Chapter 3
Linking Industrial Crop Production and Food Security in Sub-Saharan Africa: Local, National and Continental Perspectives

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3.1 Introduction

Food security is one of the major sustainability challenges and development priorities facing sub-Saharan Africa (SSA) (UNECA 2015; FAO 2018; Sasson 2012) (Chap. 1 Vol. 1). Currently about a tenth of the global population is undernourished, but this rate is even higher in SSA standing at about 20% (FAO 2015) (Chap. 1 Vol. 1; Chap. 1 Vol. 2). Despite some progress, most SSA countries fall at the lowest ranks globally for many indicators related to hunger, child stunting and calorie deficit, among several others (FAO, IFAD, UNICEF, WFP and WHO 2019). Despite the constant increase in food supply across all sub-regions during the past decades (Fig. 3.1), there has been little progress in many countries to halt food inadequacy despite large economic growth in terms of gross domestic product (GDP) (Fig. 3.2).

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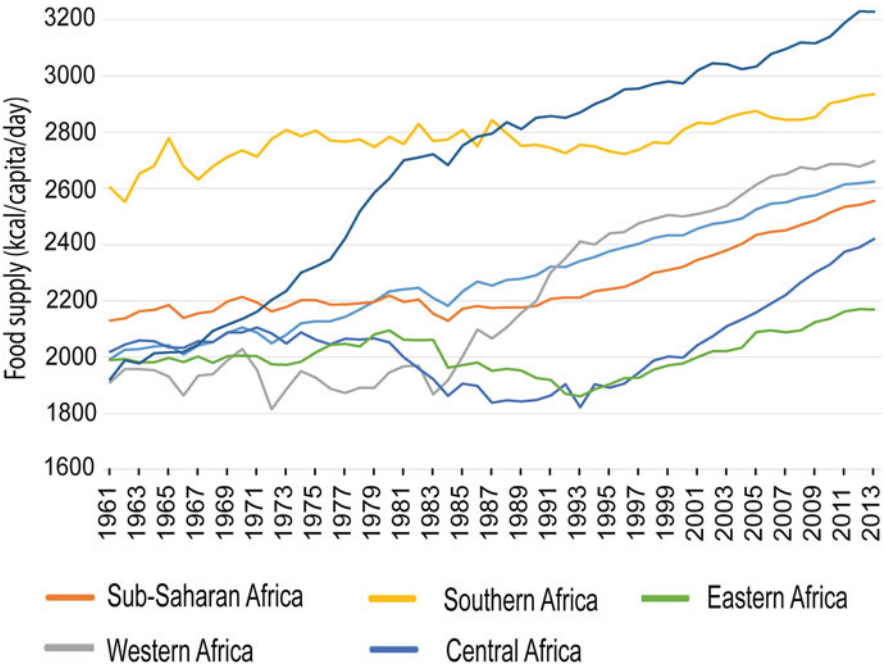

Fig. 3.1 Food supply in sub-Saharan Africa and its sub-regions. Source: FAOSTAT (2019)

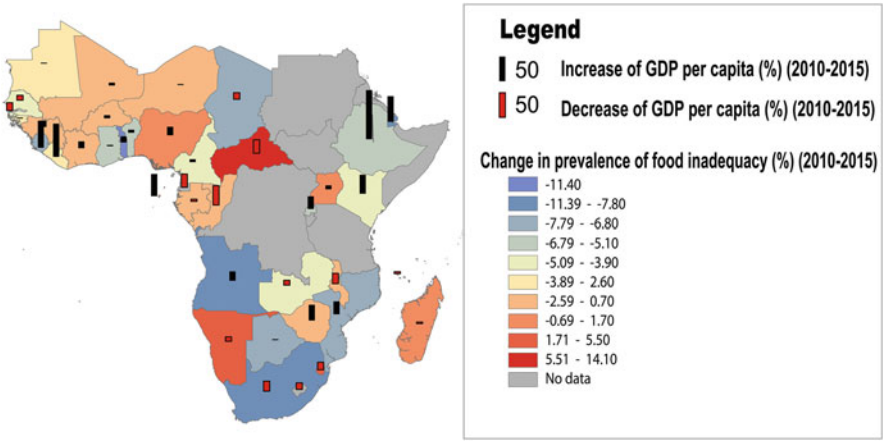

Fig. 3.2 GDP per capita and prevalence of food inadequacy in sub-Saharan Africa. Source: FAOSTAT (2019)

Thus ending hunger and ensuring food security have been major development targets at the national and international level. For example, many local, national and international policies, programmes and interventions have aimed at reducing hunger

and achieving food security at different levels across the continent (FAO and ECA 2018; FAO and ECDPM 2018) (Chap. 1 Vol. 2). Ending hunger was a central part of the Millennium Development Goals (MDG1: "eradicate extreme poverty and hunger"). However, despite some success stories, many SSA countries failed to meet the goal by a wide margin (UNDP 2015).

Ending hunger and ensuring food security has become a strong element of the follow-up sustainable development goals (SDGs), with SDG2 (Zero Hunger) aiming to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (Chap. 1 Vol. 1). However, the path to meeting SDG2 is particularly challenging as it is linked with many other SDGs including SDG1 (no poverty), SDG4 (quality education), SDG5 (gender equality), SDG6 (clean water), SDG8 (decent work and economic growth), SDG13 (climate action), SDG14 (life below water) and SDG15 (life on land), among others. In fact SDG2 has many interlinkages with several other SDGs, suggesting the centrality, but at the same time difficulty and importance in meeting the goal (ICSU 2017).

Indeed there seems to be no silver-bullet approach towards achieving food security in SSA, as multiple socio-economic and environmental factors combine to affect it (FAO and ECA 2018; FAO, IFAD, UNICEF, WFP and WHO 2019). Often the actual mechanisms are very context-specific, suggesting that what might enhance food security in one context might have a different effect elsewhere (Palm et al. 2010). This is largely because food security is a multi-dimensional concept that combines several different elements and has different interpretations and definitions across international and national contexts (Gibson 2012; Jones et al. 2013). The most prevailing definition includes the four dimensions/pillars proposed by the UN Food and Agriculture Organization (FAO), namely availability, stability, access and utilization[1] (FAO 2006).

Enhancing food crop production has become a central element of reducing hunger and improving food security in SSA, especially related to food availability (FAO and ECA 2018). This is because a large fraction of the SSA's population is either involved in subsistence agriculture or occupied in the agricultural sector (Gollin 2010; IFAD 2013; Ricciardi et al. 2018; FAO, IFAD, UNICEF, WFP and WHO 2019) (Chap. 1 Vol. 1). However, despite the very low past performance there has been evidence of a modest agricultural production growth in past two decades (Wiggins et al. 2015; FAO, IFAD, UNICEF, WFP and WHO 2019). Indeed agricultural output (and its contribution to national economic growth) have been steadily increasing, but with important discrepancies between sub-regions (Fig. 3.3).

[1]Food availability relates to the general supply of food, and addresses issues of food production, stocks and trade. Access to food (both economic and physical) reflects the sufficient supply of food at the national and international levels. Aspects related to income, expenditure, markets and prices are critical in enabling food access. Food utilization relates to nutrient utilization within the human body, as the basis of the good nutritional status of individuals. Food stability reflects the stability of the three aforementioned dimensions over time, which is a necessary pre-condition for sustaining a stable food intake and overcoming periodic risks and food insecurity.

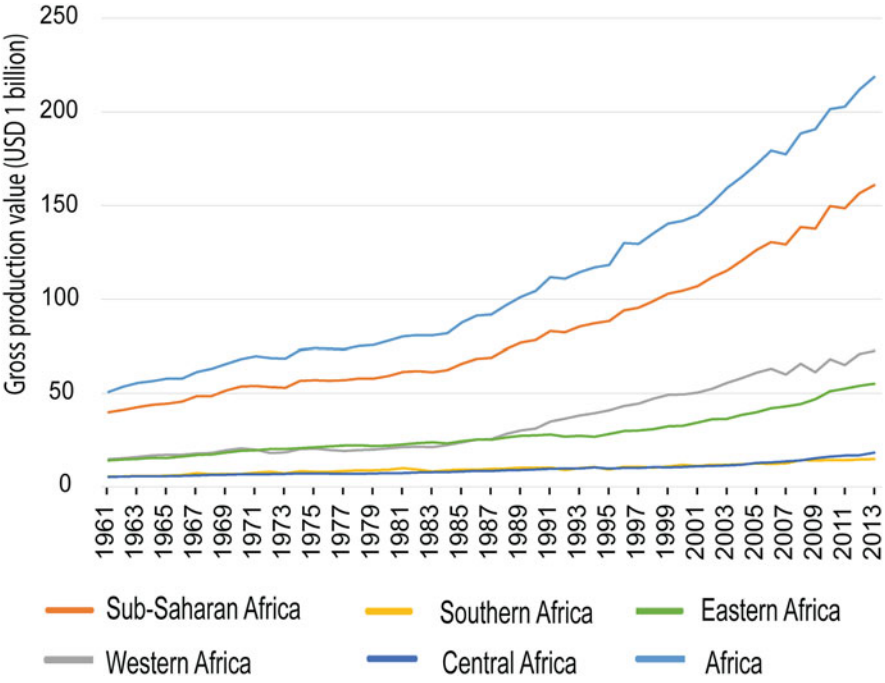

Fig. 3.3 Agricultural gross production value in sub-Saharan Africa and its sub-regions. Source: FAOSTAT (2019)

Apart from food crops, many SSA countries produce crops that have non-food uses for fibre, bioenergy and other industrial products (Singh 2010). These industrial crops[2] cannot be usually used for food consumption (e.g. cotton, tobacco, jatropha) or that have non-food uses but are also integral components of the food industry without being staple crops (e.g. oil palm, sugarcane) (Wiggins et al. 2015; Singh 2010; Jarzebski et al. 2019). Many SSA governments perceive industrial crops as opportunities for modernizing and diversifying the agricultural sector, and thus as potent engines of economic growth and rural development (Schoneveld et al. 2011; Gasparatos et al. 2015). Thus, many SSA countries have opened up their rural frontiers for foreign direct investments (FDIs) related to industrial crop production (Giovannetti and Ticci 2016) (Chap. 4 Vol. 1). This was especially pronounced

[2]Some industrial crops can be mono-functional, used, for example, only for fibre (e.g. cotton), recreation (e.g. tobacco) or energy (e.g. jatropha). Others such as sugarcane can have multiple functions including such as food supplements (i.e. sugar), fuel (i.e. ethanol), and industrial products (i.e. bioplastics). Major staple food crops in SSA such as maize and cassava also have non-food uses (e.g. alcohol production), so they can also be considered to be industrial crops. However, these uses are miniscule in across most of SSA, as these crops are overwhelmingly the main staples across most of the continent.

during the recent land rush that was partly spearheaded by bioenergy crops such as jatropha and sugarcane (Schoneveld et al. 2011).

However, industrial crop production can have various socioeconomic and environmental impacts depending on factors as diverse as the crop, the mode of production, the context within which production takes place and the institutions that govern industrial crop production, use and trade (e.g. Gasparatos et al. 2015) (Chap. 2 Vol. 1; Chap. 5 Vol. 2). Many recent studies have explored a series of impacts related to industrial crop production in SSA including economic growth, poverty alleviation, loss of livelihoods and environmental degradation, among many others (Gasparatos et al. 2015; Arndt et al. 2010; Hess et al. 2016; Strona et al. 2018).

Food security has emerged as one of the most extensively studied impacts (Jarzebski et al. 2019), largely due to the rapid expansion of biofuel projects during the recent land rush, and the popularity of negative narratives such as land grabbing, land dispossession and "food vs. fuel" (Kuchler and Linnér 2012; Tenenbaum 2008; Tomei and Helliwell 2016). Many studies have explored the food security outcomes of industrial crop production in SSA across different scales, (i.e. from the household level to the national and international level) (e.g. Zeller and Sharma 2000; Komarek 2010; Wood et al. 2012; Negash and Swinnen 2013). The perceptions and outcomes of industrial crops articulated in these studies are very polarized, ranging from "industrial crops as major risks to food security" (e.g. Molony and Smith 2010; Matondi et al. 2011; HLPE 2013) to "important agents of economic growth and rural transformation" whose expansion could have positive food security outcomes (e.g. Arndt et al. 2009; Arndt et al. 2012; Hartley et al. 2019; HLPE 2013). However, it is extremely complicated to unravel the food security outcomes of industrial crop production as they are mediated by many different mechanisms (Wiggins et al. 2015; Jarzebski et al. 2019).

The above suggest that the interface of industrial crop production and food security presents a major sustainability challenge for many SSA countries. On the one hand industrial crops can drive the modernization and diversification of SSA agriculture, offering important income and employment opportunities locally and economic growth nationally. On the other hand, they can have profound environmental and socioeconomic impacts, which are mediated through multiple different mechanisms. Collectively these effects can have important ramifications for food security, which can be positive or negative depending on many context-specific factors.

The aim of this chapter is to provide a broad overview of how industrial crop production intersects with food security in SSA. We provide insights about these intersections at different levels (i.e. local, national, continental) through a literature review, secondary data analysis and policy analysis. Section 3.2 outlines the methodological approach. Section 3.3 highlights the history and drivers of industrial crop production in SSA (Sect. 3.3.1) and the mechanisms through which industrial crop production intersects with food security (Sect. 3.3.2). Section 3.4 discusses some of the main literature patterns (Sect. 3.4.1), and policy implications in the context of the SDGs (Sect. 3.4.2).

3.2 Methodology

Initially we conduct a secondary data analysis and policy analysis to understand the drivers, production patterns and policies supporting industrial crop production in different parts of SSA (Sect. 3.3.1). We extract agricultural production data from the statistical database of the FAO (FAOSTAT 2019), and compare them with basic food security indicators such as the "Depth of Food Deficit" and "Global Hunger Index" for selected countries (FAOSTAT 2019; von Grebmer et al. 2018). We focus on countries with different experiences and trajectories of industrial crop production, namely Burkina Faso, Ethiopia, Ghana, Kenya, Malawi and Swaziland.

Subsequently, we conduct a systematic review to synthesize the evidence about the impacts of industrial crop production on food security (Sect. 3.3.2). In particular, we identify the mechanisms through which industrial crop production intersects with food security, and the underlying processes mediating these mechanisms. As a starting point, we use the common food security mechanisms identified in the literature across the pillars of food availability, access, utilization and stability (Wiggins et al. 2015; Jarzebski et al. 2019) (Table 3.1). We use various criteria and variables to categorize the different studies and find patterns within the literature, including study characteristics (e.g. author affiliation, crops, study scale), methods, mechanisms and food security outcomes (Table 3.2). The food security outcomes are categorized based on the presence of mechanisms and whether the mechanism has the predicted effect on food security, the opposite effect or a bi-directional effect.

