Forgone opportunities of large-scale agricultural investment: A comparison of three models of soya production in Central Mozambique

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Abstract

Agriculture is one of the main engines for prosperity and economic growth in Africa but effective agricultural strategies to support rural development and poverty alleviation are not yet identified. While state investment in the small-scale farming sector is minimal, and the medium-scale "emergent" household farm sector remains underrepresented, large-scale land investments are advocated as means to bring capital to rural areas and stimulate development. Yet, little empirical research has been done to contrast agricultural development strategies and to understand their strengths and weaknesses. We present an analysis of different soya production models - small-scale farmers, medium-scale mechanised emergent farmers, and large-scale commercial operations - and their socio-economic aspects in Central Mozambique. Based on purposefully collected data in 10 villages in Gurué district, our findings suggest that large-scale plantations create localized land scarcity and that the benefits from wage labour and local investments do not compensate rural populations for lost access to land. Small- and medium-scale soya farming also leads to decreasing land availability, but provides greater socio-economic benefits such as on-farm employment and work opportunities along the local value chain. Small- and medium-scale soya production increases on- and off-farm income and leads to spill-over effects to the local economy. Negative effects of these models of soya production on food production could not be detected; instead the cultivation of soya significantly increases maize yields grown in rotation. These findings suggest that small- and medium-scale commercial farming can compete with large-scale operations in key socio-economic parameters and that a concentration on large-scale investments can result in forgone opportunities regarding rural development and poverty reduction.

Keywords: commercial agriculture; emergent farmer; socio-economic assessment; land-use change; rural development;

1. Introduction

Agriculture is one of the critical engines for rural economic growth in Africa, employing more than 70% of the labour force, and has highest leverage on poverty reduction in rural areas where the majority of the poor live (ECA 2016; World Bank 2008). Although investment in the small-scale farm sector has long been seen as a powerful lever for rural development, and the Comprehensive African Agricultural Development Programme (CAADP) foresees 10% of the government budget allocated to agriculture, state investments remain minimal and low productive subsistence agriculture remains the dominant production model (Hazell et al. 2010; Arndt et al. 2016; Imai & Gaiha 2016).

Large-scale land investments are often advocated as means to fill the present investment gap in rural areas and to stimulate rural development by providing employment, enabling farmers to access markets, credits, knowledge and technology or by investing in infrastructure as part of corporate social responsibility commitments (Deininger & Xia 2016). The coexistence of large-scale operations and small farms is often seen as ideal scenario where the investors bring capital to rural areas and develop land considered idle (De Schutter 2011). However, systematic evidence of poverty alleviation and rural development driven by large-scale agricultural investment remains scant, which limits the scope for evidence-based policy making (Deininger & Xia 2016; Herrmann 2017). While many authors may conceptually demonstrate the case for large-scale agricultural investments' potential for rural economic development, the empirical evidence tends to show ambivalent results depending on policy regulations, community-investor partnerships and business models (Brüntrup et al. 2016; Baumgartner et al. 2015; Herrmann & Grote 2015; Herrmann 2017; German et al. 2016; Cotula et al. 2011).

Large-scale investments are often treated as inevitable and policy regulation as the solution for risk minimisation, yet the development of alternative programmes for rural development are neglected (De Schutter 2011). To date however, there is limited evidence that contrasts the main strengths and weaknesses of different agricultural development strategies in-situ (German et al. 2016), and it remains unclear whether certain agricultural production models have higher potential for effective poverty-reducing impacts, or whether different models can coexist given the potential trade-offs between for land, labour, markets and ecosystem services (De Schutter 2011; Messerli et al. 2014). Governments have a challenge in identifying effective strategies to support rural development and poverty alleviation (German et al. 2016) and require evidence-based recommendations on agricultural investment programmes. The aim of this study is therefore to contribute to the identified need for comparison of agricultural development strategies. We contribute to this research gap by comparing three different soya production models and their relative socio-economic performance in the main soya-producing region of Mozambique.

Geographically, Mozambique as a land and water abundant country has huge agricultural potential (Jayne et al. 2014; Aabø & Kring 2012; do Rosário 2012). However, it remains a net importer of agricultural products with poverty deeply rooted in underdeveloped agriculture and markets (do Rosário 2012). In the last decades, agricultural growth was neither inclusive nor ecologically sustainable but has stemmed from the expansion of low-productive cropping area without generating new employment opportunities (ECA 2016). The adoption of technologies, integration into markets and the provision of extension services remains weak (Benson et al. 2014). Attempts to attract capital into the agriculture sector in the form of large-scale land investments are often premised on the idea that this will accelerate socio-economic development of neglected rural areas (Deininger & Xia 2016; Mosca 2014). Following the food crisis in 2008, Mozambique has seen a significant rise in the number of large-scale land acquisitions using the country's land abundance as a rationale for investment (Anseeuw et al. 2012). At a national level, this argument holds, but prime agricultural land is actually rare, highly concentrated in the central and northern regions (Chamberlin et al. 2014; Jayne et al. 2014) and associated with relatively high population densities (INE 2014). The rush in land acquisitions – commonly called "land grabbing" – has initiated controversies about land allocation and agricultural production models in Mozambique, supported by a growing body of literature showing that most of the large-scale investments do not bring the desired positive effects for rural economies (Hanlon & Smart 2012; Di Matteo & Schoneveld 2016; Deininger & Xia 2016; Bleyer et al. 2016; German et al. 2016; Aabø & Kring 2012) and has led to increasing civil society contestation (Shankland & Gonçalves 2016). One of the most prominent examples is PROSAVANA[1], a project that aimed at large-scale agricultural transformation but that was almost entirely put at halt through civil society contestation.

Mozambique's agrarian policies aim at agrarian dualism with the country being integrated in international commodity markets, by means of agribusiness expansion in Agricultural Growth Corridors and exportation (Clements & Fernandes 2012; Paul & Steinbrecher 2013), and with state interventions in the small-scale farm sector (GoM 2010b). The country's Land Law (GoM 1997) - described as among the most progressive in the region (Nhantumbo & Salomão 2010) - follows the dual objective by supporting rural community land-rights and encouraging private investment. Between the two extremes, the medium-scale entrepreneurial farming sector remains underrepresented (Hammar 2012; Hanlon & Smart 2012). Additionally, state investment in agriculture remains minimal: 4% of the annual budget was allocated to agriculture between 2000 and 2008 (World Bank 2011). New policy options have called for a more comprehensive economic diversification where agricultural increased productivity is based on sound environmental concerns, market integration, job creation and equity in access to inputs and outputs (Gradín & Tarp 2019; World Bank 2018)

Soya production in Mozambique presents an interesting case of agricultural intensification, with demonstrable potential risks and benefits. Soya cultivation mainly serves the growing demand for feed in the national poultry industry. Due to favourable market prices, the number of farmers starting to produce soya is increasing; between 2000 and 2010 production rose by 44% and the land under soya by 35% (Pereira 2014)[2]. Nationally, 82% of the land under soya is cultivated by small-scale farmers, 3% by medium-scale farmers and 15% by large-scale operations (INE 2011). In a country where social and economic development is closely connected to the agricultural sector, this case can illuminate the implications of different agricultural investment routes.

The aim of this study is to compare small-scale farmers, medium-scale mechanised "emergent" farmers, and large-scale commercial operations. To do this, we critical examine and compare the outcomes of four socio-economic indicators - economic profitability, impact on food crop production, local livelihood and land conflicts - of the three soya production models . We draw on mixed-method data from 10 villages in one of the main soya-producing regions of Mozambique. We enrich the analysis with an assessment of land dynamics and the creation of land-scarcity classes, as we argue that the performance

[1] Prosavana is a Japanese, Brazilian and Mozambican cooperation program established in 2009 aiming at the modernization of the agricultural sector in Mozambique by applying Brazilian agribusiness and agricultural expertise to the target region, the Nacala Corridor in Northern Mozambique. The "Master Plan" foresaw significant private-sector investment in commercial agriculture and agro-processing while governmental support for small-scale farmers was only emphasized after civil society has started campaigning for more transparency and participation of the small-scale farming sector (Shankland & Gonçalves 2016).

[2] In 2014, soya was cultivated on 39139 hectare, corresponding 0.7 % of the arable land. Average yields were at 1.3 t ha^{-1} (Pereira 2014).

of production models has to be discussed in the context of land availability. In order to understand our observations in time and to make trends visible, we use the land-scarcity classes as space-for-time substitution. This assumes that the study villages move from land available to land limited parameters, driven by gradual population increase and expansion of commercial agriculture. In this way we infer past trajectories from present patterns and develop recommendations about the most appropriate agricultural production models.

