intensive LAI horticultural production. Horticultural farms require more irrigation and have greater environmental impacts than the generally less intensive (at least in terms of irrigation) production models studied in Mozambique and Madagascar.

The input intensity and irrigation needs of different production models also shape off-site environmental impacts. For instance, households in Kenya perceived the input-intensive Pattern 1 LAIs as over-extracting river water and polluting the air and water with chemicals. This has led farmers living downstream to change their land management practices, e.g., abandoning irrigated crops and switching to crops they perceived to be more resistant to the lower water quality (Zaehringer et al. 2018b). In contrast, the Pattern 2 LAI in in Madagascar—one featuring a contract farming system and the other a Jatropha plantation that failed shortly before interviews were conducted—required few external inputs, and irrigation was unnecessary. This eliminated household concerns about negative impacts on land or water resources.

Impact variations can also be explained by management interventions explicitly adopted to reduce environmental harms, sometimes compromising short-term profitability. Typical conservation measures include preservation of environmentally significant tree species, creation of riparian buffer zones, preservation of high conservation value areas, avoidance of cultivation on steep terrain and/or fragile soils, and integrated pest management. In some cases, low productivity soils were made more productive by LAIs using agronomic technologies and inputs that were inaccessible or unaffordable to small-scale farmers. In the cases in Mozambique and Madagascar, we observed more moderate agrochemical use, possibly as a result of lack of infrastructure or cost concerns rather than an explicit desire to limit environmental harms.

Agricultural Investment, Resource Frontiers, and the Transformation of Land Systems

Our results show that 12 of the 16 LAIs in our sample caused expansion of agricultural resource frontiers. This share is larger than the range of 32–60% identified in previous global analyses (Messerli et al. 2014, Nolte et al. 2016). These LAIs mobilized capital investments and expanded agricultural areas at the expense of forest cover, grasslands, and shrublands at the perimeters of LAI farms (Eckert et al. 2018, Zaehringer et al. 2018a, b). Data on land use change were lacking for three LAIs. Interestingly, only one LAI did not involve agricultural expansion. In this Kenyan case, greenhouses for flower production replaced vegetable production on intensively cultivated, irrigated cropland. In the 5 km surroundings of this LAI, a sizable amount of previously rainfed cropland (883 ha) was left fallow, and together with some shrubland (109 ha) had become (temporary) grassland (920 ha). Also, several forest plantations had been established nearby, giving rise to increased overall forest area (374 ha).

Large-scale agricultural investments drive agricultural intensification. In 12 of the 16 LAIs, remote sensing and fieldwork data indicated land use conversions from small-scale farming to irrigated cropland or greenhouses at the perimeter of LAI farms. Among the four cases lacking intensification, one LAI involved an investment implemented on grassland (thus expanding agricultural area, but not intensifying previous agriculture); data were lacking for two LAIs; and one case was the failed investment in Madagascar, in which land cover was converted from grassland to jatropha and back again.

Indirect land use changes were observed in 13 of the 16 LAIs. Six LAIs involved construction of small-scale fields by clearing adjacent forests for agriculture. In seven other cases, the LAIs induced land management change on small-scale farms. However, these spillovers did not occur primarily via knowledge transfer, as was expected based on previous research (cf. "Current Controversies around Large-scale Agricultural Investments" above). In Kenya, small-scale farmers abandoned irrigated crops in response to perceived over-extraction and pollution of water by LAIs. In one Malagasy case, cropland management changed because land users lacked sufficient labor to farm their own land separately while working for LAI farms. In the two remaining cases in Madagascar, household members lost jobs at the LAI farm and thus changed management on their own cropland, e.g., planting new crops for sale (n = 2) or learning new techniques from the LAI (n = 1).

In terms of off-site land use changes, Pattern 1 and Pattern 2 LAIs generally involved loss of natural habitats—except in the vicinity of one LAI where several tree plantations were implemented. In Pattern 1 LAIs, primarily bush-, shrub- and grasslands were converted to small-scale cropland. In Pattern 4 LAIs in Mozambique, primarily forest and natural wetlands were converted to small-scale cropland. The Pattern 4 LAIs in Madagascar did not cause major off-site land use/land cover changes in the vicinity of investment areas, but did cause major on-site conversion (grassland to LAI cropland). No or only minimal, temporary land use/land cover changes were observed for Pattern 2 LAIs, mostly because they relied on a contract-farming scheme that did not cause land use changes or because of investment failure making land use change strictly temporary.

The Role of Business Models

Our results indicate that specific business-model features are associated with particular impacts. We have assessed 21 indicators of business model features here (Append. 1). Among those, we find that labor intensity, prior land use, utilization of land, farm size, type of production, and experience in local agricultural systems are of particular importance, because they are associated consistently with particular impacts.

First, the LAIs in our sample varied widely in terms of labor intensity. Some LAIs created as many as 20 jobs/ha, whereas others realized no more than 0.07 jobs/ha. Large-scale agricultural investments with higher labor intensity tended to operate on smaller farms, thereby limiting smallholder displacement effects. This, in turn, tends to be associated with slightly better local food security by limiting land access losses and boosting employment effects. However, the LAIs in our sample with higher labor intensity operated with high levels of input intensity and mechanization, thereby inducing adverse local and global environmental impacts. The LAIs exhibiting low labor intensity operated over very large land areas, ranging between 830 ha and 6,000 ha, thus compromising land access among smallholders. In terms of wages, even LAIs with high labor intensity rarely paid salaries higher than USD $5/day, despite exporting produce to high-income countries.

Second, LAI production models influenced labor intensity, and were influenced by standardization processes. Production of fresh goods for international markets is associated with highly specialized, industrialized production and high labor intensity—characteristics absent from other business models. The flower and vegetable farms in Kenya exhibited these features. The flower farms displayed the highest labor intensity, whereas the vegetable farms were more varied in labor intensity based on different vegetables demanding different levels of mechanization. Production models in the horticultural cluster in Kenya did not vary according to the age of the farms or the experience in agriculture or origin of investors; however, standardization and competition in the sector have forced all the producers to adopt the same production model over time, including similar technologies of drip irrigation, water ponds, and greenhouses. Along the way, contract farming has diminished due to the increased difficulty of meeting strict standards imposed by international value chains.

Third, our results suggest that investor experience in local agricultural systems can improve the performance of LAIs in certain areas. More locally knowledgeable, networked investors may gain land access in less intrusive ways (Burnod et al. 2013) and may be familiar with the specific agronomic conditions of targeted areas. Indeed, the Pattern 4 LAIs ("widespread hostility") in our sample consistently involved international investors as opposed to domestic investors or managers. However, experience in local agricultural systems was not a sufficient condition to eliminate unsustainable impacts: four of seven investors of Pattern 4 LAIs were familiar with local conditions, yet their investments still generated widespread hostility. Finally, economically successful implementation of LAIs in the Nanyuki area was associated with local investors, commercial farmers, or investors with experience in the sector who were able to recruit experienced managers for the type of production needed.

Governance of Agricultural Investments

Our cross-country analysis also sheds light on how agricultural and land policy development differentially shape LAI implementation and impacts. Our focus here is on actual implementation of legal and policy provisions, not merely their existence on paper. In this way, despite the progressive land tenure rights for communities recognized in Mozambican or Malagasy law for instance, we observed that those rights were seldom enforced on the ground.

In Kenya's Nanyuki area, land tenure for smallholders is relatively secure, and the legal status of their land appeared to shield them from land acquisitions against their will. Investors were accessing land already used by agribusinesses rather than smallholders. Government accountability toward smallholders and civil society mobilization capacity were comparatively high, aiding protection of legal land rights among small landowners. Importantly, this tenure security also safeguards the interests of investors, providing them security for long-term investments, which is economically necessary for the type of horticulture production found in this area. This relatively secure land tenure and mode of accessing land by investors shapes impact patterns, as displacements are essentially ruled out (Pattern 1 and Pattern 2). The relative inability of LAIs to obtain large areas of land favors highly capitalized, labor-intensive investments with high rates of utilization. Nevertheless, land and water use conflicts remain, as seen when pastoralists use the land of large privately owned ranches during droughts (Jacobi et al. 2018, Ngutu et al. 2018) or when water over-extraction by upstream users—large and small landowners—depletes river flows in downstream areas. Local governance somewhat mitigates these tensions, as in the case of water user associations that help regulate water use and resolve conflicts (Baldwin et al. 2016, McCord et al. 2017, Ngutu et al. 2018).

When compared with Madagascar and Mozambique, Kenya appears to exhibit lower levels of policy extraversion (i.e., influence of external actors in shaping public policies) in domestic agricultural and land policy. However, Kenyan LAIs willingly incorporate voluntary sustainability standards based on their high degree of foreign market focus. Most of Kenya's horticultural farms are certified according to one or more voluntary sustainability standards—such as GlobalGAP, the Kenyan Flower Council, or Fairtrade—which are often viewed as necessary for farms to market their flowers or vegetables abroad.

In Madagascar, LAIs have gained a central place in land and agricultural policy in the last decade. Official discourses—such as that of the 2015 Agriculture, Livestock, and Fisheries Sector Programme (PSAEP)—have actively promoted the idea of moving from "peasant" agriculture to market-oriented agriculture, fostering agricultural growth by means of large-scale production. One of PSAEP's flagship goals was to develop two million hectares of agricultural investment areas. This was planned for implementation via Agricultural Investment Zones (ZIA) offering secure access to arable land to large-scale investors. Promulgation of the ZIA instrument in 2016 triggered counter mobilization on the ground, reinforced by national and foreign NGOs. Based on this, policymakers adapted the initial concept, expanding it to offer secure land access to small-scale farmers as well. Following a tense pre-electoral period, they eventually scrapped the ZIA project. This process points to policymakers first incorporating critiques, suspending corresponding policy processes, and ultimately maintaining the status quo. This situation has wider implications for implementation of LAIs in Madagascar. Despite initiatives to promote LAIs across the country, more than 90% of announced deals have not been implemented (Burnod and Andriamanalina 2017). The land reform, legally protecting local rights on agricultural land, has not affected investors' land access networks of actors. Investors' land demand has created incentives for the land administration to not promote the land reform but to move backward by claiming all the land as state-owned land, by strengthening the centralization of land management, and by seizing opportunities of corruption (Burnod and Andriamanalina 2017). Lack of enforcement of local land rights engenders conflict or fears of conflict and stalls start-up phases, scaring away commercial investors. The LAIs implemented in Madagascar to date are exceptions, promoted by investors who managed to navigate the difficult context (Burnod and Andriamanalina 2017).

Similarly, in Mozambique, official policy discourses and the country's commitment to the New Alliance for Food Security and Nutrition (NAFSN) in 2012 have created, on paper, a favorable political climate for LAIs. However, the actual political climate for LAIs has been less open for LAIs after some of them were associated with scandals and were forced to be abandoned based on advocacy and resistance by international and local NGOs linked to foreign civil society movements (Di Matteo and Schoneveld 2016). Despite recurring efforts, global-level rhetoric, and initiatives—especially emphasizing Mozambique's land law—did not yet influence national governance of LAIs in Mozambique. Much of the responsibility and agency regarding implementation of LAIs lies with national political elites. They may negotiate deals with investors but are wary of antagonizing a vivid and connected civil society that might denounce the deals. Hence, the implementation of LAIs in Mozambique may depend more on the number of political intermediaries and brokers negotiating deals than on the official political discourses around LAIs. High numbers of intermediaries have deterred investors for years. Lack of formalization of land use rights exacerbates challenges. Land rights are often not formally registered, not demarcated, and not surveyed. This might have been perceived by investors as a great appeal at first, but it soon led to contestation and conflicts with rural communities because the land was indeed not idle but used. The situation led to a deadlock in several cases, which did not help the investors in the long run. After a while, representatives of investors and donor communities were willing to get greater clarity around land rights. Major donors in Mozambique have dedicated programs to modify the land administration system for more than 10 years. Therefore, if land rights were to be enforced, LAIs may be more restricted on the one hand. On the other, the law does not only protect communities' rights, it also provides for opportunities for LAIs, which are encouraged providing communities get compensated (Bourblanc and Belenfant 2018, Salomão 2020).

Implications of Large-scale Agricultural Investments for Resilence and Social–Ecological Transformations at Regional Scales

Large-scale agricultural investments transform the social-ecological systems in which they operate, with profound implications for the resilience of livelihoods and land systems (Schoneveld et al. 2011, Magliocca et al. 2019). The four patterns identified here offer nuances to the notion of resilience grabbing, i.e., the process by which LAIs reduce the resilience of local communities as a consequence of displacing them from access to food and non-food resources held as commons (Haller et al. 2020). This process may operate most concretely in LAIs of Patterns 3 and 4 with large losses of land access among communities. In contrast, the LAIs in Patterns 1 and 2 do not deprive smallholders and communities from access to land and related commons. In these patterns, families tend to use labor opportunities on LAI farms when they are in need of monetary income amidst alternative livelihood options (Reys et al., *unpublished manuscript*). This is also reflected in slightly better food security outcomes for the engaged households in Patterns 1 and 2. These opportunities may therefore contribute to resilience (Lade et al. 2020). However, this may only hold for privileged households with enough household labor and land, whereas the more vulnerable households lost in food-related coping capacities, and women's dietary diversity was lower among engaged households in Pattern 1. An increased wage dependency also increases vulnerability to the risk of failure of LAIs (Nolte 2020), and the conflicts about environmental impacts of air and water pollution as well as pest increases may indicate an alternative mechanism of adverse impacts of LAIs on resilience, which is consistent with findings for LAIs in Sierra Leone (Bottazzi et al. 2018) and Lao PDR (Nanhthavong et al. 2021).

This study offers insights into how LAIs represent drivers of social-ecological transformations at regional scales (Rocha et al. 2019), with differences observed in our three focal countries. Laikipia County in Kenya and—to a limited extent—the study area in the Nacala Corridor in Mozambique experienced cluster effects in the region's economic structure (Porter 2000, Ketels and Memedovic 2008), as they saw the inflow of LAIs in similar horti- and agricultural sectors. In Kenya, a cluster of highly specialized horticultural projects enabled the development of specialized human competences (technical, managerial) and support services (Giger et al. 2020), a development that can provide comparative advantage for neighboring LAI farms (Porter 2000). This can be interpreted as a profound change in the regional economic structure, transforming with it important components of the social-ecological system toward highly intensive land uses. The pre-existing large-scale farms, which were devoted to mechanized farming or extensive ranching, have been transformed into labor intensive production units, using high numbers of laborers, and changing their livelihood strategies away from small-scale, subsistence-oriented maize farming. In our study area in Mozambique, many of the new investments have failed (Di Matteo and Schoneveld 2016, Glover and Jones 2019; J. L. Adalima, *unpublished manuscript*), but we still find many LAIs that focus on commercial crops (such as sisal, tea, macadamia, maize or soya) (J. L. Adalima, *unpublished manuscript*). In contrast, the LAIs in Madagascar displayed a much more patchy pattern of single, often larger LAIs (Burnod and Andriamanalina 2017), geographically disbursed across the country, with no priority region or investment corridor discernible. A lengthy land concession process and conflicts due to frequent overlaps with communal land use have left few investments active (Burnod et al. 2013). Nevertheless, whether the LAIs are active or not, they have transformed the land tenure regime, by reversing the land tenure reform policy (Burnod and Andriamanalina 2017), weakening the opportunities for a progressive land tenure systems reform.

Therefore, the considered LAIs in Kenya and Mozambique seem to contribute to social-ecological transformation pathways of agro-industrialization at a regional scale. Where the LAIs are economically viable, they contribute to shift entire regional production systems from reliance on local markets and subsistence to national and international markets. However, new dependencies and risks arise, which can reduce resilience of livelihoods. Moreover, the ecological changes in such social-ecological transformations are clearly far reaching: intensive use of external inputs, often intensive water use, and dependency on intercontinental air transport, causing carbon emissions, represent a transformation in the ecological sphere. These changes are strongest in LAIs of Pattern 1 with its focus fresh products for global markets, and they are moderately strong in Patterns 2 and 4, as these LAIs mostly produce soy and cereals for domestic markets, using moderate levels of inputs.

CONCLUSIONS

The present study demonstrates how differences in business models, governance systems, and land use changes mediate the influence of global drivers of change in land use and agro-food systems, influencing how LAIs impact development in Kenya, Madagascar, and Mozambique. Our results demonstrate that LAI impacts do not neatly fit one unifying land-grab narrative. Instead, we find that the 16 LAIs in our sample follow four distinct impact patterns: conflicted neighborhood, moderate neighborhood, land loss to main employer, and widespread hostility. Each pattern features a distinct profile of socio-economic, food security, and environmental impacts. The results further demonstrate how particular features of business models, governance systems, and land use changes influence the socio-economic, food security, and environmental impacts of LAIs.

There is no single business model that generates consistent impact patterns. Instead, labor intensity, prior land use, utilization of land, farm size, type of production, and experience in local agricultural systems are the key features of business models shaping LAI impacts. Impacts further depend on how public policies provide for land tenure security, accountability of state and local elites toward land users, and the mobilization capacity of civil society. Finally, LAIs generate socio-economic, food security, and environmental impacts by expanding agricultural resource frontiers, agricultural intensification, and indirect land use changes.

Most evident is the key trade-off between losses in access to land for previous land users, losses in environmental quality, and the emergence of new wage-dependent livelihoods. When labor intensities are low, this trade-off is particularly likely to trigger conflicts. Preferential inclusion of particular community members or attraction of migrants for employment in the region can intensify conflicts (Bottazzi et al. 2016). Effective measures to minimize this trade-off include strong provisions for smallholder land tenure security, strong civil society, government recognition for smallholder rights, and targeting of LAIs toward land already under large-scale production rather than displacing small-scale farmers.

Large-scale agricultural investments and rural development questions in the regions of this study—but also elsewhere in Africa (Collier and Dercon 2014)—should not be framed as a dichotomous choice between promotion of commercial agriculture vs. smallholder agriculture. The key challenge is to identify what organizational strategies, governance structures, and agro-ecological practices are most suited to develop inclusive, resilient, and diversified rural economies that foster growing incomes, improved food security, and rapid reductions in poverty, while operating within environmental limits. System dynamics modeling is a methodology for promising future research to tackle this challenge. Our results indicate that commercial agriculture and increased rural wage labor can be components of such strategies under certain conditions, but that they will fail without substantial, sustained increases in the agro-ecological productivity, economic viability, and inclusiveness of smallholder agriculture, land tenure security, agro-ecological land management, and support for broader patterns of endogenous agrarian transformation.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.php/12653

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Data Availability:

The data/code that support the findings of this study are uploaded as part of this submission.

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[1] The different work packages used different sampling techniques as appropriate to their methodology (e.g., household surveys, key informant interviews, remote sensing data). We constructed the present synthesis based solely on those LAIs for which sufficient data were available from multiple work packages.
[2] Note that contract farming does not create the equivalence of a full-time job.
[3] Note that due to our study design, we cannot rule out that pastoralists or prior residents—who left the area earlier—may have lost land. Furthermore, our data focus on current farms and do not indicate the extent of possible displacement decades ago when initial large-scale farms were established.