For the systematic review, we mainly focus on peer-reviewed literature (i.e. journal papers, relevant book chapters), complementing it with limited relevant grey literature. The search keywords were combinations of industrial crops and the names of SSA countries that are the major producers of these crops as identified from the database of the Food and Agricultural Organization of the United Nations (FAOSTAT 2019) (e.g. "cocoa" + "Ghana", "coffee" + "Ethiopia"). The main studied crops include cocoa, coffee, cotton, jatropha, rubber, sugarcane, shea, tea, tobacco, oil palm and vanilla. We identify the reviewed literature though Elsevier Scopus and Web of Science (for peer-reviewed studies), and Google Scholar (technical reports) (Gentles et al. 2016). Other relevant literature was also identified through snowballing (e.g. through the references of reviewed studies). Literature selection was performed in October 2017.

After locating the relevant documents, we screen the abstracts to establish their relevance to the objective of the review (i.e. food security). If the document is relevant, we proceed with the full review. If the abstract does not allow us to conclusively determine relevance, we undertake a full review to avoiding missing any relevant literature. Overall, we fully review 118 papers, *of which 90 are peer-reviewed studies*, with the full list included in the four tables of Sect. 3.3.2.

Table 3.1 Impact mechanisms and predicted outcomes for each pillar of food security

Impact mechanism	Food security outcome	
Pillar A: Food availability		
A1. Food crop area	Industrial crop expansion reduces areas that provide food crops, possibly reducing the production of food crops (land use change: Food crop farms converted for industrial crop production)	↓
A2. Wild food area	Industrial crops expansion reduces areas that provide wild food such as plants, mushroom and game, possibly reducing wild food availability for household use (land use chance: Forest area converted for industrial crop production)	↓
A3. Livestock grazing area	Industrial crops expansion reduces grazing areas for livestock, possibly reducing livestock production (land use change: Grazing area converted into areas for industrial crop area)	↓
A4. Labour/capital diversion	Involvement in industrial crop production (e.g. as plantation workers, industrial crop smallholders) diverts labour and capital from activities related to food production (e.g. food crop cultivation, livestock rearing), reducing thus the production of food crops and livestock	↓
A5. Farming inputs	Industrial crop production increases access to farming inputs, such as seeds, fertilizers, pesticides and herbicides, which can be used/diverted for food crop production increasing food crop yields	↑
A6. Technology	Industrial crop production (and related investments) can introduce new farming technologies (e.g. irrigation, mechanization), which can be used/diverted for food crop production increasing food crop yields	↑
A7. Other	Other mechanism linking industrial crop production to food availability	↑ or ↓
Pillar B: Access to food		
B1. Infrastructure	Industrial crop production can catalyse infrastructure development especially in plantation settings (e.g. opening/enhancing roads and local/public transportation for large-scale production), increasing access to markets to purchase food	↑
B2. Market linkages	Industrial crop production facilitates market linkages (e.g. enhances access of local food/industrial crop producers to buyers), which gives incentive to local farmers to expand food crop production for sale	↑
B3. Food prices	Industrial crops expansion can increase food prices, making it less affordable (and thus accessible) particularly to urban poor and rural landless households	↓
B4. Income generation	Income generated directly through the involvement in industrial crop production (e.g. as plantation workers or smallholders) can be used to purchase food	↑
B5. Job creation	Employment generation by industrial crop estates, processing plants, and other downstream activities can become a dependable and stable source of livelihoods, ensuring a dependable and stable access to food	↑
B6. Land compensation	Lack of compensation for land loss due to industrial crop production does not compensate for the loss of income opportunities and food crop production, causing short- or long-term loss of access to food	↓

(continued)

Table 3.1 (continued)

Impact mechanism	Food security outcome	
B7. Other	Other mechanism linking industrial crop production to access to food	↑ or ↓
Pillar C: Food utilization		
C1. Time diversion	Female engagement in industrial crop activities (e.g. plantation employment, smallholder production) diverts their time from child care, nutrition and unpaid care work, taking a toll on food preparation and especially child nutrition	↓
C2. Energy security	Engagement in industrial crop production value chains can affect household energy choices and the adoption of clean and improved energy options through multiple pathways, improving food preparation practices	↑
C3. Other	Other mechanism linking industrial crop production to food utilization	↑ or ↓
Pillar D: Food stability		
D1. Natural disasters	Engagement in industrial crop activities acts as a buffer against food security risks posted by natural disasters, especially by offering a stable source of livelihoods that can help households cope during such events	↓
D2. Market stability	Industrial crops increases risks of food price fluctuation (i.e. unpredictable increases and decreases) thus reducing food stability	↓
D3. Food imports	Industrial crop production and export generates foreign exchange that can enable food import, enhancing thus the stability of food within the country	↑
D4. Food assistance	Industrial crop plantations/companies can provide food assistance, reducing incidence of seasonal hunger during periods of high food insecurity	↑
D5. Political stability	Industrial crop production can contribute manifold to the national economy and prosperity, catalysing political stability that can have a stabilizing effects for multiple other mechanisms and the wider economy	↑
D6. Women empowerment	Involvement in industrial crop value chains can increase women's access to land, income, and training/education opportunities, enabling them to provide better for their families.	↑
D7. Environmental impacts	Industrial crop introduction can affect local environmental conditions through land use and cover change, soil quality degradation, water quality degradation, and depletion of water resources depletion, among others. Collectively such effects reduce the capacity of local agro-ecosystems to produce food in a stable manner	↓
D8. Other	Other mechanism linking industrial crop production to food stability	

Note: (↑) denotes an expected positive effect on food security, and (↓) a predicted negative effect.
Source: Wiggins et al. (2015), Jarzebski et al. (2019)

Table 3.2 Variables and values used in the systematic review

Variable	Range of values
Peer-reviewed	1 = Yes 2 = No
Crop	1 = Oil pam 2 = Rubber 3 = Sugarcane 4 = Coffee 5 = Jatropha 6 = Shea 7 = Tobacco 8 = Tea 9 = Cotton 10 = Cocoa 11 = Vanilla
Author affiliation	1 = Local (affiliated with institution in the study SSA country) 2 = Regional/African (affiliated with institution in another SSA country) 3 = Outside Africa (affiliated with an institution outside SSA) 4 = Collaboration of African and non-African institutions 5 = Not specified/not known
Research funding	1 = Local (offered by an institution within the study SSA country) 2 = Regional/African (offered by an institution from another SSA country) 3 = Outside Africa (offered by an institution outside SSA) 4 = Co-funded by African and non-African institutions 5 = Not specified/not known
Spatial scale of study	1 = Local 2 = Sub-national 3 = National 4 = Regional 5 = Continental 6 = Global 7 = Not specified
Methodology	1 = Qualitative 2 = Quantitative 3 = Mixed method
Use of direct measure of food security	1 = Yes 2 = No 3 = Both 4 = Not applicable
Type of outcome	1 = Historical/baseline (current state) 2 = Predictive (future state) 3 = Both 4 = Not specified

3.3 Results

3.3.1 Drivers and Production Patterns

3.3.1.1 Continental Perspectives

Some industrial crops such as cotton have been produced for a long period in some parts of SSA, sometimes predating the colonial period (e.g. Kriger 2005). During the colonial era, the production of cotton, cocoa, coffee and rubber expanded rapidly across many parts of SSA to meet the large demand in Europe (Brun 1991). In the post-colonial era, industrial crop production became a major component in the economies of several SSA countries. For example, tobacco and sugarcane are the major export commodities in Malawi (Chinangwa et al. 2017), while cocoa has contributed substantially to the national economies of Ghana and the Ivory Coast (Breisinger et al. 2008). Sugarcane and cotton have dominated the economies of countries in Southern and Western Africa, such as Swaziland and Mauritius (Terry and Ogg 2017; Kwong 2005) and Burkina Faso and Mali respectively (Tschirley et al. 2009; Vitale 2018).

Cocoa is the most widely produced industrial crop in SSA in terms of area (11.37 Mha in 2012), with area under cocoa increased sharply from the mid-1980s onwards, surpassing coffee by a wide margin (Fig. 3.4). Sugarcane is the leading industrial crop in terms of tonnage (94.6 Mt. in 2012) (Fig. 3.5). Export revenues from the major industrial crops have also increased rapidly in the past decades (USD 19.6 billion in 2011) (Fig. 3.6), with industrial crops being the main export commodities across many of the sub-regions (Table 3.3).

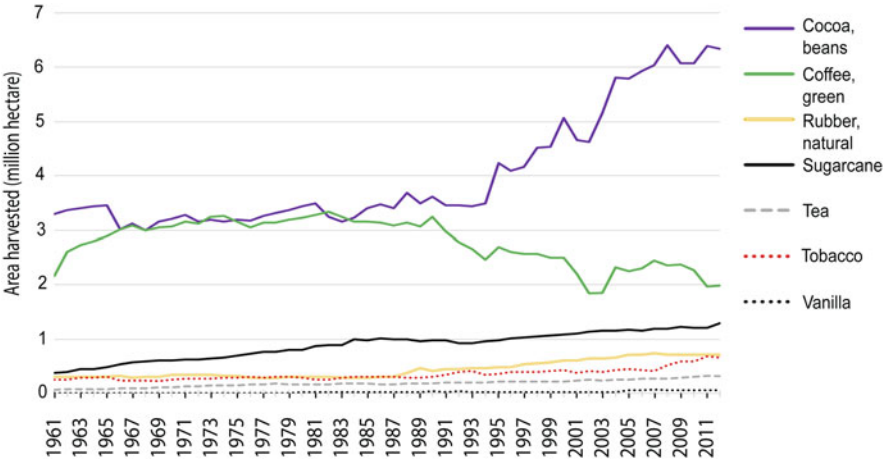

Fig. 3.4 Harvested area for major industrial crops in sub-Saharan Africa. Source (FAOSTAT 2019)

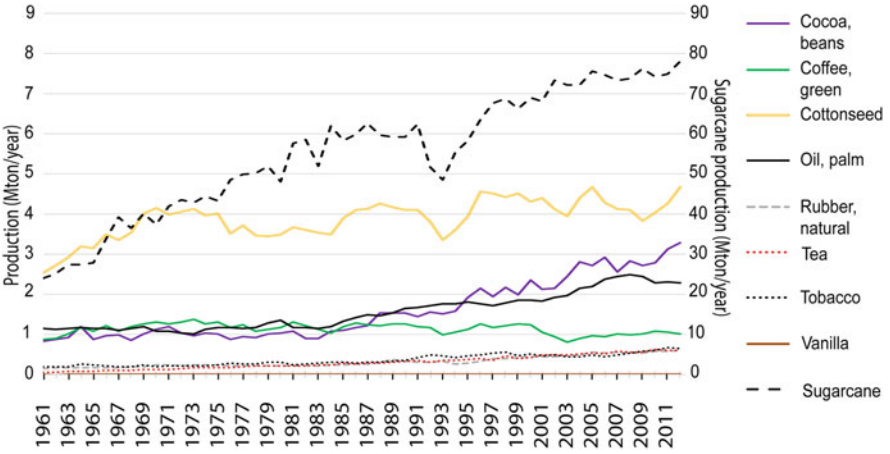

Fig. 3.5 Production output of major industrial crops in sub-Saharan Africa. Source (FAOSTAT 2019). Note: The secondary y-axis in the right denotes sugarcane production.

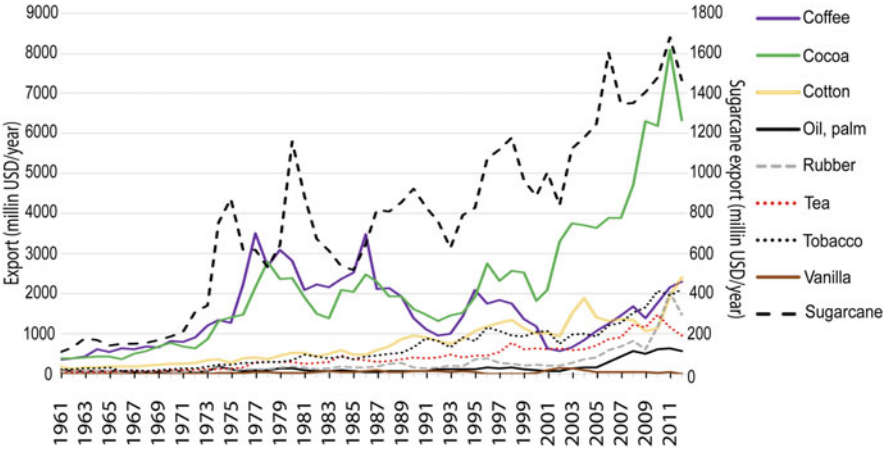

Fig. 3.6 Export value of major industrial crops in sub-Saharan Africa. (Source: FAOSAT 2019). Note: Estimates include raw materials, refined materials and by-products of cocoa, coffee, cotton, oil palm, rubber, tea, tobacco, vanilla and sugarcane

In the past couple of decades, bioenergy crops such as jatropha and sugarcane accounted for most industrial crop expansion, often through foreign-led large-scale land acquisitions (Schoneveld 2014) (Chap. 4 Vol. 1). Estimates suggest that jatropha investments accounted "*for 31.1% of the total area acquired; with the largest areas acquired in Madagascar (979,610 ha), Zambia (707,476 ha), and Ghana (671,951 ha)*" (Schoneveld 2014: 39). However, it is unclear how much land was eventually allocated and converted before the widespread collapse of the sector (Gasparatos et al. 2015; von Maltitz et al. 2014), with evidence suggesting lower

Table 3.3 Prevalence of undernourishment in sub-Saharan Africa and its sub-regions (in %) between 2014 and 2016

Region	Prevalence of food inadequacy (%)	Undernourishment (%) (average between 2014–2016)	Main exports ordered by value (as of 2013)
Middle Africa	47.6	41.3	1. Cocoa 2. Bananas 3. Cotton 4. Rubber natural dry 5. Coffee (green)
Eastern Africa	40.3	31.5	1. Tobacco (unmanufactured) 2. Coffee (green) 3. Tea 4. Crude materials 5. Sugar (raw and refined)
Southern Africa	9.1	5.2	1. Wine 2. Maize, 3. Oranges 4. Sugar raw centrifugal 5. Grapes
Western Africa	13.8	9.0	1. Cocoa 2. Cotton 3. Rubber natural dry 4. Cashew nuts 5. Oil, palm
Sub-Saharan Africa	29.4	23.0	
Africa	25.5	19.8	

Source: FAOSTAT (2019)

land conversion in most countries (Locke and Henley 2013). Recently, palm oil production has increased sharply in Central and Western Africa to meet an the burgeoning regional and global demand (Ordway et al. 2017; Carrere 2013).

