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Review

A Systematic Review of Drivers and Constraints on Agricultural Expansion in Sub-Saharan Africa

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Abstract: Understanding the dynamics of agricultural expansion, their drivers, and interactions is critical for biodiversity conservation, ecosystem-services provision, and the future sustainability of agricultural development in Sub-Saharan Africa (SSA). However, there is limited understanding of the drivers of agricultural expansion. A systematic review of the drivers of agricultural expansion was conducted from 1970 to 2020 using Web of Science, Elsevier Scopus and Google Scholar. Two researchers reviewed the papers separately based on inclusion and exclusion criteria. Fifteen papers were included in the final systematic review. The paper proposed expansion pathways in a conceptual framework and identified proximate and underlying drivers. Population dynamics and government policies were found to be key underlying drivers of agricultural expansion. The proximate drivers include economic opportunities such as agriculture mechanisation and cash crops production, and more troubling trends such as soil fertility decline and climate change and variability. This paper further explores the constraints that have been found to slow down agricultural expansion, including strong land institutions and good governance.

Keywords: agricultural expansion; drivers; Sub-Saharan Africa; conservation; constraints

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1. Introduction

Population growth and rising incomes are generating ever greater demands on agriculture to supply food, fuel, fibre, and animal feed [1,2]. As the global population is projected to reach approximately 10 billion by 2050, of which around 2 billion will be in Sub-Saharan Africa (SSA), it is likely that these demands will only increase further, putting pressure on the natural environment [3–5]. The intensification of agricultural practices and agricultural expansion have both contributed to meeting these increasing demands [6–10]. Agricultural expansion, defined as the conversion of natural vegetation to land-use for agriculture [7], that occurred in the 1980s and 1990s has resulted in an increase in the area under food production in SSA and increased opportunities for income-generation and food security [6]. However, this expansion may also threaten a wider array of provisioning and regulating ecosystem services that are provided by areas of natural vegetation [6,11–15]. Given the increasing pressure on agricultural land and the impacts of agricultural expansion on livelihoods and ecosystem services, a better understanding of the drivers of agricultural expansion in SSA, where a driver in this context is defined as any factor that alters "an aspect of an ecosystem" [15,16], is both imperative and timely.

Agricultural expansion into natural vegetation, such as grasslands, woodlands or forests [6,8,17] is typically a non-linear process [18,19] and caused by different factors, such as market incentives and institutional arrangements [20]. That expansion may be to increase crop or grazing land [21], and whether it occurs is influenced by both bio-physical aspects of the landscape, a weak or strong land governance [22]. A growing body of evidence on the drivers of land-use change, including drivers of agricultural expansion, can be found at the global and regional scale [18,23,24]. However, there has been limited research on the drivers of agricultural expansion specific to SSA compared with other regions of the world [21].

Understanding current trends, and drivers of agricultural expansion and their interactions can support policy decisions for better management of future agricultural development, forests and other natural habitats, at local and regional levels [25–27]. As such, our review is situated within broader debates including the sustainable intensification of agriculture, and land sparing versus land sharing. A common thread amongst these debates is how agricultural production can increase without harming a broad range of ecosystem services at the scale of landscapes that might variously include intensive farming, extensive farming, areas protected for biodiversity and other ecosystem services. Extensive farming (extensification) refers to the increase in the output of agriculture through agricultural land expansion [28].

It is against this backdrop that we set out to systematically review and synthesise the existing literature on trends, drivers and constraints of agricultural expansion in SSA. The rest of the paper is divided into six sections: Next, we explore the global level drivers and constraints to agricultural expansion; in section three, we describe the conceptual framework and the systematic review methodology; section four presents the results and findings of the systematic review; section five discusses the implications of the findings for future agricultural land-use; and, finally, section six concludes.

2. Perspectives on Agricultural Expansion Drivers, Pathways, and Constraints

In this section, we review the broader literature to highlight and classify key drivers of agricultural expansion. These drivers can be categorised as either proximate or underlying [24]; have different spatial and temporal dimensions [29,30]; and differ depending on the scale of agriculture [23]. Proximate drivers are also referred to in the literature as direct drivers, and underlying drivers as indirect drivers.

A proximate driver is an immediate activity or human action that has a direct impact on vegetation cover [24]. An example of a biophysical proximate driver could be declining on-farm soil fertility [21]. Underlying drivers include institutional, economic, and socio-demographic factors, that influence the proximate drivers [15]. For example, a proximate driver of land-use change such as infrastructural development may be in response to underlying drivers, such as population growth and changes in consumption patterns [15,31]. However, considerations of factors as proximate and underlying drivers may differ, depending on context or scope of a study. The interactions of proximate and underlying drivers together affect the overall system [30]. Briefly, we introduce institutional, economic, and socio-demographic drivers for agricultural expansion below.

Institutional drivers can be considered as rules, policies, or international agreements that may affect agriculture-related land-use change [32]. For example, in Latin America, MERCOSUR, the South American free trade agreement, has been identified as an important underlying driver of agricultural expansion in the region [33]. More broadly, agricultural expansion may be driven by export-led agricultural commodity production [33] and international agricultural trade flows [34].

Economic drivers of agricultural expansion are often linked to the relative marginal private values of agricultural and non-agricultural land, and the costs of converting non-agricultural land. Increased profitability of croplands, through increased efficiency from agricultural technological developments [21], and reduced costs of market access through better infrastructure and information flow, have been identified as important drivers for agricultural expansion [35]. Foreign direct investments in agriculture for feed and fuel crops have also been identified as creating incentives for agricultural expansion [36,37]. The introduction of agricultural technology can encourage agricultural land expansion likened to the Jevon's Paradox phenomenon as witnessed in Brazil [38].