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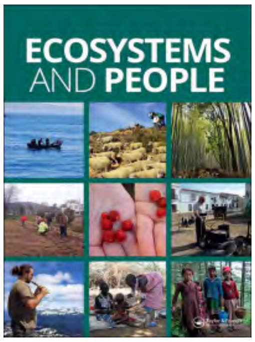

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Large-scale agricultural investments in Eastern Africa: consequences for small-scale farmers and the environment

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ABSTRACT
Available empirical evidence about the impacts of large-scale agricultural investments (LAIs) in low-income countries is skewed towards the assessment of economic benefits. How LAIs affect land use and the environment is less understood. This study assesses how small-scale farmers living close to an LAI perceive the changes LAI's inflict on land use, land management, and tree cover in Kenya, Mozambique, and Madagascar. It also investigates their perceptions regarding LAI's impacts on the general environment and people's health, as well as on employment opportunities, infrastructure, and conflicts. 271 small-scale farmers were interviewed and their perceptions supported by a remote-sensing-based analysis of land use and land cover changes. Results show that LAIs contributed both directly and indirectly to deforestation in Mozambique, triggered changes in small-scale farmers' agricultural land management in Kenya, and caused pastoralists to lose access to grazing land in Madagascar. Despite some benefits from employment opportunities and infrastructure improvement, the majority of respondents perceived the overall impacts of LAIs as negative, highlighting reduced access to land and water, pollution, health issues, and unsatisfactory working conditions. We urgently need to invest in devising concrete transformative options to improve LAIs' contribution to sustainable development in their host countries.

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1. Introduction

Since the 2008 food–energy–finance crisis, transformative pathways towards increasing low-income countries' agricultural production and national income while simultaneously improving poor land users' livelihoods and well-being have still not been found. Increasing demand for food from consumers in the global North, as well as the 2008 food price spikes (Margulis and McKeon 2013), have led both governments and private investors to increasingly put money into agriculture in low-income countries (Anseeuw et al. 2012; Cotula 2012). Investments come from around the globe, and their target areas are likewise dispersed throughout the world; most of them are located in Africa, Southeast Asia, Latin America, and Eastern Europe (Nolte et al. 2016).

Large-scale agricultural investments (LAIs) into what is often considered 'idle' or 'underused' land have been propagated as potential win–win situations that make it possible to meet various national-level development objectives (Collier and Dercon 2014). Unlike the Land Matrix Initiative (Nolte et al. 2016), we interpret the word 'large-scale' in 'large-scale agricultural investments' as referring not only to the size of the cultivated area, but also to economic size in terms of capital involved and labour employed. LAIs were specifically seen as a solution to rural poverty (The World Bank 2014). Accordingly, many African governments met this renewed interest in their agricultural sector with great optimism (The World Bank 2011; Cotula 2012). Indeed, several studies have shown that large investments in agriculture do have a certain positive effect on local communities' livelihoods, for example through employment, newly generated livelihood opportunities, and the uptake of technological farming practices, or by improving access to agricultural inputs (Smaller et al. 2015; Deininger and Xia 2016).

However, with more empirical studies being done, scholars have increasingly been finding negative impacts of LAIs. In much of sub-Saharan Africa, land tenure regimes are organized through customary arrangements that are often poorly protected by statutory law. For this reason, growing commercial demand for farmland exposes rural populations to increased risks of involuntary displacement and dispossession of valuable livelihood resources (Schoneveld 2017). Recent research has documented adverse livelihood impacts of LAIs such as loss of

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Supplemental data for this article can be accessed here.

housing and farmland (through forced resettlement) and loss of access to land and common-property resources like water, pasture, and non-timber forest products. These impacts increase people's food and income insecurity, reduce their capacity to cope with shocks, and widen pre-existing inequalities intensifying social conflicts (German et al. 2011; Schoneveld et al. 2011; Ulrich 2014; Boamah and Overå 2016; Oberlack et al. 2016; Hufe and Heuermann 2017; Bottazzi et al. 2018). Further, LAIs are considered to be a major driver of deforestation and environmental degradation (Rudel et al. 2009; Gibbs et al. 2010; Davis et al. 2015; Magliocca et al. 2020). Many LAIs target small-scale farmers' extensively cultivated mosaic croplands or areas of great ecological significance, such as wetlands, savannahs, and dry and tropical forests (Anseeuw et al. 2012; Eckert et al. 2017; Schoneveld 2017; Zaehringer et al. 2018a). Most LAIs are therefore environmentally unsustainable, as confirmed by a review of case studies in sub-Saharan Africa (Hufe and Heuermann 2017). Moreover, achieving a profitable and reliable production for the global market requires many LAIs to install modern irrigation schemes, adding pressure on scarce water resources especially in dryland contexts. Indeed, studies have shown that access to water resources is an important criterion in selecting LAI target areas (Rulli et al. 2013; Breu et al. 2016).

Nonetheless, the complex impacts that LAIs have on land use and the environment remain poorly understood. Most studies focus exclusively on direct impacts occurring at the sites where LAIs are implemented – for example, when diversified extensively used cropland is converted into intensively managed monoculture plantations. However, LAIs may also affect land use and associated ecosystem services indirectly, beyond the actual LAI site – for example, by displacing cropland into forested areas (Zaehringer et al. 2018a), polluting water resources (Muriithi and Yu 2015), or decreasing water availability further downstream (Zaehringer et al. 2018b). Empirical evidence of such off-site impacts is scarce, and particularly so with respect to land use and the environment; this is due to the difficulty of establishing the causality between changes observed at a spatially distant location and changes on the LAIs premises (Carlson et al. 2018; Meyfroidt et al. 2018). Assessing these links requires an interdisciplinary approach combining quantitative methods to measure and observe land use changes in space and time with a qualitative in-depth case study assessment.

The present study addressed this research gap by empirically investigating the consequences of LAI establishment in three African countries. As LAIs are entering rural areas dominated by small-scale land users, they are likely to affect people through changes in land use and the environment. We focused primarily on assessing how land users living close to an LAI perceive the changes LAI's inflict on land use, land management, and tree cover. To verify and support their perceptions, we assessed land cover and land use change on the LAIs' premises and in their surroundings using remotely sensed data. To complement our assessment, we also asked about land users' perceptions regarding LAI's impacts on the general environment and people's health, as well as on employment opportunities, infrastructure, and conflicts. This helps to comprehend why land users might prefer LAIs to remain operational despite adverse environmental impacts. With our study, we provide novel evidence on the under-researched aspect of land use and environmental change in the context of large-scale investments on land in low-income countries. Broadening our understanding of the diverse ways in which LAIs affect land use and the environment is a prerequisite for eventually proposing and negotiating pathways that enable LAIs to improve their contributions to achieving the 2030 Agenda's sustainable development goals (United Nations 2015).

2. Methods

2.1. Overall approach

We took an empirical, case-study based approach and focused on a specific number of LAI cases in each of the three project countries of Kenya, Mozambique, and Madagascar. Our aim was to assess how LAIs directly and indirectly lead to (1) land use change, (2) changes in land management, (3) tree cover change, and (4) how they affect wider aspects of sustainable development including employment, the environment, health, infrastructure, and conflicts. By land use, we mean the broader types of use of land, such as subsistence crop production, commercial crop production, or pasture; whereas land management includes the types of crops planted and technologies or practices applied to manage the land. We chose a mixed-methods approach, focusing on structured interviews with small-scale land users and supporting this with a remote-sensing-based analysis of land use and land cover change. According to our definition of LAI, in the context of this study, an LAI need not necessarily cover a large area if it involves a great amount of capital or has a large number of employees.

2.2. Study areas

Our study was part of the 'African Food, Agriculture, Land and Natural Resource Dynamics, in the context of global agro-food-energy system changes (AFGROLAND)' project, which aimed to understand how changes in the global agro–food–energy system affect countries in Africa. The project investigated the economic, social, and environmental impacts of changes in land use patterns driven by global development trends in Kenya, Mozambique, and Madagascar. In each country, we selected a number of LAIs for our in-depth assessment from a larger list of LAIs that had been inventoried in a first stage of the overall project. In total, we investigated 13 LAIs representing a variety of crops produced in the three countries. In Madagascar, the selection of LAIs was challenging. Many planned projects were abandoned before the start of production due to difficulties with land tenure, accessibility, political instability, and other issues; others went out of production after the 2008 food price crisis. Indeed, one of the two LAIs presented here abandoned production very shortly before we conducted our study. In Mozambique's Monapo district, one of the sampled LAIs went bankrupt shortly after our study. We decided to present these cases nonetheless, as the highly dynamic nature of LAIs in Eastern Africa is an important aspect of this phenomenon of globalization, and we can learn from the impacts of failed LAIs for the future.

For the purpose of this synthesis effort, we aggregated the 13 LAIs into six cases for comparison based on a combination of the crops they produce and the administrative and climatic context in which they operate (Table 1, Figure 1). Cases 1 and 2 are situated in Kenya, in the upper Ewaso Ng'iro basin, including parts of Laikipia, Meru, and Nyeri counties. The climatic conditions range from semi-humid to semi-arid and arid (UNEP/GRID 2017). Two distinct rainy seasons determine the cropping calendar. The majority of the rural population are small-scale farmers; who own about two hectares of land per household on average (Wiesmann 2008; Ulrich et al. 2012), they practise a combination of crop farming and livestock keeping, mostly for subsistence but partly also for sale on local markets. Purely pastoral systems dominate in the drier areas. The presence of LAIs has increased considerably over the last 20 years (Eckert et al. 2017). They focus on producing either vegetables (e.g. runner beans, broccoli, kale) (Case 1) or flowers (Case 2), mostly for the export market. Only a small part of the vegetables is sold on the Kenyan market.

Cases 3 and 4 are located in Mozambique, in the west and east of the Nacala corridor, in Guruè and Monapo districts, respectively. They represent two different agroecological zones. While Guruè has a temperate climate, Monapo has a semi-arid to subhumid one (The World Bank 2006). The mountainous, temperate areas of Guruè have been used for tea plantations – Mozambique's largest – since colonial times. The area has attracted different types of agricultural investors since around 2003 (Joala et al. 2016). Local production systems have changed tremendously since non-governmental organizations (NGOs) and aid agencies began to promote soybeans (Di Matteo et al. 2016). Today, soybeans are

Table 1. Case study characteristics and overview of methods applied.

	Kenya		Mozambique		Madagascar	
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Case study characteristics						
Number of LAIs per case	2	3	3	3	1	1
County/district/region	Laikipia	Laikipia	Guruè	Monapo	Boeny	Ihorombe
Crops produced	Vegetables	Flowers	Soy, macadamia	Vegetables, banana, soy	Jatropha	Maize
Rainfall (mm)	600–1,200	600–1,200	1,400–2,000	800–1,000	1,000–1,500	600–1,000
Operational status of LAI	Running	Running	Running	1 (banana) abandoned, 2 running	Abandoned	Running
Date of LAI establishment	2000–2005	2003–2013	2009–2012	2007–2013	2009	2010
Methods applied						
Remote-sensing data and analysis	Landsat 5 and 8; supervised classification	Landsat 5 and 8; supervised classification	Landsat 5 and 8; supervised classification	Landsat 5 and 8; supervised classification	Sentinel 2 and Google Earth; visual interpretation, digitization	Sentinel 2 and Google Earth; visual interpretation, digitization
Observed time period	2000–2016	2000–2016	2000–2015	2000–2015	2010–2018	2010–2018
Number of interviews	40	60	49	52	25	45
Male/female respondents	22/18	25/35	39/10	46/6	19/6	40/5

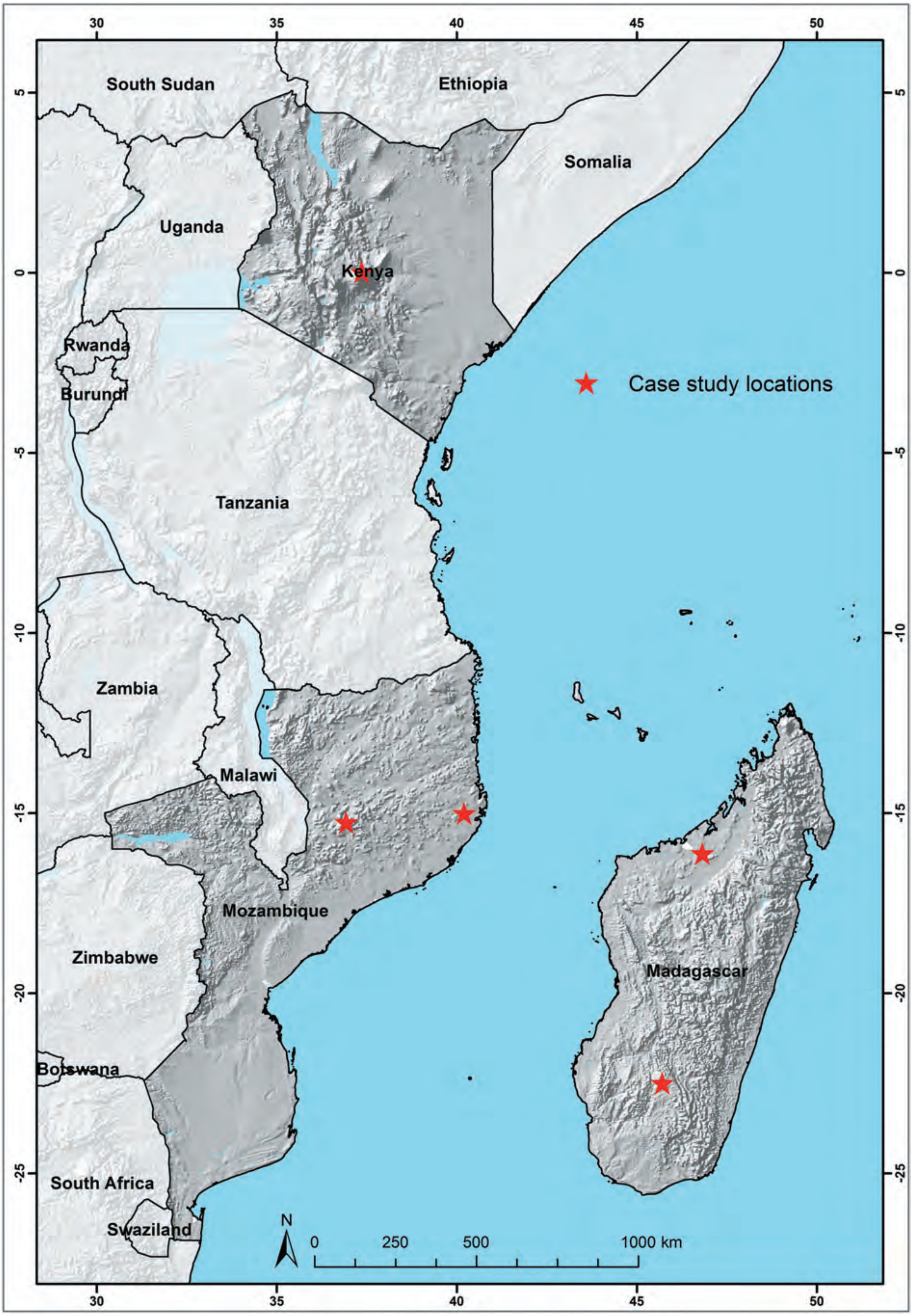

Figure 1. Overview of the study area in Kenya, Mozambique, and Madagascar, showing the approximate locations of the cases.

by far the main cash crop grown by small-scale farmers in the district (Joala et al. 2016). Case 3 represents LAIs established between 2009 and 2012 that produce soy and macadamia nuts. For Case 4, in Monapo district, we chose LAIs established between 2007 and 2013 that are at least partly foreign-owned. They produce soybeans, banana, and vegetables. The LAIs in both cases are representative of the most recent wave of LAIs in the Nacala corridor. They produce for the national (soybeans, vegetables) as well as the international market (macadamia and banana). In both districts, the local population's main livelihood income stems from small-scale rainfed farming of maize and pulses.

Case 5 is located in the Boeny region in the north-west of Madagascar. This area is characterized by a tropical savannah climate with an annual rainfall of about 1,500 mm and a 6-month dry season in winter (Oldeman 1990). The LAI was granted a concession of 2,000 hectares by the national government and started planting jatropha in 2009. However, until 2015 no more than 600 hectares were planted in two villages (Soafilira et al. 2015). Although no published information is available, we know from our own investigation that the LAI was abandoned before January 2017, probably at some point in 2016. Case 6 is located on the Ihorombe plateau in the southern highlands. Ihorombe is a typical pastoral region that receives less than 1,000 mm of rainfall per year (Oldeman 1990). Besides raising zebu cattle, local land users also plant rainfed rice in small depressions and maize for subsistence.

2.3. Land user interviews

We obtained information about small-scale farmers' perceptions of LAI impacts on land use, land management, tree cover, and general aspects of sustainable development by conducting structured interviews. To select the respondents, we generated random coordinates within a one- or two-kilometre buffer, depending on the population density around each LAI, in ArcGIS. In each country, we worked with enumerators who were familiar with the context and spoke the local language. The enumerators approached the household closest to each generated random point and introduced the purpose of our research project, the academic institutions involved, and the planned use of the data. They then asked whether the household member most knowledgeable about the household's land use activities would be willing to participate in an interview. If this household member refused to participate, they continued to the next closest household until they obtained a household member's consent. Through this approach, we avoided biases in the selection of households, which might have occurred if households had been selected to participate in the study through village authorities. As such, we are confident that the interviewed sample of land users is representative of the population living near the studied LAIs and that we can draw conclusions regarding the impacts of the studied LAI cases. In total, we interviewed 271 land users – between 85 and 94 land users per country (Table 1). The majority of the respondents were men, except in Kenya; in Mozambique and Madagascar, women often declared that they would prefer their husbands to answer our questions. The enumerators conducted the interviews from October to December 2016 in Mozambique and in January and February 2017 in Kenya and Madagascar.

We applied the same interview guide in all three countries, with some adaptations to the different contexts (Zaehringer et al. 2018a, 2018b) (the original interview guides are provided in the Supplemental Materials S4). The guide consisted of open and closed questions on four main topics: (1) general household characteristics and employment with the LAI; (2) perceived changes in agricultural land use and land management and their link to the LAI; (3) perceived tree cover changes in the landscape; (4) perceived direct impacts of the LAI on the household in general, the environment, health, infrastructure, and conflicts. To be able to link the interview data to spatially explicit LULC change results, we made sure to use the same LULC categories as we did for the remote sensing analysis, when asking the respondents about perceived LULC changes. The enumerators held the interviews in the respective local language, taking written notes, which they later translated into English. If permission was given, interviews were recorded to support the written notes if needed.

The first author of this paper coded qualitative information and transferred it into a database to calculate frequencies of responses using the R statistical software (R Core Team 2015). We further checked for significant associations between the cases and the different categorical variables using a Pearson's chi-square test. If the expected frequencies of one or more cells were smaller than five, we used Fisher's exact test instead (Field et al. 2012). For the one quantitative variable in our sample, we first used a Levene's test to check whether the data met the assumptions for a one-way ANOVA, and then conducted a one-way independent ANOVA (Field et al. 2012).

2.4. Land use and land cover change analysis

In order to verify and support small-scale farmers' perceptions regarding on- and off-site land use and land cover (LULC) changes in the surroundings of LAIs and how they are linked to the establishment of the LAIs, we analysed LULC within a 5-km radius around, as well as on the premises of each LAI in our six cases (Table 1). We chose the specific size of buffer based on the information from interviewed land users, that they cultivated fields and collected firewood within about 5 km from their villages. In this way, we increased the chances of capturing remotely sensed LULC changes caused by land users living close to the investigated LAI. The LULC classes were defined reflecting the typical vegetation covers and land uses present in sub-Saharan Africa. More specifically, we differentiated the following key classes: forest, grassland, shrub- and bushland, cropland, waterbodies, settlements, and bare soil or rocks. For Cases 1 to 4, we automatically classified LULC at two distinct times. For the two points in time, we chose Landsat satellite data captured shortly before the establishment of the LAIs, i.e. in 2000 and 2002, respectively, and in 2015 and 2016. The selection and compositing of cloud-free Landsat surface reflectance products, which are already geometrically coregistered, orthorectified and atmospherically corrected, as well as the subsequent supervised classifications were performed using the Google Earth Engine cloud computing environment. In order to obtain accurate land use and land cover maps for each of our 'pre' and 'post' satellite data stack consisted of a dry and a wet season Landsat composite. Such seasonal composites representing key phenological stages are helpful in separating certain land cover and land use classes (Griffiths et al. 2013, 2014). After the classification and a rigorous accuracy assessment, we conducted a spatial LULC change analysis for the period in between. The intention was to investigate the direct impacts of LAIs on LULC and to identify overall LULC trends in the case study areas in order to put respondents' perceptions into a broader context of landscape change.