2. Methodology

The present study is part of the interdisciplinary ACES project (Abrupt Changes in Ecosystem Services and Wellbeing in Mozambican Woodlands), which aimed to understand how woodland loss and degradation is changing ecosystem services availability, and the wellbeing of the rural poor in Mozambique.

2.1. Study area

This paper is based on research carried out in Zambézia province. Zambézia is the second most-populous province of Mozambique estimated to accommodate more than 20% of all smallholders in Mozambique and is one of the country’s main soya-producing regions (INE 2011; INE 2014). The present study took place in the northern part of Zambézia, district of Gurué, *Posto Administrativo* (PA) Lioma. Lioma has a population density of 64.3 inhabitants/km^2 compared to 44 people/km^2 for Zambézia and 31 people/km^2 nationwide (INE 2014). The climate is humid with a precipitation of 1030 mm per year. The rainy period starts in November and continues until April (INE 2013). More than 90% of all agricultural land is cultivated by small-scale farmers who have 1.5-2.5 ha of land and do not use modern inputs; 6.8% of agricultural land is used by large-scale companies (GoM 2015). In Lioma the most important subsistence crops are maize, cassava, rice and beans; the most important cash crops are pigeon pea, soya, cowpea, sunflower and sesame (GoM 2015). The landscape consists of agricultural land and miombo woodland, which is largely confined to mountainous areas and small patches. The woodland provides most local inhabitants with fuel wood, and like most of the miombo is also used for a wide range on not timber forest products, including wild fruits, honey and construction materials. Estimates from 2005 suggest that Zambézia has a forest cover of 49% and a deforestation rate of 0.71% per year (1990-2002), slightly higher than the national average (Marzoli 2007). During a provincial stakeholder workshop organised by the ACES project, commercial agriculture was identified as one of the important drivers for land use change.

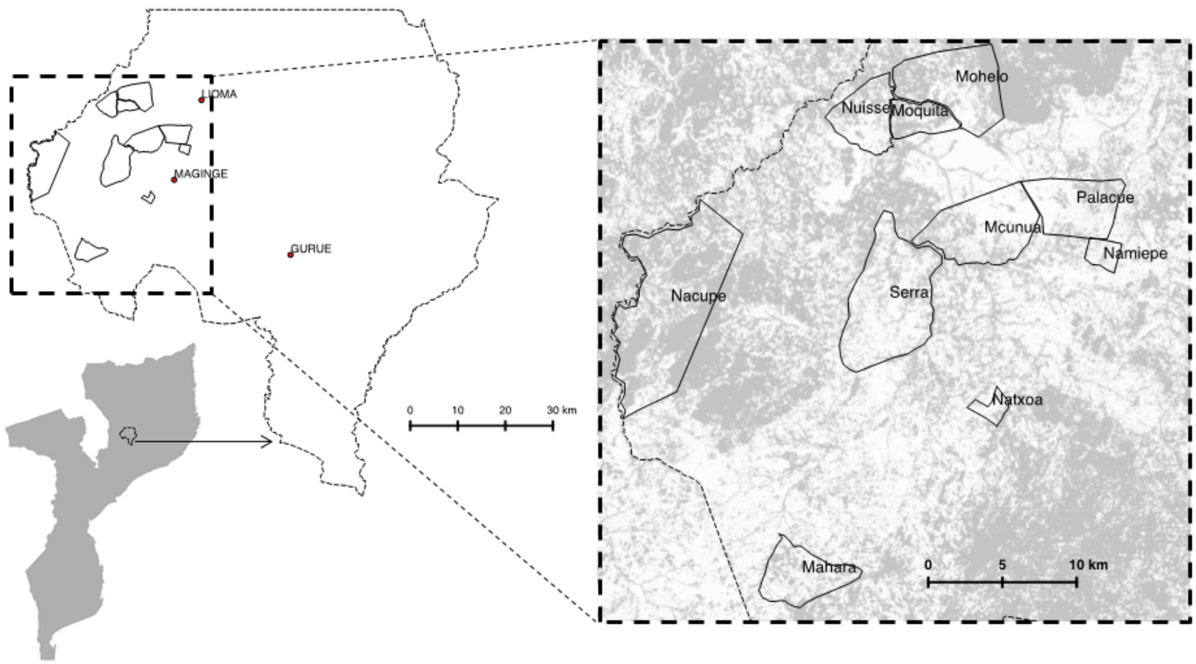

Figure 1 Biomass cover and boundaries of selected villages in Gurué district, Mozambique. Grey shows area with biomass > 10 t C/ha, white shows area with biomass < 10 t C/ha. Land scarcity classification: ‘land available’ (Nacupe, Mohelo), ‘land availability decreasing’ (Nuisse, Serra, Palacue, Mahara), and ‘land limited’ (Moquita, Mucunua, Natxoa, Namiepe).

Soybeans were first introduced by Brazilians on the Lioma state farm in the 1980s, but all activities closed in the late 80s due to the civil war. From 2002 onwards soybean production was reinitiated by a variety of donors and NGOs (World Vision, CLUSA, TechnoServe, Gates and others) that heavily promoted soya production by providing a technology and support package particularly to small-scale farmers over more than a decade (Pereira 2014; Hanlon & Smart 2012). Rising national demand for soya, a guaranteed market and high prices led to fast uptake of soya production (Pereira 2014). Currently, one fifth of all Mozambique’s soya production is located in the district of Gurué. The household farming sector (comprising small- and medium-scale farmers) produce soya on 11,232 ha, equalling 7.6% of the agricultural land in Gurué (INE 2011; GoM 2015). According to district statistics, this contributes approximately 65% to total soya production in Gurué (GoM 2015). By 2010, once early successes had been demonstrated, large-scale companies started to invest in soya production on former state land and on newly cleared land (Hanlon & Smart 2012). At the time of data collection in 2015 they had 5,050 ha under cultivation, equalling 2.8% of agricultural land and contributing approximately 35% to total district-level soya production (GoM 2015).

2.2. Village selection and land scarcity classification

The selection of villages to be included in the study was guided by the creation of a land-scarcity gradient running from villages with abundant land to those with intense land constraints, mainly driven by expanding agricultural activities and population density. During a scoping visit, ten villages at different stages of the gradient with similar infrastructure, soils, rainfall, and vegetation types were selected. The villages were post hoc classified into the following categories: 'land available', 'land availability decreasing', and 'land limited', following the criteria: 1) population density, 2) forested land potentially arable and available, 3) other land potentially arable and available, and 4) locally perceived land limitation. A hierarchical cluster dendrogram gave information about the level of similarity of the villages based on the selected criteria and was used for the final classification of the villages (more information in supplementary material S1 and S2).

The choice of the criteria followed the rationale that land scarcity is not only dependent on population density, as shown in many studies (e.g., Ricker-Gilbert et al. 2014; Headey & Jayne 2014), but also on competing land use. Potentially available arable land per capita can give a first indication for land constraint (Headey & Jayne 2014), which can be enhanced by local perceptions of land scarcity and the proportion of land already under ownership. The land-scarcity classes were developed to: 1) contextualise observations at different stages of land scarcity, and; 2) as space-for-time substitution, assuming that all villages move from land available to land limited due to a gradual population increase and expansion of commercial agriculture. Thus, inference about implications of soya production models in time can be made.

2.3. Data collection

Between September and December 2015, investigations were undertaken in the selected villages to collect quantitative and qualitative social and biophysical data. Qualitative methods include: 1) semi-structured interviews with the village leaders covering village characteristics, main livelihood activities and forest resources (n=10), 2) focus group discussions (FGD) with small-scale soya producers in the selected villages (n=10; 5-10 participants each) and medium-scale soya producers (hereafter emergent farmers) (n=1; 5 participants), 3) semi-structured interviews with large-scale commercial operations (n=3), and 4) semi-structured interviews with other stakeholders involved in the soya value chain (NGOs, traders, and SDAE (District Services of Economic Affairs)) (n=10). The interviews and FGD with the soya producers covered soya production history, production processes, land availability, marketing processes and prices. Moreover, perceived trends of wellbeing, land availability and land conflicts were inquired (Baumert 2017).