Socio-demographic drivers, whether local, national, or global, also influence agricultural expansion. At the local level, examples include the combination of high rates of population growth and subsistence farming [33]. Similarly, migration or changes in sectoral employment can drive changes in land use towards or away from agriculture [39]. While, urbanisation may result in the direct loss of farmland, it can be a driver of agricultural expansion elsewhere as individuals look for alternate locations to farm [40]. Generally, socio-demographic drivers such as dietary shifts, reflected in an increased consumption of meat leading to a rise in demand for animal feed and pasture, can also drive an increase in demand for agricultural land [2,41]. In Mexico, Mendoza-Ponce, Corona-Núñez [42] found that distance from human settlements, roads, population density, gross domestic product (GDP), and marginalization all drove agricultural expansion into forestland, while access to water drove agricultural expansion into grassland.

Just as there are drivers of agricultural expansion, so too are there factors that can constrain or slowdown agricultural expansion in to areas of natural vegetation [43]. These include a broad range of approaches to strengthening governance over non-cultivated lands; making use of 'protected status' designation; and enforcing existing restrictions and regulation [44]. Weak governance more generally has been found to likely result in considerable loss of areas that are designated "protected" from agricultural expansion [22,45]. Increasing the private value of non-agricultural land, such as through payments for ecosystem services (PES), can allow landowners to receive additional economic benefits from non-agricultural land, thereby, creating an economic incentive not to convert natural lands to agricultural lands. However, the current reality in many low and middle income countries (LMICs) is that protection of forest and other non-cultivated land is difficult due to low incentives for communities to protect, high costs of enforcement, and highly constrained government budgets [46]. Within communities, there are also competing demands between those whose livelihoods rely heavily on resources, such as non-timber forest products harvested from natural habitats, and those whose livelihoods rely on agricultural crops [46].

3. Materials and Methods

First, we undertook an unstructured scoping review of the literature addressing drivers of and constraints to agricultural expansion generally, as presented in the Section two. Based on this review we drew up a list of proximate and underlying drivers of agricultural expansion, key constraints, and developed a conceptual framework demonstrating the key interactions. Guided by this framework, we then undertook a systematic review of the literature that explicitly addresses drivers of, and constraints to, agricultural expansion in SSA, based on a widely used methodology [47–49] and the preferred reporting items for systematic reviews and meta-analyses (PRISMA) [50]. This was done so as to ensure reproducibility of the systematic review on drivers of agricultural expansion in SSA.

3.1. Conceptual Framework

We develop a conceptual framework that is informed by various existing frameworks that concentrate on "drivers of change". Examples of such frameworks include that developed for the Millennium Ecosystem Assessment [16]; Kaimowitz and Angelsen [51]'s model of tropical deforestation; and Seabrook et al.'s conceptual framework of the drivers of landscape change and their interactions in the context of Australia [52]. Each of these frameworks articulates the interactions between drivers and outcomes in the context of agricultural expansion. Our conceptual framework highlights underlying drivers, that may affect one or more proximate drivers in a diffuse or focused way; and the proximate drivers that can have a direct impact on agricultural expansion. In addition, we explicitly include constraints, such as strong governance over nearby protected areas. This is because whether agricultural expansion does actually occur depends also on whether there are constraints to expansion within the system that may interfere with human activities. While different pathways for agricultural expansion can be conceptualized that might include poverty, food insecurity, market access, governance and improved infrastructure more broadly [53], the drivers of, and the magnitude of agricultural expansion are context specific, and our conceptual framework reflects this.

3.2. Systematic Review

The systematic review is based on defined analytical criteria, as laid out in Table 1 with clear exclusion and inclusion criteria applied to ensure that the emphasis remains on drivers and constraints to agricultural expansion in Sub-Saharan Africa.

Table 1. Inclusion and exclusion criteria for the review articles in the order of selection.

Criteria	Included	Excluded	Justification for Criteria Application
Date of publication	1970 to 2020	Before 1970	Used available papers from selected databases to have a contemporary perspective on drivers of agricultural land expansion
Language of publication	English	All other languages	To increase readability and due to researchers' proficiency in English language
Country or location of study	Africa related papers	Non-African papers	To remain within the scope of the systematic review
Article availability	Fully available paper using University of Reading library subscription	Full paper not accessible	Due to access related issues
Type of article	Peer reviewed research journal article, conference papers, book chapters, review papers, grey literature	-	To increase validity of study findings
Main publication topic	Papers specifically on drivers of agricultural expansion.	Papers that included drivers of 'land-use change' in general	To remain within the focused scope of the systematic review

These criteria list the steps in which papers were identified (Figure 1), categorized, and included in the study, to minimize biases that might be found in narrative reviews [54]. We augment our systematic review with additional literature found from the reference lists at the end of the studies from the initial search on agricultural expansion/land-use change, drivers, and constraints across SSA. This is to provide a more detailed and nuanced picture of the proximate and underlying drivers of agricultural expansion in this region.