The kappa accuracies of the supervised classifications range between 82% and 90%, with values > 80% considered a strong level of agreement (Congalton and Green 2008; McHugh 2012). LULC changes were assessed by applying a post-classification pixel-to-pixel comparison and creating cross-tabulation matrices for the observed periods. Detailed information on the classification algorithm and validation methods applied for Cases 1 to 4 are provided in Eckert et al. (2017) and Zaehringer et al. (2018a). For Cases 5 and 6, we assessed LULC changes by means of visual interpretation and manual digitization of very-high-resolution satellite imagery accessible through Google Earth Pro (Google Earth Pro 2017). In this comparative study, we present percentage area losses and gains for the most important LULC classes within the buffer areas.

3. Results

3.1. Changes in agricultural land use

Our spatial data analysis revealed that several LULC changes occurred both in and around the active LAIs between the two points in time analysed (Table 2; Figure 2). In all cases, LAI establishment had led to loss of forest and small-scale cropland. While it was mostly forest in some cases, in others the LAIs had been established on previous small-scale cropland or on grassland, fallow land, and bush- and shrubland. In line with this, the agricultural land use changes perceived by respondents were significantly different between the cases (Table 3).

Looking at changes within the LAIs' perimeters, the studied LAIs in Kenya had mainly converted

Table 2. LULC change to LAI and small-scale cropland (SSC) as a percentage of the LAI and new cropland areas, respectively, aggregated for each case. The same statistics are disaggregated for each LAI in Table S1 in the annex.

	Kenya		Mozambique		Madagascar	
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
LULC converted to LAI	(Total LAI area: 627 ha)	(Total LAI area: 153 ha)	(Total LAI area: 5,460 ha)	(Total LAI area: 1,706 ha)	(LAI area: 770 ha)	(LAI area: 5,507 ha)
Forest to LAI	21%	17%	47%	14%	0%	0%
SSC to LAI	40%	54%	47%	80%	3%	0%
Other[a,b] to LAI	39%	29%	6%	6%	97%	100%
LULC converted to small-scale cropland in vicinity of LAI	(New SSC area: 3,203 ha)	(New SSC area: 3,314 ha)	(New SSC area: 16,524 ha)	(New SSC area: 4,560 ha)	(New SSC area: 0 ha)	(New SSC area: 0 ha)
Forest to SSC	22%	38%	96%	73%	0%	0%
Other[b] to SSC	78%	62%	4%	27%	0%	0%
Afforestation by LAI					–	11 ha

[a]'Other' for Cases 1 to 4; grassland for Cases 5 and 6.
[b]'Other' includes bare soil, grass- and fallow land, bush- and shrubland, and small waterbodies.

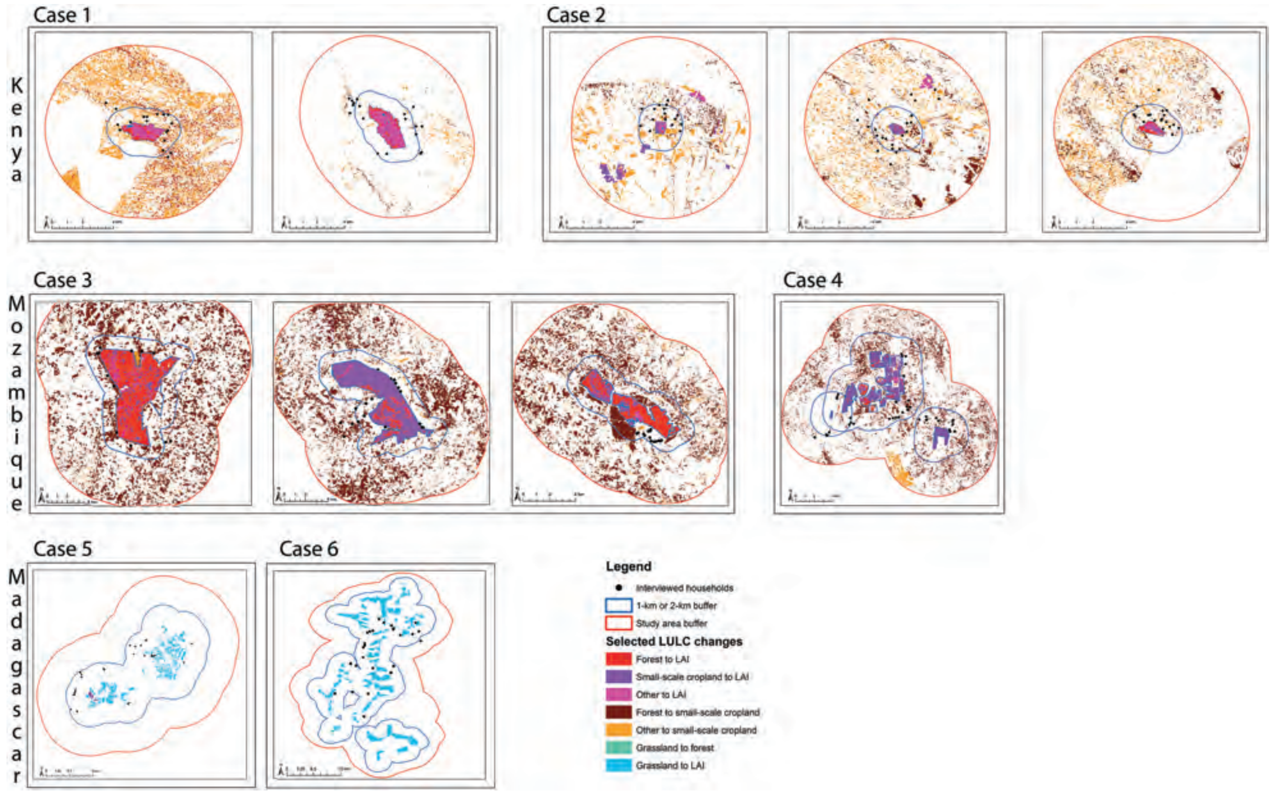

Figure 2. LULC change maps of the analysed Cases and LAIs. The maps follow the sequence given in Table 3. Kenya: Case 1 and 2, Mozambique: Case 3 and 4, Madagascar: Case 5 and 6. The maps indicate only the most important class changes.

small-scale cropland and other land (bare soil, grass- and fallow land, bare land, bush- and shrubland, and small waterbodies) into large-scale monocultures, water storage dams, and buildings (Table 2, Figure 2). Cases 1 and 2 are technologically developed, with fields connected to efficient irrigation networks and some of them even equipped with artificial lighting. Particularly in Case 2, land use conversion on the LAI premises included the construction of large greenhouses and water storage dams. We also observed that the LAI areas in these two heavily industrialized cases are smaller than in the other cases. For Cases 1 and 2, only about one-quarter of the respondents reported a decrease in the size of their cropland, and very few related this to the establishment of an LAI (exclusively in Case 2) (Table 3). One respondent in Case 1 said that an LAI had purchased part of the communal grazing land. In Mozambique, in Case 3, the LAI was established partly on small-scale cropland and partly on forested land, while in Case 4, the LAIs mainly converted small-scale cropland. Correspondingly, Case 4 had the highest percentage of respondents attributing a reported decrease in their cropland to the establishment of an LAI. The average size of cropland lost, however, was larger in Case 3, at four hectares, than in Case 4 (two hectares). In Madagascar, the situation was different, as the LAIs had been established almost exclusively on extensive grasslands. In Case 6, all 35 households reporting a decrease in their grazing land said it was because of the LAI, which received large areas of grazing land based on negotiations with the local chief. These households lost access to shared grazing land between 5 and 147 hectares in size. They somewhat adjusted to the decrease in available grazing land by reducing livestock numbers or by taking their livestock to graze on neighbouring communities' land.

In the 5-km buffers around the LAIs, we specifically examined what type of land had been affected by the expansion of small-scale cropland (Table 2). In Kenya, this was mainly land in the category 'Other', which mainly includes grassland, fallow land, and bush- and shrubland, representing Kenyan savanna – a mixed woodland-grassland ecosystem; it was thus mostly uncultivated and unmanaged land. Although about half of those respondents in Kenya who reported a change in the size of their own cropland said that it had increased, this was not related to the LAIs in any way. In Mozambique, where remote sensing showed that most of the new cropland had been established at the expense of forest, this was at least partly related to the displacement of small-scale farmers' cropland by the LAI. In Case 3, where 71% of small-scale farmers who had lost cropland to an LAI had received some financial compensation from that LAI, 65% had acquired new cropland. And even in Case 4, where only 5% reported having received a compensation, 45% had replaced their lost cropland with new cropland. In both cases, the new cropland

Table 3. Reported changes in small-scale farmers' agricultural land use. Percentage values are presented only for samples larger than five.

		Kenya		Mozambique		Madagascar		
	Overall	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Statistics
Net changes in cropland size	(n = 271)	(n = 40)	(n = 60)	(n = 49)	(n = 52)	(n = 25)	(n = 45)	$\chi^2 = 38.67$
Change in cropland size	47.6	57.5	45	75.5	48.1	44	13.3	$p < 0.001$
	(n = 129)	(n = 23)	(n = 27)	(n = 37)	(n = 25)	(n = 11)	(n = 6)	
Increase in cropland size	41.1	43.5	51.8	27.0	20.0	81.8	83.3	$\chi^2 = 20.93$
Decrease in cropland size	58.9	56.5	48.2	73.0	80.0	18.2	16.7	$p < 0.001$
Net changes in grazing land size	(n = 140)	(n = 34)	(n = 52)	(n = 5)	(n = 3)	(n = 9)	(n = 37)	$\chi^2 = 49.82$
Change in grazing land size	35	23.5	11.5			0	94.6	$p < 0.001$
	(n = 49)	(n = 8)	(n = 6)	(n = 0)	(n = 0)	(n = 0)	(n = 35)	
Increase in grazing land size	14.3	75	16.7				0	$p < 0.001$
Decrease in grazing land size	85.7	25	83.3				100	
Reasons for decrease in cropland	(n = 76)	(n = 13)	(n = 13)	(n = 27)	(n = 20)	(n = 2)	(n = 1)	
Land taken by LAI	57.9	0	7.7	88.9	95.0			
Environmental factors	9.2	23.1	30.8	0	0			
Used by relatives	9.2	15.4	30.8	0	5.0			
Left fallow	4.0	7.7	0	0	0			
Lack of market	4.0	23.1	0	0	0			$p < 0.001$
Used for settlement	4.0	0	23.1	0	0			
Increased livestock production	2.6	15.4	0	0	0			
Low yield	1.3	7.7	0	0	0			
Pollution from LAI	1.3	0	7.7	0	0			
Other	6.5	7.7	0	11.1	0			
Land taken by LAI	(n = 271)	(n = 40)	(n = 60)	(n = 49)	(n = 52)	(n = 25)	(n = 45)	$\chi^2 = 94.43$
	28.4	0	1.7	63.3	38.5	0	55.6	$p < 0.001$
Size of land taken by LAI (ha)	(n = 72)	(n = 0)	(n = 1)	(n = 30)	(n = 20)	(n = 0)	(n = 21)	
Minimum	0.5			0.5	0.5		5.0	
Maximum	147			25.0	5.0		147.0	
Mean (SD)	11.6 (± 24.7)			3.9 (± 5.0)	2.1 (± 1.2)		32.2 (± 38.8)	$p < 0.01$
Type of land taken by LAI	(n = 77)	(n = 0)	(n = 1)	(n = 31)	(n = 20)	(n = 0)	(n = 25)	
Cropland	67.1			100	100		0	
Grazing land	32.9			0	0		100	
Consequences of LAI taking land	(n = 77)	(n = 0)	(n = 1)	(n = 31)	(n = 20)	(n = 0)	(n = 25)	$\chi^2 = 31.02$
Received compensation	35.1			71.0	5		12	$p < 0.001$
	(n = 77)	(n = 0)	(n = 1)	(n = 31)	(n = 20)	(n = 0)	(n = 25)	$\chi^2 = 24.95$
Acquired new land	37.7			64.5	45		0	$p < 0.001$
Previous use of new cropland	(n = 29)	(n = 0)	(n = 0)	(n = 20)	(9)	(n = 0)	(n = 0)	
Forest	65.5			60	77.8			ns
Cropland	27.6			40	0			
Bush	6.9			0	22.2			

had been established mainly at the expense of forest. Overall, 28% of all interviewed households in our study (n = 271) had lost land to an LAI.

3.2. Changes in the management of agricultural land

Whether respondents had changed the way they managed their cropland since they had begun to cultivate differed significantly between the cases (Table 4). Overall, about 38% of the respondents (n = 266), most of them in Kenya, reported a cropland management change. Most frequently, this involved a change of seed varieties or the entire crop, mechanization for tillage, and a reduction in irrigation. However, some households actually increased their use of irrigation. The main reason given for these changes was lack of water. Whether respondents perceived the LAI to be the cause for the changes they implemented on their cropland, was significantly different between the cases. Of those respondents who reported a change in their cropland management, 37% (n = 38) in Case 2 and 15% (n = 26) in Case 1 related this to the LAIs, mainly because they perceived them to use an excessive amount of river water. In Case 3, in Mozambique, although only 38% of the respondents (n = 45) mentioned a change in their cropland management, 87.5% of these (n = 16) said this was due to the loss of land to the LAIs. The decrease in available land had caused households to abandon certain crops (e.g. rice, sunflowers, soy) that they had grown before. In Case 4, although one-fifth of the respondents (n = 52) reported a change in their cropland management, only few linked it to the LAIs. Most said they had wanted to increase yields and income from the sale of crops. In Case 5, in Madagascar, 24% of the respondents (n = 25) said they had changed the way they managed their cropland; this mainly involved the introduction of new crops (e.g. chilli, tomatoes), use of fertilizers, and irrigation. In one case, the household had abandoned their own crop production after having found employment with the LAI.

Looking at the management of grazing land, only 11% of all households with livestock (n = 140) reported a change, mostly in Kenya. There, the

Table 4. Reported changes in agricultural land management. Only responses with a total percentage value five or more are presented, and percentage values are given only for samples larger than five.

		Kenya		Mozambique		Madagascar		
	Overall	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Statistics
Change in cropland management	(n = 266)	(n = 39)	(n = 60)	(n = 45)	(n = 52)	(n = 25)	(n = 45)	$\chi^2 = 68.58$
Yes	38.4	71.8	65	37.8	19.2	24	4.4	$p < 0.001$
LAI responsible for change	(n = 97)	(n = 26)	(n = 38)	(n = 16)	(n = 10)	(n = 5)	(n = 2)	$p < 0.001$
Yes	41.2	15.4	36.8	87.5	30			
Reasons (several responses possible)	(n = 96)	(n = 27)	(n = 36)	(n = 15)	(n = 10)	(n = 6)	(n = 2)	
Lack of water	28.1	44.4	36.1	6.7	0	16.7		
Desire to increase yield	18.8	14.8	25	0	20	16.7		
Land taken by LAI	14.6	0	0	73.3	30	0		
Desire to increase income	8.3	3.7	5.6	0	20	50		
Other	30.2	37.1	33.3	20	30	16.7		
Type of change (several responses possible)	(n = 88)	(n = 28)	(n = 38)	(n = 10)	(n = 4)	(n = 6)	(n = 2)	
Change/abandonment of crop	43.2	39.3	31.6	80		66.7		
Change of seed variety	30.7	46.4	36.8	0		0		
Less irrigation	13.6	21.4	15.8	0		0		
Use of tractor for tillage	12.5	25.0	10.5	0		0		
Change of agricultural inputs	11.4	3.6	18.4	0		16.7		
More irrigation	10.2	10.7	13.2	0		16.7		
Adoption of SLM[1] practices	8	0	18.4	0		0		
Change in grazing land management	(n = 140)	(n = 34)	(n = 52)	(n = 5)	(n = 3)	(n = 9)	(n = 37)	$p < 0.001$
Yes	10.7	23.5	13.5			0	0	
Reasons	(n = 15)	(n = 8)	(n = 7)	(n = 0)	(n = 0)	(n = 0)	(n = 0)	ns
Overgrazing	33.3	25	42.9					
Drought	26.7	25	28.6					
Desire to increase milk production	20.0	25	14.3					
Personal reasons	6.7	12.5	0					
NA	13.3	12.5	14.3					
Type of change	(n = 15)	(n = 8)	(n = 7)	(n = 0)	(n = 0)	(n = 0)	(n = 0)	ns
Increased stall feeding	46.7	62.5	28.6					
Rotational grazing	20.0	12.5	28.6					
Abandonment of livestock keeping	13.3	25	0					
Change in cattle breed	6.7	0	14.3					
NA	13.3	0	28.6					

[1]Sustainable land management.

main changes included increased stall-feeding, the introduction of rotational grazing, the abandonment of livestock breeding, or a change in the breed of cattle. The main reasons given were overgrazing, drought, the desire to increase milk production, and personal reasons. In the other cases, respondents did not report any changes in their grazing land management.

3.3. Tree cover changes

The changes in tree cover perceived by respondents were significantly different between the cases (Table 5). Nearly all respondents in Kenya and a majority in Mozambique did notice a change in tree cover. In Madagascar, not a single respondent observed any change, as tree cover is generally very low in Case 5 and even more so in Case 6. The specific types of tree cover changes observed by the respondents differed significantly between cases. Three-quarters of all respondents (n = 271) perceived a decrease in natural or planted tree cover in their surrounding landscapes. In Cases 3 and 4, in Mozambique, the remote-sensing results clearly support these perceptions; in both cases, we found a loss in tree cover of 9.4% between 2000 and 2015 (See

Table 5. Perceived changes in tree cover in the landscapes surrounding the LAIs. Percentage values are given only for samples larger than five.

		Kenya		Mozambique		Madagascar		
	Overall	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Statistics
Perceived changes in tree cover	(n = 271)	(n = 40)	(n = 60)	(n = 49)	(n = 52)	(n = 25)	(n = 45)	$\Sigma^2 = 185.89$
Yes	64.9	100	96.7	71.4	82.7	0	0	$p < 0.001$
Specific change	(n = 176)	(n = 40)	(n = 58)	(n = 35)	(n = 43)	(n = 0)	(n = 0)	
Increase in planted tree cover	22.7	17.5	55.2	0	2.3			$p < 0.001$
Decrease in natural or planted tree cover	75	75	43.1	100	97.7			
Other	2.3	7.5	1.7	0	0			
Reasons for tree cover change (several responses possible)	(n = 176)	(n = 40)	(n = 58)	(n = 35)	(n = 43)	(n = 0)	(n = 0)	
Decrease: Expansion of agriculture and settlements	39.8	22.9	5.2	74.3	74.4			
Decrease: Exploitation of wood resources	35.8	52.5	46.6	20	18.6			
Increase: People planting trees on their land	22.7	22.5	48.3	8.6	0			
Other	1.7	2.1	0	0	7			

Table S2). By contrast, in Case 1, in Kenya, where the majority of the respondents likewise perceived the tree cover to have decreased, remote-sensing results showed a slight increase by 1.5%. Case 2, also in Kenya, is an exception: Here, 55% of the respondents (n = 58) had noticed an increase in planted tree cover. This is supported by the remote-sensing results, which indicate that the tree cover increased by 4.1% between 2000 and 2016 (See Table S2).