Characteristics and livelihood strategies of the households living in the study villages (sample of n=703 households) and of the emergent farmers (n=14) were assessed through a comprehensive household survey. The survey covered sections on household composition; education; health; housing and access to facilities; harvested ecosystem services; land and agriculture; assets and savings; income; subjective wellbeing; coping strategies) (Vollmer et al. 2019). The survey was conducted on tablets with locally trained enumerators using Open Data Kit software. Enumerators were selected based on their knowledge of the study area and the local language. Data were checked for consistency on a daily basis during the field season prior to submission to an internal database. Data cleaning occurred following the field season and involved a second check for consistency in the data recording, the elimination of duplicated entries, spell checking, the checking of uniformity of the spelling for text entries, as well as the handling of missing values.

In terms of sampling, the emergent farmers were identified via snowball sampling and the large-scale operators were purposively sampled. The household survey was conducted in the 10 selected villages using a stratified random sample of (on average) 35.5% of all households (n=703). Strata were based on the participatory wealth ranking information collected by asking a small group of each village's leadership and other community members to assign each household in the village to one of four wealth categories (Lupera et al. 2017) The use of multiple methods within the research allowed the triangulation of findings. All data are curated and publicly available at the NERC Environmental Information Data Centre (Vollmer et al. 2019; Lupera et al. 2017; Baumert 2017).

2.4. Statistical analyses

Descriptive statistics were used to illustrate the main characteristics of the soya production model. Mean values ± standard error are given if not indicated otherwise. Statistical analyses (linear regression, ANOVA) and Bonferroni corrected posthoc-test were conducted for the identification of statistically significant differences between groups at the 0.01, 0.05 and 0.1 level. Different sampling intensities within each wealth strata and thus different probabilities of being sampled were accounted for by a weight factor (calculated as N/Ns with Ns being the size of each strata) included in all statistical analyses. Standard errors were adjusted for nested design (households nested in villages) through robust cluster estimation. Household data were analysed using STATA (13.0). Qualitative data offer 'thick descriptions' of causal processes (Geertz 1973) relating to the quantitative trends observed, and these data were analysed on a thematic basis. These qualitative data are particularly useful for giving depth to interpret quantitative findings and to understand local perceptions of important phenomena and trends.

In order to compare the different models of soya production, economic margins are calculated as the difference between soya revenues and all production costs. Income streams were recorded for all households covering the 12-month period leading up to the data collection event. Gross household income is calculated as sum of all cash income streams comprising income from agricultural production, livestock rearing, fishing, non-forest and forest activities, business, wage labour and other activities. Net income is computed as gross value (price times quantities of all products) minus the total costs (price times quantities) of all purchased inputs (e.g., fertilizers, seeds, tools, hired labour). Due to the difficulty to accurately estimate household labour efforts, related costs are not part of the equation. On-farm income is derived from agricultural production and livestock rearing. All other income generating activities are considered as off-farm. Income inequality is measured using the Gini coefficient and poverty is measured as the proportion of the population below the national poverty line of 18.4 MZN[3] per day per person (GoM 2010a).

2.5. Assessment Framework

Three main soya-producing models could be distinguished: 1) small-scale farmers integrating soybean production in their largely subsistence agricultural activities; 2) medium-scale mechanised farmers that have emerged from smaller scale household based production, and; 3) large-scale commercial

[3] *MZN: New Mozambican Metical. At the time of this study (1st October 2015), the official exchange rate between MZN and US$ was 42.05 (https://www.oanda.com/lang/de/currency/converter/).*

operations (Table 2). The models were evaluated using four different assessment criteria and corresponding indicators. These criteria were selected in regard to their informative value about economic and social sustainability issues relevant for the Mozambican context, and the choices were informed by the literature (van Eijck, Romijn, Balkema, et al. 2014; van Eijck, Romijn, Smeets, et al. 2014; Elbehri et al. 2013; Baumgartner et al. 2015; Herrmann & Grote 2015). The indicators were developed corresponding to data availability and used to evaluate to what extent the criteria are met. As data were collected at different levels (at HH, company, village and community level – indicated as legend to Table 1), indicators vary in their applicability to the three presented production models (Table 1).

From the perspective of economic sustainability, the foremost objective is to ensure financial profitability of the production system (Elbehri et al. 2013) in the short-term, expressed as production margin and net income derived from this model, but in the long-term dependent on other factors such as resource management and market access.

The impact of soya production on food crop production is an essential assessment criterion as cash crop cultivation bears the risk to replace food crops without leading to adequately increased household income and the diversion of large-scale land resources away from food production might probably have effects on local food security (Aabø & Kring 2012; Paul & Steinbrecher 2013). Information about land area allocated to soya and maize production on HH and company level, as well as agricultural practices (such as crop rotation, intercropping, opening of new land) can give a good indication for potential impacts of soya production on food crop production.

The social dimension of sustainability relates to the potential of soya production models for rural development, poverty reduction and inclusive growth. Prominent arguments for large-scale operations and their potential benefits are the generation of on- and off-farm employment opportunities, the increases in local purchasing power and the creation of other spill-over effects on the local economy (Smart & Hanlon 2014; Aabø & Kring 2012; Deininger et al. 2010; Baumgartner et al. 2015). Others argue that equal land distribution and a larger share of small and medium farmers have greater impacts on poverty reduction due to higher labour intensity, local multiplier effects and lower income inequality (Imai & Gaiha 2016; Christiaensen et al. 2011). We focus on the indicators employment generation, impact on the local economy and social wellbeing, and analyse how growth in agriculture driven by the different soya production models effect overall 'local livelihood'. We acknowledge that only inclusive agricultural growth contributes to sustained reduction in poverty and improved social wellbeing (ECA 2016; Imai & Gaiha 2016). Therefore, we compared soya producer with non-producer on village level and derived information on social barriers to soya production and generation of inequality by looking at the participation in the soya value chain according to wealth groups and social criteria, and at perceived changes in wellbeing.

Expanding soya production is likely to lead to greater competition for land and consequently a higher incidence of land conflicts, particularly in a country where informal customary land laws prevail. In the case of large-scale land investments we assess land acquisition processes, land compensation payments and displacement procedures as lacking transparency in land deals is often reported (Cotula et al. 2011; van Eijck, Romijn, Smeets, et al. 2014). The evaluation of local perceptions further gives insight about the promises made by investors and the expectations of villagers. Additionally to the static analysis of the criteria as presented in Table 1, we evaluate small-scale soya production in the context of land dynamics (across land-scarcity classes). This way we could generate inferences between soya production and land availability, agricultural growth and inclusiveness of growth. We use on and off-farm income, income poverty (national poverty line) and inequity (Gini coefficient) as indicators.

Table 1 Socio-economic evaluation criteria and their measurable indicators

Criteria	**Indicators**
Data collection instruments and collection levels: [a)] Interviews with **commercial operations**; [b)] **Household** survey; [c)] Focus group discussions with **villagers**; [d)] Focus group discussions with **small-scale and emergent soya farmers**; [e)] Interview with person from **SDAE Gurué**; [f)] Participatory wealth ranking with **villagers**.	
1. Financial profitability	• Production margins [MZN kg^{-1} ha^{-1}]; net income [MZN] [a), d)].
2. Impact on food crop production	• Proportion of land cultivated with soya and with maize [%][a), b)] ;crop yields of maize [t ha^{-1}]; price of soya and maize [MZN kg^{-1}]; consumption of soya [%] [b)]; agricultural practices (crop rotation, intercropping, opening of new land) [d)];
3. Local livelihood	• *Employment generation:* [no. employees ha^{-1}]; spending on wages [MZN ha^{-1}]; type of employment [a), d)]; origin of workers and working conditions [a)]. • *Impact on local economy*: purchase on local markets; off-farm work opportunities [a), b), c), d)]; qualitative descriptions of: investments in local economy (infrastructure, health care, education facilities) [a), e)]. • *Social wellbeing*: Perceived changes in wellbeing [c)] ; participation in soya value chain according to wealth groups [b) f)] and social criteria [b)];
4. Land conflicts	• Official land titles (DUAT) [%]; incidents of land conflicts [%][b)]; perceived land conflicts [c)]. • Land procurement [ha]; compensation payment; displacement procedure [a)]. •

DUAT: Direito do Uso e Aproveitamento da Terra. HH: households.

3. Results

3.1. Sample characteristics

Small-scale farmer

In 2015, 27% of the households investigated (N=703; n=186) produced soya on a small-scale with an average field size of 1.1±0.09 ha occupying 38-50% (44.2±2.6) of the farmers' cropland. Eleven of the soya producers had a soya area between 2 and 8 ha. Farmers did not use modern inputs for soya cultivation, and they prepared their land manually. 4.7% (n=8) of the soya producers used tractors - those having more than one hectare under soya production. The average yield recorded for 2014/2015 was 0.35-0.45 t ha^{-1} (0.4±0.02), lower than average because heavy flooding at the beginning of 2015 provoked severe yield losses for all crops. As stated in FGDs, in a year with good rainfall 0.75-1.25 t ha^{-1} (15-25 50kg-sacks) can be harvested when soil is prepared manually and 1.25-1.75 t ha^{-1} with mechanical soil tillage (Table 2).