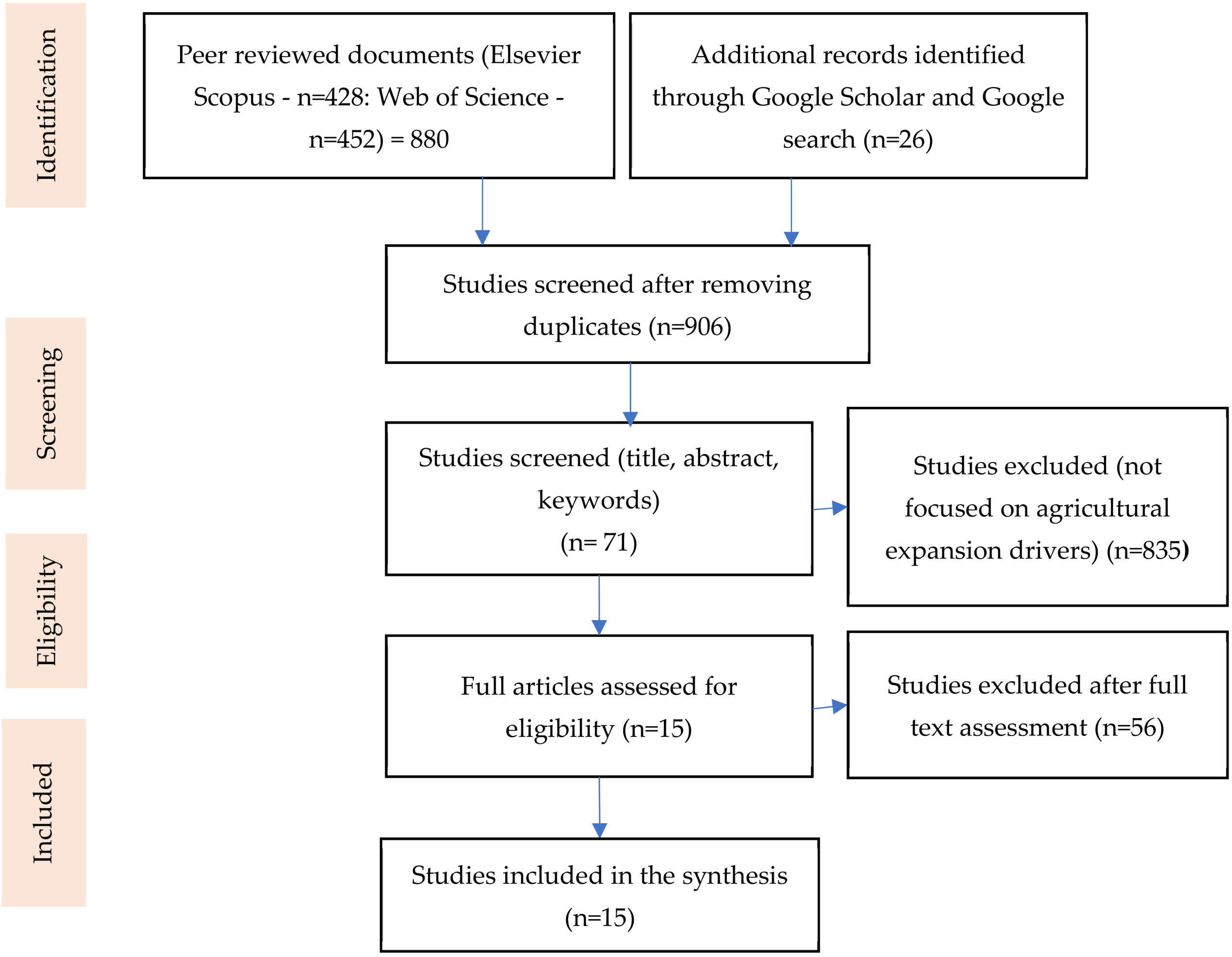

Figure 1. PRISMA flow chart for the systematic review methodology. Adapted from: Moher, Liberati [50].

Data Acquisition

We generated our data using Web of Science, Scopus and Google Scholar in February 2020 to search for the relevant papers related to drivers of agricultural expansion/land-use change in Africa, based on our criteria. We also searched additional papers through a Google search. Using titles, abstracts, and keywords, we selected the relevant papers to be included in this review based on the date (1970-2020), language of publication (English), publication topic, country or location of study, article availability and type.

The terms used in the search engines were ("agricultural expansion") Or ("agricultur* landuse change") And (cause*) Or (driver*). Initial output was 194,301 papers from Web of Science. After applying the specific criteria, the number of candidate papers was reduced (Figure 1). On Elsevier Scopus and Google Scholar, papers were found after keywords searches, and after applying criteria and removing repeated papers from other searches (Figure 1). An additional search on Web of Science and Google Scholar up to October 2020 based on our search criteria (Table 1), did not return any additional relevant papers. For the Google Scholar search, the following terms were specifically used: 'drivers of agricultural expansion Africa', and 'drivers of agricultural land-use change Africa'. Duplicate papers and articles not specifically related to issues of agricultural expansion in SSA were excluded. There is high overlap between Scopus and Web of Science which makes the review comprehensive [55]. After screening each of the papers, 71 were saved at this stage for further screening. Finally, 15 papers that explicitly related to "agricultural expansion or land-use change drivers in SSA" were analysed in-depth.

4. Results

The fifteen papers identified through the systematic review comprise two studies each that focus on Ethiopia and Ghana; two that are multiple country studies; and one study each that focuses on Angola, Nigeria, Senegal, South Africa, Tanzania, Uganda, and Zambia. The agricultural production that is the focus of these studies includes food and cash crops such as maize, beans, rice, wheat, palm oil, coffee, and groundnuts. Other crops mentioned in the reviewed papers include cotton, sunflower, oats, finger millet, sorghum, and soybeans. Methods used in the reviewed studies include remote sensing and participatory methods, such as focus group discussions and interviews.