The main reasons given for a decrease in tree cover are the expansion of other land uses – mainly cropland, but also settlements – and the exploitation of wood resources for timber, firewood, and charcoal production (Table 5). The importance of these reasons differs between Kenya and Mozambique: In Kenya, the exploitation of wood resources is more important than land expansion, whereas it is the other way round in Mozambique. Some of the other reasons mentioned by few respondents were dry spells, tree diseases, less strict enforcement of logging bans, forest fires, water pollution affecting tree growth, and elephant damage (in Kenya), as well as population growth in general (mainly in Mozambique). The only reason given to explain the observed increase in tree cover was that individual land users planted trees for a variety of purposes, including as windbreaks, to create aesthetic value (in Kenya and Mozambique), to provide shade, to increase rainfall, to improve environmental conditions more generally, to expand their supply of wood resources or timber (for sale), and for use in agroforestry (only in Kenya).

A few respondents perceived a direct link between the LAIs and a change in tree cover. This was most pronounced in Case 4, in Mozambique, where five respondents linked the decrease in tree cover to mainly one LAI having cleared trees. In Case 1, in Kenya, one respondent mentioned the same reason. In Case 2, two respondents explained a perceived decrease in natural tree cover with the LAIs' demand for construction wood, whereas, conversely, one respondent attributed a perceived increase in tree cover to an LAI planting trees as a windbreak. One other respondent mentioned that one of the LAIs had provided tree seedlings to the surrounding households, which had led to more trees being planted.

3.4. Other perceived impacts of LAIs

The majority of the households interviewed (41.1%, n = 270) perceived that the LAIs had exclusively negative impacts on their household, while only 22.6% stated that the LAIs had exclusively positive impacts (Figure 3). Another 14.1% perceived both positive and negative impacts, and 22.2% did not perceive any impact at all. However, this differed significantly between cases ($p < 0.001$). In Case 4, in Mozambique, 71.2% of the respondents (n = 52) perceived only negative impacts, whereas in Case 5, in

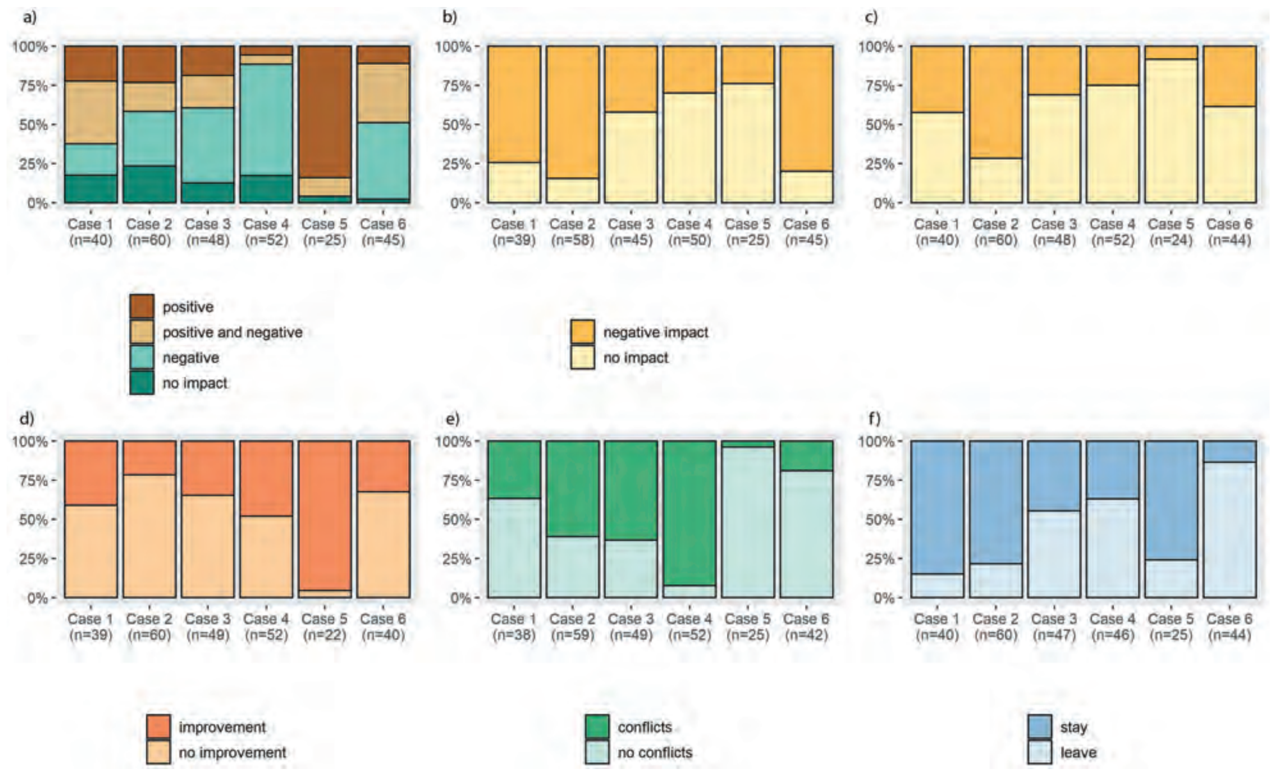

Figure 3. Perceived impacts of LAIs on (a) households, (b) the environment, (c) people's health, (d) infrastructure, and (e) conflicts, as well as (f) overall preference of households for LAI companies to stay or leave; all expressed as percentages of households reporting impacts or no impacts (a–e) or a certain preference (f).

Madagascar, 85% of the respondents (n = 25) perceived exclusively positive impacts.

Increased employment opportunities were mentioned most frequently across all cases by respondents reporting exclusively positive impacts (49.2%, n = 61). As employment opportunities are often mentioned as a benefit for local communities in the public discourse on LAIs, we would like to provide some more details regarding this aspect. Whether households had someone employed with the LAI currently, previously, or never before, was significantly different between the cases (Table S3). At the time of the interviews, overall, about 13% of all respondents (n = 270) had at least one member working for the nearby LAI. This was most common in Case 3, in Mozambique, where about 33% of respondents (n = 49) had a household member currently employed by the nearby LAI, whereas in Cases 1, in Kenya, and 6, in Madagascar, this was very rarely the case. Overall, about 28% of households (n = 270) had previously had members employed. In Case 5, in Madagascar, consisting of the jatropha-producing LAI that collapsed shortly before we conducted the interviews, 80% of the households had worked for the LAI (n = 25). However, the majority of all interviewed households had never had members working for any of the LAIs. Respondents mentioned many reasons for this, which differed significantly between the cases, the most important one being that it was difficult to find a job. This indicates that there is an unfulfilled demand for employment opportunities with LAIs, especially in Cases 4, in Mozambique, and 6, in Madagascar. In Kenya, the majority of respondents were already employed elsewhere, ran small private businesses, preferred to work on their own farms, or were generally not interested in working for an LAI. Perceived bad working conditions were an important reason why respondents did not want to work for an LAI in Case 3, in Mozambique.

After employment, improved security in the area was the second most frequently mentioned positive impact reported (8.2%, n = 61) (Figure 3), although it was mentioned only in Cases 1 and 2, in Kenya. The impact mentioned most frequently by respondents who reported exclusively negative impacts was loss of land to the LAI (28.8%, n = 111); this was mentioned in Cases 3 and 4, in Mozambique. Other frequently mentioned negative impacts included air pollution from chemicals (9.9%), mainly in Cases 1 and 2, in Kenya; blocked footpaths (9.9%) in Cases 3 and 4, in Mozambique; and general disregard of local communities' needs (9.9%), mainly in Case 6, in Madagascar.

In terms of adverse environmental impacts, 58.8% of the respondents (n = 262) did perceive the nearby LAI to have affected the environment (Figure 3). Case 2, in Kenya, had the highest percentage of respondents perceiving environmental impacts of the LAI (84.5%, n = 58), and Case 5 in Madagascar the lowest (24%, n = 25). The most commonly reported environmental impact was air pollution (38.3%, n = 154), mentioned mainly in Cases 1, 2, and 6. This was followed by reduced availability of river water (20.1%) in the same cases, and water pollution from chemicals (14.3%) mainly in Case 6. Respondents attributed the reduced availability of river water to the LAI's use of river water to irrigate its crops; to mechanized ploughing, which brought more sediments into the streams; and to the in-migration of LAI workers, which led to an overuse of groundwater wells. One respondent in Case 6 stated that he believed the LAI had stopped the rain on purpose because they did not need a lot of rain for their maize plantations; lack of rain mainly affected the drinking water supply for the zebu cattle. Water pollution, in Case 6, was attributed to pesticides that the LAI used on its maize plantations; the runoff from the fields carried the chemicals into the river, polluting the water that the respondents used for cooking. One respondent went as far as to suggest that the LAI purposely polluted local people in order to be able to occupy their land.

Negative health impacts from the LAIs were reported by 39.9% (n = 268) of the respondents, with the highest percentage occurring in Case 2, in Kenya (71.7%, n = 60), and the lowest in Case 5, in Madagascar (8.3%, n = 24). Frequently mentioned impacts were respiratory problems, reported by 40.2% (n = 107), mainly in Cases 1, 2, and 6, as well as cold and diarrhoea, reported by 13.1%, mainly in Case 6; and exposure to chemicals, mentioned by 11.2%. Infrastructure was reported to have been built by the nearby LAI by to 40.1% of the respondents (n = 262), with the highest percentage occurring in Case 5 (95.5%, n = 22) and the lowest in Case 2 (21.7%, n = 60). Of the respondents who reported a contribution to infrastructure by the LAI (n = 84), 47.6% mentioned school buildings (in all cases) and 31% a well (in Cases 5 and 6, in Madagascar). Conflicts between the LAI and the surrounding communities were reported by the majority of the respondents (52.1%, n = 265). This was most pronounced in Case 4, in Mozambique, with 92.3% (n = 52) of respondents reporting a conflict, and least pronounced in Case 5, in Madagascar (4%, n = 25). The main sources of conflict mentioned were water use (28.4%, n = 74), mainly in Case 1 and 2, and water pollution (16.2%), in Case 2. In Case 4, which had the highest percentage of respondents reporting conflicts, only few respondents specified the reasons. Apart from loss of access to land, these included some land users being jealous of others who had found employment with an LAI, and the mistreatment of workers.

Despite the various negative impacts of LAIs reported, the majority of the respondents (55%, n = 262) stated that they preferred the nearby LAI to remain operational. However, this again differed widely between cases. In the two Kenyan cases, as well as in the Malagasy Case 5, the majority of respondents wished for the LAI to stay. (In Case 5, respondents regretted that the LAI had stopped operating). In contrast, the majority of respondents wished for the LAI to leave in the two Mozambican cases and, most strongly so, in the Malagasy Case 6.

4. Discussion

Our results highlight a range of impacts of LAIs on surrounding farmers' use and management of land, tree cover, as well as on other aspects relevant for sustainable development in Kenya, Mozambique, and Madagascar.

Regarding the LAIs' contribution to land use change, we found that the LAIs were mostly established on small-scale farmers' cropland or grassland. Only in one case in Mozambique did the LAIs clear forest to make room for commercial crop plantations. This finding is in contrast to those of other studies which showed that LAIs acted as powerful drivers of deforestation (Davis et al. 2015; Curtis et al. 2018; Magliocca et al. 2020). Nevertheless, the Mozambican case shows that the assumption that LAIs mainly target degraded land to improve its production value does not hold. Moreover, the remote-sensing-based analysis showed that in the landscapes surrounding the LAIs in Mozambique, the main LULC change was from forest to small-scale cropland. Combining this finding with information from land users, we can confirm that at least part of this deforestation was indirectly linked to the establishment of LAIs. In the Mozambican context, where forested land was still available, part of the land users who lost land to an LAI would mainly make up for this loss by clearing new land for crop production. This empirical evidence supports the land science theories of indirect land use change and activity leakage (Meyfroidt et al. 2018). While we did not find any sign of displaced homes in our study, we provide evidence that in the Mozambican Nacala Corridor, local land users' cropland was displaced through the establishment of LAIs, at the detriment of natural forest. In Madagascar, the LAI in Case 6 had a direct impact on local land users' pastures, part of which were lost due to their conversion for mechanized maize production. Whether intentionally or not, governmental stakeholders often consider grassland and pastures to be idle and underused land and therefore offer them to investors for the development of commercial agriculture (Li 2014; Messerli et al. 2014; Schoneveld and German 2014). Our case in Madagascar shows that these are highly contested decisions, as out of the six cases studied this was the one that received the least support from local land users.

In Kenya, where land users were not dispossessed of their land, we found that the LAIs had an indirect impact on land management rather than land use. Some respondents had switched to crop varieties requiring less water or had reduced the irrigation of their crops, because they had perceived a decrease in river water availability – which they attributed to LAIs' excessive use of water for irrigation. A few others abandoned potato farming due to perceived water pollution from an LAI upstream that released wastewater into the river. We would like to note that this evidence is anecdotal and it is unclear how many land users in the area did take such action due to perceived environmental impacts from LAIs. Nevertheless, this confirms that water use and management is a highly contested issue between LAIs and small-scale farmers in the Laikipia region (Ulrich 2014; Ngutu et al. 2018). As so far no quantitative measurements are available to clarify who uses how much water at what time of the year or who pollutes water through what sources it remains a disputed issue. While small-scale farmers have organized into Water Resource Users Associations that regulate access to and use of water (Kiteme and Gikonyo 2002), LAIs have invested in rainwater harvesting measures and large storage ponds (Ngutu et al. 2018). Nevertheless, it is clear that the establishment of LAIs for flower and vegetable production has added pressure to the already tense situation around water quantity and quality. Indirect impacts on land management were observed in Mozambique as well: Respondents who had lost land to an LAI explained that this not only led them to search for new cropland, but that they also abandoned certain crops because they no longer had sufficient land. While a growing number of studies show causal links between LAIs and off-site land use change in Africa, South America, and Asia (Arima et al. 2011; Andrade De Sá et al. 2013; Boamah and Overå 2016; Magliocca et al. 2019), our study is among the first to show that the establishment of LAIs also has indirect impacts on how farmers in its surroundings manage their land.

The widespread tree cover changes observed in the landscapes surrounding the LAIs were only infrequently perceived to be linked to the LAIs' establishment. It was mainly in Mozambique where some respondents attributed a decrease in tree cover to an LAI clearing trees. In Kenya, where respondents reported an increase in tree cover, a small number of them thought that this was thanks to the LAIs planting trees or providing seedlings. Other processes happening in these landscapes, such as the expansion of cropland and settlements by small-scale farmers and the exploitation of wood resources for timber, firewood, and charcoal are more important drivers of tree cover loss. In Kenya, respondents further observed that people planted trees on their fields out of their own will, for a number of environmental, sociocultural, and economic purposes. Unravelling the LAIs' role in directly affecting tree cover (e.g. felling trees for timber or planting trees as windbreaks) in the wider landscape would merit more in-depth research, as so far there is only limited evidence for such actions provided by our interviews.

We also looked at the wider perceived impacts of LAIs on households, of which increased employment opportunities was the one most often mentioned as a positive one. Nevertheless, overall, only few of our respondents were employed by the nearby LAI at the time of the interviews. This corresponds to findings from other empirical studies showing that employment benefits from LAIs in Africa occurred only to few local people (Byerlee and Deininger 2013; Hakizimana et al. 2017; Palliere and Cochet 2018). Only in one of our six cases – the LAI planting jatropha in Madagascar – did a majority of the respondents work for the company. However, this project collapsed after only a few years, leaving the workers to return to subsistence farming and livestock keeping. This, and the fact that a higher percentage of respondents had worked for an LAI previously than at the time of the interviews, highlights the insecure and temporary nature of most employment opportunities provided by the LAIs in our study. However, it is also important to consider that some people prefer not to be employed by an LAI. In Kenya, land users find other opportunities to earn additional income or prefer to work on their own farms. In Mozambique, the perceived bad working conditions deterred land users from seeking employment with LAIs. Only in Madagascar did the majority of those not employed by the nearby LAI regret this fact. Our study suggests that the questions of what land users wish for in terms of employment, and whether the potential benefits from employment in commercial agriculture would outweigh other impacts on well-being and people's values, should be put at the centre of the scholarly discussion around the employment impacts of LAIs.

Small-scale farmers' general perceptions of LAIs established in their rural landscapes mostly vary between cases, and less so between countries. It seems that the type of LAI and its business and production model (Giger et al. 2020) is therefore more decisive with regard to its impacts on the ground, than the surrounding social-ecological context. Only in two of the six cases did our respondents perceive the LAIs' impacts to be predominantly positive or at least mixed. This was the case for the vegetable-producing LAIs in Kenya and the abandoned jatropha LAI in Madagascar. In these cases, the employment opportunities and benefits from infrastructure establishment seemed to outweigh the disadvantages in terms of environmental or health issues. Negative perceptions of LAIs were fuelled mainly by the issues of land loss to LAIs and environmental impacts in terms of air and water pollution, as well as a wide range of other perceived environmental and health impacts. Our results therefore support the available scientific evidence regarding LAIs' impacts on surrounding land users in low-income countries, which paints a rather bleak picture (e.g. Li 2011; Oberlack et al. 2016; Hufe and Heuermann 2017). Far from the initial promises of providing a win–win situation that promotes national economic development and rural poverty alleviation, such large-scale commercial investments in land provide at best some employment and infrastructural benefits to few. More importantly, however, they cause harm to many in the form of land dispossession, environmental impacts, and impacts on human health. This is unacceptable in the context of the Agenda 2030's sustainable development goals (United Nations 2015) and raises severe concerns about environmental justice (Schlosberg 2004; Hall et al. 2015). We therefore urgently need to direct future research efforts towards options to support the transformation to more sustainable development in such contested situations of large-scale land acquisition. This will require carefully facilitated negotiations among the different stakeholders involved, from the government agencies issuing concessions to the companies implementing LAIs and the land users who largely bear the costs of these investments.

5. Conclusion

Our empirical study, drawing on small-scale farmers' perceptions and analysis of remotely sensed land use and land cover data, provides novel insights into the broad impacts that LAIs in Kenya, Mozambique, and Madagascar have on land use and the environment. This is one of the first studies to comprehensively assess both direct and indirect impacts of LAIs on land use and land management. We found that LAIs contributed directly as well as indirectly to deforestation in Mozambique, triggered changes in small-scale farmers' land management due to water shortage and pollution in Kenya, and caused pastoralists to lose access to grazing land in Madagascar. Despite some benefits from employment opportunities and infrastructure improvement, the majority of small-scale farmers interviewed perceived their nearby LAI's overall impacts as negative, highlighting reduced access to land and water, pollution, health issues, and unsatisfactory working conditions. However, just slightly more than half of the respondents stated that they would prefer their nearby LAI to remain operational. This seems to be more the case in countries where a clear regulatory framework for land acquisitions exists and is implemented, and where land tenure rights are clearly formalized and registered. Further, it seems to apply to LAIs who make an effort to avoid environmental impacts, care for the social and economic well-being of people in their surroundings, and contribute to the region's wider economic development. Overall, there is ample space for negotiations among the different actors to improve LAIs' contribution to sustainable development. Future research should look into concrete options for supporting such a transformation, which needs to take into account small-scale farmers' needs and visions, as those are the actors mostly depending on the land for their livelihoods. This would correspond to increasing concerns for social and environmental justice of global consumers' impacts in distant places, and reduce the risk of harm and conflicts in LAI host countries.