Continuous seed supply was the biggest challenge for soya producers (ref FGD). While the uptake of soya production worked very well beyond the engagement of NGOs and donors – most projects stopped around 2012 – established producer associations and seed banks collapsed with the end of the projects. At the time of our investigations, none of the associations (five in total) were functioning. More than 90% (n=155) of the small-scale soya producers reported the use of seeds from their last year's harvest, however, during FGDs many of the participants stated that they were not succeeding to store enough seeds due to lack of dry and secure storage capacities and emergency sales of complete harvests. Many farmers would have liked to expand their soya production; land was no constraint but current seed supply did not allow for expansion.

Table 2 *Characteristics of the three different soya production models identified in the study area*

Production model **Characteristics**	**Small-scale farmers** *(n=186)*	**Emergent farmers** *(n=14)*	**Commercial operations** *(n=3)*
Mode of planting [a, b)]	Maize-Soya crop rotation (50%/50%)	Maize-Soya crop rotation (33%/66%)	Maize-Soya crop rotation (33%/66%)
Mode of production [b, c)]	Mainly manual (4.7% of producers use tractors for field preparation)	Partly mechanised	Fully mechanised
Type of labour [a, b, c)]	Household labour and seasonal labour (14.7% of producers)	Household labour and seasonal labour	Permanent and non-permanent staff
Input use [a, b)]	No inputs	Certified seeds and inoculants	Certified seeds, fertilizer, pesticides, inoculants
Mode of harvest [a, b)]	Fully manual	Fully manual	Fully mechanised

Average land area under soya (ha) [b, c]	1.1±0.09	18.8±3.1	1683±508
Soya yield (t ha^{-1}) [a, b]	0.75-1.25	1.8-2.25	1.5-2.0
Storage [a, b]	No storage capacity	Storage houses	Silos
Commercialisation [a,b]	Sale to mobile traders with high price uncertainty	Sale to larger-scale traders with price bonus of 1 MZN kg^{-1} for large quantities	Sale to large trading companies or directly to processing units
Processing [a, b]	National market	National market	National market
District area under soya cultivation (ha)[d]	11,232	570	5,050
Beneficiaries [a, b, d]	10,304 households; Approx. 14.7% of producers use 20 seasonal workers per hectare	30 households; Producers use approx. 20 seasonal workers per hectare	202 permanent staff; 460 seasonal workers

Mean value ± standard error. n= number of samples. Data source: [a)] Focus group discussions with small-scale and emergent soya farmers; [b)] Interviews with commercial operations, [c)] Household survey, [d)]Data from SDAE Gurué (GoM 2015).

Emergent farmers

The emergent farmers have expanded their production area beyond the average of the small-scale farmers and intensified their production processes (Table 2). The majority of the interviewed emergent famers (eleven out of fourteen) originate from the same rural area and have been small-scale farmer before. The farmers received substantial support starting in 2010, when a non-profit organisation (Technoserve) initiated a project supporting emergent farmers in the development of commercial farms, both for grain and seed production. Technoserve selected thirty farmers in regard to their viability in terms of farm size end entrepreneurial skills, provided them with a technology package (tractor, plough, and disk) and covered 50% of the cost of the package (with the remaining costs met by the farmer (10%) and bank credit (40%)).

Survey data of the emergent farmers (n=14) showed an average land holding of 24.7±3.6 ha of which 60-83% was occupied with soya (18.8±3.1 ha). Nearly all (12 out of 14) held a DUAT (*Direito do Uso e Aproveitamento da Terra*) for their land, which Technoserve supported them to obtain. In the production season 2014/2015, soya yields were reported to be very low and soya prices unusually high due to the heavy flooding at the beginning of 2015. Recorded yields were between 0.2 and 1.75 t ha^{-1} (0.8±0.5), with a mean price of 18 MZN kg^{-1} (14-19 MZN kg^{-1}). Farmers usually gained a price premium of 1 MZN kg^{-1} when selling quantities of above 1,000 kg to traders. In years with good rainfall, farmers reported to attain yields of 1.8-2.25 t ha^{-1} (ref FGD). Seeds used by the emergent farmers were sourced from their last harvest (36%), from Technoserve (50%; certified seeds) and from the local markets (14%; certified seeds). All producers used their own machinery for the field preparation and 13 of 14 farmers received inoculant for their soya production from Technoserve. During the FGD, they stated that in addition to the use of inoculant and mechanical soil tillage, certified seeds gave much higher yield as all broken seeds and dirt were filtered out.

Commercial operations

In 2015, three large-scale operations were producing soya in PA Lioma (one since 2010, the others since 2012). They had 5,050 ha under production in total and 14,500 ha with DUAT. They practiced a maize-soya rotation which according to them should ideally be 50-50% in order to retain soil fertility. Their yields averaged 1.5-2.0 t ha^{-1}. They used inputs such as certified seeds, herbicides, fertilizer, insecticides, inoculants and machinery for soil preparation and crop maintenance (Table 2). Most of their inputs were sourced from Zimbabwe and Brazil.

3.2. Financial profitability

Beside seed shortage, small-scale and emergent farmers stated that the two main challenges in soya production were high production costs and risk of low prices. Households cultivating more than one hectare of soya needed seasonal labour for field preparation and weeding, required twice per season in order to guarantee good yields (ref FGD). Depending on the yield (0.75 – 1.25 t ha^{-1}) and the market price (14-19 MZN kg^{-1}) a small-scale farmer could attain a production margin of 5-13.5 MZN kg^{-1} on a cash cost basis (Table 3). Emergent farmers could reach a production margin of 6-14 MZN kg^{-1} with yields varying between 1.8 and 2.2 t ha^{-1} and prices between 14 and 19 MZN kg^{-1}. Higher production costs were offset by higher yields and larger scale production, which resulted in higher net incomes.

Profitability was highly sensitive to yields and prices. For small-scale farmers, both are difficult to control: low use of production inputs leads to yields below potential, and sales of small seed quantities to informal buyers underlie fluctuating prices. This made soya production a marginally profitable crop for small-scale farmers. The importance of timely agricultural interventions for high productivity was highlighted in FGDs. At the beginning of the season, most farmers were short of cash and had difficulties in affording certified seeds and measures such as weeding. Here, a credit system could help to realize all measures while maintaining high yields. With timely interventions, emergent farmers achieved the same or even higher productivity than large-scale operations (Table 2). Underlying data of production margin calculations are presented as supplementary material (S3).

Table 3 Production margin and net income of soya production models

Indicator	Small-scale farmer	Emergent farmer
A: Area allocated to crop (ha)	1.09	19
B: Total yields (t ha^{-1})	0.75	1.8
C: Price (MZN kg^{-1})	16	17
D: Gross income (MZN ha^{-1})	**12,000**	**30,600**
E: Production costs (MZN ha^{-1})	**6,800**	**14,350**
Seeds	800	1,250
Inoculants	-	300
Field preparation	2,000	2,500 (mechanical)
Harrowing	-	1,500 (mechanical)

Seeding	Household labour	1,500 (mechanical)
Weeding (2x)	4,000 (manual)	4,000 (manual)
Harvesting	Household labour	1,500 (manual)
Threshing	Household labour	1,800 (mechanical)
F: Net return to land (MZN ha^{-1})	5,200	16,250
G: Production margin (MZN kg^{-1})	6.9	9.0
H: Net income from soya (MZN per farm)	**5668**	**308,750**

*MZN: New Mozambican Metical. At the time of this study (1st October 2015), the official exchange rate between MZN and US$ was 42.05 (https://www.oanda.com/lang/de/currency/converter/). Calculations: D=C*B;F=D-E; G=F/B; H=F*A.*

All of the commercial operations were still in their investment phase, thus production margins and income levels were difficult to calculate. According to one of the operators, the breakeven point would be reached with a yield of 2.5 t ha^{-1} and a price of 500 USD ton^{-1} [4]. The biggest challenge was the clearing of new land and the import of material to Mozambique, hence why they had small proportions of their total land area under cultivation. Large-scale land investment for soya production was unlikely to spread imminently in Mozambique. The commercial operators contributed this to low yields, high production costs, limited domestic market expansion and difficulties with accessing the export market.

