Agricultural Expansion Drivers and Constraints

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Agricultural expansion refers to the conversion of uncultivated land, including natural forests, woodlands, grasslands and wetlands into crop or grazing land, and may be undertaken by smallholders or largescale farmers.

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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][4][5]. The intensification of agricultural practices and agricultural expansion have both contributed to meeting these increasing demands [6][7][8][9][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][12][13][14][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][26][27].

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

In this section, we 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 [28][29]; 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][30]. 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 [29]. 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 [31]. 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 [32]. More broadly, agricultural expansion may be driven by export-led agricultural commodity production [32] and international agricultural trade flows [33].

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 [34]. Foreign direct investments in agriculture for feed and fuel crops have also been identified as creating incentives for agricultural expansion [35][36]. The introduction of agricultural technology can encourage agricultural land expansion likened to the Jevon’s Paradox phenomenon as witnessed in Brazil [37].

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 [32]. Similarly, migration or changes in sectoral employment can drive changes in land use towards or away from agriculture [38]. 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 [39]. 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][40]. In Mexico, Mendoza-Ponce, Corona-Núñez [41] 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 [42]. 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 [43]. Weak governance more generally has been found to likely result in considerable loss of areas that are designated "protected" from agricultural expansion [22][44]. 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 [45]. 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 [45].

3. 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, proximate drivers, such as soil fertility decline, climate change and variability, access to services, demand for food and fuel, constitute important drivers of agricultural expansion. Underlying drivers such as 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 operating at both micro and macro levels are likely to indirectly cause agricultural expansion. 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 can 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.

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