4.1. Drivers of Agricultural Expansion in SSA

Historically, agricultural land expansion has been at the expense of natural ecosystems [55,56]. Between 1980 and 2000, the demand for agricultural land across the tropics was mostly met from intact (55%) and disturbed (28%) forests [6]. Cropland expansion in SSA was more rapid in the 1980s than the 1990s, and predominantly in favour of maize, rice, soybeans and oil palm [57]. In some cases, smallholder farmers grow crops for domestic consumption and/or sale while, in other cases, crops are grown in commercial quantities to be sold [58–60]. Drivers of agricultural expansion are explored based on a review of 15 papers and categorised into proximate and underlying drivers (Table 2).

Table 2. Overview of agricultural expansion, crops grown, methods and country of study identified in literature.

Country of Study	Proximate Drivers	Underlying Drivers	Crops Grown	Reference
Angola	-	Population, resettlement	Maize, beans	(Schneibel et al., 2017) [56]
Cameroon	-	Land tenure laws	Palm oil	(Ordway et al., 2017) [57]
Ethiopia	Climate change and variability, change in soil fertility	National-level policy, population increase	Ensete, haricot beans, khat	(Kebede et al., 2019) [58]
Ethiopia	Commercial agriculture	Resettlement	Cereals, tea, coffee, rubber tree, soapberry, black pepper,	(Kassa et al., 2017) [59]
Ghana	Climate change	Fertiliser and agricultural subsidy, commodity price increase, government provision of credit	Maize	(Badmos et al. 2014) [60]
Ghana	-	Population increases and distribution, market, government policies, technological change	Rice	(Braimoh, 2004) [61]
Kenya	Large scale agriculture, land suitability, economic (input prices, and transport costs); small-scale agriculture drivers include socio-economic factors (education, social services)	Population growth (in or out-migration), accessibility to market	Cereal- wheat	(Serneels and Lambin, 2001) [23]
Nigeria	-	Distance to cities and water, soil depth and pH, elevation, lowland landform	Not stated	(Arowolo and Deng, 2018) [62]

Table 2. *Cont.*

Country of Study	Proximate Drivers	Underlying Drivers	Crops Grown	Reference
Senegal	Climate, commodity production	Population, development projects (government programmes), land tenure, sustainable intensification of agriculture	Cotton, groundnuts, rice, maize, millet, sorghum	(Wood et al., 2004) [63]
South Africa	-	Population	Maize, wheat, oats, sunflower, sugar cane	(Biggs and Scholes, 2002) [64]
Tanzania	-	Increased agricultural output prices	Food and export crops	(Angelsen et al., 1999) [65]
Uganda	-	Government programs	Maize, finger millet, sorghum	(Nakalembe et al., 2017) [66]
Zambia	-	Population increases, increased income	Maize, soya beans	(Estes et al., 2016) [67]
Cross- country	Demand for food, feed, and fuel	-	Maize, sorghum, millet, cassava, groundnuts, coffee, yam, and rice	(Gibbs et al., 2010) [6]
Cross-country	-	Demand for land for subsistence, technology, and management practice	Maize, groundnuts, beans	(Mortimore et al., 2005) [68]

4.1.1. Proximate Drivers of Agricultural Expansion in SSA

From our systematic review, we identified four key proximate drivers of agricultural expansion that were addressed in five of the reviewed studies (Table 3). Declining soil fertility is identified explicitly as a proximate driver in just one of the papers; climate change, as manifested in increasing temperatures, increasing rainfall variability, greater extremes of weather, and change in seasonality, is reported as a key biophysical driver of agricultural expansion in three of the included studies [58,60,63]; and access to services and demand for food and fuel are each found as drivers in one study. These drivers can interact in complex ways, as is particularly highlighted in the paper focused on Ethiopia [58].

Table 3. Proximate drivers of agricultural expansion.

Proximate Drivers	References
Decline in soil fertility	(Kebede et al., 2019) [58]
Drought, climate change and variability	(Wood et al., 2004, Badmos et al., 2014, Kebede et al., 2019) [58,60,63]
Access to services	(Serneels and Lambin, 2001) [23]
Demand for food and fuel	(Gibbs et al., 2010) [6]

Kebede, Baudron [58] found that the loss of soil fertility, and the subsequent negative impact on yields, combined with a need to sustain food production by the national level policy makers, is an important driver of agricultural expansion in the southern parts of Ethiopia. A similar mechanism has been documented in Cameroon, where a decline in soil fertility results in falling cocoa yields, leading farmers to expand their cocoa farms into the forest to maintain production and farm revenues [69]. In this latter case, however, the immediate imperative is income from a cash crop rather than food production. The study focusing on Ethiopia highlights both how different drivers can interact in complex ways, and how households can respond in different ways [58]. While some households expand their agricultural landholdings to maintain food production and income, others move out of agriculture to find alternative sources of income or diversify their portfolio of livelihood activities. As such, the drivers may lead to agricultural expansion, but may equally lead to households diversifying away from agriculture, if there are profitable opportunities to do so.

Changing climatic conditions are also identified as a potential driver of agricultural expansion in the Ethiopia paper, through the negative impact on crop yields [56]. Similarly, the scenario study in northern Ghana reports on a household survey that identified climate change and socio-economic factors as being "clear drivers of agricultural land-use change" in the area of study. However, the underlying mechanisms for this are not addressed [60].

Access to services such as schools, health clinics and local markets was found by Serneels and Lambin [23] as a proximate driver of agricultural expansion. The authors taking an explicitly spatial perspective, find that in one part of southwestern Kenya, agricultural expansion of smallholder agriculture is driven by what they term "land rent". This can be considered to relate to how favourable the location of that land is, for example, in terms of accessibility and proximity to those services highlighted [23].

Finally, the need to increase production to meet the demand for food, feed and fuel more broadly is identified as a driver of expansion of pasture and cropland in lower-income countries including those in SSA in one paper [6]. This paper highlights demand for animal fodder and biofuel being important drivers in some Asian and Latin American countries. However, in most African countries, the fraction of harvested area used to produce feed or other non-food products tends to be relatively low (Figure 2).