3.3. Impact on food crop production

Soybeans had a high price (18 MZN kg^{-1} in comparison to 9 MZN kg^{-1} for maize in 2015) and a guaranteed market, therefore many farmers with means for production in terms of land, labour and seeds engaged in the business. However, there was no evidence to suggest that soya production replaced or threatened subsistence crop production. Farmers generally preferred to maintain a diversity of cash crops and subsistence crops in order to reduce their vulnerability to price volatility and crop failure (ref FGD) and to open new land for soya cultivation (providing that such land was available to the farmer). As such, soya production was repeatedly reported as one of the reasons for land-use change and deforestation (ref FGDs). In villages with reported land limitation and without the possibility of cropland expansion, the number of soya farmers was lower and the land allocated to soya was significantly smaller (see Table 7 in section 3.6). Rather in these villages, people increasingly practised soya and maize intercropping.

Results from the household survey showed (over all villages) that small-scale soya farmers allocated a significantly smaller proportion to their maize production (50.6±1.3%, $p<0.01$) compared to non-soya producing households (66.7±1.1%) . However in absolute terms, they had slightly more land under maize than non-soya producing households (1.3 ha vs. 1.1 ha; no statistically significant difference). Farmers preferred to cultivate soya in rotation with maize and unanimously stated that post soya cultivation, soil fertility was improved and higher maize yields were recorded (ref FGD). Data from the survey supported this statement, showing significantly higher maize yields for soya producing households (672±70.9 kg ha^{-1} vs. 495±28.5 kg ha^{-1}; $p<0.05$). Processing and consumption of soya within

[4] This would equal a price of 21 MZN kg^{-1} at the point of interview (October 2015 http://www.oanda.com/currency/converter/)

the villages was low, due largely to a lack of knowledge and awareness about its utility. In three villages, people reported being trained in the preparation of soy milk and pap by one of the projects. On average, 35.4±3.9% of all soya producers indicated they consumed some part of their soya harvest.

Emergent farmers used on average 2.5±0.5 ha (12.2±2.7% of total land) to produce maize, for consumption and sale. The commercial operations used maize as part of their crop rotation. The share of maize in the rotation should ideally be 50%, but this was dependent on the market price. In addition to maize production, commercial operations also showed some effort to minimise adverse effects on local food production, such as maintaining their sale of maize and rice to local people below market prices, payment in kind, and distribution of maize seeds.

3.4. Local livelihood

Employment generation

In addition to income generation for the producing farmer, all soya production models generated income opportunities for farm workers: 14.7% of the small-scale soya producers hired seasonal labour (n=29) for field preparation and weeding (approx. 20 worker per hectare) and paid in kind or money equalling approximately 100 MZN per person, per day. This kind of seasonal work (locally called *ganho-ganho*) was an income source for 8.6% of households (n=59) of which 74% were non-soya producers and offered an annual income of 683 to 1,406 MZN per worker (1,044±157 MZN). The emergent farmers had their own machinery and had a partly mechanised production process. Most had one permanent employee responsible for the machinery and the field management, and recruited seasonal labour for specific tasks such as weeding and harvesting (ref FGD) (Table 3).

The commercial operations had fully mechanised production processes and employed 0.02-0.06 permanent workers and 0.02-0.3 seasonal workers per hectare. According to the operation managers, all seasonal workers came from surrounding villages, with labour needs announced when relevant. Permanent employees were recruited according to the skills needed locally, regionally or nationally. Most management staff were not Mozambican nationals. The wages paid were slightly above the monthly minimum wage of 3,298 MZN set by the Mozambican Government (TTA 2016) and managers emphasised efforts to introduce social insurance and pension funds for permanent staff. In the household sample, 2.2% (n=14) of households were seasonally employed by one of the commercial operators, earning 885 – 9,975 MZN (5,430±1,637) per annum. 1.8% (n=12) of households were regularly employed for more skilled tasks earning 19,301 – 53,815 MZN (36,558±7840) per annum. Emergent and small-scale farmers spent the most on labour per hectare. At the district level, commercial operations contributed most to the wage sector due to their large-scale of operations (Table 4).

Table 4 Spending on labour per hectare and spending on district level according to the production model

Parameters	Small-scale	Emergent	Commercial
Seasonal labour (pers. ha^{-1} day^{-1})[a)]	20	20	0.1
Frequency of employment (days)[a)]	3	3	30
Permanent labour (pers. ha^{-1})[a)]	-	0.05	0.04

Salary for seasonal workers (MZN pers.$^{-1}$ day^{-1})[a]	100	100	150
Wage for permanent employees (MZN pers.$^{-1}$ month^{-1})[a]	-	3000	3500
Approx. spending on labour per ha and year (MZN)[b]	**6000**	**7800**	**2130**
Number of soya producers on district level [c]	**12,480**	**30**	**3**
Percent of farmers hiring labour [d]	15	100	100
District area under soya cultivation (ha) [c]	11,232	564	5,050
Approx. spending on labour on district level (MZN)[b]	**10,108,800**	**4,399,200**	**10,756,500**

Data source: [a] FGD with soya producers (n=10)/Interviews with commercial operations (n=3), [b] own calculation, [c] GoM (2015)*, [d] data from household survey. At the time of this study (1st October 2015), the official exchange rate between MZN and US$ was 42.05 (https://www.oanda.com/lang/de/currency/converter/).*

Impacts on local economy

Taken together, commercial operations generated high revenues per employee; the small-scale and emergent farming models had higher labour spending per hectare, had more workers that benefited, but with lower revenues per person. In addition to farm employment, small-scale soya production created employment opportunities through the commercialisation of soya. 2.4% (n=17) of the household sample worked as middlemen between small-scale farmer and larger-scale traders, earning between 7,427 and 15,039 MZN (11,233±1,609) per annum. In total, 38% (n=268) of the surveyed households were involved in the soya value chain (**Error! Reference source not found.**). Emergent farmers were also locally rooted and performed multiple functions within the value chain: they provided hiring-out services of tractors to local farmers and acted as soya seed multipliers and distributors (ref FGD). Only three of the fourteen investigated emergent farmers had an ethnicity other than Elomwe and lived in the district centre Gurué, indicating that most of them originated from the area and only few of them were 'lateral entrants' making a migration opportunity from the soya boom.

In contrast, commercial operations were functioning largely independently from local structures. Equipment and agricultural inputs were imported from other countries due to their unavailability in Mozambique, taxes were paid at the national level, commercialisation happened outside the local value chain, and management staff and shareholders were non-nationals. As part of their land loss compensation strategy, investors agreed on a diversity of investments during community negotiations. Since the start of investments in 2010, each of the investors had realised one or more of their promises (e.g. purchase of an ambulance and provision of maintenance and fuel, establishment of a health post and supply of medicine, boreholes, supply of seeds, renting-out of tractors). In addition, most commercial operations ran a type of out-grower program, providing selected farmers with seeds and/or machinery on the basis of credit. Contracting farmers for sales of their harvest was not relevant for farmers because markets were readily accessible, neither were they strategic for companies because they were not vertically integrated into trading or processing businesses. All interactions with local structures were voluntary in nature and depended on the corporate responsibility of the operations, rather than being under official control. As stated (ref interview SDAE), "according to their financial means", each investor decides where and when to take what action. On request, no commercial operations could provide quantitative figures on their social investments transacted, or on how this related to other operation statistics. From the perspective of local farmers, no communities in the vicinity of the large-scale operations had benefited from the operation but all could tell of at least one perceived injustice (ref FGD).

Social wellbeing

Participation in the soya value chain generally increased with increasing wealth. Very poor and poor households represented an important pool for seasonal labour; richest households were mainly involved in the production, commodity trading and regular employment in one of the commercial operations. The wealth groups presented in table 5 are relative and were derived from participatory wealth rankings in the villages. We compare amongst the wealth groups proportion of their participation in different aspects of involvement with the soya chain.