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Author contributions

Julie G. Zaehringer and Sandra Eckert: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision. Peter Messerli: Writing - Review & Editing, Funding acquisition. Markus Giger and Boniface Kiteme: Writing - Review & Editing. Ali Atumane, Maya da Silva, and Lovasoa Rakotoasimbola: Investigation, Writing - Review & Editing.

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Smallholders' livelihoods in the presence of commercial farms in Central Kenya

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Smallholders' livelihoods in the presence of commercial farms in Central Kenya

Abstract: We study smallholder households livelihood profiles in central Kenya in an area characterized by the presence of many large commercial farms. We surveyed 375 smallholder households, compared them according to three categories (employed, contract farmers, households non-engaged with commercial farms), and constructed a livelihood index. The results show that contract farmers and households employed on farms are only a small fraction of all smallholders. Employed and non-employed households show little difference in overall livelihood profiles. Results suggest that employment on large commercial farms is mainly a coping strategy for younger households or in times of need. Contract farmers were found only in a specific location and had better access to irrigation water and higher livestock holdings. Comparison with earlier data shows the persistence of precarious livelihood levels and household strategies aiming at diversification of activities, with little evolution over the last 20 years despite the presence of commercial farms. Overall, there is little evidence that the proximity to the commercial farms offers a way out of poverty for nearby smallholder farmers.

Keywords: Smallholders; livelihood; poverty; commercial agriculture; employment; contract farming

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1. Introduction and objectives

The role of commercial agricultural investments in fostering innovation and contributing to technology transfer, employment creation, and poverty reduction is an important topic of debate for the development of the agricultural sector in Africa (Collier and Dercon, 2014; Deininger and Byerlee, 2011; World Bank, 2007). While the World Development Report 2008 (World Bank, 2007) prominently affirmed the importance of smallholder agriculture in development, Collier and Dercon (2014) have questioned the exclusive focus on smallholder agriculture, casting doubt on its prospects for productivity growth and a route out of poverty. They called for a more flexible approach, in which larger commercial farms – but not state-led mega projects – would play an important role. This issue gained added importance following the wave of international investments in land in Africa after the financial crisis of 2008/2009 (Borras Jr and Franco, 2012; Cotula et al., 2009). Research efforts have often tended to focus on the impact of these new land acquisitions with regard to issues such as loss of land, short-term job creation, and land use change (Alden Wily, 2012; Bottazzi et al., 2016; Nolte et al., 2016; Oberlack et al., 2021; Oberlack et al., 2016; Schoneveld, 2017; Schoneveld et al., 2011).

But other key open questions remain: What are the more long-term effects and spillover effects of commercial farms if they are present in a region for a longer time? And what implications do such commercial investments have for the livelihood strategies in adjacent areas? There are surprisingly few studies that investigate these questions, and our study aims to help to fill this gap through the analysis of empirical data from an area characterized by the presence of such commercial farms and a large number of smallholders.

Recent studies from Africa that investigated impacts on job creation and technological spillovers found relatively modest effects, for instance in Ethiopia (Ali et al., 2019), Mozambique (Deininger and Xia, 2016), and Zambia (Ahlerup and Tengstam, 2015; Lay et al., 2021). For Mozambique, Deininger and Xia (2016) found positive short-term effects on job creation but decreased perceived well-being within a 25 kilometre (km) band and no other additional spillovers in terms of better access or yields. For Zambia, Lay et al. (2021) and Ahlerup and Tengstam (2015) both found that yields of farmers in the adjacent areas increased, but not for smallholders with less than 1.4 hectares (ha). Further, Ahlerup and Tengstam (2015) found that households with small land sizes had more to gain from employment than those with greater landholdings. Lay et al. (2021) suggested that technology transfer is not likely to happen as technology on commercial farms is not easily adapted to circumstances on small farms, such as is in the case of industrial flower farms, production of high-value vegetables for export, or no-till cereal farming. Zähringer et al. (Zaehringer et al., 2018) investigated perceptions of smallholders regarding the impact of commercial farms and found only limited technology spillovers from the farms, although some adaption to increased water scarcity did take place. They also found little involvement of smallholders as employees on the farms, but reported positive smallholder perceptions regarding the overall impact of these farms on economic development.

Regarding out-grower schemes, the literature reveals mixed findings. Herrmann (2017) found significant, strong positive differences in terms of income and poverty between participants and non-participants in sugarcane out-grower schemes, but more nuanced results for the agro-industry labour market channel. For a horticulture project in Senegal, Van den Broeck et al. (2017) found income increases of 30% among the poorest half of the population, and income increases as much as 53% among the poorest 10%. Conversely, Meemken and Bellemare (2020) analysed representative data from six countries and found only moderate or partly (for three countries) insignificant gains in income among contract farmers. They also did not find robust evidence that non-participating households in the community benefitted from additional income opportunities. However, they found that participating contract farmers and their households were more likely to own productive resources such as land and livestock, concluding that access to such resources could be a precondition for, or the outcome of, participation in contract farming. Chamberlain and Anseeuw (2019) found that imbalances in control over resources, lack of knowledge transfer, and specific characteristics of contracts being in favour of the company (rather than the smallholders) were enough to explain the modest benefits of contract farming.

We intend to link these findings from the literature on the impacts to a broader discussion regarding the question of livelihoods and livelihood diversification strategies of smallholders.

The livelihood framework (DfID, 1999) is a well-known conceptual framework that has been used in many studies to assess well-being and resilience among smallholder households (Baffoe and Matsuda, 2017; Hall et al., 2015; Marschke and Berkes, 2006; Ulrich et al., 2012; Zoomers and Otsuki, 2017). The livelihood concept (Antwi-Agyei et al., 2013; Chambers and Conway, 1992; Ellis, 1998) has been developed to investigate challenges faced by rural households and to provide a more holistic perspective rather than a mere focus on monetary poverty (Rakodi, 1999). Physical, natural, human, and social capital complement financial capital in the analysis of this approach (Scoones, 1998). Based on these forms of capital, people build their livelihood and well-being. Scoones (Scoones, 1998) emphasizes that investigating all elements of the livelihood framework represents a significant undertaking and thus advocates "optimal ignorance" i.e. seeking only the information that is necessary. In this study, we use the livelihood framework and focus on "livelihood capitals", an approach which allows us to compare our results to earlier findings in the same study area (Ulrich et al., 2012).

Diversification of livelihoods is a strategy that can aim at increasing incomes, but also to increase the capacity to withstand shocks and create greater resilience of house (Asfaw et al., 2017). A literature review of diversification strategies in Africa (Alobo Loison, 2015) found that diversification is generally occurring in contexts of gradually diminishing farm sizes, low agricultural yields, and urbanization without industrialization. Though income diversification was found to be associated with higher incomes in Mali in the early 1990s (Abdulai and CroleRees, 2001; Reardon et al., 1992), a frequent finding was that diversification is often restricted by constraints to assets (Abdulai and CroleRees, 2001), and therefore incomes and livelihood assets often remain limited. For instance, Lay et al. (2009) could not find evidence of diversification of farm income portfolios among smallholders in Burkina Faso (Lay et al., 2008). Bryceson (2002) posits that when diversification occurs, it is mainly driven by desperation. According to Lay et al. (2008), poor households with low asset endowments engage in multiple livelihoods, in particular non-agricultural activities. Using data from Western Kenya, Lay et al. (2008) showed that only high-return non-farm activities such as salaried employment had positive effects on agricultural productivity. Livelihood diversification has also been described as a strategy for climate adaption and reducing vulnerability (Eakin, 2005). For Senegal, based on large and repeated surveys by the World Food Programme, Giannini et al. (Giannini et al., 2021) have shown that diversification strategies shape household vulnerability, and demonstrate that households engaged in non-climate sensitive activities (employment, self-employment) and receiving remittances are more food secure than those that do not. Drawing on research in Central America on climate adaptation measures, Donatti et al. (2019) highlighted crop-diversification, but also emphasized the importance of livelihood diversification and social safety nets. Finally, Eakin (2005) described different levels of climate adaption and diversification strategies of smallholders in Mexico, highlighting the importance of institutional and economic factors that shape these diversification processes.

At the same time, the literature review cited above (Alobo Loison, 2015; Asfaw et al., 2017) also indicated a lack of longitudinal data that would enable deeper, more detailed understanding of these processes. To this end, the present study helps to fill this gap with empirical data.

For our case study area, relatively good data were available with respect to diversification of household strategies. Wiesmann (1998) conducted a comprehensive survey of smallholders in the region and analysed their diversification strategies. He showed the importance of extended family networks, remittances through such networks, pensions, self-employment, and off-farm wage employment as a strategy to diversify risks. A smaller, qualitative follow-up study (Ulrich et al., 2012) constructed a livelihood index. It indicated a striking persistence of low asset endowments among the majority of smallholders, from an aggregated perspective, but also a high level of individual transition in and out of precarious livelihood status. Here, the unstable nature of many off-farm jobs was highlighted.

This review of the literature guided our interest in the present analysis. The geographic area under investigation offered us the chance to study the livelihood profiles among smallholder households co-existing in a region hosting an important cluster of commercial farms. We investigated a large group of households not engaged with commercial farms (hereafter called "non-engaged"), on the one hand, as well as those engaged with commercial farms either as employees or as contract farmers.

The objectives of this paper are therefore to examine the status and evolution of livelihood profiles of households that live in the proximity of these large commercial investments and the role of labour opportunities provided by these investments. First, we analyse the frequency of employment on commercial farms and contract farming amongst the smallholders in the study area. Second, we assess the wages earned in off-farm employment and specifically the wages paid on commercial farms. Third, we analyse the differences in term of livelihood profiles between these groups and discuss whether these differences were caused by the commercial farms, or whether, conversely, the differences determine people's participation or non-participation in employment on commercial farms or contract farming. Finally, we reflect on longer-term changes to smallholders' livelihood profiles and diversification strategies based on a comparison with older data from the same area.

2. Material and methods

2.1. The study area

Our study area was chosen based on the high number of commercial investments in the region (Giger et al., 2020). It is located between 1,800 and 2,500 meters above sea level, encompassing an area of 1,500 km^2 and a population of 200,000 inhabitants. Located on the western side of Mt. Kenya, the climate of the area ranges from sub-humid to semi-arid (Wiesmann, 1992). Population increases, urbanization, and increased water abstraction for irrigation by both small-scale and large-scale farmers have greatly contribute to overuse of water resources in the area (Lanari et al., 2018).

Being suitable for intensive agriculture and relatively close to the country's capital, Nairobi, the area has been an important agricultural production centre since colonial times. It was originally inhabited by the pastoralist Maasai. Some of the Maasai were displaced as a result of colonialism by settlers during the 20th century (Tignor, 2015). The few families that were not displaced largely went to work, along with Kikuyu and Meru people, on the new farms and ranches founded by the early European settlers (Hughes, 2003). As a result, land use shifted to extensive farming, primarily for cereals and livestock production (Hughes, 2003; Kohler, 1987). With Kenya's independence in 1963, land distribution programmes led to new changes in the agricultural system. Numerous farms and ranches were subdivided into small plots measuring up to 3 ha. These smaller plots were subsequently settled by many Kikuyu and Meru ethnic groups (Kohler, 1987; Wiesmann, 1998), whereas other larger farms and ranches were maintained. The corresponding influx of people led to a high population increase in the region, with internal migrants representing 70% of adults in the region in the 1990s (Wiesmann, 1992). Smallholders practice farming on plots typically measuring 0.5–2 ha, while keeping small numbers of cattle and other animals (Wiesmann, 1998). Private property rights are usually duly registered and considered secure in this area, enabling a land market accessible to investors via purchase or long-term leases.

In the study area (Figure 1) in 2016, a total of 48 commercial farms were identified as operational (Mutea et al., 2017). 56% of these farms were founded before the year 2000. The majority of investors (81%) in the region's commercial farms are Kenyan citizens, albeit of varying origins (Mutea et al., 2017)

Flower farms (especially roses) are the most common commercial farm type in the region, followed by vegetable farms. A few wheat farms and livestock ranches remain. The sizes of the commercial farms are diverse: They range from 14 ha to 4,000 ha, with flower farms usually being the smallest and livestock ranches the largest. In comparison with smallholder farms, however, commercial farms are clearly larger in size, investment levels, and production levels. Figure 1 shows a map of the region indicating the location of currently operational commercial farms, as well as the areas that were surveyed.

Approximately 8,000 workers are employed by the farms, including 70% on a permanent basis (Giger et al., 2020). This workforce is partly supplied by households living in the area, but also by workers commuting by foot or buses from nearby Nanyuki or other settlements (Peter et al., 2018).

Some commercial farms, mainly the vegetable farms, also contract smallholder farmers in the region through out-grower schemes (Giger et al., 2020). Some smallholder farmers were also contracted by other commercial companies engaged in retail and export. However, analysis showed that contract farmers were located in specific spatial clusters, and very few were found in our randomized survey.

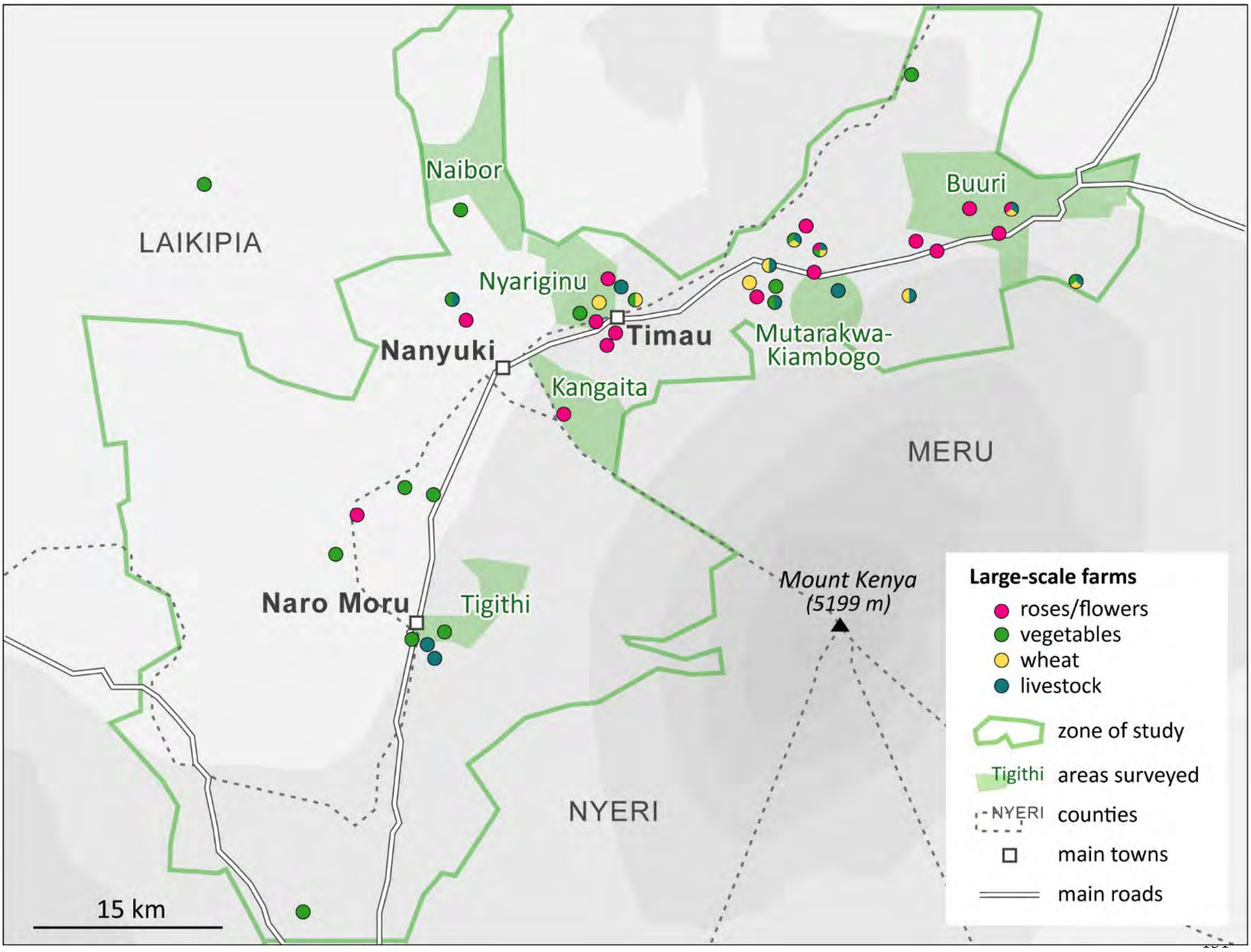

Figure 1. Nanyuki area: large commercial farms and surveyed zones. Source: Afgroland survey (2017). In: Reys et al. (2018).

2.2. Data

A socio-economic survey was designed to assess the socio-economic status of households employed on commercial farms, households not employed on such farms, and contract farmers in the study region. It was carried out between

January and March 2017 in six different areas, encompassing in 13 localities, and spanning three different counties – Laikipia, Nyeri and Meru – where 48 commercial farms (Mutea et al., 2017) are found (Figure 1).

Data were collected via a systematic household survey using closed and, to a lesser extent, semi-closed questions. In preparation for the survey (sampling frame, questionnaire design), the team conducted 16 qualitative interviews with households in the area and gleaned insights from a long-term research collaboration with project partners in the area. These qualitative interviews were conducted to better understand the context and to adapt the research questions to the field reality. The survey was coordinated by two researchers. Questionnaires were distributed using tablets by 10 Kenyan enumerators, working in teams of two, under the supervision of the two coordinating researchers. The respondents were usually men, in their role as head of the household. They were sometimes assisted by their wives, especially for questions related to food security.

The survey collected information at the *individual level* (age, gender, marital status, origin, occupation, wages earned, perception regarding the presence of commercial farms and labour employment, etc.) as well as at the *household level* (size of household, ownership of livelihood assets etc.).

Interviewed households were selected according to a stratified random sampling methodology. Interviews were conducted in five sub-locations: Buuri (approximately 2,100 households inhabiting the sub-location), Tigithi (600 households), Kangaita (1,200 households), Nyariginu (1,500 households), and Naibor (600 households) (Figure 1). These sub-locations were purposefully chosen based on the presence of commercial farms with characteristics representative of others established in the area (rose/flowers or vegetable production farms). The location of these farms was previously systematically investigated by researchers (Mutea et al., 2017). Each of the sub-locations were divided into groups of approximately 300 households. In each sub-location, interviews were conducted within only one group (Tigithi, Kangaita, Nyariginu, Naibor) or two groups (Buuri), which were randomly selected. In each group, one out of five households were interviewed in their homes. The homes were previously identified using publicly available satellite images that enable to identification of all roofs/houses in the area (20% random selection rate). As a recent formal census of households was not available, the number of households in each area was estimated by means of these satellite images.

A total of 318 out of 360 questionnaires were fully completed in this randomized sample. For each household surveyed, we attributed a weighting proportionate to the total number of households in its sub-location, so as to eliminate under- and over-representation (Table 1).