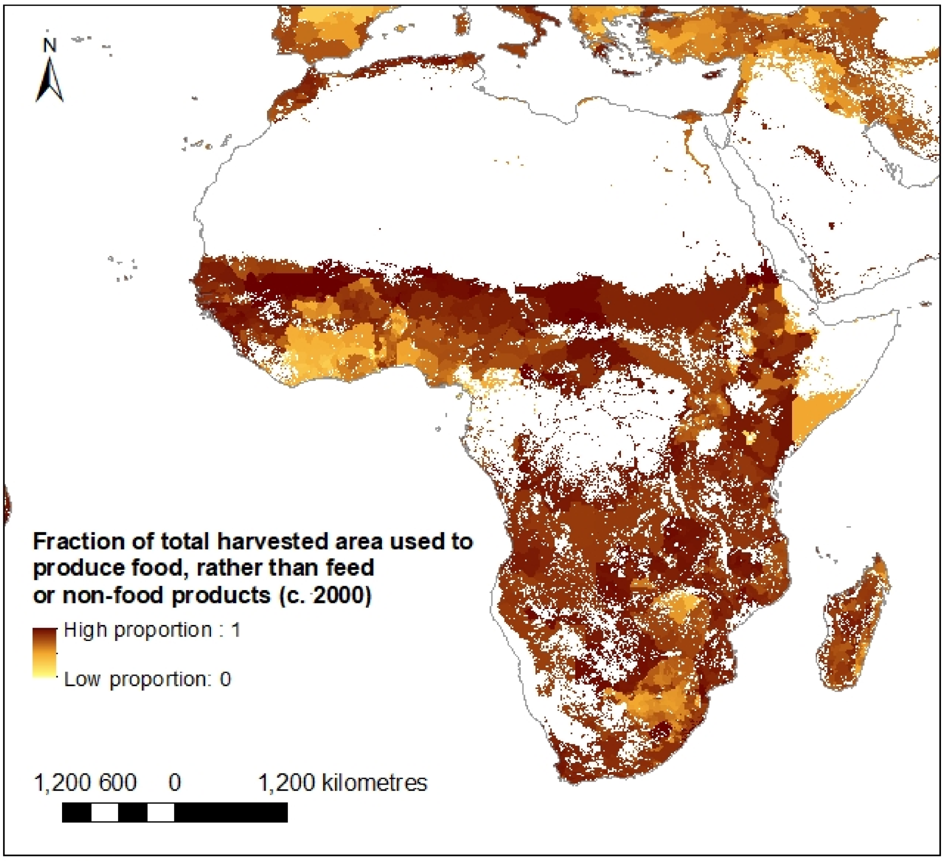

Figure 2. Map showing the fraction of total harvested area used to produce food in Africa (with the remaining fraction used for animal feed and non-food products, such as biofuel). Areas shown in white may simply represent locations for which data are unavailable. **Source**: Map produced using data made available by Cassidy, West [70], deemed representative of circa (c.) 2000. Maps throughout this article were created using ArcGIS®software by Esri. ArcGIS®and ArcMap are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved. For more information about Esri®software, please visit www.esri.com.

4.1.2. Underlying Drivers of Agricultural Expansion in SSA

The systematic review revealed seven key underlying drivers of agricultural expansion (Table 4). These operate at both micro and macro levels, and include economic opportunities and policy changes by communities that could likely lead to land-cover change [20].

Table 4. Underlying drivers of agricultural expansion.

Underlying Drivers	References
Population dynamics and human resettlement	(Serneels and Lambin, 2001, Biggs and Scholes, 2002, Wood et al., 2004, Estes et al., 2016, Kassa et al., 2017, Schneibel et al., 2017, Kebede et al., 2019) [23,56,58,59,63,64,67]
Demand for agricultural land	(Mortimore et al., 2005) [68]
Institutions and policies (e.g., agricultural subsidy, trade liberalization and currency devaluation)	(Braimoh, 2004, Nakalembe et al., 2017) [61,66]
Accessibility/distance to market	(Serneels and Lambin, 2001) [23]
Increase in agricultural output prices	(Angelsen et al., 1999) [65]
Increased income	(Estes et al., 2016) [67]
Land tenure	(Wood et al., 2004, Ordway et al., 2017) [57,63]

Population dynamic is a key underlying driver of agricultural expansion at both site and country levels in seven of the fifteen studies [23,56,58,61,63,64,67]. This is perhaps not surprising, given the prominence of population in our broader review of the literature. Often population is identified as one of several drivers, as is the case for the paper focusing on Kenya [23] where increasing population is reflected in increasing population density, and the paper focusing on Senegal [63]. In Zambia, population growth has led to the conversion of woodland and grazing land into cropland, and indeed the authors suggest that increasing population and incomes make cropland expansion “nearly inevitable” [67]. A similar conclusion is implied with respect to Ethiopia, where population growth is seen more broadly as driving “fast changes in land cover/land use” [58], and Ghana, where both population growth and migration affect the conversion of woodland to agricultural land [61]. Resettlement of populations to new areas has led to cropland expansion in South-Western Ethiopia, after people were resettled from the central part due to an epidemic. Settlers were provided with new infrastructure and agricultural inputs, which enabled them to clear land for farming [59]. A similar pattern can be found in Angola, where a combination of population growth and resettlement increased the rate of conversion of miombo forests to cultivated land [56].