The main modes of industrial crop production include (a) smallholder-based schemes, (b) large plantations and (c) hybrids systems that combine large-scale and smallholder-based production (Fig. 3.7). These production systems are integrated in radically different land uses, usually representing a mosaic of agricultural land and natural ecosystems (Gasparatos et al. 2018).

Smallholder-based production is most typically integrated into current farming practices (e.g. intercropping, hedge growing) or totally displaces prior cropping practices (e.g. small block plantations within smallholder farms), with the latter being common in sugarcane production (von Maltitz et al. 2018) (Box 3.1). Smallholder-based systems are often small in size (usually below 5 ha) using labour from inside the household (Lowder et al. 2016). In some cases smallholders have access to agricultural inputs, irrigation and credit, usually through rural development efforts of the respective governments, organization of smallholders in growers' groups and/or extension efforts of government and/or industrial crop companies (von Maltitz et al. 2019; Burney et al. 2013).

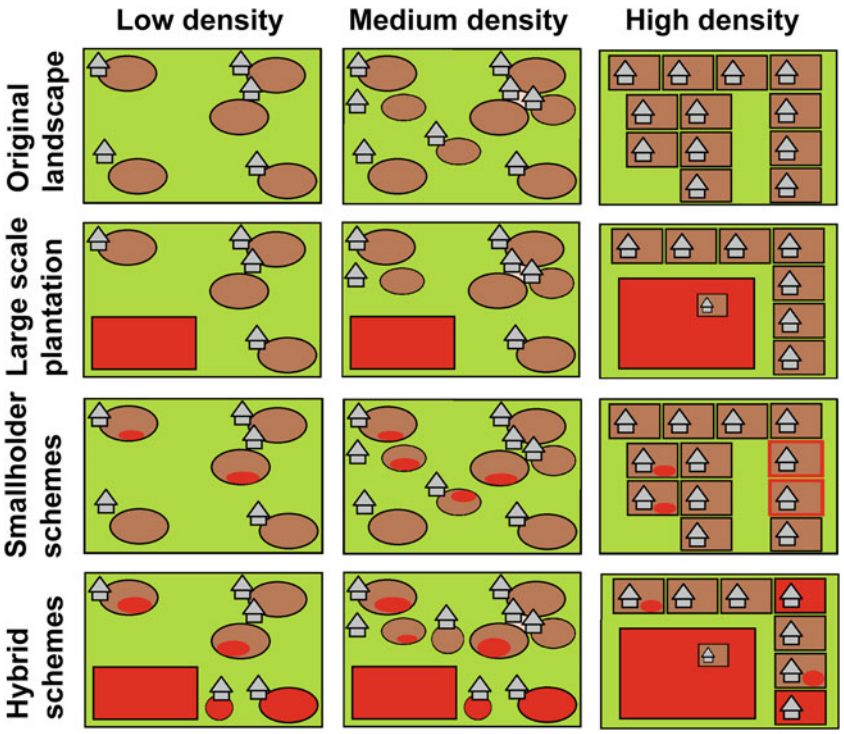

Fig. 3.7 Main modes of industrial crop production in sub-Saharan Africa. Source: Gasparatos et al. (2018). Note: Green denotes natural ecosystems (e.g. woodland, grassland), brown denotes agricultural land, and red industrial crop production

Box 3.1: Food Security Impact Mechanisms in Smallholder-Based Industrial Crop Production Systems

The Komati Downstream Development Project (KDDP) is a smallholder community development programme promoted by a para-statal agency in Swaziland (SWADE) in the late 1990s. Its main aim was to develop capacity for irrigated sugarcane production among smallholders (Terry and Ogg 2017). Smallholders were incentivized to pool their cropland to accommodate sugarcane production, forming 28 associations spanning an estimated 5500 ha (Gasparatos et al. 2018). These associations operate as independent cooperatives or companies, with the involved smallholders becoming equal partners and receiving annual dividends through sugarcane sales to the two mills operated by the Royal Swazi Sugar Company (RSSC) in Mhulme and Shimunye.

(continued)

Box 3.1 (continued)

KDDP was instrumental in providing irrigation and knowledge for sugarcane production to thousands of smallholders (Terry and Ogg 2017). Furthermore, it generated local employment in the community plantations for households that did not join sugarcane production (Mudombi et al. 2018). Overall, sugarcane production has become a major avenue to boost rural development and livelihood diversification (Terry and Ogg 2017), succeeding to reduce poverty among smallholders (Mudombi et al. 2018), despite the extensive conversion of dryland agriculture and degraded ecosystems (Romeu-Dalmau et al. 2018). In this respect, many of the different mechanisms of food security impacts intersect in the broader area, and especially A1 "Food crop area"; A3 "Livestock grazing area"; A5 "Farming inputs"; A6 "Technology"; B1 "Infrastructure"; B2 "Market linkages" and B4 "Income generation."

The BioEnergy Resources Ltd. (BERL) was a private company that promoted jatropha production in Malawi. In particular, BERL incentivized smallholder-based jatropha production in hedges along the boundaries of small family farms, buying in return the produced jatropha. This model assumes that farm boundaries are underutilized (von Maltitz et al. 2014, 2016), and that planting jatropha in these hedges would have minimal trade-offs with food crop production. However, the income generated from jatropha production was relatively low, having little effect on poverty alleviation (Mudombi et al. 2018). Even though BERL targeted around 100,000 farmers across Malawi, only a fraction of these farmers took up and maintained jatropha production. In this respect only a few of the different mechanisms of food security impacts intersect in the broader area, and especially A4 "Labour/capital diversion"; B2 "Market linkages" and B4 "Income generation."

Large industrial crop plantations produce industrial crops in large blocks that can extend from a few tens of hectares to several thousand hectares depending on the crop and the area (e.g. Hall et al. 2017; Smalley 2013). Industrial crop production usually follows intensive monocultural practices and requires extensive land consolidation processes, often displacing rural communities and converting/degrading natural ecosystems (Hall et al. 2017). However, large plantations often generate employment and income, and develop infrastructure (e.g. roads) in poor rural areas that lack such options (Smalley 2013). Several studies have found that plantation employment has very different characteristics depending on the context, ranging from insecure, precarious and lowly paid (Ahmed et al. 2019a), to highly beneficial and appreciated by some local communities (Hall et al. 2017). In any cases plantation employment can divert substantial amount of labour from other local activities (e.g. food crop production), often under questionable working practices and wages. Plantation owners and investors can be private companies, state agencies, parastatal bodies or joint partnerships.

Hybrid production systems usually comprise of a core large plantation surrounded by hundreds or thousands family farmers (Brüntrup et al. 2018) (Box 3.2). These farmers can be contractually linked to a single buyer that is usually the core plantation (i.e. outgrowers), or sell to multiple buyers depending on markets signals (i.e. independent producers) (von Maltitz et al. 2019). Hybrid systems are more common for crops such as sugarcane and oil palm that are perishable and whose production benefits from economies of scale (von Maltitz et al. 2019; Carrere 2013).

Box 3.2: Food Security Impact Mechanisms in Hybrid Industrial Crop Production Systems

The Ghana Oil Palm Plantation Development Company (GOPDC) has adopted a hybrid production system that combines large-scale oil palm production undertaken by GOPDC in a large plantation surrounded by individual outgrowers and independent smallholders (Ahmed et al. 2019a). The core plantation is located in the Kwae community and spans 8200 ha and is surrounded by approximately 10,000 ha cultivated by outgrowers and independent smallholders. This hybrid production system has converted extensive areas of natural vegetation and other agricultural land (mainly under food crops and cocoa).

The GOPDC currently employs approximately 4500 staff members, over 70% of which are occupied in plantation-related activities such as harvesting, fertilizer application and weeding. Workers are engaged in both permanent and seasonal employment, with salaries and wages paid on a monthly basis. The GOPDC also directly supports about 7200 outgrowers that have contractual relationships with the company, which in turn co-finances the establishment of small oil palm farms. The company serves as the direct market for these outgrowers, as well as a possible market option for independent growers willing to sell fresh palm fruits to GOPDC. Usually independent growers decide whether to sell to the GOPDC mills or other independent processors depending on local prices. Employment and access to this mature market secure income flows to workers, outgrowers and independent growers, improving the livelihoods of many types of households (Ahmed et al. 2019a).

The GOPDC also maintains a road network spanning approximately 500 km within the Kwaebibirem district that facilitates the transportation of oil palm from outgrowers and independent growers to the GOPDC mills. The company also assists local communities in the rehabilitation and construction of community markets. Such infrastructure facilitates the transport and sale of oil palm, as well as the distribution, sale and marketing of food crops within the district.

In this respect many of the different mechanisms of food security impacts intersect in the broader area, and especially A1 “Food crop area”; A2 “Wild food area”; A4 “Labour/capital diversion”; A5 “Farming inputs”; B1 “Infrastructure”; B2 “Market linkages”; B4 “Income generation”; B5 “Job creation”; C1 “Time diversion”; D7 “Environmental impacts.”

3.3.1.2 National Perspectives

General Patterns

Different countries across SSA have promoted a wide variety of industrial crops (FAOSTAT 2019), through different modes of production and for different policy goals (Gasparatos et al. 2015). Economic growth, rural development, energy security and conducive policy environments are some of the most common drivers of industrial crop expansion in SSA (Table 3.4). While rural development and economic growth have been the main driver of industrial crop production in many of SSA countries, energy security and conducive policy environments have played a major role in some countries (Table 3.4).

Similarly, the dynamic interface of industrial crop expansion and national food security has been rather different across SSA countries. Figure 3.8 highlights patterns of industrial crop production (in terms of allocated land) and food security (in terms of depth of food deficit and hunger) for some of the major industrial crop producers in SSA. In some of these countries, the long-term expansion of industrial crop production has been relatively moderate (even reaching a plateau in some countries such as Ghana), and has coincided with a constant reduction of hunger and food deficit (Fig. 3.8). In some of these countries the reduction of hunger and food deficit has been rapid (e.g. Ghana), while in others more gradual (e.g. Ethiopia, Malawi). However, such food security outcomes might reflect broader national socio-economic processes, with industrial crop expansion being one of the activities that might influence national food security (de Graaff et al. 2011).

Conversely, the expansion of single industrial crops has been very aggressive in countries such as Burkina Faso and Swaziland, eventually dominating the respective national economies (Vitale 2018; Terry and Ogg 2017) (Fig. 3.8). In these countries, the periodical rapid industrial crop expansion or contraction cycles have also tended to coincide with rapid changes in hunger and food deficit (Fig. 3.8). This possibly suggests a closer linkage between industrial crop production and national food security in countries whose economies are dominated by industrial crop production, and especially of a single crop. However, this most certainly also reflects many other related factors including reforms in the industrial crop sector (Kaminski et al. 2009) and international commodity prices and trading regimes (Terry and Ryder 2007).

It is important to note that industrial crop production is rarely uniform within individual countries. In fact, the production of many industrial crops is concentrated in specific areas. This is especially the case for crops such as sugarcane and oil palm

Table 3.4 Drivers of industrial crop expansion in selected SSA countries

Driver	Kenya	Ethiopia	Malawi	Burkina Faso	Ghana	Swaziland
Economic growth	–	✓	✓	✓	✓[a]	✓
Energy security	✓	✓	–	–	✓	–
Rural development	✓	✓	✓	✓	✓	✓

Note: [a]Excluding cotton

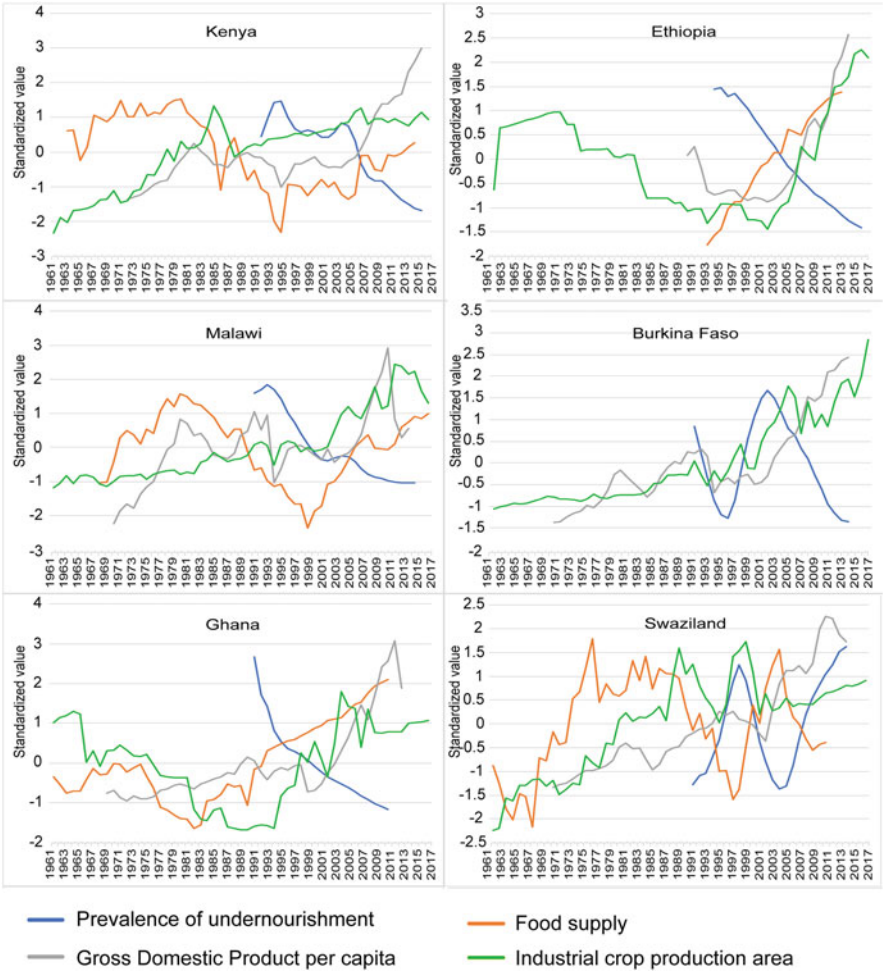

Fig. 3.8 Patterns of food security and industrial crop production in selected SSA countries. Note: Data points represent indicator levels for each year compared to the base indicator value in the year 2016. Hence data points do not report absolute indicator values, but reflect increases or decreases in indicator level compared to the 2016 baseline. Data for "Industrial crop production area" report aggregate production area figures for all industrial crops produced in each SSA country and considered in this study (Sect. 3.2), with the exception of jatropha (FAOSTAT 2019). Hence, land under industrial crop production is likely to be underestimated for countries that have experienced large jatropha expansion such as Ghana (Schoneveld 2014). Data for "Depth of Food Deficit" and "Global Hunger Index" are collected from (FAOSTAT 2019; von Grebmer et al. 2018). The right-hand y-axis in Fig. 3.8a (Ghana) reports values for the "Depth of Food Deficit"

that require large investments to achieve economies of scale. For example, sugarcane production in Malawi and Swaziland is concentrated in just two relatively small areas in each country; Nchalo and Dwangwa in Malawi (Chinangwa et al. 2017), and Big Bend and Northern Lowveld in Swaziland (Terry and Ogg 2017). Conversely, industrial crops geared mainly towards smallholders (e.g. coffee, cocoa, cotton, tobacco) tend to be produced in wider areas that offer conducive agro-ecological conditions. For example, tobacco in Malawi is mainly produced in the Central, Northern and Southern regions (Chinangwa et al. 2017). In Ethiopia, coffee is produced in many parts of the country, and mainly in the southern regions of Sidamo, Harrar, Ghimbi and Limu (Moat et al. 2017). Cotton is grown in most regions of Burkina Faso (except for the arid north regions), with the eastern cotton zone of Bobo-Dioulasso accounting for most of cotton output (Boafo et al. 2018). Cocoa production spans large parts of Ghana and especially southern Ghana. This concentration of industrial crop production can have more pronounced and easily tracked outcomes on local food security (rather than national food security), as discussed throughout this paper (see list of mechanisms in Sect. 3.3.2).