Additionally, as in this first representative sample, very few households were found to be engaged – presently or previously – in contract farming schemes (only six out of the 360 households interviewed). This was not expected, as six out of 33 farm managers said they had contracts with smallholders in a 2016 survey (Giger et al. 2020), though they indicated this practice had declined in importance. As a result, we purposefully selected 60 additional households engaged in contract farming in Timau's vicinity (sub-locations of Mutarakwa and Kiambogo). This area is known for its high density of contract farmers. According to information from VegPro, a major grower and exporter of cut flowers and fresh vegetables in Kenya, 400 of the company's contract farmers are located in this area.

Table 1. Interview details of surveys , by sub-location. Source: Afgroland survey (2017). In: Reys et al. (2018).

Type of zone	Name of the sub-location surveyed	Name of the main commercial farm found (main crop)	Total approx. no. of households inhabiting the sub-location	Total no. of households interviewed	Total of Interviews completed	Weight – total no. of households represented by one interview
STUDY AREA	Buuri	Blooming Dale (roses)	2,100	120	111	19
	Tigithi (Naro Moru)	AAA Growers (vegetables)	600	60	53	11
	Kangaita	Kairiki Limited (flowers)	1,200	60	52	23
	Nyariginu	Equinox (flowers)	1,500	60	50	30
	Naibor	KHE (vegetables)	600	60	52	12
CONTRACT FARMING ZONE	Mutarakwa-Kiambogo (Timau)	VegPro (peas)	-	60	57	1

We also used data from Wiesmann (1998), dating back to 1989/90and 1997, and from Ulrich et al. (2012), for the year 2010, to investigate longer-term changes to smallholders' assets and livelihoods in the same study area. The studies differ only slightly in the exact locations of households, and have different sampling size and methods applied, but we found them to be representative of our study area and able to serve as a valid benchmark for comparison.

Ethics statement: Verbal informed consent was obtained from the entire sampled population before the study. Participants were informed that the information provided would remain confidential and would only be used for research purposes. Ethical approval was not sought for the present study because it is not required as per the University of Bern guidelines and applicable national regulations.

2.3. Data analysis

To explore the influence of commercial farms, the surveyed households were divided into three groups depending on their engagement with a commercial farm:

Employed: households interviewed in areas where large commercial farms are located (Buuri, Tigithi, Kangaita, Nyariginu, and Naibor) and who have at least one household member employed at a commercial farm;

Contract: households interviewed that are working under a farming contract in an out-grower scheme (located in Mutarakwa and Kiambogo);

Non-engaged: households interviewed in areas where large commercial farms are located (*Buuri, Tigithi, Kangaita, Nyariginu, and Naibor*), but have no household members employed at a large agricultural farm. Note that non-engaged households may be engaged in other types of business or jobs not related to commercial farming.

Households that form part of the group of commercially employed or contract farmers are referred to as "engaged" households in this study.

We performed a detailed analysis of demographic and socio-economic data at the household level to assess the differences between these groups[1]. Additionally, we analysed data on wages paid on commercial farms and compared them to other labour opportunities. Besides basic socio-economic and demographic statistics of household members and assets, we applied a livelihood index (Table 2). Ulrich et al. (2012) developed the index using the livelihood approach (Chambers and Conway, 1992) to measure the livelihood capitals of the households. The index developed by Ulrich et al. (2012) is based on eight indicators that represent five different types of capital – human, natural, financial, physical, and social – that were selected and weighted by the authors with the participation of local researchers and farmers. The authors applied this methodology 10 years ago for a study in the same region, thus enabling comparison with our findings. Using the index by Ulrich et al. as a starting point was especially advantageous because the indicators and

[1] *Because of the different type of their relationship with agribusinesses, «contract" and the "employed" groups are analysed as different groups. These groups represent two different models of how commercial farms are be linked to the smallholders in the area, and may have different socio-economic characteristics. This is a question of high topical interest. These two groups are compared separately with each other and with the group of non-engaged.*

scales were developed in a participatory process with local stakeholders, who confirmed their relevance and validity based on their own perceptions (Ulrich et al., 2012). We reasoned that because their study was carried out relatively recently, the same indicators and scales could and should be used. Nevertheless, due to some differences between the type of our data available from the household survey and the ones collected by Ulrich et al., we had to adapt some of the indicators and integrate other variables. Overall, however, each indicator remains very similar to the original used by the Ulrich et al., with the exception of the community participation indicator (social capital), which was not used because of lack of information, and the subsistence indicator, which was modified. These changes led to some adjustments in the weights for household performances (Table 2).

Table 2 shows the indicators, weights and scales as applied in our study. As described above, these were chosen and weighted in a participatory exercise with smallholder and researchers (Ulrich et al. 2012). Land holdings have been attributed the highest weight, as smallholders attribute very high importance to this indicator. Education, livestock, farm income and housing are of intermediate importance, whereas off-farm income and subsistence are of lowest importance. As a proxy for human capital, we used the education status of the head of household, using the information in our survey and fitting it to the scale use by Ulrich et al.. The scale reflect the importance given to higher education by local stakeholders. We did not include health, an important aspect of human capital (Scoones, 1998), which we unfortunately lacked data for. Land size (total land owned or used by household) was used as indicator for natural capital, although obviously the quality of land and access to irrigation would also be important. The five land size intervals correspond to the intervals chosen by Ulrich et al..Relating both to natural and financial capital, another important indicator was subsistence, as identified by Ulrich (2012). We measured it based on the number of months the family was not able to meet its needs in the last year[2]. We made sure the scale captured the severity of the situation: *62% of the non-engaged experienced at least one month of insufficient food supply for the family. This figure was lower for the "employed" (42%) and for the "contract" group (46%).*. Livestock holdings were measured in standard livestock units

[2] *"Ulrich et al. were referring to the number of months the households could cover their food needs through their own production. We did not have this data available. As a proxy, to address the dimension of subsistence, we used the information on food supply, more specifically the number of months when households did not have enough food to cover their needs. The scoring intends to trace the severity of food insecurity. Already a month or two of insufficient food supply is a severe problem for a family*

and serve as indicators for financial , physical and natural capital[3]. Further indicators for financial capital were crop sales (in the season preceding the survey), and estimation of income through off-farm employment. This estimation of off-farm employment was based on the type of employment of any household member; thus, the total per household can reflect the earnings of more than one household member. We acknowledge that not all forms of financial capital were captured by these indicators – for example, remittances and income from sales of animal products were not directly measured (though they depend on livestock holdings). An important indicator that can serve as a gross indicator for physical capital is people's quality of housing. According to many rural studies in Kenya, it is also a general proxy indicator for well-being of smallholders (Ifejika Speranza and Wiesmann, 2006). . .

Table 2. Weight and scales used to measure performance according to well-being indicators.

Note: the table is adapted from Ulrich et al. (2012); weights and point values have been slightly adjusted to reflect changes in purchasing power and the omission of social assets.

[a] Human (H), natural (N), financial (F), and physical(P) capital. [b] Factors for livestock unit: *1 milk cow and ox; *0.25 goats and sheep; *0.02 chicken. [c] Value of crops sold in the season preceding the survey.[d] Factors for estimation of off-farm income: 0.5 commercial farm temporary/casual employee; *1 non-agriculture permanent/full time employee; *0.5 non-agriculture temporary/casual employee; *0,5 self-employment. Figures above 1 result from several household members involved in off-farm income.

Capital [a]	Indicator	Weight	Comparably, from worse off to better off				
			0 point	1 point	2 points	3 points	4 points
H	Education level completed by the head of household	15	No school	Primary	Secondary	High school	University
N	Land size (ha)	20	<0.8	0.8-1.2	1.2-2.4	2.4-4.0	>4.0
N/F	Subsistence: Number of months (in the past 12 months) in which household did not have enough food to meet family's needs	10	7–12	4–6	2–3	1	0
P/F/N	Livestock (LSU) [b]	15	<1	1–2	2–3	3–4	>4

[3] Livestock can be seen as contributing to different assets. (DfID, 1999; Rakodi, 1999). We follow Ulrich et al., who based on stakeholder interviews, classified it as natural and financial capital. Livestock and the manure it produces is seen by stakeholders a "natural asset", and livestock may also be a form of saving. The classification by stakeholders is also found in the literature (Bhandari, 2013; Erenstein et al., 2010; Tran et al., 2022). However livestock can also be physical asset by providing animal traction or as a factor of production (DfID, 1999; Pour et al., 2018; Rakodi, 1999)

F	Farm crop income (USD) [c]	15	0<100	100-200	>200–300	>300-500	>500
F	Estimated level of off-farm income [d]	10	0	0.5	1	1.5	>2
P	Housing material	15	Mud, grass, or corrugated iron	-	Wood	-	Partly in cement or bricks

We applied descriptive and multivariate statistics to analyse the socio-economic and demographic data. Multivariate statistics include chi-2 tests to verify statistically significant differences between the groups. *All the chi2 tests were performed on contingency tables (Howell, 2011). However, the figures are reported in the tables as proportion data to help the reading and ease the comparison of the differences between the different groups. The Pearson Chi2 tests performed were non-parametric. The null hypothesis states that there is no relation between the variable tested and the household groups tested. (hypothesis rejected when the result is less than 0.05).*A partial and preliminary analysis of our data was summarized in an internal research report (Reys et al., 2018)

We calculated the livelihood index to provide a synoptic overview of the livelihood status of smallholders. The index is composed of the indicators listed in Table 2. They act as proxies for livelihood capitals, providing a holistic representation of the livelihood assets available to households (with the exception of social capital, as noted above). We assigned each household a score for each indicator according to the scoring system (Table 2) ranging from 0 to 4. The higher the score, the better the status of livelihood assets for the given indicator. The weight and the scores were based on Ulrich et al. (2012), with slight adaptations, and used to calculate the index for each household. The score for each group can be compared for each indicator or as a total (by adding up all the scores for the individual indicators according to their weight, ***see Table 6***).

3. Results

3.1. Frequency and spatial distribution of employment and contract farming in the study area

In our study, 15% of households were involved in providing labour to commercial farms with at least one household member, and we found a strong variation among the various sub-locations (5.8 –26.1 %). The highest percentage was found in Buuri (26%), an area with the largest concentration of large employers (five farms with a total of 2,490 workers). The second-highest percentage was found in Nyariginu (14%; four farms with 1,430 workers), in the other three locations, the percentage of households involved in providing labour and the total number of workers on farms were lower (farms with an offer of 300–500 jobs). Note that commercial farms also employ staff that do not reside in the area. For example, in the area of Naibor, a study with workers of a large farm found that the large majority were not farmers from the area, but rather commuted with buses from Nanyuki (Peter et al., 2018). Indeed, in the same location, our survey found only three households that were employed by commercial farms.

Only six households (2%) in the representative sample were contract farmers. Interestingly, though, we also found 53 households that had previously been involved as contract farmers. This confirms earlier findings (Mutea et al. 2017) that contract farming is losing importance in the area. Further investigation revealed that contract farmers are now more concentrated in a specific area that had not been included in the original survey area. Information on this group of contract farmers is also included in the results of our analysis.

3.2. Demographic and basic socio-economic characteristics of the households

3.2.1. Demographic results

Gender, marital status. Overall we find rather subtle differences in the demographic characteristics between the household groups. Most of the heads of households surveyed were men. This was also true for the employed household group, even though we know that a majority of those working for commercial farms in the area are women (Table 3). Women are employed mainly for planting, weeding, harvesting, grading and packaging, whereas men are employed mainly for spraying the crops. Male household heads tended to be married, whereas a significant portion of female household heads were divorced or widowed and remained single. This is probably due to social, cultural, and religious reasons that assign men the role of household head.

Table 3. Socio-demographic profiles of the households, descriptive results by groups and chi-squared tests by pairs of groups.

VARIABLES		DESCRIPTIVE RESULTS			CHI2 TEST (P-VALUES)		
		*Employed**	Contract	*Non-engaged**	Employed/ Non-engaged	Contract/ Non-engaged	Employed/ Contract
		%	%	*%*			
Gender HH head	male	*93*	89	*74*	0.005	0.008	0.703
	female	*7*	11	*26*			
Marital status HH head	Married	*91*	95	*74*	0.087	0.005	0.601
	Divorced	*0*	0	*4*			
	Widowed	*6*	4	*15*			
	Single	*3*	2	*7*			
Education	no school	*19*	16	*22*	0.748	0.651	0.697
	primary	*48*	56	*49*			
	secondary	*30*	23	*23*			
	higher	*2*	5	*6*			
Age HH head	<30	*6*	4	*5*	0.001	0.000	0.519
	30-39	*39*	35	*16*			
	40-49	*25*	32	*17*			
	50-59	*12*	19	*27*			
	60+	*18*	11	*35*			
Total members per HH	1-3	*23*	19	*37*	0.214	0.019	0.717
	4-6	*67*	72	*53*			
	7+	*10*	9	*10*			
Total children per HH	0	*10*	11	*29*	0.043	0.002	0.304
	1-2	*58*	70	*48*			
	3+	*31*	19	*23*			
Migrant status HH head	far	*9*	2	*11*	0.180	0.063	0.173
	nearby	*71*	84	*78*			
	no	*20*	14	*11*			

Notes: statistically significant differences between the groups at a 5% rate or under are highlighted in grey. Source: Afgroland survey (2017). In: Reys et al. (2018). * data weighted.

However, “Employed” and “Contract” households were even more likely to be male-headed households compared to “Non-engaged” households. Married couples were also more frequently found amongst the “Contract” households, a fact which can be explained by the need for more labour availability and greater ease of managing the overall workload of the household (domestic tasks, non-agricultural off-farm work) alongside the more sophisticated farm production necessary for contract farming. We did not find statistically significant differences in the education level between the different household groups (Table 3).

The majority of jobs on commercial farms were occupied by women (54%), a figure which was also reported in another study on employment using the same data (Mercandalli et al., 2019). A total of 74% were younger than 40 years. Women were frequently wives (56%) or daughters (40%) in the household, and very rarely the household head (only 4%). Some of them were divorced (6%) or widows (2%). Men employed by a commercial farm were usually husbands (82%) in the household, or occasionally sons (18%). No widowers or divorced men were recorded. Among, the other non-agricultural off-farm employment categories, women only represented 26% to 42% of the workforce.

Results at the household level (Table 3) also reflected this age structure: "Employed" and "Contract" households were younger than "Non-engaged" households (42 and 40 years, respectively, compared to 53 years). Possible explanations for this emerged from more detailed interviews which revealed that for many younger households, employment in commercial farms is perceived as beneficial to earn cash for children's education or to consolidate household assets. Being younger, they are also in their prime working age, which makes them attractive to employers. Also emerging from our qualitative interviews, such jobs are perceived as a way to save some money to reinvest in a little business afterwards. Further, younger households find it easier to adapt to the stringent requirements of out-grower contracts.

In addition to being younger, "Employed" and "Contract" households also have more members and children than "Non-engaged households". One reason could be that having more children increases the need for additional income.

Migration*:* No significant differences were found between the groups regarding migration status. Households in all groups were overwhelmingly internal migrants (80–89%), most were from places located nearby in one of the three counties where our study took place (Table 3). When asked about the main reason for migration, the search for land (approx. 80%) was given as the main reason, while only about 10% came for a job. However, immigration among the "Employed" group appeared to be more recent compared to the other two groups (10 years, as opposed to 20 years) (SI Table 1.)

3.2.2. House and home assets

House and home assets were generally very modest and displayed little difference between the groups (SI Table 2). Houses in the area studied are most commonly made of wooden walls. Only a small portion (18 to 26%) is made of cement or bricks. Almost all of the houses in the area have corrugated iron or zinc roofs. Virtually all the households surveyed had toilets.

About half of the "Non-engaged" and "Employed" households reported access to piped water (55% and 56%). Conversely, all "Contract" households had access to piped water. Only half of the households had access to electricity, with "Employed" households displaying a significantly lower access rate (40%) than the "Non-engaged" (56%). One possible explanation for this may be "Employed" households being younger, and thus not yet connected to the grid.

Almost all the surveyed households owned one or more beds with mattresses, as well as sofa sets and tables. Electronic devices were widely owned, including mobile phones (96–98%), radios (84–94%), and televisions (38–65%). Between 15% and 36% owned a motor vehicle. “Employed” households most frequently owned TV sets and motor cars, unlike other assets. Notably, motor vehicles also represent a productive investment in the area, as they can be used for transport services.

3.2.3. Agricultural assets

Land: The size of land owned was around 1.2 ha per household and did not differ significantly between the groups (Table 5). The majority held an individual land title that provided land tenure security. A total of 50% of plots were held through a freehold title, 28% through a lease of private land, and 16% were under traditional tribal ownership (Table 4).

Table 4. Land ownership, by household groups. Source: Afgroland survey (2017). In: Reys et al. (2018). (Weighted data.)

VARIABLES		GROUPS OF HOUSEHOLDS		
		Employed	**Contract**	**Non-engaged**
% Type of land access to plot	freehold	57	46	69
	traditional	26	13	11
	leasehold	17	39	12
	other	0	3	8
% Year access to plots	>2013	32	39	26
	2008–2012	25	16	26
	2003–2007	11	16	22
	1998–2002	10	5	8
	1993–1997	3	10	8
	<1992	18	15	31

There was no case of a respondent mentioning that he or she lost land due to a commercial farm. Smallholders in the area generally have secure land rights, as mentioned by many respondents, and described in the literature (Wiesmann, 1987, Ulrich, 2012). However, as noted in the section on data and methodology, we did not survey those who might have left the area.

A total of 49% of the “Employed” group and 33% of the “Non-engaged” group stated that commercial farms have an impact on the land. The respondents frequently cited commercial farms as a reason that land is no longer available at an affordable price for smallholders. They referred explicitly to the high cost of leasing land. Where land would still be available and affordable, the essential infrastructure to attract settlement for farming is lacking.

Irrigation: The plots owned by “Contract” farmers were 100% irrigated, far more than for “Employed” (31%) or “Non-engaged” (27%). Perceptions of irrigation differed between the groups. Changes in the performance of water management were perceived as mostly positively by those in the “Employed” (51%) group, but were perceived negatively by “Contract” farmers (31%) and the “Non-engaged” groups (28%). Interestingly, the majority of “Contract” farmers did not report a positive evolution of irrigation water management in the last 10 years. Irrigation, therefore, represents a precondition for working as a “Contract” farmer, and has not come about as a result of contract farming activities or income related to it.

Infrastructure changes in general were seen as increasingly positive by all groups in terms of quality and quantity (59–67%). About a quarter (20–27%) of households in all groups considered the changes to be related to the presence of commercial farms, as these farms seek to upgrade roads as corporate social investments and to create an enabling environment for the smooth running of their businesses.

Agricultural equipment: Manual sprayers, weeders, ploughs, and ox carts are the tools and equipment most used in the region. Related differences been household groups were surprisingly small, except that “Employed” households is more likely to hold a weeder , and “Contract” farmersare more susceptible to own manual sprayers, irrigate their land or hold a smaller cattle herd. It shows that “Contract” farmers may have a higher propensity to invest in assets bringing returns after longer periods, in contrast to “non-engaged” households who seem to rely less on such assets, and thus less able to make investments to improve their yields.

.. (Table 5).

Table 5. Agriculture profiles of the households, descriptive results by groups and chi-squared tests by pairs of groups.