Institutional drivers operating at the macro level have been linked to agricultural land-use change in SSA. For example, during the structural adjustment period of the International Monetary Fund (IMF) in the 1980s through the 1990s in Ghana, trade liberalisation of food, fertilizers import and devaluation of the Ghanaian currency led to rises in the prices of farm inputs [61]. The removal of agricultural input subsidies led to price increases of inputs, such as improved seed varieties and fertilisers, consequently leading to the expansion of agricultural areas to improve production by households that could not afford expensive seeds and fertilisers. As food imports were more expensive due to the currency devaluation during that period, the country relied more on domestic production. In one part of Uganda, government programmes that encouraged a move from pastoral livestock-based livelihoods to sedentary agriculture have been found to be the most important driver of cropland expansion [66].

Improved accessibility to markets has been found to cause agricultural expansion in southwestern Kenya, where better accessibility to market has led to the expansion of large-scale agriculture into areas of natural vegetation [23], and in Ghana, where increased market demand for rice has led to agricultural land expansion. The proximity to markets is said to serve as a proxy for transportation cost [23]. Braimoh [61] found that distance to markets positively correlated with changes in agricultural land use in Ghana; however, they were not significant.

The influence of agricultural crop price increases in causing agricultural expansion is mixed. While, increased agricultural prices of annual crops have been found to lead to agricultural expansion in Tanzania [65], no correlation was found between agricultural crop prices and clearing of new areas in the short-run in a Malawi study [71]. This suggests that the influence of crop prices on expansion depends on other contextual factors, drivers, and constraints to expansion.

Income increases may lead to expansion of cropland despite increases in crop yields [67]. High income will lead to demand for more animal-sourced foods in diets, leading to expansion of agricultural land to produce more feed [2,11] and pasture [72]. On the contrary, poverty has also been linked to the expansion of agricultural land in Africa [73]. The high unemployment rates in cities and rural areas have contributed to an increase in shifting cultivation for increased production and on-farm work [73].

Finally, land tenure systems have been reported as influencing agricultural expansion. In a study of oil palm producers in Cameroon, farmers expand cultivation of oil palm into forested areas as a way of claiming de facto ownership of this land and hoping to gain formal title to the land [57,74].

4.2. Constraints on Agricultural Expansion in SSA

Just as the drivers of agricultural expansion in SSA put pressure on areas of natural vegetation, the systematic review has found a number of constraints that limit the extent to which expansion actually occurs. These constraints are highlighted in Table 5.

Table 5. Constraints to agricultural expansion.

Constraints	Country	References
Effective law enforcement	Tanzania	(Angelsen, 1999) [65]
Endemic disease/pests	Not stated	(Reid et al., 2000a, Chamberlin et al., 2014) [9,75]
Conflict and insecurity	DRC, South Sudan	(Chamberlin et al., 2014) [9]
Productivity uncertainty	Zambia, Angola	(Chamberlin et al., 2014) [9]
Culture	Ethiopia	(Kassa et al., 2017, Woldemariam et al., 2018) [59,76]
Cost of land clearing	-	(Meyfroidt et al., 2014) [77]
Agricultural subsidies	Malawi	(Chibwana et al., 2013) [71]

Law enforcement and regulation act as a barrier to agricultural expansion into natural habitats that have designated protection status [44]. The statutory de jure protected areas are designated as areas under protection from encroachment in order to conserve plant or animal species that are at risk of extinction [74]. However, these are argued to be de facto areas of expansion, due to remoteness and absence of institutional capacity to enforce government regulations [74].

Disease load may constrain expansion of agricultural area. For example, much of the potentially available cropland in some parts of SSA is located in disease-prone locations [9]. However, whether this does indeed restrict agricultural expansion is not certain. Tsetse flies that transmit both livestock and human trypanosomiasis have been found in some areas to disappear due to expansion of area to grow food for the increasing human population [75].

Chamberlin, Jayne [9], in their study on reassessing the potential for cropland expansion in Africa, reported that countries with surplus resources, located in conflict areas, such as the Democratic Republic of Congo (DRC) and South Sudan, will experience difficulty in expanding agriculture into those areas [9]. This is due to the safety implication of producing in such regions.

Twenty-five percent of total potentially available cropland in SSA is in areas that experience high rainfall variability. For example, in Zambia and Angola, livelihoods from crop production in areas of dry savannah and woodlands are risky due to rainfall variability, which makes it difficult to open new lands in those areas as productivity may not be guaranteed [9].

Cultural considerations can also constrain agricultural expansion into natural habitats such as forests [59,76]. Final land-use decisions are often made by users influenced by cultural, economic and political considerations [78]. Woldemariam and colleagues [76] reported that in Ethiopia, such cultural reasons could include the use of natural habitats (e.g., forests) as sanctuaries, where people in the communities go to worship. Valuing natural habitat as sacred have led to natural-habitat protection [76].

The costs of clearing land area also determines whether or not expansion of agriculture into new areas can take place [77]. These costs could be associated with the nature of the area – waterlogged, steep slopes, civil conflict affected areas, disease burden and reduction in carbon offset capabilities [9]. Land characteristics, such as slopes, determine how agricultural land-use change can be undertaken [20]. Slopes could hinder expansion into new areas due to the cost attached to such operations [9]. Evidence for northern Ghana suggests that agriculture more frequently expands into grassland rather than other natural vegetation due to the ease of clearing grassland areas [79]. Agricultural expansion may also follow forest degradation due to charcoal production, as has been found to be common in Tanzania [80].

Interestingly, agricultural subsidies, which have been shown to be a driver of agricultural expansion in Ghana [60], have been found to limit the expansion of agriculture into forests in Malawi [71]. The authors found that households with access to agricultural input subsidies were more likely to intensify rather than extensify the production of food crops, such as maize, compared to households with no access to subsidies.