Table 5 Participation in the soya value chain expressed in percentage of people belonging to a certain wealth group (%)

Relative wealth group	**Soya production**	**Commodity trading**	**Seasonal worker**	**Plantation worker**	**General participation in soya**
Very poor (n=181)	10.3±1.4^{a}	0	8.6±2.2^{ad}	3.6±2.2	21.9±1.1^{a}
Poor (n=205)	23.2±3.9^{b}	2.6±1.2	8.9±2.2^{ad}	5.4±2.5	37.7±3.5^{b}
Better-off (n=114)	38.6±5.8^{b}	4.1±1.3	4.6±1.4^{ab}	3.9±1.5	46.0±5.8^{b}
Rich (n=58)	54.9±16.4^{ab}	6.4±2.8	0^{b}	5.2±2.6	57.9±15.8^{ab}
Unknown (n=145)	28.5±7.9^{ab}	1.8±1.1	13.3±1.9^{cd}	2.0±1.6	42.3±6.2^{b}
Total (n=703)	**26.7±4.4**	**2.4±0.6**	**8.6±1.4**	**4.0±1.5**	**38.5±3.7**

The wealth groups are relative and were defined during participatory wealth rankings in the villages. "unknown" classifies those households not known to the people doing the ranking. Different letters indicate significant differences within column at the 5% level. No significant differences at the 1% level detected.

Moreover, soya producing and non-producing households can be clearly distinguished by the following characteristics (Table 6): Soya producers cultivated significantly larger areas and had more household members of working age. The percentage of household heads born in the village was significantly smaller for soya producers, suggesting that the soya boom of 2000 acted as a pull factor for migration. Social variables that might be expected to create participation barriers also show significant differences: soya-producing households had a higher proportion of household-heads that had ever attended school and a lower proportion were female-headed. Moreover, more soya producers had received advice for agricultural activities than non-producers, indicating the importance of agricultural extension for the development of more market-oriented agriculture. Soya producing households had significantly higher farm and off-farm income than non-producing households. Significantly more soya-producing households had improved housing (58±9.8 vs 35±6.4 $p<0.05$) and owned more than one personal asset (86±2.6 vs 57±2.3 $p<0.001$). Amongst soya producing households, farm income comprised 38% from soya, 46% from beans (*feijão boer, feijão manteiga, feijão nhemba*) and 7% from maize sales, compared to 63% from beans and 13% from maize for non-soya producers, reflecting the fact that most households were integrated in a variety of cash-crop activities. The high share of pigeon pea (*feijão* *boer*) is explained by a high market price, which reached 29 MZN kg^{-1} at the end of the 2015 season. The off-farm income mainly comprised business income. Nineteen households had no income at all.

Table 6 *Characteristics of soya producers versus non-producers based on the household survey in Gurué, Mozambique*

	Soya producer *(n=186)*	**Non-producer** *(n=517)*	**p-value**
Average land holding (ha)	3.0±0.35	1.8±0.06	<0.05
Average HH size in AEU	3.5±0.07	3.2±0.08	<0.1
HH-head born in village (%)	65±2.7	77±2.7	<0.05
Years HH head is living in village	9.3±1.7	6.9±0.65	nsd
Average age of HH-head (years)	38.2±0.93	39.0±0.58	nsd
Female-headed households (%)	8.4±2.3	19.3±2.0	<0.05
HH-head attended school (%)	86±3.9	59±3.1	<0.01
Received advice for agriculture (%)[a)]	12.5±3.4	3.4±1.4	<0.05
Average net annual farm income (MZN)	20,504±1,411	8,333±812	<0.01
Average net annual off-farm income (MZN)	13,597±3,672	4,225±546	<0.05
HH below national poverty line (%)[b)]	59.1±4.1	82.6±1.6	<0.01
Average HH income of poorest 20%	4,555±321	1,030±91	<0.01
Average HH income of richest 20%	103,801±13,886	39,632±2,942	<0.01

Mean value ± standard error. Significance as indicated at 1%, 5% and 10% level. Bonferroni adjusted pairwise comparison with robust cluster estimation and sampling weights accounting for stratified sampling. n: number of sampled households. nsd: non-significant difference. HH: households. AEU: Adult equivalent unit with people under 15 years and above 64 weighted at 0.5. All data refer to year 2015. [a)] The national average of farming households that received extension service is 8.3% (GoM 2014)*. [b)]The national poverty line is 18.4 MZN per day per person* (GoM 2010a)*.*

3.5. Land conflicts

More than 99% of the sampled households had customary land rights and did not hold an official land title[5]. In cases where families wanted to expand their agricultural area without having their own land resources, either the village chief was consulted about community land, or neighbours were asked about renting part of their land (ref FGDs). The same applied for people coming from outside, seeking land within the community. In 8 of the 10 investigated villages, people stated that all community land was under formal or informal ownership; emergent farmers seeking to expand their cropped area, reported difficulty finding available land (ref FGDs). Farmers reported land conflicts amongst locals, immigrants and commercial operations in villages with land restriction, as land was increasingly recognised as a source of capital. In all villages, 7.8±2.1% of the surveyed households (n=56) reported experiences with land conflicts, with higher incidents in the villages facing land limitation (9.5±3.1%).

[5] According to the Mozambican Land Law (GoM 1997), land rights are obtained after a residency of 10 years, however, this unwritten right is difficult to defend in case of conflict. Obtaining an official land title (DUAT) is extremely difficult and costly. The farmer is required to repeatedly travel to the district centre and to pay different fees (USAID 2011).

The majority of these had experienced conflicts with neighbours concerning boundary demarcation (n=30) and land expropriation (n=6). Eleven households reported conflicts with one of the commercial operations concerning land expropriation (n=8) and compensation payments for land loss (n=3).

The commercial operation with the highest incidence of conflict was located on a former state farm in the most densely populated area of Lioma, which affected the community land of villages classified as 'land limited' and 'land availability decreasing' (see Table 7 in section 3.6). In 2010 the company received 3,000 ha, and 2,500 ha were under production at the time of data collection. 836 households with a total of 1,945 ha were displaced from the land (source: Hanlon & Smart 2012). The households could choose between resettlement or compensation payment. According to the company manager, the amount paid per hectare followed the officially guideline set by the DPA (*Direcção Privincial de Agricultura*) and 90% of farmers accepted compensation payment. However, during conversations with locals it was repeatedly stated that many of these farmers had difficulties finding new land because most land was already under ownership; Others who opted for resettlement experienced long distances to resettlement areas, bad soils and flood-prone land . In contrast, the land occupied by the operation was known to be prime land where, even in 2015 with flooding, good yields were achieved (ref Interview). Furthermore, the resettlement area already had a resident population with land rights and claims, meaning that land-use conflicts were displaced rather than resolved. The other two operations we investigated received a DUAT for 11,500 ha of forested land in communities classified as 'land availability decreasing'. One of the operations compensated 300 farmers who had their fields in parts of the 1,800 ha taken under cultivation; the other stated that the land they cleared (750 ha) was thick bush and unused. Most displaced farmers took the compensation payment and opened new fields in nearby forested areas, although they stated that the payments were inconsistent (2,000-4,000 MZN per hectare) and were insufficient to pay for their costs of opening new land (ref FGD). According to an inventory undertaken by the district authorities in 2015, 70,000 ha of land in such "forested and scarcely populated areas" was available for further private investments (ref interview SDAE). It needs to be noted that effects of land loss and resettlement associated with large-scale land acquisition were locationally discrete, and mainly occurred outside of our study villages. Only 11 of the surveyed households experienced land conflicts with one of the investigated operations. To analyse effects of land loss on local livelihoods in detail further investigations are required.

All operation managers emphasized that steps required by the Mozambican law[6] (GoM 1997), including community consultation, were undertaken in order to receive a DUAT. However, conflicts with the local

[6] Concessions of less than 1,000 ha were administered by the provincial governor, between 1,000 and 10,000 ha by the Minister of Agriculture and over 10,000 ha by the Council of Ministers. Before any land titles are issued, a detailed project proposal *(plano de exploração)* has to be presented and consultations with the respective communities and local administrative authorities have to be undertaken in order to confirm the availability of the land and to agree about the investment plans and social promises. The negotiation minutes (*acta da consulta*) have to be signed by at least three representatives of the local community and the district Administrator. The consultation of the local community is defined in Ministerial Decision No. 158/2011 (GoM 2011). Farmers that lose their land through the land acquirement have the right for compensation payments which are set by the government according to the land size and the assets located on the land. Instead of compensation payment, farmers can also choose to be resettled to another area. The "*Regulamento sobre o Processo de Reassentamento*"

population could not be prevented, particularly in areas with land limitations. Expectations amongst communities were high because most people still had former state farms with high labour requirements in mind, and promises made by investors sounded ambitious. Households that gave up their land in the expectation of better living conditions felt betrayed (ref FGD). There was apparent mistrust among the locals towards the operations, which was attributed to low levels of information about procedures, fears about change, and feelings of powerlessness (ref FGDs). From the perspective of the operation managers, the communication with the local population had been a constant learning process and many measures were required to minimise misunderstandings. Frequently, modern practices used by the operations clashed with traditional ones e.g., hunting of rats using fire conflicts with zero tillage; collection of the remnant soya harvest by women and children conflicted with the use of heavy machinery; maize cultivation at the borders of soya fields conflicted with the spraying of pesticides (ref interviews). Such conflicting situations required different measures including strict protection of the plantations, and compensation of farmers for yield losses. However, farmers perceived those measures as interfering with their freedom, restricting them from land they previously could freely access.