Below we unpack industrial crop production patterns, drivers and policies for some of the main producing countries in SSA, namely Kenya (Sect. 3.1.2.2), Ethiopia (Sect. 3.1.2.3), Malawi (Sect. 3.1.2.4), Burkina Faso (Sect. 3.1.2.5), Ghana (Sect. 3.1.2.6) and Swaziland (Sect. 3.1.2.7).

Kenya

Sugarcane is the major industrial crop produced in Kenya in terms of output followed by tea and coffee (FAOSTAT 2019). The sugar industry supports an estimated two million Kenyans and contributes about USD 540 million to the national GDP (FAOSTAT 2019), with smallholder farmers supplying more than 92% of the sugarcane processed by the domestic sugar mills (KSI 2009; KSB 2010). Sugarcane output increased rapidly between the early 1960s to the early 1980s (from 570,000 tons to 4.5 million tons) (FAOSTAT 2019). For the next 15 years, the sugarcane output oscillated around this level, but then experienced a rapid increase from 4.7 million tons in 2004 to 7.2 million tonnes in 2016 (FAOSTAT 2019). However, the sugarcane output experienced a rapid decline falling to 4.8 million tonnes in 2017 (33.3% decline) (FAOSTAT 2019). This drastic production reduction causes the sharp decline in the value of marketed sugarcane, from USD 234 million in 2016 to USD 195 million in 2017 (17% decline) (GoK 2018). This decline sugarcane output has been linked to multiple interconnected challenges related to low yields such as the (a) widespread use of low-quality sugarcane varieties; (b) shortage of irrigation water; (c) poor agricultural and land management practices and (d) delayed harvesting of mature sugarcane due to weather variability and/or logistical constraints (Mulwa et al. 2005; Mulianga et al. 2015; Onyango et al. 2012; Lindell and Kroon 2011; Hess et al. 2016). The Kenyan sugar industry has also faced critical challenges related to the (a) trade liberalization under the COMESA and

WTO protocols; (b) high production costs compared to other sugar-producing countries in the region (e.g. Tanzania); (c) poor governance and management; (d) insufficient funding and (e) inadequate research and extension services (KSI 2009; GoK 2007a).

The coffee sector plays an important role in the national economy in terms of income/employment generation, foreign exchange earnings and tax revenue generation. Coffee production increased rapidly in the first two decades following the 1963 independence, with the total coffee output from large estates and smaller cooperatives increasing from 43,778 tons in 1963, to 130,000 tons in 1988. Since then, however, the coffee industry has been on a downward trend, with the total output reaching only 53,400 metric tonnes in 2007 (GoK 2007b). Coffee output further declined in the following decade, reaching about 41,000 tons in 2017 (FAOSTAT 2019). As a result, the contribution of the coffee sector to the national economy has declined appreciably (Thuku et al. 2013). The sector faces many challenges including monopolistic practices, cooperative mismanagement, repeated droughts, decreasing international prices and weak infrastructure (Condliffe et al. 2008).

Tea cultivation and production have expanded from 18,000 tonnes and 21,488 ha (Nyagito 2001) (in 1963), to 328,500 tonnes and 141,300 ha, respectively, in 2005 (CBS 2005). The tea output and cultivation area increased further to 293,670 tonnes and 218,538 ha, respectively, in 2017 (FAOSTAT 2019). In 2002, Kenya was second only to Sri Lanka in exports of black tea (Bassett 2010). The success of tea sector has been attributed to the (a) supportive government policies following independence that have integrated successfully the small-scale growers into the sector, (b) adoption of high-yielding varieties mainly developed nationally by the Tea Research Foundation of Kenya (TRFK) and (c) selective application of herbicides and improved planting and cultivation methods (Kagira et al. 2012; Onduru et al. 2012). On the other side, obstacles facing tea smallholders include the prolonged droughts, lack of credit facilities and poor road infrastructure to transport the produced tea (Gesimba et al. 2005).

Since 2001, several policy initiatives have sought to support the agricultural sector, both targeting the main industrial crops discussed above and the broader sector. The Poverty Reduction Strategy Paper (2001–2004) developed different initiatives aiming to achieve sustainable growth in the agricultural sector through improved extension services, provision of credit to smallholders, improvement of rural infrastructure, development of stronger marketing links and capacity-building for institutions implementing these initiatives (GoK 2001). The Strategy for Revitalizing Agriculture (2004–2014) aimed at reversing the declining performance of the agricultural sector by introducing new management approaches including drastic changes in the operation ministries overseeing the sector and their interaction with other key stakeholders. The strategy emphasizes on the role of private–public partnerships as a means of facilitating competition, enhancing market performance and raising resource utilization efficiency (GoK 2004). The Kenya Rural Development Strategy (2002–2017) has been a longer term framework emphasizing on food security as the first step towards poverty alleviation and equitable growth and rural

development (GoK 2002). Finally, the Strategic Plan (2008–2012) was a 5-year strategic management plan promoted by the Ministry of Agriculture that catalysed institutional, policy and civil service reforms. Particular emphasis was paid to governance bottlenecks, food insecurity and volatile trade and financial regimes that have large influence on national agricultural production (GoK 2008).

Ethiopia

Coffee is the main industrial crop and export revenue stream in Ethiopia, generating approximately 25–30% of the national total export earnings (Moat et al. 2017). Ethiopia is the leading coffee producer in SSA and the fifth largest producer globally. In 2018, coffee production reached 7.1 million 60-kg bags (~426,000 metric tons), with exports forecasts at 3.98 million bags (~239,000 metric tons) (USDA 2018). Coffee production is predominantly characterized by traditional farm management systems, limited use of fertilizers/pesticides and manual cultivation systems and drying methods (Tefera and Tefera 2014). The estimated area used for coffee production (525,000 ha) (Tefera 2015) shrinks occasionally largely due to increasing population, land use conflicts, extensive deforestation, expansion of other industrial crops and other agricultural practices (Minten et al. 2017; Sisay 2018).

Sugarcane is another major industrial crop produced in the country. The sugarcane sector has undergone extensive transformation in the country, which has been mostly driven by the government. Even though smallholder-based sugarcane production has been prevalent for centuries, its large-scale cultivation started in the early 1950s with the establishment of the Wonji Sugar Factory (Wendimu et al. 2016). Subsequently the government pushed for the development of additional sugar plants to meet the increasing domestic sugar demand. The Sugar Corporation of Ethiopia currently administers six sugar factories (e.g. Wonji-Shoa, Metahara, Finchaa, Tendaho, Arjo-dedessa, Kessem), and nine sugar development projects at Kuraz, Tana Beles and Welkayit (Gashaw et al. 2018). Annual production has currently reached approximately 100,000 ha of sugarcane, 400,000 tons of sugar and 25,000 m^3 of ethanol, with the new sugar factories expected to expand significantly the production of sugar and other energy co-products through ethanol distilleries and bagasse cogeneration facilities (Gashaw et al. 2018).

Economic growth and rural development have been the two major drivers fuelling coffee expansion in the country. Conversely, energy security and economic growth have been the main drivers for sugarcane production (Tefera 2015; Hailemariam et al. 2019). Sugarcane ethanol production and bagasse co-generation are seen as possible avenues to increase domestic energy security considering Ethiopia's high reliance on imported fossil fuels (Berhanu et al. 2017). Indeed, the Ethiopian government has identified the sugar sector as a focal point in its efforts to become a middle-income country by 2025.

The Ethiopian government has fully supported the production of industrial crops through multiple relevant initiatives. In 1995, the Agricultural Development-Led Industrialization programme (ADLI 1995–2005) sought to boost the performance of

the agricultural sector by transforming smallholder-based agriculture into a vehicle to catalyse the shift towards an industrial economy. The "Plan for Accelerated and Sustainable Development to End Poverty" (PASDEP) (2005–2010) emphasized on economic growth through agricultural commercialization. Essentially the national government and other key development partners such as the World Bank perceived large-scale commercial agriculture as essential for increasing food production, enhancing economic growth, increasing foreign exchange earnings, generating employment, enabling technology transfer to smallholders, modernizing agriculture and developing infrastructure and basic services to local communities (Rehmato 2011). Around that period, the government started to actively promote large-scale commercial agriculture (especially of sugarcane) by allocating land for large-scale agricultural investments to domestic and international investors. Other relevant government policies seeking to boost the performance of the agricultural sector partly through industrial crops include the (a) Sustainable Development and Poverty Reduction Program (2002–2005), (b) Plan for Accelerated and Sustainable Development to End Poverty (2005–2010), (c) the first Growth and Transformation Plan (2010–2015) and (d) the second Growth and Transformation Plan (2016–2020).

Malawi

Tobacco, sugarcane, tea coffee and cotton are some of the main industrial crops produced in Malawi. Of these tobacco and sugarcane have traditionally contributed significantly to the national economy and rural livelihoods. They collectively account for approximately 79% of the national foreign exchange earnings and 22% of the gross domestic product (GDP) (Chirwa 2011).

Tobacco production started in the early twentieth century, but only reached high production levels in the 1960s. Total production increased from about 15,000 tonnes in the mid-1960s to about 160,000 tonnes in 1997, before declining sharply (FAOSTAT 2019). Production bounced back and reached an all-time high of about 175,000 tonnes in 2011, before declining again (FAOSTAT 2019). Many different reasons have contributed to tobacco expansion in Malawi such as (a) shifts in tobacco demand from developed to developing countries; (b) declining political support for tobacco production in developed countries; (c) cost competitiveness and the relatively high profitability of the crop; (d) technical and financial support and (e) large investments from international companies (Jaffee 2003). Currently, tobacco is produced overwhelming by smallholders that grow it either on their own land or as tenant farmers (Kulik et al. 2017). The declining tobacco output and prices in recent years have been possibly due various interconnected reasons such as exceeding farmer quotas, poor quality product, international competition, global demand decline and certain corporate strategies (Kulik et al. 2017).

Conversely, sugarcane production has experienced a large and constant expansion since the late 1960s. The two main plantations in Malawi started operating in 1968 (Nchalo) and 1978 (Dwangwa) (Chisanga and Zulu-Mbata 2017). The sugar industry was privatized in 1998, with the South African company Illovo taking over

the two production estates at Nchalo and Dwangwa. This meant that Illovo practically accounted for all sugar milling and refining capacity in the country. Overall, sugarcane output increased from about 170,000 tonnes in 1968, to over 2.9 million tonnes in 2017 (FAOSTAT 2019). Even though the two large estates in Nchalo and Dwangwa account for most sugarcane production, smallholder-based production has been promoted in both areas through various policies and incentives put in place by the national government (Chisinga et al. 2017). Furthermore, there has been continuous sugarcane ethanol production since the early 1980s, as a response to the energy crises (Gasparatos et al. 2015) (Chap. 2 Vol. 1; Chap. 5 Vol. 2). Malawi has been constantly blending high proportions of ethanol in gasoline, and is thus considered one of the pioneer countries globally in the transition to alternative transport fuels (Johnson and Silveira 2014).

Tobacco production seems to be overwhelmingly driven by national government efforts to boost economic growth and rural development. As mentioned above, tobacco is by far the main export in the country and is almost entirely produced nowadays by smallholders. On the other hand, sugarcane production has been mostly driven for economic growth. Even though Illovo undertakes most sugarcane production, a relatively large number of irrigated and rain-fed smallholders have been involved in the sector. Interestingly, despite sugarcane ethanol being blended in high proportions with gasoline, energy security does not seem to have been a major driver of sugarcane production. However, this might be gradually changing considering the current ongoing efforts to diversify ethanol feedstock production to boost the national ethanol output.

Many national policies and initiatives have been put in place to assist industrial crop production in Malawi. One of the first such regulations was the 1970 Tobacco Act that regulated tobacco production (Wiggins et al. 2015). Since 1981 structural adjustment programmes funded by the World Bank and the International Monetary Fund (IMF) were implemented, precipitating many institutional and policy changes in the agricultural sector in general, and food marketing in particular (Chilowa and Chirwa 1997). The liberalization of marketing and production inputs was implemented in 1990 under the Agriculture Sector Adjustment Credit initiative, which allowed the entry of private traders (of varying sizes in terms of scale of operations) in the marketing of farm inputs. Changes in the Special Crops Act of 1994 allowed for smallholder farmers participation in burley tobacco production, which was formerly undertaken only by large-scale estates. The smallholder tobacco sector benefited from the targeted Farm Input Subsidy Programme (FISP) (2006–2010), which offered poor farmers access to seeds and fertilizers. Similarly, the Malawi government has been supporting smallholder sugarcane growers with loans and grants mainly through two outgrower management companies, namely the Dwangwa Cane Growers Ltd. (DCGL) in Dwangwa and the Kasinthula Cane Growers Ltd. in Nchalo (Chisanga and Zulu-Mbata 2017). The National Export Strategy of 2012 was established to maintain the stable production of sugarcane for sugar and ethanol production (Wiggins et al. 2015).