5. Discussion

From our systematic review, it is clear that there is a broad range of drivers of agricultural expansion into the natural vegetation across different countries in SSA. This is similar to Geist and Lambin [24] who argued that underlying drivers of agricultural expansion that degrade forests comprise institutional, cultural, demographic, technological and economic factors. Equally, there is a variety of factors that may constrain this expansion. The proximate drivers reflect both economic opportunities for cash crops production, and more troubling trends such as declines in soil fertility, climate change and variability. Maize was the mostly cultivated crop found in the papers reviewed. Maize is a major staple used for both subsistence and income in most countries in SSA [80]. Hence, the area of maize production will continue to expand with increased price and population growth [58,60] further exacerbated by climate variability [58,60,63]. In the past, subsistence agriculture and cultivation for the local markets have been the main drivers of expansion in SSA compared to export crops [6,81].

Population featured as an indirect driver in seven out of fifteen papers in the systematic review [23,56,58,61,63,64,67]. This, in part, could be argued to reflect the reality of population in SSA, which has almost doubled over the last two decades [82]. However, the role of population growth per se in causing agricultural expansion is contested in the literature. For example, population may be drawn to a newly established agricultural frontier due to shortage of labour in that area owing to fewer inhabitants living around the expansion frontier [65]. Agricultural expansion may attract farm migrants to the newly expanded area rather than population growth driving new expansion [65]. In our systematic review, we found that increased income in Zambia empowered households in the study area to hire in labour and other inputs for new land clearing in high rainfall savannahs, at the expense of biodiversity [67]. Many environmental management policy formulations in the past were based on population drivers of forest expansion, often neglecting market drivers [83]. Further, as is clear from our review, population often interacts with other factors to drive agricultural expansion [20]. Other drivers that are linked to population dynamic are demand for feed, and demand for agricultural land to produce food for subsistence and/or cash.

As climate change and variability was found to be an important proximate driver of agricultural expansion, Wood, Tappan [63] reported that climate change in the form of dwindling precipitation and drought resulted in decreased rice cultivation in the lowlands and fossil river valleys of Velingara-Senegal. This led to more focus on irrigated rice cultivation in the Anambe Basin and increased farming activities near the forest reserves. As the drivers operate at macro levels beyond the control of local farmers, gains from climate change mitigation policies at the global level will likely play a role in curbing the effects of these drivers.

Our analysis revealed institutional drivers to be another important underlying cause of agricultural expansion [58,63,66]. Underlying drivers, such as trade liberalization and currency devaluation, are often harder to quantify and study, and so proxies are often measured. The prominence of institutional factors in our study draws attention to the significance of such factors in determining the trend in agricultural expansion. For example, lack of land property rights has been found to act as a disincentive to intensively cultivate existing land, but rather an incentive for farmers instead to expand their agricultural practices onto the margins of forests in Indonesia [84]. Equally, the reality of forest clearance found in Cameroon [57], leading to the granting of formal land rights, has been documented in many countries, and may have increased rates of deforestation [74].

In many SSA countries, agriculture is dominated by small-holder farmers, while policies for resettlement or commercial expansion decisions are mostly at the higher government level, with indigenous occupants of resettlement areas having less power to influence such decisions, particularly where government motives may be influenced by political or financial gains [20]. Where large-scale expansion occurs, or a government resettlement scheme is introduced at the frontier at the expense of the local inhabitants, it could lead to land conflicts [20,85]. Given the current land governance frameworks of natural habitat areas in most SSA countries, an opportunity exists to pursue a more holistic land reform program to properly assign land property rights. This should also improve the functioning of land markets and make it more likely that agricultural expansion can be sustainably managed, and conflicts minimized.

The distance to markets is an important determinant of the location of large-scale production of cash crops. Therefore, it is perhaps not surprising that distance to market is linked to agricultural expansion. A similar observation is reported in Mendoza-Ponce, Corona-Núñez [42], who identify hotspots of land use cover change in Mexico. The authors find that distance from human settlements, population density, marginalization and GDP drive agricultural expansion into forestland. This finding resonates with Gibbs, Ruesch [6] who found agricultural expansion to be linked to the demand for feed, fuel and food.

Our findings confirmed the role of constraints in determining whether the potential drivers of agricultural expansion indeed lead to expansion (Figure 3).

These constraints include enforcement of land-use regulations [74]. The enforcement of protected area laws in most low and middle-income countries (LMICs) has been found in other studies to be dysfunctional due the poor framing and lack of a competitive incentive to protect such areas [46]. In most SSA countries, natural vegetation are managed under a customary law arrangement and decisions to allocate these lands to households for crop production vest with the community leaders [86]. Culture was also found to be a constraint on agricultural expansion into forested areas in an Ethiopia-based study, as forest was regarded as a place of worship and any activity that result in forest degradation was regarded as a sacrilege [76]. Such cultural beliefs act as mechanisms for hindering the expansion of agriculture into such natural habitats, hence creating a gap to be further explored by policy makers as a local means of protecting natural habitats from degradation.

Agricultural subsidies in SSA, such as maize seed and fertiliser subsidies, have been found to both limit agricultural land expansion [71] and encourage expansion [60]. These findings highlight the importance of understanding how drivers, constraints, and opportunities to intensify agricultural production, interact together to determine the net impact on land-use change.

