Fallow Lengths and the Structure of Property Rights*

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Abstract

We study a fundamental institution in many societies: the structure of property rights over land. Across societies, communal land rights have been more common than private land rights. We test the hypothesis that longer fallowing requirements – the time needed to leave land uncultivated to restore fertility – led to a higher prevalence of communal property rights. Longer fallowing requirements generate higher protection costs, and therefore make communal rights more beneficial. We construct an ecological measure of the optimal fallow length for the most suitable staple crop across grid cells based on soil type, temperature, and climate. We find that places where land needs to be fallowed for longer periods are more likely to have communal property rights both historically and presently. We then examine the implications for efforts to title land. We find that World Bank land titling interventions are less effective in places with longer fallowing requirements, suggesting a mismatch between development policy and underlying institutions. Finally, we examine implications for income inequality and conflict. We find that longer fallowing requirements are associated with less inequality and less conflict. Our results highlight the origins of property rights structures and how communal property rights interact with development policies.

Keywords: Property Rights, Communal Land, Titling Reforms, Fallow, Culture, Institutions
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1. Introduction

This paper examines a fundamental institution in many societies: the structure of property rights over land. In most contemporary Western societies, private property – where an individual or a nuclear family own land – is the predominant way of organizing land rights. However, many societies instead rely on communal land rights, in which extended families or communities jointly own and allocate land. In fact, historically, communal property rights were common. Over 50% of societies in the Standard Cross-Cultural Sample relied exclusively on communal land rights and over 70% had at least partially communal land rights (Murdock and White 1969). This presents a puzzle: under what conditions are communal relative to private property rights over land more likely to evolve?

Despite the observed prevalence of communal land rights, there are theoretically many potential benefits of private property rights over land (e.g. de Soto 2000; de Soto and Cheneval 2006). This view has led to many land titling policies in developing countries – at times with disappointing results in terms of take-up and effects on agricultural productivity and investment (see e.g. Platteau 1996, 2000; Easterly 2007; Fenske 2011; Vendryes 2014). Understanding what drives variation in the structure of property rights may also generate insight into when land titling policies are likely to be effective.

To understand what drives variation in the structure of property rights over land, we test the hypothesis from Boserup (1965) and Demsetz (1967) that longer fallow requirements make communal land rights more likely. Fallow land is land that is usually cultivated but that is allowed to lie idle for several years to let it recover its fertility. The amount of time that land should be left fallow is a product of the types of inputs used (such as fertilizer), the main crop grown, and features of the soil and climate. Both Boserup and Demsetz suggest that in societies with longer fallow requirements, it is less likely that there will be private property over land because of the cost of protection during long fallow periods.

We develop a conceptual framework to clarify how the length of fallow affects the structure of property rights. In our model, the length of fallow increases the cost of protecting land. Land can be protected individually or jointly by a community. A key assumption is that there are returns to scale in the provision of protection if done as a community. Thus, the main prediction of the model is that when the fallow requirement is sufficiently long, communal property rights will be preferred to private property rights.

We combine ethnographic and ecological data to systematically explore the relationship between fallow length and communal land rights. Using models from the FAO, we construct an ecological measure of the optimal fallow length for the maximum caloric suitability crop (as defined by Galor and Ozak (2016)) across 5′ x 5′ degree cells worldwide assuming low inputs. The FAO fallow requirement measure is a non-linear function of soil types, temperatures, and climate for a particular crop. The fallow requirement measure reflects the share of time during the fallow-cropping cycle that land should be left fallow. For example, with a fallow requirement measure of 75%, if the land is cultivated for 5 years it should be left fallow for 15 years.

We take several steps to validate the FAO fallow requirement measure. First, we test whether the fallow requirement measure predicts historical fallowing practices using a variable from the Standard Cross-Cultural Sample (SCCS) (Murdock and White 1969), a data set that captures historical ethnic-group level practices. The variable is a proxy for the amount of land that lay fallow in a given year. We find that the fallow requirement predicts historical fallowing practices; longer fallow requirements are significantly correlated with having more land under fallow. Second, we turn to present day plot-level data for 9,500 households across 11 countries in sub-Saharan Africa (Waha et al. 2016). While limited to sub-Saharan Africa, the benefit of these data is that they provide detailed information on the fallowing status of plots in the household. We find that the fallow requirement measure is predictive of present day fallowing practices in this sample. Finally, we use data from the Afrobarometer (Afrobarometer 2019), which has a question on the importance of traditional leaders for the allocation of land. We find that traditional leaders are more likely to have a role in the allocation of land in places with longer fallow requirements.