VARIABLES		Descriptive Results			CHI2 TEST (P-VALUES)		
		*Employed**	Contract	*Non-engaged**	Employed/	Employed/	Contract/
		%	%	%	Non-engaged	Contract	Non-engaged
Land (surface)	>2.4 ha	1	5	8	0.296	0.585	0.564
	0.8-2.4 ha	43	44	38			
	<0.8 ha	56	51	55			
Land irrigated	yes	31	100	27	0.667	0.000	0.000
Plough	yes	14	13	9	0.188	0.756	0.353
Weeder	yes	54	38	36	0.036	0.135	0.838
OxCart	yes	6	7	6	0.853	0.856	0.649
Manual sprayer	yes	80	96	73	0.211	0.011	0.000
Cattle (heads)	>4	2	14	9	0.304	0.001	0.001
	1-4	59	75	56			
	0	39	11	36			
Sheep (heads)	>9	13	9	9	0.429	0.178	0.532
	1-9	42	60	51			
	0	44	32	40			

Notes: statistically significant differences between the groups at a 5% rate or under are highlighted in grey. Source: Afgroland survey (2017). In: Reys et al. (2018). * data weighted.

As expected, “Contract” households also spent more on agricultural inputs (SI Table 3). Interestingly, “Employed” households also invested almost 40% more in seeds, fertilizers, and other inputs than “Non-engaged” households. Around 60% of all households said they adopted new technologies, sometimes explaining that they borrowed ideas from their work on farms.

Livestock: “Contract” farmers reported owning the largest herds of cattle (Table 5) About one third of households, in each group, claimed to be less engaged in livestock keeping than 10 years prior, and cited lack of grazing land and fodder as the main reasons for this change. Among the groups, the “Contract” households were the most likely to claim to have larger herds than before (14%). They cited the availability of money to invest as the main reason for this increase. However, overall, about one third of all households claimed to have fewer livestock than 10 years prior.

3.3. Off-farm employment: opportunities and constraints

Employment on commercial farms: About 9% of the active household members (18–65 years old) reported being employed by a commercial farm. Most of these jobs were permanent positions (89%) with declared contracts (86%). In total, 55% of the contracted employees were women. Temporary or casual jobs were less common (11%).

However, jobs appeared to be a short-term option for households. Over 50% of those employed were hired only recently (two years ago or less); only 15% of those employed in our sample were working 10 years or longer. Reasons cited by respondents to explain why they no longer worked for an agribusiness, or never sought to work for one, were often the same: low pay, preference for working as an independent farmer, illness or fear of illness from the effects of the chemicals used. People's perceptions of the impacts of commercial farms on job creation were overwhelmingly positive: 95% of "Employed" households (and 86% of the "Non-engaged") said that the commercial farms have a positive impact on job creation.

Wages paid by commercial farms: Median daily wages were about USD 3.20 (also reported in (Mercandalli et al., 2019) –lower than other non-agriculture employment (USD 4.20 per day) but higher than self-employment jobs (USD 2.50 per day).

Wage levels varied widely depending on workers' position and qualifications. Unskilled jobs (56% of jobs on large farms) were paid USD 2.80 per day, only slightly higher than the minimum wage for unskilled labour in Kenya's agricultural industry overall (USD 2.70 in 2017). These jobs are typically held by women. Jobs requiring technical skills (35% of jobs on large farms) paid around USD 4.20 per day, while lower-level managers (9%) can receive over USD 10.00 per day. At the same time, farm employees frequently obtained other benefits, such as health insurance or sick leave.

Our data revealed a gender gap: wages paid to women were 25–40% lower than men, whatever the contract type or skills required. Some of these salaries were reported to be below the minimum wage (unskilled labour on commercial farms). The type of farm did not influence wage levels. SI Table 4 provides more details on the gender gap in daily wages. Nevertheless, as noted above, women make up the majority (55%) of employees on commercial farms, in contrast to other off-farm employment opportunities (37%). So, the sector does offer women certain opportunities.

Figure 2 depicts a comparison of the wages paid on commercial farms with other non-agricultural employment. It is evident from the findings that the wages on commercial farms occupy a middle ground. They are not extremely low (like many self-employment or non-agricultural jobs), but also seldom found in higher wage classes. Adherence to certain minimum standards can be attributed to the fact that the formal sector must conform to certain rules set by the government and international retailers.

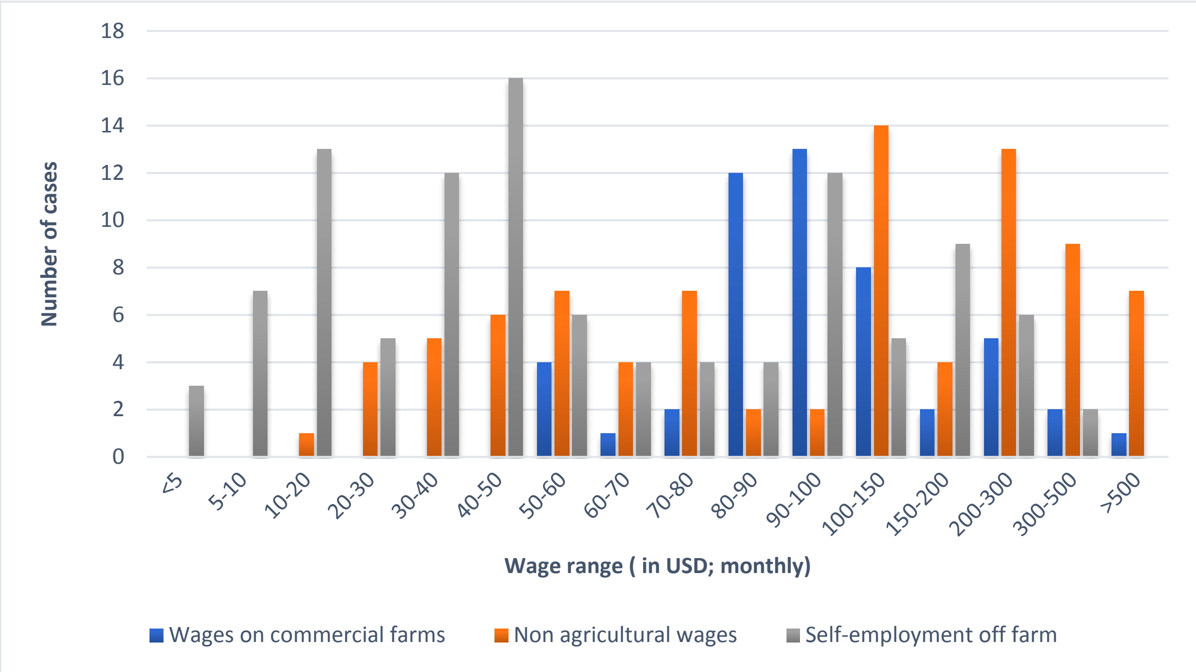

Figure 2. Comparison of wages on commercial farms, non-agricultural wages, and off-farm self-employment. Wages were asked per day, per month, or per year. For calculation, the medians of the range were reported. For wages given per month or per year, we respectively divided by 30 or 360 to obtain the daily wage, as most respondents reported working every day. N=50 (commercial farm wages); N=85 (non-agricultural wages); N=108 (off-farm self-employment).

Uses of income earned on commercial farms: Respondents mainly indicated using income to cover daily expenses (98% of responses). Also mentioned were savings (61%), investment in education (56%), farming (35%), and livestock purchases (7%). Women tended to invest more in education and less in livestock or other expenses. Daily expenses included a wide range of uses, including food purchases, small items for daily use, as well as small improvements in house assets. The importance of savings and investments in education shows that income through employment is also invested in the long-term – although not primarily in farming activities.

In general, there were only small differences in the socio-economic profile and assets of “Employed” households and “Non-engaged” households, also when compared to the high disparities among all the households. The differences indicated greater potential to engage in employment on farms or in contract farming among younger households, headed by men, and married. However, these households also had more children, indicating greater need for cash income than other households, possibly explaining employment on farms. In some cases, grown-up children still living in the household were employed on commercial farms.

3.4. Well-being index

The livelihood index provides a synoptic overview of the livelihood status of smallholders. The score for each group showed that “Contract” farmers had the highest score (19.7), followed by “Employed” households (16.5) and “Non–engaged” households (14.3) (Table 6).

Table 6 and Figure 3 display the different dimensions of the well-being index and reveal marked differences in the scoring between the groups – enabling some interesting interpretations:

The contract farmers exhibited a higher overall index due to higher livestock and crop scores, a possible result of investments made using the returns from contract farming. Their performance was inferior only in terms of off-farm labour as compared with the employed, thus the family workforce of contract farmers may be absorbed by their main contract activities. This could also be interpreted as indication of further specialization in farming activities.

The group of “Employed” households scored highest for off-farm activities, but this was due to their employment on commercial farms. Considering them in terms of other off-farm activities, they were less involved (minus 0.30 index points) and had a slightly lower self-employment level (-0.1). This can be explained by their labour being absorbed by the commercial farms. The “Employed” scored low for most other indicators, except for crop production, where they scored higher than the “Non-engaged” (Figure 3). This could be an indication of investment made with salaries from employment or a transfer of technology and skills, for which there were some supportive statements made by respondents. Regarding subsistence, the “Employed” scored only slightly higher than the non-employed.

Those with other types of off-farm activities in turn scored substantially higher on subsistence (score of 3.5 for other employed households; and 3.5 for self-employed households). However, for other dimensions, there were no marked differences from the average of all the other households.

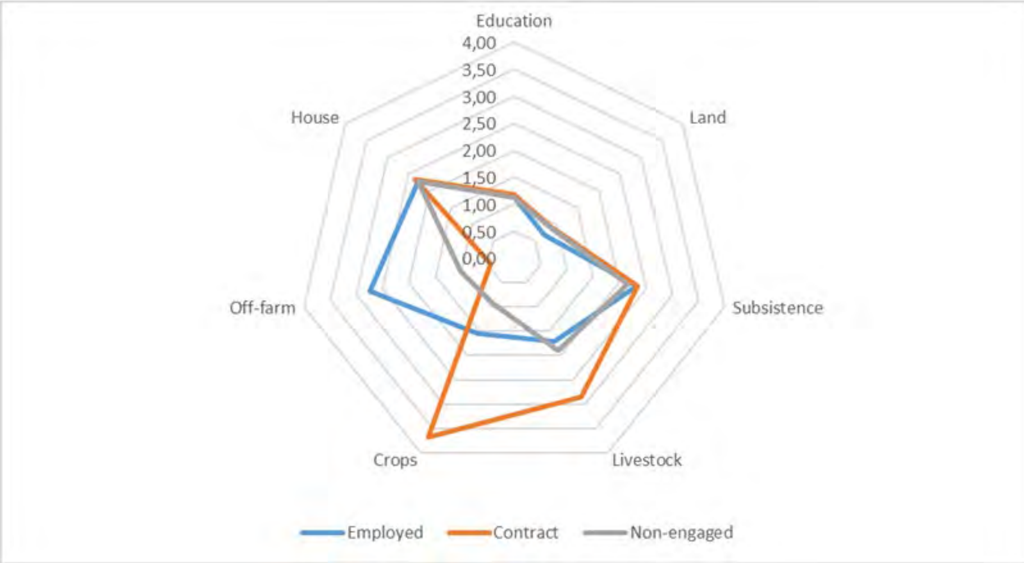

Figure 3. Indicators by household groups. Notes: adapted from (Ulrich et al. 2012).

Table 6. Individual indicator scores of the livelihood index for the different groups and total weighted score. Notes: adapted from (Ulrich et al. 2012); weights and point values have been adjusted.

Categories	Education	Land	Subsistence	Livestock	Crops	Off-farm	House	Total Score
Weights	15	20	10	15	15	10	15	
Employed	1.72	1.42	2.34	2.56	2.32	2.74	3.41	16.51
Contract	1.76	1.79	2.35	4.29	5.53	0.44	3.53	19.68
Non-engaged	1.69	1.79	2.16	2.85	1.40	1.02	3.41	14.32

Three indicators showed remarkably little difference between the groups: education, subsistence, and house assets. “Employed” households were able to meet their family food needs as much as other groups, suggesting that employment helps them maintain their food security by enabling them to supplement their subsistence means via some cash income, as limited as it may be. However, as noted earlier, almost half of households (44%) in all groups experienced at least one month where there was not enough food for the family, highlighting the precarity of food security among all groups, as noted by other authors (Fitawek and Hendriks, 2021; Mutea et al., 2019).

3.5. Inequalities and evolution of livelihoods status

We found high disparities in livelihood status among smallholders. Figure 4 depicts disparities in the largest group, the “Non-engaged” households. Marked differences were revealed especially with regards to landholdings, livestock, and crop production. These disparities were already found by Wiesmann (1998), Kohler (1987) and Ulrich et al. (2012), and are thus not new to the area. The graph also shows that the better-off households did not engage more in off-farm activities than the medium group, but were likely able to invest more in agricultural production, as they had more livestock and land and produced more crops.

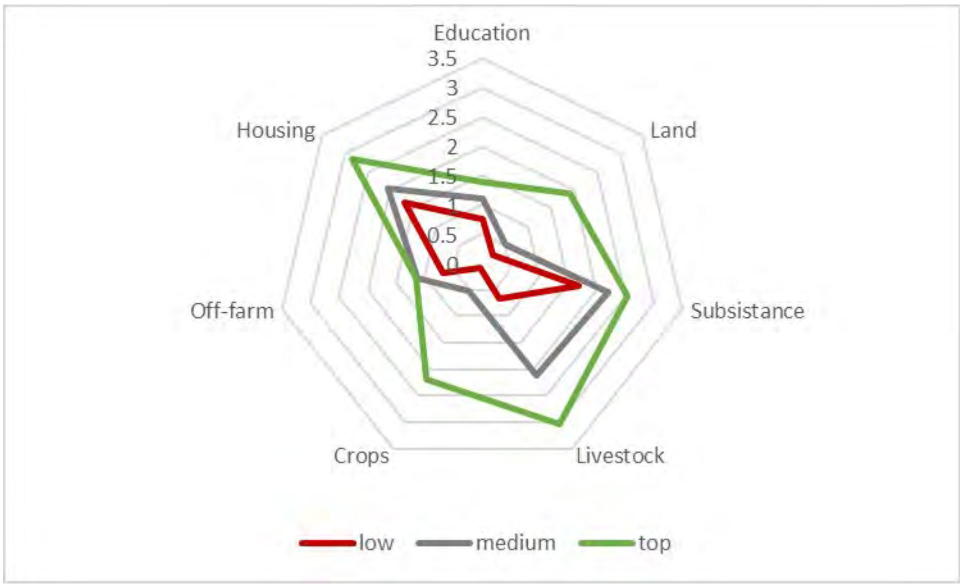

Figure 4. Disparities among non-engaged households. Source: Afgroland survey (2017). In: Reys et al. (2018). Notes: adapted from (Ulrich et al. 2012); weights and point values have been adjusted. N=271. The three groups were formed by ranking the households according their total livelihood score, and assigning them to three groups of equal size. The cut-offs were: Low: < 21.5, medium 21.5-42.5; top >42-5

The distribution of means per quantile showed that while the "Employed" group had a relatively good score among the 20% of its poorest households compared to the 20% poorest in other groups, it had the lowest means among the wealthiest quantiles. This may suggest that employment on commercial farms prevents households from falling into extreme poverty, but it does not represent a path to wealth. This was echoed in personal interviews, with household respondents portraying commercial farms as an additional option for use when cash income is needed, and there are no other means to access it. However, in turn, if there is not enough labour available, this option is not available for the poorest of households, in particular widows and the elderly. Overall, the results show a relatively low level in the livelihood status of all groups, indicating generally precarious livelihood conditions.

Comparison of the evolution of households' livelihood assets: We compared our findings to two earlier studies that were made in the area, dating back to 1989/90 (Wiesmann, 1998) and 1997 (Wiesmann, cited by Ulrich et al. (2012)) (Table 7). Data from 1989/90 is based on a large plot-based survey of 2,787 households. It was later updated based on a random sample of 10% in 1997 (Wiesmann, 1998), and further exploited by Ulrich et al. (2012). Because of the small sample size used, data from 2010 (Ulrich et al., 2012) is only provided for reference.

	1989/90	**1997**	**2010**	**2017**

Data source	Wiesmann 1998 (n=2,728)	Wiesmann, cited in Ulrich 2012 (n=170)	Ulrich, 2012 (n=30)	own data (n=318)
Land (ha)	2.7	1.9 (sd: 1.2)	2 (sd: 1.5)	1.2 (sd: 1.4)
Livestock (LU)	3.2	3.2	1.8	3.2
House built in stone		1% (1997)	30%	21% (brick/cement)
Access to piped water			33%	55%
Completed secondary school (% HH members)		40% (n=80)	26% (n=73)	24% (n=2098)
Beyond secondary (% HH members)		3%	4%	1%
HH with off-farm employment (%)		40% (n=30)	93% (n=30)	38% (n=318)
Women in off-farm employment (%)		20%	40%	38%

Table 7. Comparison of data on households' livelihood assets between 1998 and 2017 in the study area. Sources: Wiesmann,1998, Ulrich et al. 2012, Afgroland survey (2017).

Comparison of access to land showed that landholdings have decreased continuously since 1987, due to the influx of population and local population growth. This confirms farmers' perception of increasing difficulty in accessing new land, owing to population growth and the lack of available land, the latter in part because of commercial farms which now occupy land. Livestock numbers remained at the same level as in 1987. Ulrich et al. reported lower livestock holdings (based on a small sample), but also reported that households emphasized the importance of livestock keeping and expressed desires to invest in dairy farming – something that may have occurred in the last eight years, in some cases. Indeed, we observed that more intensive dairy farming is gradually taking place.

Data regarding housing illustrated improvements. In 2017, around 20% lived in stone/brick houses compared to 1997 (1%). In 2017, about 50% had access to piped water and over 84% considered it safe to drink, whereas less than 25% had access to safe water in 1987 (data for piped water unavailable).

Education levels showed a declining trend. While in 1997, 40% had completed secondary school, this had decreased to 28% in 2017. Higher education levels appeared to be stagnating: In 1997, 3% of all household members managed to reach beyond secondary school; in 2017, this rate went down to 1%. Nevertheless, these education data are partial: our survey did not capture family members who, based on better education, might have migrated to other areas and towns where they were able to find better living and working conditions. In this way, increased outmigration might explain some of the perceived negative trends in education levels among the local smallholder community.

Off-farm employment increased markedly, also among women. Our findings revealed that 38% of the active population was involved in off-farm activities, similar to 1997 (40%). Women constituted almost 38% of those engaged in off-farm activities, compared to 20% back in 1997. Indeed, Ulrich et al (2012) already noticed that "male adults were the dominant group engaged in off-farm activities, but that the number of women working off-farm had more than doubled in the observed period".

This comparison of livelihood profiles over the last 20–30 years shows the persistent importance of off-farm non-agricultural employment, but also the persistence of low livelihood assets among households. While a majority of households indicated improvements in household assets (73% of "Employed"; 86% of "Contract" farmers; and 66% of "Non-engaged"), the data indicated very little asset accumulation beyond modest improvements in housing. Income earned is predominantly spent on food, education, and health.

The limited reach of contract farming: While we found only six contract farmers in our original random sample, we found 53 households in the same area who reported having quit contract farming. While the sustained practice of contract farming may benefit some farmers, and help them to accumulate livelihood assets, it may not be a suitable option for many others. These former contract farmers attributed this to difficulties in meeting the standards required, as well as to low productivity and insufficient prices. These households still had a higher number of members engaged in agriculture compared to others; thus, lack of family labour availability cannot explain their quitting contract farming. They also had as many oxen as before, and the percentage of irrigated land remained quite high compared to other households, although much less than those who continued with contract farming (Table 8). In-deed, the explanation for “dropping out” cannot be lack of these assets, as irrigation equipment is not fixed but is installed on fields when required.