3.6. Understanding effects of small-scale soya production in the context of land dynamics

Results from the HH survey disaggregated according to the land-scarcity classes suggest the following interpretation: The occurrence of soya production is influenced by land availability, and vice versa soya production affects land availability (Table 7). This interrelationship between soya production and land availability wasconfirmed in FGDs, where farmer stated that they prefer to open new land for soya production. The most noticeable differences among the land-scarcity classes are noted for soya-producing households regarding their agricultural activities (Table 7). The relative number of soya farmers, the land under annual cropping and soya cultivation per household was highest in villages with decreasing land availability. These villages also had the highest number of soya farmers who had received agricultural advice. Soya producers' farm income comprised a variety of cash crops such as soya, beans, maize, sesame and sunflower and was lowest in villages facing land limitation. Off-farm income was remarkably high for soya farmers in 'land availability decreasing' villages and mainly consisted of business income.

Increasingly market-oriented small-scale agriculture and the settlement of commercial operations can be interpreted as one of the main causes of decreasing land availability. The effect of emergent farmers on land dynamics was probably modest due to their relatively small numbers; with a rise in their number the effect will become more pronounced. Elevated off-farm income in the villages with highest soya production (land availability decreasing) suggests that growing market-oriented agriculture affected the non-farm sector positively, through the generation of employment and business opportunities, e.g. the commodity trading was a very lucrative business, particularly for soya producers. Lower on-farm income for soya producers in land limited villages could be an indication of decreasing soil fertility, as a

(Decree no. 31/2012) states that the quality of life has to be maintained or improved when resettlement takes place (VdAtlas 2012).

consequence of permanent cultivation, cash crop intercropping and difficulties in opening new fertile lands for cash crop cultivation.

Table 7 *Land-scarcity classification and characterisation separated for soya producing and non-producing households*

	Land limited *(4 villages)*	**Land availability decreasing** *(4 villages)*	**Land available** *(2 villages)*	**p-value**
Small-scale soya farmers (% of village HH)	19.1±3.0	39.3±10.0	25.4±0.1	nsd
Land under large-scale plantations (% of potentially arable community land)	27.0	6.0	0.0	
Soya producing households (*n=186*)	***n=69***	***n=87***	***n=30***	
Land under annual crops (ha per HH)	2.3±0.3^{a}	3.8±0.3^{b}	2.3±0.1^{a}	<0.01
Area cultivated with soya (ha per HH)	0.9±0.05^{a}	1.3±0.08^{b}	0.9±0.11^{a}	<0.05
HH head born in village (%)	62.6±5.2	67.2±0.7	63.6±9.8	nsd
Received advice for agriculture (%)	7.6±4.3^{ab}	20.2±3.2^{b}	3.3±1.8^{a}	<0.01
Net annual farm income (thousand MZN)	16.9±1.4^{a}	23.4±1.7^{b}	20.1±0.7^{ab}	<0.05
Net annual off-farm income (thousand MZN)	5.2±1.1^{a}	23.9±3.0^{b}	4.7±1.8^{a}	<0.01
All households (*n=703*)	*n=357*	*n=218*	*n=128*	
Very poor HH defined by wealth ranking (%)	20.1±8.4	19.1±8.5	15.5±6.5	nsd
Rich HH defined by wealth ranking (%)	4.4±1.3	6.7±3.4	4.4±4.0	nsd
GINI coefficient$^{a)}$	58.9±2.4^{ab}	65.5±4.4^{b}	52.3±2.2^{a}	<0.05
Income of poorest 20% (thousand MZN)	1.0±0.1^{a}	2.0±0.1^{b}	1.4±0.1^{a}	<0.01
Income of richest 20% (thousand MZN)	45.9±3.3^{a}	90.8±10.6^{b}	41.8±2.2^{a}	<0.01

Mean value ± standard error. n=sample size. Bonferroni adjusted pairwise comparison with robust cluster estimation and sampling weights accounting for stratified sampling. Different letters indicated significant difference between groups. Significance level as indicated. nsd: non-significant difference. HH: households. $^{a)}$The national per capita consumption Gini is 45.6 (Arndt et al. 2016). *All data refer to year 2015.*

It is important to examine whether benefits that accrue with small-scale soya production are inclusive for all households or whether structural participation barriers exist for poorer households. The local perception of the wealth status of households suggested an increase in rich and in very poor households, portraying an agricultural growth pattern where wealthier households accrue relatively more gains and inequality increases. The cash-income Gini coefficient supports this and shows greatest inequality in the main soya producing villages (Table 7). That soya production is difficult to access for very poor households, with education and gender the main barriers (see Table 6 in section 3.4), corresponds with farmers' statements describing field enlargement and year-round maintenance of food security as first steps out of poverty before starting cash crop production (section **Error! Reference source not found.**). Other lucrative soya-related activities, such as plantation work in commercial operations and commodity trading, also presented high entry barriers and were reserved for wealthier households (see **Error! Reference source not found.** in section 3.4).

Nonetheless, the income of the poorest quintile was highest in villages with decreasing land availability, suggesting that very poor households may profit from agricultural development, although, this does not imply causality, and there may also be other reasons for this trend. Extension services could play an important role to reinforce this trend by reaching out particularly to poorer households; Only 9% of households who had received agricultural advice belonged to the lower two income quintiles.

4. Discussion

The evaluation of the three soya production models showed different characteristic and demonstrates that the active promotion of different production models would affect socio-economic conditions and rural development in a variety of ways (Table 8).

Table 8 Summary of the investigated evaluation categories and their impacts (low, medium, high) attributed to the production models

Production model **Evaluation category**	**Small-scale farmer**	**Emergent farmer**	**Commercial operation**
Economic profitability	Medium	high	Yet not reached
Impact on food crop production	Low	Low	medium
Local livelihood	High	medium to high	low to medium
- Employment generation	High	medium	low
- Impact on local economy	High	high	medium
- Social wellbeing	Medium	medium	/n.a.
Land conflicts	Medium	medium	high

This table aggregates the reported findings. Each of the outcomes described is a balanced judgement of the qualitative and quantitative findings and is placed on an ordinal ranking (low, medium, high).

The small-scale and emergent farmer models performed best in all categories: they generated substantial income to farmers without compromising food crop production, created employment on and off-farm, linked into local value chains, and had spill-over effects on the local economy. Although the presented case does not allow for quantifying the spill-over effects of emergent farmers, our observations suggest that emerging farmers can play an important role in the development of a local value chain, by triggering demand and supply multipliers and by providing seeds and machines to local farmers as also reported by other authors (De Schutter 2011; Hazell et al. 2010). It is argued that labour-intensive small commercial farms have more significant and longer lasting positive effects on local livelihoods than large-scale agricultural investments, as increased incomes of farmers and farm workers are normally spent locally and thus stimulates the local non-farm economy and income diversification

(De Schutter 2011; Hazell et al. 2010; Baumgartner et al. 2015). In general, the evidence base for quantifying such impacts of medium-scale farms remains weak and requires targeted research efforts (Jayne et al. 2016).

Beyond multiplier effects, the emergent farmer model reached the same or better levels of productivity compared to large operations. This is supported by findings from Norfork & Hanlon (2012) and Smart & Hanlon (2014) and corresponds with the reported “inverse relationship” between farm size and productivity (Hazell et al. 2010). Contrary to observations described in literature (Jayne et al. 2016; Sitko & Jayne 2014), that most emergent farmers in many African countries entered the agricultural business through off-farm activities as “lateral entrants”, in Gurué the majority of emergent farmers had been living and farming in the area, although these households may have been relatively wealthy for a number of years. Overall, the small and medium-scale soya production model in Mozambique has high growth potential as it needs to satisfy the constantly increasing national demand (Pereira 2014).