Apart from these policies there is a constellation of national policies and institutions that affect industrial crop production. Some of the most prominent include:

(a) Malawi Growth Development strategy I (2006–2011) and II (2011–2016), which have been the overarching national development framework; (b) National Agriculture Policy Framework (NAPF) 2010–2016; (c) Agricultural Sector Wide Approach (ASWAP) 2010–2014; (d) Green Belt Initiative 2011–present; (e) National environmental Policy 2004 and (e) Malawi Energy policy, 2003.

Burkina Faso

Cotton was produced in Burkina Faso during the pre-colonial times as a secondary crop by family farmers. During the colonial period, cotton was produced in a top–down technocratic system that treated poorly these cotton smallholders (Vitale 2018). However like many other countries Western Africa, Burkina Faso re-oriented its economy towards cotton production in the post-colonial period. Despite some variability, cotton output increased sharply, from a few thousand tonnes in the early 1960s, to more than 370,000 tonnes in the late 1990s (FAOSTAT 2019). In the early 2000s, sudden cotton price drops precipitated a large decline across the sector, leading the country to insolvency. However, despite price volatility and concerns amidst stakeholders about the sector's viability (Vitale 2018), cotton output reached record levels in the early 2010s at more than 400,000 tonnes (FAOSTAT 2019). Up to the early 1980s, output gains materialized largely through the huge yield improvements catalysed by the introduction of animal traction and agricultural inputs (Vitale 2018). However, as yields leveled off in the mid-1980s, it has been cotton land expansion that caused the increases in output (World Bank 2013).

Economic growth has been perhaps the major driver of cotton production in Burkina Faso. Indeed cotton is the main agricultural commodity produced in the country and has historically constituted a substantial fraction of the GDP. On average cotton export revenues have accounted about 2.5% of GDP over the past decade, offering a stable source of foreign exchange that has catalysed economic development in other sectors (Vitale 2018).

Since independence and up until the early 2000s, SOFITEX (a government parastatal company) and CFDT (a privately owned French company) had complete control over cotton processing and marketing. In this "one-stop" cotton farming system SOFITEX provided on credit all of the production inputs to growers and maintained exclusive rights to purchase the seed cotton from farmers (Vitale 2018). A series of economic failures influenced major donors to push for reforms in the sector including among others: (a) changes in the laws for establishing farmer groups (1994, 1996–1999), (b) the establishment of the national cotton union (UNPCB) (1996–2001), (c) the partial privatization of SOFITEX (1999), (d) the delegation of major responsibilities from government and SOFITEX to UNPBC (2000–2006); (e) the introduction of new players in the sector such as private input providers, new regional private cotton monopsonies (SOCOMA, FASOCOTON) and private transport companies (2002–2006) and (f) changes in price-setting mechanisms to reflect better the prevailing global circumstances (2006–2008) (Kaminski 2009). Currently,

three cotton companies operate in the major production areas, namely Burkina Faso–SOFITEX, Faso Coton and SOCOMA. These companies purchase cotton at the same price and follow a common pricing scheme. However, despite maintaining the "one-stop" approach, cotton prices are now negotiated among the principal stakeholders within the sector (Vitale 2018). Despite the increase of cotton output in past decades, there are mixed perspectives about the success of these reforms in increasing the sustainability of the sector (Vitale 2018; Kaminski 2009; Boafo et al. 2018).

Ghana

The main industrial crops produced across the different agro-ecological zones of Ghana include cocoa, cotton, rubber, coffee, shea, sugarcane, tobacco, oil palm and citronella. Below we examine the drivers and production patterns for three rather different industrial crops, namely cocoa, cotton and jatropha. These crops have experienced radically different trajectories influenced by their different agronomic characteristics, modes of production, national policy priorities they cater for, and international circumstances.

Cocoa has been the most important export crop of Ghana since its introduction in the mid-nineteenth century. Ghana is currently the world's second largest producer of cocoa behind the Ivory Coast (FAOSTAT 2019). As one of the main export crops, cocoa has been central to Ghana's development, economic growth and poverty alleviation efforts, as it supports about 800,000 households (Vigneri and Kolavalli 2018; GSS 2014). The evolution of the Ghanaian cocoa sector spans four distinct phases: (a) introduction and exponential growth (1888–1937); (b) stagnation followed by a brief but rapid growth following independence (1938–1964); (c) near collapse (1965–1982) and (d) recovery and expansion following the introduction of the Economic Recovery Program (ERP) (1983–present) (Quarmine et al. 2014; Williams 2009). It is worth mentioning that during the collapse phase cocoa production fell from about 580,000 tonnes (in 1964) to less than 170,000 tonnes (in 1984) (FASOTAT 2019). Since then, the cocoa output has been increasing constantly reaching record output in 2017, standing at more than 880,000 tonnes (FAOSTAT 2019).

Similar to Burkina Faso, the first coordinated efforts to promote cotton production in Ghana in the northern semi-arid regions of the country started following independence. Cotton output increased significantly until the late-1990s, albeit not to the same levels as other West African countries (i.e. 26,000 tonnes in 1998) (FAOSTAT 2019). The international cotton price decline of the 1990s affected the sector to the extent that it is now virtually at the point of collapse (Howard et al. 2012), with the total output currently amounting to less than 1% of cotton output in Western Africa, despite excellent growing conditions in the northern part of the country. Overall, cotton production has been driven by various factors during different periods including, rural development, exports for foreign exchange earnings and the production of raw material for local textile industry (Boafo et al. 2018). Similarly, the reasons behind the sector's underperformance are multi-faceted (Boafo et al. 2018),

including the lack of institutional and regulatory frameworks that could promote effectively cotton to meet its rural development potential (MOFA 2013).

Jatropha was the most recent widely promoted industrial crop in Ghana. Jatropha received substantial attention in mid-2000s as a biofuel feedstock crop, with the National Jatropha Project Planning Committee pushing for the development of 1 Mha of jatropha plantations within a period of 5–6 years (by 2015) (Ahmed et al. 2017). However due to a set national circumstances such as the discovery of offshore oil deposits and the death of the early proponent of jatropha promotion, the impetus for jatropha expansion passed from the government to the private sector, and especially foreign interests (Ahmed et al. 2017). Many FDIs between the late 2000s to mid-2010s targeted large expanses of land to produce jatropha for export, and especially in the EU (Ahmed et al. 2017) (Chaps. 2 and 4 Vol. 1). This extensive allocation of land essentially made jatropha production the main driver of the land rush in Ghana (Schoneveld 2014). However, the sector has practically collapsed by the mid-2010s due to a combination of (a) low jatropha productivity, (b) weak business planning, (c) community conflicts, (d) institutional barriers and (e) civil society opposition (Ahmed et al. 2017, 2019b).

The promotion of these different industrial crops in Ghana was driven by slightly different factors. For example, cocoa production was largely driven by the availability of land in rural agro-ecosystems, and the need to generate foreign exchange to boost national economic development and poverty alleviation (Kolavalli and Vigneri 2011). Cotton, on the other hand, was promoted for rural economic development (especially targeting the arid and semi-arid regions of the country), as well as to boost exports of merchandize exports as part of the export substitution development strategy (Hussein et al. 2005; Baffes 2005). The drivers of jatropha production also varied over time. Initially, national energy security was the main driver behind the early promotion of jatropha, as implied by the strong focus on transport mandates of the early biofuels projects (Energy Commission 2006; Ahmed et al. 2017). However, by 2008, rural development through FDIs became the major driver of jatropha expansion in Ghana, given its prospects to create jobs in plantations and income for rural communities (Ahmed et al. 2017; Iddrisu and Bhattacharyya 2015; Boamah 2014).

The cocoa sector was shaped by the early establishment of the Ghana Cocoa Marketing Company in 1947, which formed into the Ghana Cocoa Board that seeks to promote the production, processing and marketing of high quality cocoa. Following the expansion and near collapse of the sector in the 1980s due to diseases, the government initiated two rehabilitation programmes (Cocoa Rehabilitation Programme I and II), which were unsuccessful (Amoah 1995; Kolavalli and Vigneri 2017). More importantly this period saw the implementation of the Economic Recovery Programme, which promoted, among others, the liberalization of the cocoa sector, the dissolution of all para-statal agencies and the adoption of a rehabilitation drive. Currently, the cocoa sector is partially liberalized with the Ghana Cocoa Board being responsible for cocoa exports and price-setting (Kolavalli and Vigneri 2017). To further boost cocoa production, the Cocoa Sector Development Strategy I (CSDS I) was implemented in 1999. Among others CSDS I

permitted Licensed Buying Companies to export cocoa, which was however ignored by the government at that time (Kolavalli and Vigneri 2017). Policy revisions led to the CSDS II, which deals with emerging issues affecting cocoa production such as child labour, certification and climate change. CSDS II ensures consistency with the national and international development agenda. Currently, multiple government-led initiatives through the Productivity Enhancement Programmes (PEPs) aim to double yields, from the current average of 450 kg/ha to 1000 kg/ha by 2027. The PEPs encapsulate a series of programmes such as the Farm Rehabilitation Programme, the Diseases and Pest Control Programme, the Soil Fertility Management through High Technology Programme, the Irrigation of Cocoa Farms Programme and the Artificial Pollination Programme among others (MoFA 2018). In addition, there are multiple efforts to promote value addition and youth employment in the cocoa sector within the broader framework of the government-led initiative "Investing for Jobs" (MoFA 2018).

The cotton sector has undergone major policy changes throughout the past decades. The first major action was the establishment of the Cotton Development Board (CDB) in 1968, a para-statal agency tasked to oversee the cotton sector. By the mid-1980s, the national government faced strong pressure from the World Bank to reform the sector, mostly as part of the Structural Adjustment Programmes of the 1980s (Peltzer and Röttger 2013). In the mid-1980s, the cotton sector was deregulated, and the CDB was transformed into the Ghana Cotton Company Limited (GCCL), with the government retaining 30% of the shares. Over the next decade, there was a proliferation of private companies participating in the cotton industry, and in 1995 the government sold its 30% share of the GCCL. At around that period free agricultural input supply to cotton smallholders changed into input credit, and a price-setting mechanism was put in place. In 1997–1998, the Cotton Development Project 1 (CDP-1) was launched, but there were unprecedented malpractices such as poaching of farmers and adulteration of product. In the early 2000s, the financing of cotton companies ceased due to their high accumulated debts, with several companies exiting the cotton sector. In 2000–2002, MOFA introduced a zoning policy to address malpractices in the sector, and in 2004 the African Development Bank took control of the GCCL through a debt-equity swap. Shortly after that point the GCCL was liquidated and ceased its operation, but in 2010–2011 there was an effort to revive the sector through the "White Gold" campaign. The last major policy initiative was the formal inauguration of the board of Cotton Development Authority in 2016 to carefully examine the challenges of the sector.

The jatropha sector received a relatively short, but intense policy interest in Ghana that coincided with the expansion of the bioenergy sector. The starting point was the 2005 draft biofuel policy and the 2006 Strategic National Energy Plan, which were anchored on energy security concerns and established biofuel blending mandates for the transport sector. Subsequently, rural development priorities started dominating the sector, with the 2007–2008 Biofuel Implementation Group and the National Jatropha Planning Committee seeking to establish 1 Mha of jatropha plantations in 53 districts. Subsequent relevant policies have included the 2010 bioenergy policy (which included revised blending mandates) and the 2011

Renewable Energy Act (which set incentives for large-scale land acquisitions and formal licensing/permitting processes). The 2012 and 2016 guidelines for large-scale land acquisitions sought to regulate such processes, especially in the bioenergy sector that had already experienced extensive land allocation (Ahmed et al. 2017).

Swaziland

Sugarcane and cotton are the major industrial crops produced in Swaziland. Sugarcane production increased almost ten-fold since the early 1960s, from 61.7000 tonnes in 1961 to 573.7000 tonnes in 2017 (FAOSTAT 2019). Practically all sugarcane production is concentrated in two areas, with 77% produced in large-scale plantations operated by the Royal Swaziland Sugar Corporation (RSSC) and Illovo (Terry and Ogg 2017). Conversely cotton production has been largely based on smallholders Hinderink and Strenkenburg 1987, experiencing very divergent production trends, namely a large increase in production (1961–1990) followed by a large decline (1991–2017). The all-time high cotton output was achieved in 1990 (26.0,000 tonnes), dwindling to 1.1000 tonnes in 2017 (FAOSTAT 2019).

Both sugarcane and cotton production have been promoted as avenues of economic growth and economic development (Table 3.4). In terms of policies, the Sugar Act of 1967 mainly regulates sugarcane production in the country. This act essentially stipulates the main rules governing sugarcane growing, processing and marketing, with the sector regulated by the Swaziland Sugar Association and the Quota Board (UNCTAD 2000). Large-scale irrigation development projects such as KDDP (Box 3.1) were promoted through para-statal agencies to develop smallholder-based sugarcane production capacity as a means of rural development and poverty alleviation (Terry 2012). Sugarcane production further flourished through the funds and technical assistance provided by the EU, as a consequence of the reforms in its sugar regime in 2006 (Richardson 2012). In particular, Swaziland received about EUR 134 million through an "Aid for Trade" programme called the Accompanying Measures for Sugar Protocol countries (AMSP) to enhance the competitiveness of its sugar industry, diversify economic activity in sugarcane areas and address social and environmental impacts (Richardson 2012).

Cotton on the other hand received much less policy attention. Cotton production was promoted through the government in some rural development areas (RDAs) primarily in the Lowveld and secondarily in the Lubombo plateau, with production in other parts of the country relying on the efforts of individual farmers (Hinderink and Sterkenburg 1987). The cotton sector is vertically integrated and state-controlled, with the Swaziland Cotton Board being the main institutional body coordinating the cotton sector, including overseeing cotton research, production and marketing and providing a secure market for cotton producers (ABC 2017). The Board also administers the Credit Scheme, which finances agricultural inputs and other cotton activities, as a means of facilitating smallholder engagement in the sector (ACB 2017).

3.3.2 Impacts of Industrial Crops on Food Security

3.3.2.1 Main Literature Patterns

Figure 3.9 outlines the number of identified studies for each of the targeted industrial crops. Industrial crops such as coffee and cocoa that have a long history of production in SSA, account for many of the studies. Surprisingly there are very few studies for crops with an equally long history of production such as coffee, tobacco and cocoa. Even more surprising is that jatropha studies account for a very large portion of the overall studies, considering the very brief history of the crop in SSA (since mid-2000s) and its widespread collapse across the continent only after a few years. This might reflect the increasing interest that industrial crops have received in the academic literature in the 2010s, which coincides with the recent land rush and the rising prominence of the "food vs. fuel debate" (Sects. 3.1 and 3.4.1).