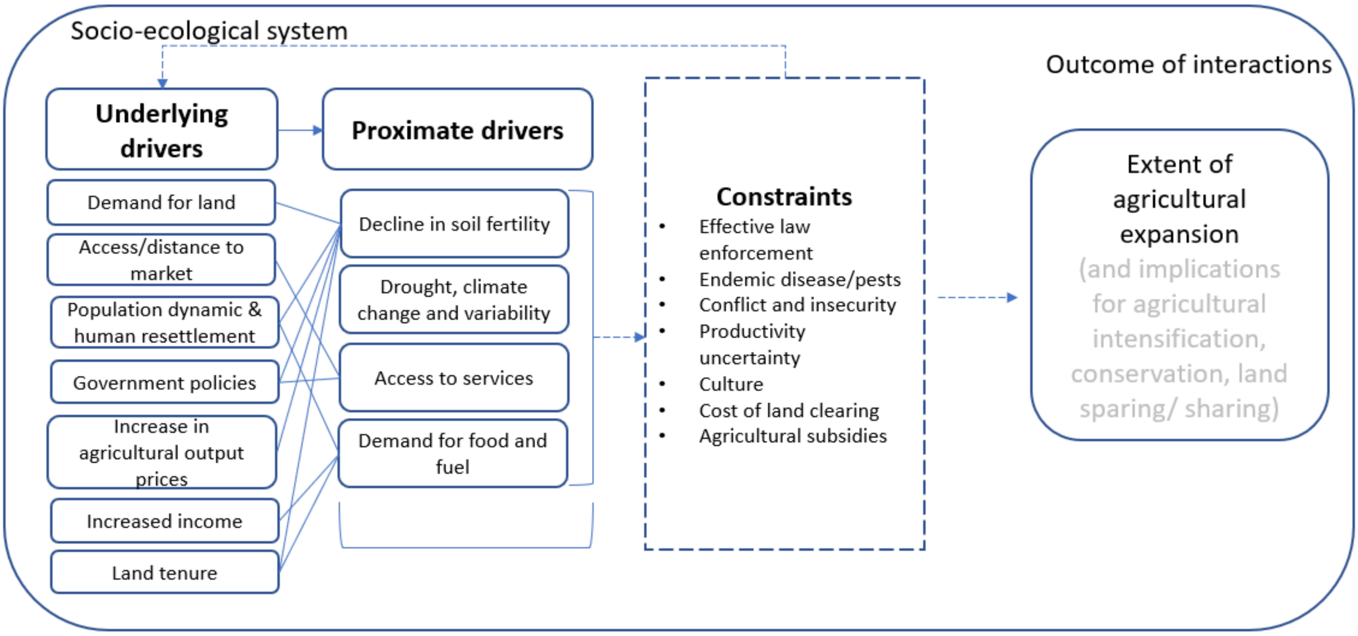

Figure 3. Interactions among underlying, proximate drivers of agricultural expansion and constraints based on the systematic review. Implications in faint.

Agricultural expansion due to falling yields, whether due to a loss of soil fertility or weather and climatic conditions, reflects efforts by households to maintain income and/or food security in the face of adversity. In contrast, increasing populations or improved market opportunities put pressure on areas of natural vegetation due to a need for increased food production or income generation at the community level. However, these pressures do not always result in agricultural expansion. This might variously be due to constraints to that expansion, household decisions to diversify away from agriculture, or availability of incentives and opportunities to intensify agricultural production. As such, when addressing agricultural expansion, it is instructive to consider how an assessment of drivers of and constraints to expansion fits into a broader discussion of extensification versus intensification of agricultural production. These two approaches have been found to be among the key means of meeting the food demand of communities in SSA, outside of the option to import increased quantities of food. Historically, extensification has been more common than intensification in SSA. This is, in part, due to the availability of uncultivated land, and in part, due to the reality that intensification can be risky and costly [63].

6. Conclusions

Agricultural land expansion for the production of both food and cash crops, such as maize, rice, soybeans and oil palm has been at the expense of natural habitats, often intact or disturbed forests, and grasslands. Across the different SSA countries, four proximate drivers, i.e., soil fertility decline, climate change and variability, access to services, demand for food and fuel, were found to be important drivers of agricultural expansion. Seven underlying drivers, i.e., population dynamic and human resettlement, demand for agricultural land, government policies, accessibility/distance to market, increase in prices of agricultural products, increased income, land tenure were found to indirectly cause agricultural expansion, operating at both micro and macro levels. In addition, certain factors such as effective law enforcement, endemic pests and diseases, conflict and insecurity, productivity uncertainty, culture, cost of land clearing, agricultural inputs subsidies availability have been found to place restraints on agricultural expansion. The location-specific influences, and interactions between the drivers, are still insufficiently understood. Yet, that understanding is critically important for managing land-use trade-offs in the future. Further, as drivers of agricultural expansion are better understood, it is equally important to address the presence or absence of constraining factors that play a key role in determining whether area expansion can occur or not.

Knowledge of the various levels of interactions of drivers and constraints can also aid policy makers that have the difficult task of balancing increased food production with the potential loss of ecosystem services where that increased production is through agricultural expansion into natural habitats. This will also have a direct bearing on biodiversity conservation, prediction of future trends and to mitigate future impacts that could hamper the provision of ecosystem services.

A potential limitation of this review may be the small number of papers included in the systematic review. However, this is due to the reality that there is a paucity of literature focused specifically on "drivers of agricultural expansion", and even less so that focuses specifically on sub-Saharan African countries. This is in contrast to the literature that addresses "drivers of deforestation", which is much broader, and within which "agricultural expansion" is often identified as a driver. By giving attention to what is driving agricultural expansion, this review makes key contributions to the existing literature, by both collating and synthesising a small number of studies that addresses the different drivers of and constraints of agricultural expansion in SSA, and situating this SSA-specific literature in the broader global context.

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