For the small-scale and emergent farmer model only few substantial negative impacts can be named. Arguably, agricultural wage employment often acts as a low-access, low-return strategy in response to stress for the rural poor (Davis et al. 2010), and is unlikely to lead to long-term improvement in household welfare (Herrmann & Grote 2015). In our study, 57% (57.4±3.9) of the households that had experienced a shortfall in harvest (n=506), indicated *ganho-ganho* as a coping strategy. The limited employment effect found on household welfare is also supported by the very low levels of annual income gained through seasonal agricultural work (section 3.4). In this regard, commercial operations created higher benefits, but only for a relatively small number of people. Beyond the non-exhaustive range of evaluation criteria used for this study there are certainly other positive and negative livelihood impacts that come along with expanding soya production. Particularly, for those households not involved in soya production, benefits might not accrue to the same degree as for those involved in soya production. Future research should bring light to these unresolved issues.

We believe that the sampling of villages along a land scarcity gradient as a substitute for temporal land use dynamics (space-for-time substitution) is the only practical approach to understand consequences of soya production in the context of land dynamics (Walker 2011). The results show that increasing small-scale soya production is associated with decreasing land availability. Soya production is part of an increasingly market-oriented agricultural model accompanying a diversity of cash crops. The production of higher value crops turns agriculture into a profitable business and increases competition for land and the incidence of land conflicts. Higher on- and off-farm income suggests that income poverty decreases, but inequality increases with agricultural growth. Female-headed and illiterate households with small landholdings – constituting the poorest - tend to be excluded from soya-production (Table 6), as soya is a relatively expensive crop to grow that requires certain investments in land and labour. Weinhold et al. (2013) observed a similar trend in Brasilia where increased soya production led to reduced poverty levels and increased inequality, as most soya production was controlled by wealthier landowners. Our findings support the often repeated statement that agricultural productivity growth of the small-scale farming sector has substantial potential for poverty reduction (e.g. Arndt et al. 2016; Hazell et al. 2010; Imai & Gaiha 2016), however attention has to be paid to growth of inequality. Smith et al. (2019) showed that agricultural intensification only leads to an improvement in wellbeing of the poorest where villages have accessible markets. Next to markets, those cash crops that have low barriers to entry are most promising. For instance, pigeon peas are successfully grown in the small-scale farming sector in Mozambique due to their low demand in terms of land and labour (extensive intercropping) (Walker et al. 2015). Regardless of the crop, extension services are essential to also reach the poorer households (Benson et al. 2014).

With increasingly limited land resources, we observed decreasing income levels and high income inequality. Agricultural transformation, sustainable intensification as well as income diversification in off-farm activities is particularly required in these areas (Muyanga & Jayne 2014; Hazell et al. 2010). Small-scale soya production could be a chance for agricultural intensification and poverty reduction in land scarce areas as it increases the value per hectare and gives access to production inputs and leads to the development of a rural non-agricultural economy (Headey & Jayne 2014). However, the potential of small-scale soya production has not yet unfolded, as scarce productive land is reserved for subsistence agriculture and productivity-increasing technologies are unavailable. Here, policy interventions are required to initiate sustainable intensification (Headey & Jayne 2014). Beside technology supply, secure land tenure is important in order to minimize land conflicts and to incentivise farmers to invest in land productivity (Headey & Jayne 2014; Josephson et al. 2014; Jin & Jayne 2013).

Commercial operations performed relatively poorly in almost all categories of our assessment. Despite contributing to national GDP, they did not bring the expected levels of rural employment opportunities, local investments, or multiplier effects to the local economy that are the most prominent arguments for large-scale operations (Aabø & Kring 2012; Baumgartner et al. 2015; Deininger et al. 2010; Messerli et al. 2014). Our study showed that only small effects on the local economy were expected for the following reasons: scarce employment opportunities benefited only a few; most inputs were purchased internationally; there was no integration in the local value chain; and technology and input transfer at the local level was rare. The large-scale soya production models were barely economically feasible under current productivity levels, which corresponds with observations made by Hanlon (2016) documenting that large-scale operations in Mozambique have consistently failed economically. It is true that those operations interviewed attempted a kind of corporate social responsibility in the form of extension provision and/or supply of infrastructure. However, this kind of commitment was voluntary, not measured, and rarely specified in legally enforceable documents or contracts. This approach has also been noted by Aabø & Kring (2012) and Nhantumbo & Salomão (2010). Nationwide, there are no freely accessible data on the performance of large-scale operations in terms of national and local investment, economic viability and employment generation (Benson et al. 2014), making it difficult to assess real contributions to the economy. However, many studies undertaken in African countries show poorly performing large-scale operations where negative impacts outweigh their benefits (Messerli et al. 2013; De Schutter 2011; Schoneveld et al. 2011; Nhantumbo & Salomão 2010).

None of the observed commercial operations could avoid conflicts with local populations concerning land acquisition, compensation payments and resettlement even though they followed legal regulations. In particular, the location of large-scale operations in areas where land is scarce, as exemplified by one of the investigated operations, led to land use conflicts with local populations. Population density can give an approximation of the number of people potentially affected (Messerli et al. 2014). Using so called ‘idle land’ in low populated areas, may reduce social conflict, however stringent environmental governance and regulations for deforestation are needed (Gasparri et al. 2015) so that both, social and environmental costs can be minimised. Messerli et al. (2014) support our finding that most of the land under large-scale plantations is located in land limited communities (Table 7) and show that one third of land investments in the global South affect cropland in easily accessible and densely populated areas, resulting in competition with multifunctional small-scale agriculture, often under unequal power relation dynamics. Regardless of the geographic location, any large-scale land investments involves important socio-ecological trade-offs leading to land-use change and local land scarcity (Messerli et al. 2014; Schoneveld et al. 2011). Following Hammar (2012), Smart & Hanlon (2014), De Schutter (2011) and Aabø & Kring (2012), we argue that even under well-governed and well-managed land investment processes, any large-scale land investment in Mozambique holds high opportunity costs compared to alternative uses of the land. Beside forgone opportunities, we present another case for the economic inefficiency of large-scale operations in Mozambique and therefore argue that the government’s attempts to support large-scale land investments are prone to failure.

Soya production in Central Mozambique presents a good example of how the provision of agricultural advice and support – in this case provided by a variety of donors and NGOs – can lead to the emergence of a small and medium-scale commercial farming sector that proved to be a powerful engine of agricultural growth, with positive effects for local economies and poverty reduction. In order to further facilitate this development and the transformation of the agricultural sector according to farmers’ needs, policy interventions need to target the development of technical, financial, and institutional capacities in participation with local populations (Mosca 2014; Shankland & Gonçalves 2016; Dawson et al. 2016). Substantial investment in infrastructure also needs to be undertaken (Headey & Jayne 2014). Extension services have the potential to reach the poorest households and could effectively reduce poverty by sharing knowledge and innovation among small-scale farmers (Benson et al. 2014; Graeub et al. 2016). Increasing the capacity of agricultural staff in the development of locally adapted approaches is key in order to promote sustainable management practises (Silici et al. 2015). Induced intensification of agricultural systems adapted to the local context better serves poverty reduction goals than imposed innovation (Dawson et al. 2016).

5. Conclusions

We conducted a socio-economic assessment of the main soya production models prevalent in Central Mozambique. The results showed better performance of small-scale and emergent farmer models over large-scale operations in terms of financial profitability, food production, local livelihood and land conflicts. A general condemnation of large-scale land investments as “land grabbers” is not justified, but our study does demonstrate that large-scale operations fail to reach local development goals and lead to localised land scarcity. Better compliance with good management practices and higher investments in social impact mitigation and community development could clearly improve their performance, but there is also a need for strong governmental regulation and guidance. Two out of three operations we studied have lost their credibility locally as well internationally; therefore transparency throughout the entire operation is important. This way, true contributions to the local economy can be tracked. Either way, the Mozambican government has to seriously examine forgone opportunities for rural development when giving land away to large investors instead of improving conditions for small- and medium-scale commercial farmers.

Our study demonstrates that small- and medium-scale commercial farming can compete with large-scale operations in key social and economic parameters and strengthens the often repeated statement that agricultural productivity growth among local farmers can be a powerful approach for poverty reduction. Apart from the inefficiencies of large scale farming presented in this study, global trends of population growth, need for increased equity, demand for environmental protection and carbon sequestration as well as increased scarcity of water and fertile land, we foresee a limited scope for a continuation of large scale farming discourse and support. Policy decisions have a major influence on farm structure and the transformation of the rural economy, and these are decisive for the development of a strong small- and medium-scale farming sector and inclusive rural development. In Mozambique, national budget spending devoted to agriculture remains well below the target of 10% formulated in the Comprehensive Africa Agriculture Development Program, presenting a substantial leeway for policy interventions in the small-scale farming sector. Challenges with the supply of technology, finance, and locally adapted extension services, as well as the improved capacity of local populations for land negotiations and institutional arrangements need to be prioritised.

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