More than half of the studies report work solely from institutions outside SSA (55%), 18% are collaborative research between SSA and non-SSA institutions, and only 15% solely from SSA institutions (Fig. 3.10a). The majority of these studies focuses on local level effects (52%), with also a significant fraction focusing at the sub-national (17%) and national (19%) levels (Fig. 3.10b). Qualitative, quantitative and mix-method research approaches are represented relatively evenly between studies (Fig. 3.10c). Most studies focus on historic and baseline trends, with only a minority using predictive approaches to understand the possible outcomes of future industrial crop expansion (Fig. 3.10d).

"Access to food" and "food availability" are by far the most widely studied pillars of food security, with 80 and 93 studies, respectively (Fig. 3.11b). "Food stability" is also relatively well-represented (58 studies), whereas "food utilization" is the least studied (20 studies) (Fig. 3.11b). Relatively numerous jatropha and cotton studies

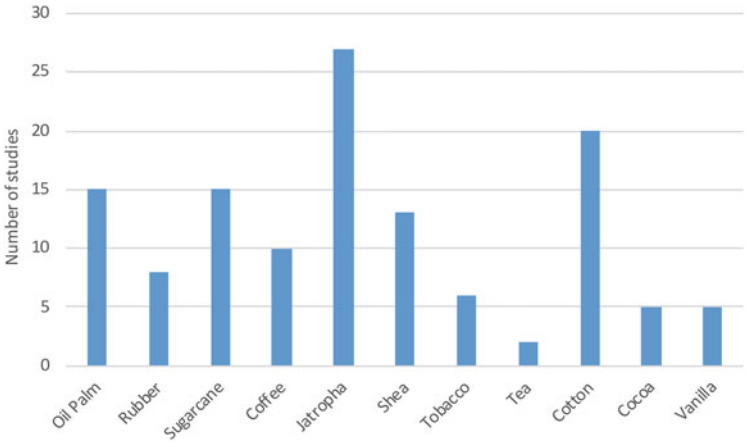

Fig. 3.9 Number of studies for each crop

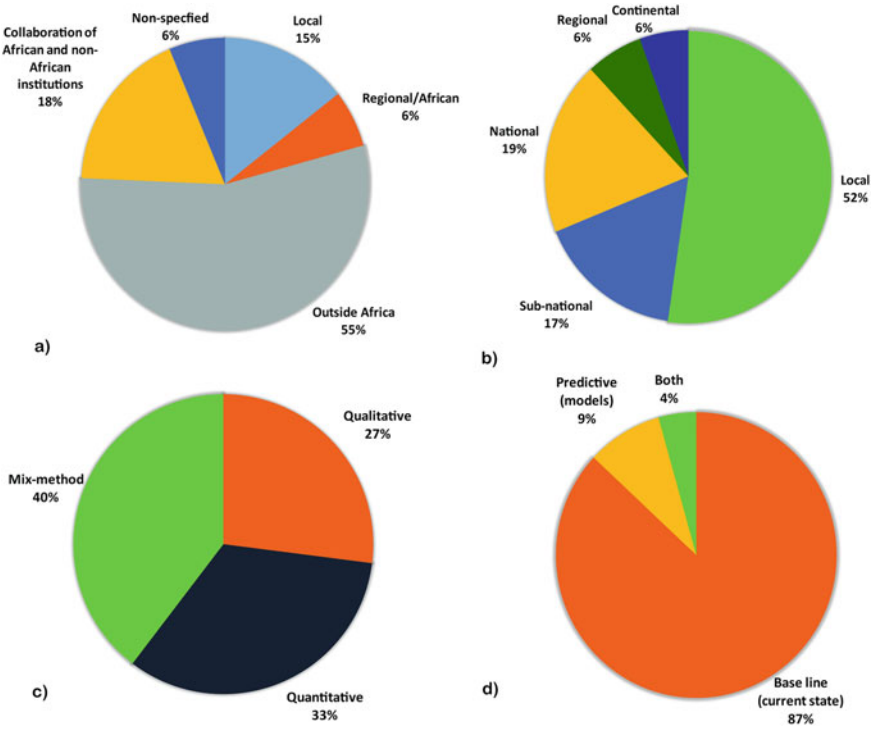

Fig. 3.10 Key characteristics of the reviewed studies: (**a**) Institutional affiliation, (**b**) spatial scale, (**c**) methodology and (**d**) temporal scale

span the four pillars of food security. Most of the tobacco, sugarcane and cocoa studies focus on mechanisms related to "food availability" and "access to food", whereas most rubber and oil palm studies focus on the "food availability" and "food stability" pillars (Fig. 3.11a, b).

The most frequently studied are (in descending order): "Income generation" (B4), "Food crop area" (A1), "Job creation" (B5), "Labour/capital diversion" (A4), "Market linkages" (B2), "Farming inputs" (A5), "Environmental impacts" (D7), "Market stability" (D2), "Women empowerment" (D6) and "Technology" (A6) (Fig. 3.12). Of these mechanisms A1, A4, B2, A5, D2 and D7 tend to have a negative outcome on food security, while B4, B5 and A5 tend to have a positive outcome (Fig. 3.13). When reading deeper the different studies it is possible to identify the underlying processes the mediate these effects on food security. Sections 3.3.2.2–3.3.2.5 discuss in more depth these underlying processes for most of the main mechanisms across the four pillars of food security.

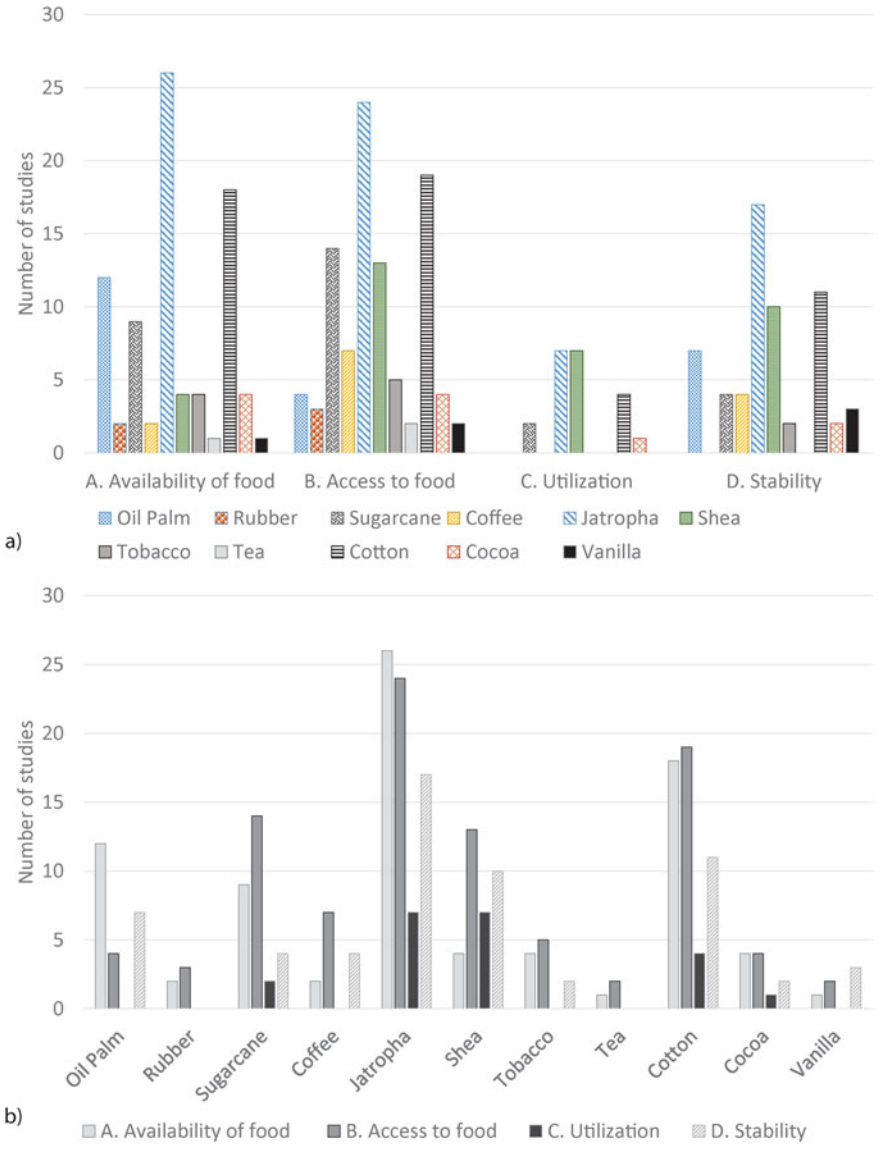

Fig. 3.11 Number of studies for each food security pillar by industrial crop (**a**) and for each industrial crop by food security pillar (**b**)

3.3.2.2 Food Availability

Most of the "food availability" studies focus on the "food crop area" mechanism (A1) (Table 3.5). Several of these studies highlight the negative food security outcomes of land competition with food crop production, whether through large-

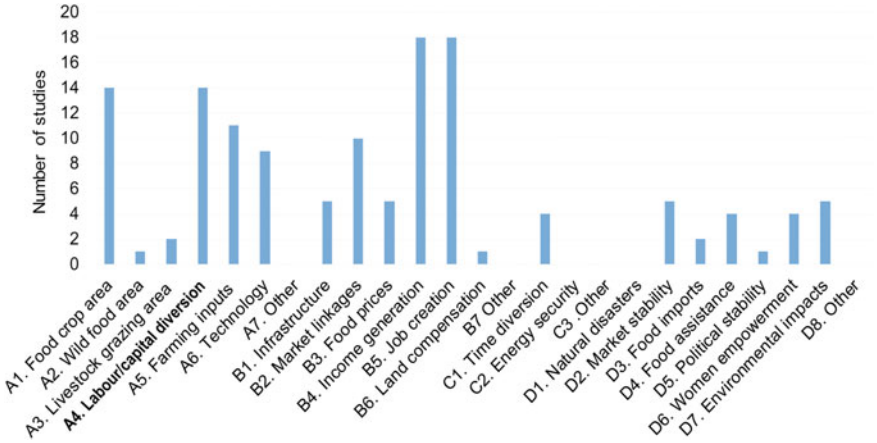

Fig. 3.12 Number of studies for each impact mechanism across all spatial scales. Note: Studies are double counted if they consider more than one food security pillar

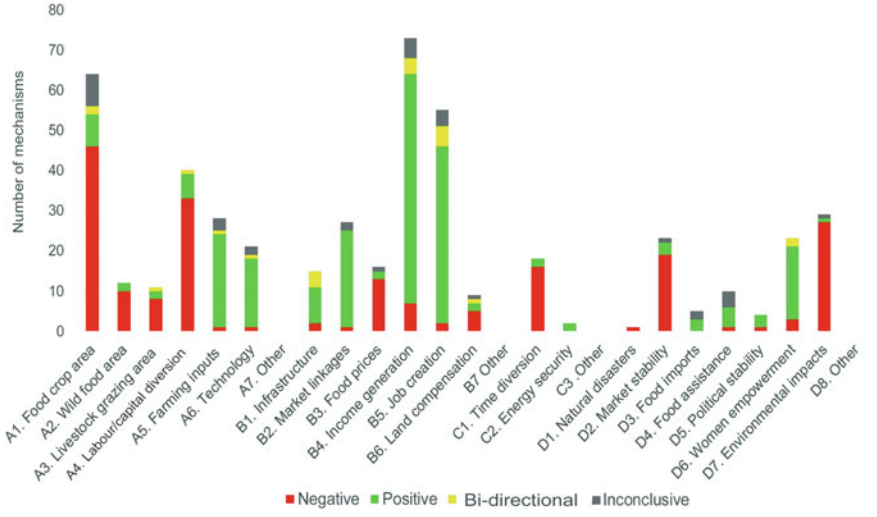

Fig. 3.13 Effect of different mechanisms on food security for all studies. Note: The total number of studies in this figure is lower to Fig. 3.11, as some studies focus on multiple crops and/or impact mechanisms

scale land acquisitions for plantation development or household-level decisions for engagement in smallholder production (e.g. Onoji et al. 2016; Terry 2007; Waswa et al. 2012; Arndt et al. 2011; Romijn et al. 2014; Timko et al. 2014; van Eijck et al. 2014; von Maltitz et al. 2016). However, many studies also point to the complementarity of industrial crops and food crops in smallholder settings that have positive food security outcomes (e.g. Wiggins et al. 2015), especially through

Table 3.5 Underlying processes related to each food availability impact mechanism

Mechanisms and underlying processes	Studies
A1. Food crop area	
Positive	
Intercropping of food crops and industrial crops allows for their joint production in smallholder farms	Uckert et al. (2015); Duvenage et al. (2012); Dyer et al. (2012); Favretto et al. (2014); German et al. (2011); Grimsby et al. (2012); Romijn et al. (2014); Leathers (1999); Komarek (2010)
Engagement in industrial crop production increases the availability of and access to agricultural inputs, which encourages the expansion of food cropland	Brambilla and Portoy (2011); Govereha and Jayne (2003); Laris et al. (2015); Theriault and Tschirley (2014)
Positive spillover effects from industrial crop production e.g. roads developed by plantations, encourages the expansion of food cropland	Laris and Foltz (2014); Ripoche et al. (2015); Vitale et al. (2011)
Engagement in industrial crop production has favorable socioeconomic outcomes e.g. education and income gains – See below, which influences smallholders to maintain better their family farms	Mponela et al. (2011); Romijn et al. (2014)
Negative	
Smallholders switch to industrial crop production from food crop production	Onoji et al. (2016); Terry (2007); Waswa et al. (2009a); Waswa et al. (2009b, 2012); Beghin (2016); Negash and Swinnen (2013); Arndt et al. (2011); Romijn et al. (2014); Timko et al. (2014); van Eijck et al. (2012); van Eijck et al. (2014); Von Maltitz et al. (2016); Theriault and Tschirley (2014); Anderman et al. (2014); Oluyole et al. (2009)
Loss of food cropland through its acquisition for industrial crop plantations e.g. international and state-owned industrial crop companies	Matondi et al. (2011); Carrere (2013); Delarue (2007); Greenpeace International (2012); Greenpeace International (2016); World Rainforest Movement (2012); World Rainforest Movement (2013); World Rainforest Movement (2015); World Rainforest Movement (2011); Acheampong and Campion (2014); Schoneveld et al. (2011)
A2. Wild food areas	
Negative	
Conversion of forest for industrial crop production causes the loss of access of forest-dependent communities to forestland, and the communal benefits it provides e.g. wild food	Gerber (2008); World Rainforest Movement (2011); Acheampong and Campion (2014); Kalinda et al. (2015); Schoneveld et al. (2011); Timko et al. (2014); Laube (2015)
A3. Livestock grazing area	
Positive	
Industrial crop growers can afford to keep more livestock	Matenga (2016); Terry (2012); Bosch and Zeller (2013)