There is little evidence that prior experience as a contract farmer contributed to lasting change in agricultural practices among relevant smallholders. The expenditures of former contract farmers for agricultural inputs were greatly reduced compared to those of ongoing contract farmers and were similar to the level among “Employed” households (Table 8). Obviously, former contract farmers will not continue to produce precisely those market crops (such as peas, etc.) that demand such inputs. However, we can deduce that these farmers did not apply the same quantity of inputs (or with the same frequency) to produce other crops such as maize. This suggests they returned to less intensive forms of production after quitting contract farming.

Table 8. Comparison of several agriculture assets between households who had a contract and the other (weighted data). Source: Afgroland (2017).

VARIABLES	**CONTRACT?**		*OTHER GROUPS*	
	Had a con-tract	**Have a Contract**	*Employed*	*Non-en-gaged*
Total members engaged in agriculture (mean)	**2.0**	**2.1**	*1.6*	*1.6*
Total of people hired full-time (mean)	**0.2**	**0.5**	*0.1*	*0.1*
Total of people hired part-time (mean)	**4.3**	**23.5**	*5.6*	*4.4*
Irrigated land - %Yes	**59**	**100**	*31*	*27*
Total of ox (mean)	**2.9**	**2.8**	*1.4*	*1.9*
Seeds	**2,500**	**14,060**	*4,800*	*2,625*
Fertilizers	**3,300**	**10,500**	*3,500*	*3,000*
Disease products	**2,200**	**8,675**	*2,000*	*1,740*
Other inputs	**1,200**	**5,000**	*1,000*	*700*

4. Discussion

The results of our study show that in an area with a major presence of commercial farms, a large number of smallholders with very small landholdings co-exist. Despite a relatively high number of jobs being offered by the commercial farms, relatively few households engage as employees (15%), and this engagement features high spatial variation. We attribute this variation mainly to the different production models of the commercial farms, which require different numbers of employees, as well as to preferences with regard to recruitment of workforce (small-holders or urban workers). Indeed, commercial farms also employ many workers from the urban and peri-urban settlements in the area. Another study in the Nanyuki area, with a different sample of households, in different sub-regions, similarly found only a small fraction of smallholder households (6%) involved in employment on commercial farms (Mutea et al., 2019). Further, we conducted additional interviews in another area further away from the commercial farms (+15 km), and found that the number of households there involved in commercial farm work was even lower (below 1%). This shows that the distance to commercial farms is important, especially considering time and the cost for employees of commuting to the workplace. Similarly, contract farming was also rare among the households surveyed (1.6%) and was found only in one specific location, mainly where smallholders have access to water for irrigation and larger landholdings.

We find some evidence that participation in the labour market may be more transitory. The wage levels that we recorded were low, and respondents often explained that the work is strenuous, and is not seen as a very attractive opportunity. Therefore, we can interpret job opportunities on commercial farms as an option to fill gaps in the household budget, according to the perception of locals. This perspective was repeatedly voiced in the individual and informal discussions with respondents. Nevertheless, the evidence also suggests that income earned on commercial farms plays a positive role in relevant households' food security, enabling families to complement their subsistence. This was found by Fitawek and Hendriks (2021) by analysing our data about food security. Käser (2018) and Peter et al. (2018) also investigated the impact and perception of employment on farms among smallholders via in-depth ethnographic research; they, too, confirmed the ambiguous impact of these employment (and contract) opportunities – wages are low, and the work is physically taxing, but it remains an important source of cash income for smallholders and employees, which would otherwise be difficult to find.

Contract farmers have more agricultural assets in terms of land, irrigation and cattle. Access to irrigation water, in particular, represents a precondition for participation in extensive vegetable production in semi-humid conditions. The livestock holdings of contract farmers and the perception of an increased number of livestock over the last 10 years can be interpreted as evidence of modest accumulation of capital and the adoption of new technologies (e.g. stall-feeding, fodder conservation). Farmers also benefit from credit facilities and spillover benefits to community members who are casually employed by the contract farmers. This confirms the results of others. For instance, Meemken and Bellemare (2020) found that contract farmers and their households are more likely to own productive resources such as land and livestock, and concluded that access to resources is a precondition for, or the outcome of, contract farming. However, they note that contract farming may not always be beneficial. Chamberlain and Anseeuw (2019) also point to imbalances in control over resources, lack of knowledge transfer, marginal benefits, and specific characteristics of contracts favouring company interests rather than smallholder interests – all of which could explain the modest benefits to small farmers. Similarly, Käser (2018) highlighted the testimonies of farmers in our research area describing such power imbalances.

Contract farming seems to be an option only for a small fraction of the local households, often only temporarily. This is evident by our finding that only 2% of households are involved in contract farming. As this type of contract farming is very much dependent on irrigation, and access to irrigation water is scarce; only limited dynamic effects through contract farming takes place in the region. In fact, contract farming for horticulture has lost importance in the region (Käser, 2018; Mutea et al., 2017). Our findings seem to confirm this decline. This decline has been attributed to exceedingly higher standards imposed on export-oriented horticulture, and which are difficult to meet in out-grower schemes. Contract farming results in a change of farming technologies, as farmers switch from maize and other field crops to higher-value horticulture crops. However, this is driven by the requirement of the particular crops and the specific value chain. The conditions for smallholders to enrol in the scheme is ownership of land and the presence of water supply. The commercial farms aim to spread production risk and meet their production deficit. They offer training and supply inputs on credit arrangements (pers. communication with one of the senior managers of the outgrower scheme). However, the farmers have often complained due to low prices and strict production conditions that eliminates a large number of potential participants (source: qualitative interviews). While data shows that contract farmers are slightly better off than other households, contract farming does not appear to lift farmers clearly to another level of wealth or income, and are a suitable arrangement only for a selected few.

There is a lack of reliable data on the incidence of contract farming in developing countries that could serve as a comparison. Oya (2012), based on earlier estimations for developed countries (Glover, 1990; Rehber, 2000), hypothesized that for developing countries it was probably below 15%. But Oya (2012) has also highlighted the importance of contract farming can be important for specific crops (for instance milk, cotton, tobacco) and also for certain countries (for instance in Africa Mozambique, Kenya, Zambia). He explicitly mentions the well-known case of Kenya, where contract farming was found to be important for tea, sugar and cut flowers (but where contract farms are large commercial businesses). In any case, it is notable we find such low participation of contract farmers. But the conditions are becoming stricter and more difficult to comply with for smallholders (Peter et al., 2018), and some commercial farms are also shifting away from contracting smallholder farmers due to increased transaction costs for the exporter (Giger et al., 2020). Based on these findings it seems not very likely that this type of contract schemes are acting as a vector for change in the agrarian system we have studied.

Non-agricultural off-farm employment and remittances continue to be important ways of diversification of livelihood strategies. Kohler (1987) already found in the study area that most households relied on incomes from their businesses or permanent and temporary employment. Wiesmann (1998) emphasized the importance of remittances. Our findings show a lower, but still important role of remittances and off-farm employment. Direct comparison is difficult, as much depends on the concrete formulation of the interview questions and the underlying definition of the terms. Notably, our investigation did not include the importance of family networks as support received through such networks.

Comparing our findings to earlier data on smallholder livelihoods in the area, **there is little evidence of significant change in farming strategies** in terms of specialization or intensification beyond a small minority of contract farmers. Generally, farmer livelihoods remain precarious and depend on rain-fed farming in small areas, a few livestock, and additional off-farm income with low wages. The food security of many households is not guaranteed for the whole year. However, in terms of incremental adoption of agricultural practices, there is indeed an adoption process going on, as evidenced in interviews on land use practices in the area (Zaehringer et al., 2018). As Wiesmann (1998) and Käser (2018) have shown, many farmers immigrated from other areas in Kenya and had to adapt their agricultural practices to local conditions on arrival. This process is continuing (Käser, 2018), but the options are limited due to climatic and soil constraints and the small surfaces available for farming. Currently, milk and horticulture production appear to be among the few options available for smallholders. More intensive milk production with stall feeding and fodder production and conservation, combined with better logistics and marketing through dairy cooperatives, could be a strategy for households who aim at a more specialized and professional production.

Limitations: Our sample includes only smallholders in the area. Consequently, those who are not settled on the land, those who are not able to access land due to high prices, or anybody who has lost access to land was not included in our sample. Regarding the loss of land, it is known that the commercial farms are located on the land owned by previous colonial and post-colonial large scale farmers and ranchers (Giger et al., 2020), hence no smallholders lost land due to these more recent investments. Nevertheless, our focus on those who have access to land creates a possible bias that must be considered when interpreting the data.

We also lacked data on social networks, which could have complemented the analysis of livelihood assets. Participation in religious and family networks, or in exchange of labour or credit groups, can be an important element of well-being – one that deserves further investigation.

Further, without time series of data, and considering the small sample size of the group of employed and contract farmers, opportunities to explore causal relationships via statistical and other quantitative methods remains constrained.

5. Conclusion

This research complements detailed ethnographic case studies performed in the region (Käser, 2018; Peter et al., 2018) and enables generalization of certain findings from a unique location to the wider study area. Overall, we find employment on the farms provided substantial, but limited benefits to a relatively small proportion of smallholders in adjacent areas. Further, contract farming remains an option only for a few households. We find only modest evidence of a transfer of technology from commercial farms to smallholders, aside from production of selected horticulture crops and the use of certain irrigation equipment. Agricultural inputs such as fertilizers and pesticides are purchased and used by all farmers; however, this cannot be attributed solely to the presence of commercial farms, but rather to the general liberalization of agricultural input markets in Kenya (Käser, 2018).

While we found some improvements for particular livelihood indicators, there is little indication of a rapid transformation towards more specialized agriculture production. Considering the large number of NGOs and government agencies active in the region (Käser, 2018), our findings are consistent with the concerns raised by Collier and Dercon (2014) regarding the limited potential of transforming smallholder agriculture as an effective way out of poverty. However, the employment opportunities on commercial farms in the region also do not appear to represent an effective way out of poverty; they seem to function more as a safety net for households in need of income to cover basic needs. Further, as described, contract farming is practised only by a few households and is not attractive or feasible for many others. This case study, despite the continued presence of large commercial farms, therefore does not find evidence for a wide-spread multiplication of “hybrid models in which smallholders interact with larger farmers” (Collier and Dercon (2014) which would be likely to transform the smallholder sector. At the same time, options to increase agricultural production in the relatively harsh environment are limited for many smallholders.

Nevertheless, improvements in access to drinking water and quality of housing point towards modest gains in local well-being standards in the last 20 years. However, again, this progress cannot be attributed solely to the presence of commercial farms. Still, in view of economic development, public services such as roads, electricity, and other goods are being expanded locally and can be attributed – at least indirectly – to the presence commercial farms. This could in turn accelerate the emergence of new activities. Moreover, the commercial farms also contribute to tax generation. Finally, the commercial farms also employ staff from outside the adjacent area (Peter et al., 2018), thus contributing to the local labour market. However, an apparent decline in education levels among area smallholders is cause for significant concern.

Our study did not investigate the cost and benefits or the sources of funds used to invest in public services in the region. However, it is evident that the commercial farms and the change in the structure of the smallholder sector should not be considered independently, but rather as part of a broader economic development pattern. Technology transfer and improved infrastructure may ultimately offer some opportunities for either off-farm employment, successful migration, or the development of more specialized, environmentally friendly agricultural production with higher economic returns.

Our results lead us to formulate the following policy recommendations: Policymakers should be aware that the development of large commercial farms can indeed provide benefits in terms of job creation, but may only support income generation among a small fraction of smallholder households. Without intervention, wages paid may not rise above national minimums. So far, these jobs are not great enough in number or quality to transform the livelihood of households. Similarly, the potential of contract farming to improve smallholder livelihoods needs to be scrutinized. In the case of high-value crops for export such as flowers and vegetables, it appears difficult to outsource this production to small producers, given the stringent requirements of export market in terms of quality and food safety. Considering the lack strong technology transfer from commercial farms to smallholders – confirmed by other studies in this area (Zaehringer et al., 2018) – there should be more efforts to train and support smallholders in intensifying their production (e.g. milk production) and provision of help with required infrastructure, such as irrigation and services (e.g. access to credit).

Overall, we recommend investing more to support smallholders in producing for local consumption and national markets. This will require ongoing and increasing support in the form of agricultural extension services and support with appropriate infrastructure and services. Additionally, support for development of other employment opportunities outside the agricultural sector remains important, as in the given semi-arid context limited opportunities to improve livelihoods of local smallholder producers seem to prevail.

Supplementary Materials: The following supporting information can be downloaded at: xxxx/xxx/s1, SI Table 1. Details about migration status, by type of employment and type of contract (weighted data); Figure S1: title; Table S1: Survey questionnaire; SI Table 2 House and home assets endowment profiles of the households, descriptive results by groups and chi-squared tests by pairs of groups; SI Table 3. Median of amounts spent in total for agriculture inputs (in USD) and new techniques adopted (%), by households groups (weighted data); SI Table 4. Median daily wages in USD, by type of activity, areas and gender (weighted data); SI Table 5 Logistic regression

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Supplementary Information

SI Table 1. Details about migration status, by type of employment and type of contract (weighted data)

VARIABLES		HOUSEHOLD'S GROUPS		
		Employed	**Contract**	**Non-engaged**
		%	*%*	*%*
Migrant	yes	80	86	89
	no	20	14	11
Why did you come here?	land	76	82	80
	work	11	6	13
	wedding	8	10	5
	other	5	2	2
Since how many years do you live here?	median	10	20	20

Source: Afgroland survey (2017) In: Reys et al. (2018)

SI Table 2 House and home assets endowment profiles of the households, descriptive results by groups and chi-squared tests by pairs of groups

		Descriptive Results			CHI2 TEST (P-VALUES)		
		Employed*	**Contract**	**Non-engaged***	**Employed/ Non-engaged**	**Employed/ Contract**	**Contract/ Non-engaged**
		%	%	%			
Cement/bricks wall	yes	18	18	21	0.398	0.682	0.699
	no	82	82	79			
Corrugated iron/zinc roof	yes	96	100	98	0.319	0.120	0.299
	no	4	0	2			
Piped water in house/yard	yes	56	100	55	0.728	0.000	0.000
	no	44	0	45			
Water safe to drink	yes	90	100	85	0.087	0.055	0.001
	no	9	0	15			
Toilets	yes	100	100	100	-	-	-
	no	0	0	0			
Electricity	yes	40	56	57	0.032	0.057	0.797
	no	60	44	43			
Bed with mattress	yes	100	100	100	0.670	-	0.646
	no	0	0	0			
Sofa set	yes	92	100	93	0.977	0.028	0.026
	no	8	0	7			
Table	yes	98	100	98	0.830	0.278	0.221
	no	2	0	2			
Electric stove	yes	49	50	39	0.354	0.524	0.064
	no	51	50	61			
Radio	yes	84	94	88	0.838	0.112	0.090
	no	16	6	12			
Mobile phone	yes	96	98	98	0.434	0.470	0.832
	no	4	2	2			
Tape	yes	32	37	33	0.639	0.259	0.303
	no	68	63	67			
Television	yes	65	59	59	0.535	0.877	0.648
	no	35	41	41			
Motor Vehicles	yes	36	20	23	0.200	0.173	0.619
	no	64	80	77			

Notes: statistically significant difference between the groups at a 5% rate or under are highlighted in grey. Source: Afgroland survey (2017) In: Reys et al. (2018)). * data weighted

SI Table 3. Median of amounts spent in total for agriculture inputs (in US$) and new techniques adopted (%), by households' groups (weighted data).

VARIABLES		GROUPS OF HOUSEHOLDS		
		Employed	**Contract farmers**	**Non-engaged**
Spending in seeds	in US$ (mean)	48.00	140.60	26.25
Spending in fertilizers	in US$ (mean)	35.00	105.00	30.00
Spending in disease products	in US$ (mean)	20.00	86.75	17.40
Spending in other input	in US$h (mean)	10.00	50.00	7.00
% having adopted new techniques	Yes	63	88	60
	No	37	12	40

Source: Afgroland survey (2017) In: Reys et al. (2018)

SI **Table 4**. Median daily wages in US$, by type of activity, areas and gender (weighted data).

		All	**Male**	**Female**
Daily wage	agribusiness employee	3.20	4.20 (24 obs.)	2.80 (30)
	non-agriculture employee-	4.20	4.20 (73)	3.20 (41)
	Non-agr. self-employee-	2.50	2.50 (76)	1.80 (49)
	.	.	.	.
	.	.	.	.
Daily wage large-scale farm only	management	13.30	8.30 (3)	13.30 (1)
	technical skilled	4.20	5.80 (13)	3.20 (5)
	unskilled	2.80	3.20 (8)	2.20 (25)
	permanent	3.20	5.80 (18)	2.80 (20)
	temporary	3.20	3.50 (2)	3.20 (2)
	declared	320	4.20 (19)	2.80 (24)
	non-declared	280	3.70 (5)	2.50 (6)

Note: Contract households are included; observations are indicated between (parentheses) and are unweighted. Source: Afgroland survey (2017) In: Reys et al. (2018)

SI Table 5 Logistic regression

(Processing data for employed and Non-engaged)

```
Logistic regression                               Number of obs     =        297
                                                  LR chi2(22)       =      32.63
                                                  Prob > chi2       =     0.0673
Log likelihood = -115.05988                       Pseudo R2         =     0.1242
```

CatEmp	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
MigrFar	-.909767	.7162607	-1.27	0.204	-2.313612	.4940781
MigrNear	-.5046518	.4676939	-1.08	0.281	-1.421315	.4120115
MigrNon	0	(omitted)				
GendFem	-1.59684	.9611759	-1.66	0.097	-3.48071	.28703
GendMale	0	(omitted)				
Land1ha	.7683623	1.098883	0.70	0.484	-1.385409	2.922133
Land13ha	1.011436	1.101362	0.92	0.358	-1.147194	3.170067
Land3ha	0	(omitted)				
WscoreRich	-.3119591	.428992	-0.73	0.467	-1.152768	.5288497
WscoreAve	-.0582773	.4110714	-0.14	0.887	-.8639624	.7474078
WscorePoor	0	(omitted)				
Age30	1.011698	.8963999	1.13	0.259	-.7452137	2.768609
Age3039	1.462275	.5849909	2.50	0.012	.3157136	2.608836
Age4049	.7979629	.5898567	1.35	0.176	-.358135	1.954061
Age5059	-.0505825	.6002699	-0.08	0.933	-1.22709	1.125925
Age60	0	(omitted)				
EducNo	1.17928	1.172623	1.01	0.315	-1.119019	3.47758
EducPrim	.6653595	1.134024	0.59	0.557	-1.557286	2.888005
EducSecu	.7592452	1.147671	0.66	0.508	-1.490149	3.008639
EducHigh	0	(omitted)				
Lstock0	1.004995	.8563199	1.17	0.241	-.6733606	2.683352
Lstock14	.7515487	.8267484	0.91	0.363	-.8688484	2.371946
Lstock5	0	(omitted)				
Members3	-.1139032	.7921585	-0.14	0.886	-1.666505	1.438699
Members46	-.0814431	.6164069	-0.13	0.895	-1.289578	1.126692
Members7	0	(omitted)				
Children0	-.6253058	.7586558	-0.82	0.410	-2.112244	.8616323
Children12	.0168374	.4359907	0.04	0.969	-.8376886	.8713634
Children3	0	(omitted)				
StatusDiv	0	(omitted)				
StatusMar	-.982811	1.105332	-0.89	0.374	-3.149223	1.183601
StatusSing	-.8348845	1.212796	-0.69	0.491	-3.211921	1.542152
StatusWid	0	(omitted)				
_cons	-2.719078	2.137651	-1.27	0.203	-6.908796	1.47064