(continued)

Table 3.5 (continued)

Mechanisms and underlying processes	Studies
Negative	
Conversion of grazing land for industrial crop production reduces livestock production	Waswa et al. (2009a, b); Von Maltitz et al. (2016); Williamson et al. (2005)
Conversion of cropland used for animal feed for industrial crop production reduces livestock production	Timko et al. (2014)
A4. Labour or capital	
Negative	
Smallholder-based industrial crop production requires intensive labour, thus reducing or diverting labour from food crop production on family farms	Negash and Swinnen (2013); Arndt et al. (2011); Bosch and Zeller (2013); German et al. (2011); Grimsby et al. (2012); Kalinda et al. (2015); van Eijck et al. (2012); Abudulai (2016); Naughton et al. (2017); Fortucci (2002); Laris et al. (2015); Leathers (1999); Moseley (2001); Anderman et al. (2014); Kiewisch (2015); Oluyole et al. (2009); Wiredu et al. (2011)
Employment in industrial crop plantations reduces or diverts the labour from food crop production on family farms	Romijn et al. (2014); Von Maltitz et al. (2016); Brambilla and Portoy (2011); Kaminski et al. (2011); Laris and Foltz (2014); Sodjinou et al. (2015); Vitale et al. (2011); Ismael et al. (2002)
High labour demand in industrial crop plantations increases the local agricultural labour costs	Borman et al. (2013)
Production of organic industrial crops increases labour intensiveness, further reducing or diverting labour from food crop production on family farms	Williamson et al. (2005)
Adoption of fair-trade and sustainable certification standards and practices for industrial crop production prohibits children from contributing to food crop production on family farms	van Eijck et al. (2014); Bassett (2010)
A5. Farming inputs	
Positive	
Engagement in smallholder-based industrial crop production improves access to fertilizers, which enhances food crop yields	Matenga (2016); Terry (2007); Brambilla and Portoy (2011); Mohammed et al. (2013); Delpeuch and Leblois (2014); Govereha and Jayne (2003); Kaminski et al. (2011); Laris and Foltz (2014); Laris et al. (2015); Moseley (2001); Ripoche et al. (2015); Sodjinou et al. (2015); Theriault and Tschirley (2014); Wiredu et al. (2011)
Engagement in smallholder-based industrial crop production improves access to other non-fertilizer agricultural assets and inputs e.g. seeds, extension, training, credit, which improves food crop production and yields	Bussolo et al. (2007); Negash and Swinnen (2013); Bosch and Zeller (2013); Mohammed et al. (2013)

(continued)

Table 3.5 (continued)

Mechanisms and underlying processes	Studies
Engagement in smallholder-based industrial crop production especially fairtrade/certified increases access to environmentally-friendly and reduces the use of harmful agricultural inputs, which improves food crop production and yields	Bassett (2010);Vitale et al. (2011)
Negative	
Engagement in smallholder-based industrial crop production does not improve access to fertilizers or knowledge how to use them effectively	Duvenage et al. (2012)
Industrial crop production increases local fertilizer prices, reducing their local accessibility to poorer households	Borman et al. (2013); van Eijck et al. (2012); Kiewisch (2015)
Industrial crop production increases the use of and access to harmful pesticides	Williamson et al. (2005)
A6. Technology	
Positive	
Industrial crop companies and grower associations provide technical support, knowledge and training for food crop production	German et al. (2011); Kalinda et al. (2015); Bello-Bravo et al. (2015); Hatskevich et al. (2011); Ismael et al. (2002); Jacques et al. (2009); Laris and Foltz (2014); Vitale et al. (2011); Wiredu et al. (2011)
Introduction of organic methods for industrial crop production improves food crops yield	Bassett (2010); Williamson et al. (2005)
Industrial crop production catalyses access to irrigation, which can also be used for food crop production	Terry (2007)
Negative	
Low technology transfer for industrial crop production brings no support for food crop growing, affecting low yield of food crops	Duvenage et al. (2012); Fortucci (2002)

Source: Jarzebski et al. (2019)

intercropping that minimizes land competition (e.g. Duvenage et al. 2012; Dyer et al. 2012; Favretto et al. 2014; Grimsby et al. 2012; Romijn et al. 2014; Leathers 1999).

Studies related to the "labour and capital" mechanism (A4) overwhelmingly focus on the high labour needs of smallholder-based industrial crop production often requires intensive labour, which often takes a toll on the availability of family labour for food crop production (e.g. Adams et al. 2016; Naughton et al. 2017; Fortucci 2002; Laris et al. 2015; Leathers 1999). Such employment diversion effects are also reported and for large-scale plantations (e.g. Ismael et al. 2002; Kaminski et al. 2011; Laris and Foltz 2014). Few studies have pointed that labour diversion from industrial crop production (especially in large plantation settings) can increase

local labour costs, thus reducing affordable local labour options for food crop production (Borman et al. 2013).

Studies have linked some of the positive local food security outcomes of industrial crop production to the improved access of smallholders to farming inputs and technology transfer (A5–6). This includes improved access to various factors of production, including:

- Fertilizers (e.g. Brambilla and Portoy 2011; Delpeuch and Leblois 2014; Govereha and Jayne 2003; Kaminski et al. 2011; Herrmann et al. 2018; von Maltitz et al. 2019).
- Diverse varieties of food crops and seeds (Bussolo et al. 2007).
- Irrigation (Negash and Swinnen 2013; von Maltitz et al. 2019).
- Technical support (e.g. Kalinda et al. 2015; Bello-Bravo et al. 2015).
- Other environmentally friendly agricultural inputs (e.g. Bassett 2010).

Improved access to all of the above can enhance the yields of both industrial and food crops, reducing (or even reversing) the effects of land competition (mechanism A1, see above). However, some studies have also found that industrial crop production can increase local fertilizer demand, and thus its price, reducing its affordability to poorer households for food crop production (e.g. Borman et al. 2013; van Eijck et al. 2012).

3.3.2.3 Food Access

Most studies in the "food access" pillar by far focus on the positive local food security outcomes brought by income, employment and occupation generation (B4–5) (Table 3.6). For example, many studies have identified that involvement in industrial crop production can boost existing income (e.g. Banye 2015; Ferris et al. 2001; Suleman et al. 2014; Govereha and Jayne 2003), or create additional income sources (e.g. Onoji et al. 2016; Dyer et al. 2012; Favretto et al. 2014). Even though the generated income often quite low and depend on the crop type and mode of engagement (e.g. smallholder vs. plantation worker), this income can be constant and allow better planning within the household (German et al. 2011), or come during periods of low food security acting thus as a livelihood buffer (von Maltitz et al. 2016).

In terms of employment and occupation generation, many studies have reported the positive effect of industrial crop production on local employment opportunities, especially in poor rural areas with few formal employment options (Duvenage et al. 2012; Dyer et al. 2012; von Maltitz et al. 2016). Sometimes employment opportunities are seasonal (e.g. James and Woodhouse 2016; Matenga 2016), and can enhance self-employment (e.g. Kuntashula et al. 2014; Chivuraise 2011) or women employment (e.g. Bosch and Zeller 2013).

Table 3.6 Underlying processes related to each access to food impact mechanism

Mechanisms and underlying processes	Studies
B1. Infrastructure	
Positive	
Industrial crop companies develop infrastructure that improves water access and/or provides irrigation	Negash and Swinnen (2013); Romijn et al. (2014); Timko et al. (2014)
Industrial crop companies construct roads that improve access to food	Romijn et al. (2014)
B2. Market	
Positive	
Higher overall development in areas of industrial crop production results in the development of new food markets	Garba et al. (2015)
B3. Food price	
Positive	
Industrial crops smallholders associations also get involved in food crop production as a secondary activity, reducing local food prices	Terry (2007)
Negative	
Increased local demand for food coupled with reduced food production increases food prices	Arndt et al. (2011); Bosch and Zeller (2013); Timko et al. (2014); van Eijck et al. (2012); Kaminski et al. (2011); Laris and Foltz (2014) Anderman et al. (2014)
Expansion of industrial crop production causes the manipulation of market food prices	Kgathi et al. (2012)
B4. Income from industrial crops	
Positive	
Engagement in industrial crop production provides income incl. For women that is used to buy food, thus increasing access to food in these studies industrial crop income is the main household income stream	Onoji et al. (2016); Matenga (2016); Terry (2007); Terry (2012); Arndt et al. (2011); Dyer et al. (2012); Favretto et al. (2014); German et al. (2011); Grimsby et al. (2012); Kalinda et al. (2015); Romijn et al. (2014); Romijn et al. (2014); Timko et al. (2014); van Eijck et al. (2014); Adams et al. (2016); Annan (2013); Bello-Bravo et al. (2015); Hatskevich et al. (2011); Naughton et al. (2017); Ismael et al. (2002); Laris et al. (2015); Sodjinou et al. (2015)
Engagement in industrial crop production increases the total household income, thus increasing access to food in these studies it is not specified if the added income is the household main or it is additional	Greenpeace International (2012); World Growth (2010); FEWS Net Liberia (2016); Dam Lam et al. (2017); Kennedy (1989); Matenga (2016); Banye (2014); Ferris et al. (2001); Suleman et al. (2014); Bassett (2010); Fortucci (2002); Govereha and Jayne (2003); Kaminski et al. (2011); Theriault and Tschirley (2014); Oluyole et al. (2009)
Labour wages increase, providing additional income, thus increasing access to food	Borman et al. (2013); van Eijck et al. (2012)

(continued)

Table 3.6 (continued)

Mechanisms and underlying processes	Studies
Growing organic industrial crops increases income, which increases access to food	Williamson et al. (2005)
Modernizing management methods improves income, which increases access to food	Jacques et al. (2009)
B5. Job and occupation creation	
Positive	
Employment generation in plantations incl. For women	Acheampong and Campion (2014); Duvenage et al. (2012); Dyer et al. (2012); Favretto et al. (2014); German et al. (2011); Romijn et al. (2014); Romijn et al. (2014); Romijn et al. (2014); van Eijck et al. (2012); Von Maltitz et al. (2016); Banye (2014); Hatskevich et al. (2011); Hatskevich et al. (2014); Jamala et al. (2013); Laube (2015); Mohammed et al. (2013); Bassett (2010); Fortucci (2002); Vitale et al. (2011); Williamson et al. (2005); Komarek (2010); van Eijck et al. (2014); Von Maltitz et al. (2016); Adams et al. (2016); Sodjinou et al. (2015)
Women employment available	Arndt et al. (2011); Bosch and Zeller (2013); Bello-Bravo et al. (2015); Naughton et al. (2017); Sodjinou et al. (2015)
Self-employment as grower	Negash and Swinnen (2013); Kuntashula et al. (2014); van Eijck et al. (2014); Chivuraise (2011); Laris and Foltz (2014)
Seasonal employment available	James and Woodhouse (2016); Lazzarini (2016); Matenga (2016); Von Maltitz et al. (2016); Adams et al. (2016)
B6. Compensation for the land	
Positive	
Land compensated with arable land at small holder level	Laube (2015)
Compensation offered only after a conflict occurred	Romijn et al. (2014)
Negative	
No compensation received for taken land	Acheampong and Campion (2014); Romijn et al. (2014)

Source: Jarzebski et al. (2019)

3.3.2.4 Food Utilization

Studies related to the "food utilization" pillar are relatively scarce, and focus mostly on the negative effects of female engagement in industrial crop production (and paid employment in plantations in particular) (Table 3.7). This is usually linked to time loss for household activities, and especially meal preparation, feeding children and general unpaid care time (e.g. Arndt et al. 2011; Bosch and Zeller 2013). Some

Table 3.7 Underlying processes related to each food utilization impact mechanism

Mechanisms and underlying processes	Studies
C1. Jobs for women	
Positive	
Exclusion of women from waged employment in industrial crop plantations and smallholder-based production allows them to spend more time for unpaid household care activities	Lazzarini (2016); Moseley (2001); Kiewisch (2015)
Negative	
Employment for women in industrial crop plantations diverts their time from unpaid household care activities	Arndt et al. (2011); Bosch and Zeller (2013); Romijn et al. (2014); Romijn et al. (2014); Romijn et al. (2014); Adams et al. (2016); Annan (2013); Banye (2014); Bello-Bravo et al. (2015); Garba et al. (2015); Jamala et al. (2013); Laube (2015)
Fairtrade-related schemes increase women engagement in smallholder-based industrial crop production, diverting their time from household care activities	Kiewisch (2015); Waswa et al. (2009b); Acheampong and Campion (2014)
C2. Energy security	
Positive	
By-products of industrial crops can be used as cooking fuel, reducing thus the time spent for fuelwood collection	Von Maltitz et al. (2016)

Source: Jarzebski et al. (2019))

studies have also identified that men dominate employment opportunities along industrial crop value chains, maintaining thus, traditional societal structures and household roles for women (Lazzarini 2016; Waswa et al. 2009a, 2009b; Moseley 2001). Even though such outcomes might not be socially desirable (Sect. 3.4.2), they still seem to have possible positive effects related to food utilization.

3.3.2.5 Food Stability

Most of the studies related to the "food stability" pillar focus on two specific mechanisms, namely women empowerment (D6) and environmental stability (D7) (Table 3.8). Engagement in industrial crop value chains is occasionally associated with women empowerment. For example, some studies have identified that females involved in industrial crop value chains often assume greater control in intra-household income allocation decisions (e.g. Adams et al. 2016; Banye 2015). Furthermore, involvement in industrial crop value chains can enhance training opportunities for women (Williamson et al. 2005; Suleman et al. 2014) and the development of women groups that can negotiate crop prices from a stronger position (e.g. Favretto et al. 2014; Annan 2013).

Table 3.8 Underlying processes related to each food stability impact mechanism

Mechanisms and underlying processes	Studies
D1. Natural disasters	
Positive	
Jatropha provides a natural "fence" that protects crops from wind or floods	Favretto et al. (2014)
D2. Market stability	
Positive	
Smallholder women cooperatives increase market stability	Banye (2014)
D4. Hunger reduction	
Positive	
Industrial crop producers are able to purchase food during periods of food shortages	Bosch and Zeller (2013); Favretto et al. (2014)
Some industrial crops (e.g. shea) can be used for food purposes during hunger period	Hatskevich et al. (2011)
D6. Women empowerment	
Positive	
Engagement in industrial crop value chains enhances income (and income opportunities) for women	Carrere (2013); Arndt et al. (2011); Romijn et al. (2014); Romijn et al. (2014); Timko et al. (2014); Adams et al. (2016); Banye (2014); Bello-Bravo et al. (2015); Laube (2015); Suleman et al. (2014); Sodjinou et al. (2015)
Engagement in industrial crop value chains catalyses the formation of women groups that are in a better position to negotiate prices	Favretto et al. (2014); Annan (2013); Garba et al. (2015)
Industrial crop schemes provide training opportunities for women	Williamson et al. (2005)
Negative	
Women do not control the income generated through engagement in industrial crop value chain, and are excluded from related decision-making	Zommers et al. (2012); Anderman et al. (2014); Kiewisch (2015)
Women lose access to education and paid employment due to their engagement in industrial crop value chains	Lazzarini (2016); Moseley (2001)
Women are paid less for their engagement in industrial crop value chains	Matenga (2016)
D7. Environmental stability	
Positive	
Industrial crop production reduces deforestation, which affects one of the other three pillars of food security (food availability)	Uckert et al. (2015)
Negative	
Industrial crop production causes deforestation, which has a negative effect to one of the other three pillars of food security (food availability)	Carrere (2013); Greenpeace International (2012); Greenpeace International (2016); Moser (2008); Grimsby et al. (2012); Naughton et al. (2017); Chivuraise (2011); Moser (2008); Patel (2007); Randriamalala and Liu (2010)

(continued)

Table 3.8 (continued)

Mechanisms and underlying processes	Studies
Industrial crop production causes biodiversity loss, which has a negative effect to one of the other three pillars of food security (food availability)	Carrere (2013); Gerber (2008); Oyono (2013); Zommers et al. (2012); Beyene et al. (2012); Senbeta and Denich (2006); German et al. (2011); van Eijck et al. (2014); Laube (2015)
Industrial crop production causes water depletion, which has a negative effect to one of the other three pillars of food security (food availability)	Gerber (2008); Beyene et al. (2012); Von Maltitz et al. (2016)
Industrial crop production causes soil degradation, which has a negative effect to one of the other three pillars of food security (food availability)	Carrere (2013); World Rainforest Movement (2011); Duvenage et al. (2012)
Industrial crop production causes water quality degradation, which has a negative effect to one of the other three pillars of food security (food availability)	Oyono (2013); Favretto et al. (2014)

Source: Jarzebski et al. (2019)

However, industrial crop production often causes negative environmental impacts (e.g. deforestation) that threaten the stability of food production (e.g. Grimsby et al. 2012; Naughton et al. 2017; Chivuraise 2011). Other negative environmental impacts linked to negative food security outcomes include biodiversity loss (e.g. Senbeta and Denich 2006; German et al. 2011), water depletion (e.g. Gerber 2008; Von Maltitz et al. 2016) and soil degradation (e.g. Duvenage et al. 2012).

3.4 Discussion

3.4.1 Knowledge Synthesis

Overall, most of the reviewed studies at the interface of food security and industrial crop production have been published in the 2010s (Sect. 3.3.2.1). This implies that the recent global land rush (Schoneveld et al. 2011) has possibly catalysed and shaped more than anything else the literature on industrial crops and food security. Indeed narratives related to land grabbing, land competition and "food vs. fuel" have been key underlying themes in the reviewed literature (see also Borras and Franco 2013; Kaag and Zoomers 2014; Nalepa et al. 2017; Zoomers 2010; Kuchler and Linnér 2012; Shortall 2013; Tenenbaum 2008) (Chap. 4 Vol. 1). In fact a substantial fraction of the reviewed studies comes from countries that were targeted extensively for large-scale commercial agriculture investments during the recent land rush such as Zambia, Mozambique, Ghana and Ethiopia (Schoneveld 2014). Additionally,

many of these studies have focused on jatropha, a relatively new and untested crop that received very sudden attention in SSA before its eventual collapse (Sect. 3.3.2.1) (von Maltitz et al. 2014; Ahmed et al. 2019b).

Most studies target a sub-set of mechanisms related to the "access to food" and "food availability" pillars of food security. Furthermore, the number and type of mechanisms captured are highly variable between crops. For example, cotton, jatropha, shea and sugarcane are the best-studied crops in terms of the number of captured mechanisms (Sect. 3.3.2.1). Conversely, important crops such as oil palm, rubber, cocoa and coffee feature in comparatively fewer studies, despite their extensive history and ongoing expansion across the continent (Sect. 3.1).

Industrial crop production facilitates local access to food by generating income and employment (Sect. 3.3.2.3). At the same time, engagement in industrial crop production (whether as plantation workers or smallholders) can divert family labour from food crop production, thus reducing local food availability (Sect. 3.3.2.2). As a result, there is a great need to ensure the generation of secure employment, and reliable and sustainable income, while minimizing the negative effects of time and labour diversion from food crop production in family farms (see also Sect. 3.4.2). Sustaining income and employment benefits would render the engagement in industrial crop value chains a worthwhile and risk-free endeavour to plantation workers and smallholders. This is very important lesson learnt from the almost total collapse of the jatropha sector and lack of materialization of the expected benefits in many rural contexts of SSA (Ahmed et al. 2019b; von Maltitz et al. 2015).

There is also strong evidence to suggest that industrial crop production often causes direct land competition with food crop production (Sect. 3.3.2.2). However, the actual land use change effects depend on the mode of production. However, there can also be indirect land use change effects that are nevertheless difficult to estimate accurately and in a non-controversial manner (Khanna and Crago 2012; Finkbeiner 2014). For example, industrial crop smallholders can either choose to expand (or not) food crop production to other areas to compensate for the land allocated to industrial crops. Similarly large-scale plantations might displace farmers, who might in turn clear land elsewhere to establish farms. In any case such direct and indirect land competition can affect local food availability either through the loss of food cropland or the loss of communal pasture/forest.

In smallholder settings increasing the use of agricultural inputs use (e.g. fertilizers, pesticides) and/or adopting improved production practices (e.g. irrigation, intercropping) could minimize the possible negative effects of land loss on food availability by increasing crop yields (Sect. 3.3.2.2). However, such agricultural intensification might lead to negative environmental impacts related to freshwater depletion, water pollution and soil degradation, all of which have been shown to have a negative effect to food stability (Sect. 3.3.2.5). The above suggest hard trade-offs between the food availability and food stability pillars.

Many of the reviewed studies pointed how gender issues mediate the positive or negative impacts of industrial crop production on food security. This happens especially through some mechanisms such as income and employment generation (B4–5), time diversion from unpaid care work (C1) and women empowerment (D6).

However, even though women are a major part of the labour force in SSA (Bryceson 2018) (see Chap. 1 Vol. 1), they are often barred from formal employment in industrial crop plantations due to lack of skillset, cultural reasons and the fact that formal waged jobs are often seen as a male domain (Sect. 3.3.2.4). Female entry in smallholder-based industrial crop production is also not straightforward, as they often lack land titles and decision-making power in family farms (Bryceson 2018).

Finally, as already discussed in Sect. 3.3.1 and above, the mode of industrial crop production can have important effects on food security through multiple impact mechanisms. However, deciding the fitness of particular modes of production is not straightforward and can depend on various factors. Some of the most important such factors include (a) crop characteristics/agronomy (b) production characteristics (e.g. labour intensity, returns to investment); (c) marketing characteristics (e.g. potential buyers, processing needs); (d) exogenous economic and political factors (e.g. land scarcity, population density) and (e) endogenous economic and political factors (e.g. input markets, low producer capacity, weak property rights enforcement) (Benfica et al. 2002).

3.4.2 Policy and Practice Implications and Recommendations

As outlined in Sect. 3.3, there are multiple trade-offs at the interface of industrial crop production and food security in SSA. When critically viewing the evidence outlined throughout this chapter it is possible to identify some priority policy and practice domains that can be targeted to enhance the positive (or reduce the negative) food security outcomes of industrial crop production. Below we outline three priority domains that are at the intersection of multiple SDGs:

- Safeguard the long-term economic and employment benefits accruing from engagement in industrial crop production,
- Enhance farm output for both industrial crops and food crops, while avoiding negative environmental impacts,
- Enhance female participation in industrial crop production, while reducing the negative effects of time diversion from unpaid household care work.

Regarding the first priority domain, income and employment generation are two of the main mechanisms through which industrial crop production has a positive effect on food security (Sects. 3.3.2 and 3.4.1). That said, government policies should support the economic viability and sustainability of industrial crop production systems. In particular, a key aim should be to achieve the better balance between competition and coordination, and provide appropriate incentives to better safeguard the interests of farmers when engaging in industrial crop value chains. This would entail different incentives to smallholders, plantation owners and other players across industrial crop value chains (e.g. millers, transporters). Such a coordinated approach could send strong signals about the long-term policy commitment in

industrial crop production, which could alleviate investor uncertainty and help attract sustained investment (Chaps. 2 and 5 Vol. 1).

There have been such coordinated national efforts in countries such as Burkina Faso, Malawi and Swaziland, where a strong policy commitment over decades has made cotton, tobacco and sugarcane the cornerstones of their respective economies (Terry and Ogg 2017; Johnson and Silveira 2014; Boafo et al. 2018; Tschirley et al. 2009) (Sect. 3.3.1). This would entail strengthening industrial crop markets and streamlining all stages of the value chain, from the land acquisition, to the economic aspects of crop production, refinement, valourization of waste and final product use. As the actual interventions and long-term strategies might be crop- and area-specific, it would be necessary to factor national and local contexts. Some additional foci for large-scale plantations would be to ensure that (a) worker salaries are sufficient to buy food locally, (b) seasonal/part-time employment is based on a standard salary rate (and not on a picking rate), (c) flexible employment is possible during important periods of crop calendar year (e.g. during food crop sowing, harvesting). All of these actions could create very strong linkages among various SDGs namely SDG8 (descent work and economic growth), SDG9 (industry, innovation and infrastructure), SDG1 (no poverty) and of course SDG2 (zero hunger).

Regarding the second priority domain, it would be necessary to understand the possible environmental and food production trade-offs from industrial crop expansion. This could be achieved through robust baseline studies undertaken prior to the development of industrial crop projects that should seek to understand the decision-making processes of local farmers in terms of land allocation, and the adoption of crops and farming practices. This information can help build a strong evidence-base to guide the development and implementation of context-specific interventions that seek to minimize the negative trade-offs of industrial crop production. However, these aspects are rarely considered during project design, even in commonly used instruments such as environmental impact assessments (EIAs) (e.g. German et al. 2013). Thus it would be necessary to "enforce" the provision of this type of information (and identify possible mitigation option in the face of important trade-offs) prior to the approval of large-scale industrial crop projects.

Furthermore, it is important to rationalize the use of agrochemicals and irrigation water both in large plantations and smallholder settings. The former could help reduce the negative environmental impacts of industrial crop production, and the latter could ensure water availability to other water users, especially during periods of water scarcity. However, EIAs have little power to deal with such effects in smallholder settings as individual farmers can unilaterally decide to start and halt industrial crop production based on market signals. Even though engagement in industrial crop production improves access to agricultural inputs (and sometimes irrigation) (Sect. 3.3.2.2), smallholders often lack the capacity to utilize them in environmentally and socially responsible manners (Morris et al. 2007). Capacity-building efforts and the promotion of responsible production practices through the support packages offered to industrial crop smallholders could go a long way towards achieving this. However, increasing the environmental and social

responsibility of smallholders through such actions would require coordinated efforts between industrial crop companies (e.g. buyers from smallholders), other private sector players (e.g. certification schemes), government agencies and civil society.

Enhancing farm output while avoiding negative environmental impacts as discussed above can have positive effects to multiple SDGs, such as SDG12 (responsible consumption and production), SDG15 (life on land), SDG6 (clean water and sanitation) and of course SDG2 (zero hunger).

Regarding the third priority domain, clearly it is not justifiable to prevent females from engaging in industrial crop value chains on grounds of safeguarding their crucial role in unpaid care work. However, we should also be aware of the almost complete lack of social services in rural SSA (ILO 2018) (Chap. 1 Vol. 1). Thus, it would be important to identify avenues to enhance female participation in industrial crop value chains as a means of accessing income/employment opportunities and achieving broader female empowerment benefits, while at the same time reducing the negative effects of time diversion from unpaid household care work.

Large-scale plantations can develop (or contribute to the development of) infrastructure that compensates for this loss of unpaid care work (e.g. schools with feeding programmes), where female employees can have priority access. Furthermore, flexible working arrangements and standardized salaries for seasonal and part-time employees can further ensure both that female workers are not discriminated and that food utilization trade-offs are minimized. A very interesting approach specific to bioenergy crops would be to provide (or support the acquisition of) improved stoves and fuel such as ethanol stoves and fuel (Chap. 2 Vol. 1). This could reduce time diversion to fuelwood collection and cooking, which is substantial in most parts of rural SSA and takes a toll on females and girls (Karanja et al. 2020; Köhlin et al. 2011).

However, it might not be as straightforward to enable the aforementioned gender inclusion interventions in smallholder settings. Possible avenues could be to valourize further female participation in industrial crop production by offering higher premiums from certification schemes (Parvathi 2017). Supporting the development of female grower associations or increasing the decision-making power of female growers in mixed-grower associations could further improve female negotiating and decision-making power. This could help maximize the gender empowerment benefits of engagement in smallholder-based industrial crop production. Furthermore, government agencies, civil society organizations and the private sector should increase the number (and improve the quality) of training activities geared towards female industrial crop growers. Apart from offering important knowledge for enhancing industrial crop production (see above), such training should further educate women about the possible negative trade-offs of their involvement in industrial crop value chains. However, even though such interventions could possibly enhance the benefits that women receive from engagement in industrial crop production, they can have a less direct effect to food security.

3.5 Conclusions

This sought to unravel the food security outcomes of industrial crop production in SSA. We reviewed the main production patterns, drivers and underlying policies in some of the most important producing countries in the region and reviewed systematically the existing literature for 11 industrial crops and 25 impact mechanisms across the four pillars of food security. The quantity of the current evidence varies considerably between crops, with jatropha, cotton sugarcane and shea being the most studied crops. Food access and availability are the only pillars of food security with substantial evidence and consensus about the direction and magnitude of the impact mechanisms. Much less literature exists for mechanisms related to food stability and utilization.

Overall, the current literature landscape is fragmented with most studies considering a sub-set of crops, modes of production regions and/or impact mechanisms. This is a major barrier for balanced policy and practice inferences at the interface of industrial crops and food security. Future research should better conceptualize the possible pathways through which industrial crop production can affect food security. Empirical studies should, to the extent possible, use compatible methods to allow for the better understanding of these mechanisms across SSA.

Policy and practice priorities should include to (a) safeguard the long-term economic and employment benefits accruing from engagement in industrial crop production; (b) enhance farm output (for both industrial and food crops) while avoiding negative environmental impacts; (c) enhance female participation in industrial crop production, while reducing the negative effects of time diversion from unpaid household care work.

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