We use the fallow requirement data to explore how the required length of fallow is related to the choice of property rights regimes across societies historically. Consistent with Boserup and Demsetz, we find that communal land rights were more common in places with longer fallow requirements using data from the SCCS. A one standard deviation increase in the fallow requirement leads to a 0.27 standard deviation increase in the communality of land rights. We also examine contemporary land tenure arrangements using data from sub-Saharan Africa (Waha et al. 2016). Consistent with the historical results, we find that the fallow requirement measure is associated with a greater likelihood of a plot being held under communal land tenure relative to private land tenure in the present-day data.

Thus far our results suggest that longer fallow requirements led to a greater likelihood of communal land tenure. We now examine how longer fallowing requirements affect land titling reforms, given the relatively lackluster success of titling reforms in some settings. Easterly (2007) posited that land titling reforms are unsuccessful because they ignore underlying property rights norms that are often communal rather than individual. To explore this hypothesis, we use World Bank project data from AidData (2017) that provide information on development projects that have been implemented, the type of project (e.g. health, governance, etc.), and ratings of how successful the project was. We find that land titling projects are significantly less successful in places with longer fallow requirements. This negative effect is specific to land titling projects, and not more general to projects in other domains. These results suggest that when there is a mismatch between underlying institutions and development policies, the policies may be less successful.

We also examine mechanisms that may explain the persistence of communal property rights. Our conceptual framework generates two additional predictions. First, communal property may reduce inequality. In the model, this is because individuals with a high cost of provision of security may free ride on the security provision of others in the communal regime, which is in effect a form of redistribution. More broadly, communal land may be more flexible at reallocating to those in need (Goldstein and Udry 2008). Second, communal property rights may lead to a reduction in conflict – either through its effects on redistribution or because overall provision of protection is higher in the communal regime. Therefore, we test whether longer fallow lengths are associated with a reduction in inequality and conflict.

To examine the effect of fallow lengths on inequality, we use data from the IPUMS Demographic and Health Surveys (DHS) for 47 countries in Africa, Asia, and Latin America (Boyle et al. 2022). We find that longer fallow requirements reduce wealth inequality. However, longer fallowing lengths are not associated with lower wealth levels in the DHS, nor are they associated with a reduction in night light density, an alternative proxy for wealth.

Using ACLED conflict data (Raleigh et al. 2010), we find that conflict is lower in places with longer fallowing requirements. The negative relationship is particularly strong in settings with low state capacity. This suggests that communal land rights might be better able to reduce conflict in settings where states are weak and ineffective at enforcing private land rights.

Our findings contribute to several strands of literature. First, we contribute to the literature exploring the origins and evolution of property rights over land (Boserup 1965; Demsetz 1967; Alston et al. 2012; Bowles and Choi 2019). We provide novel causal evidence on how ecological factors influence the structure of property rights over land. In this paper, we focus on how fallowing lengths affect the emergence and persistence of communal property rights over land. Additionally, existing research has focused on the emergence of private property rights in settings where a counterfactual property rights regime does not exist, i.e. the counterfactual is unregulated "open-access" resources (e.g. Demsetz 1967; Alchian and Demsetz 1973), while communal property rights are often likely the relevant counterfactual.

Our results also speak to the literature on how differences in property rights over land affect economic development (e.g. Galiani and Schargrodsky 2011). One challenge in quantifying the effects of private property rights is that it is difficult to disentangle whether the differences in outcomes arise from differences in the organization of property rights (e.g. communal vs. individual) or differences in the security of rights. Studies have found strong evidence that the security of property rights is essential (e.g. Besley 1995; Acemoglu and Johnson 2005; Goldstein and Udry 2008; Hornbeck 2010; Fenske 2011) and even influences cultural norms (e.g. Di Tella et al. 2007). However, as noted by Platteau (2000), communal land rights may actually offer higher security in many settings relative to private land rights – in particular in places with low state capacity or a long history of communal land rights. The endogenous formation of land rights has meant that there are few causal studies on how the organization of land rights matters. We provide evidence that fallow requirements led to more communal land rights relative to private land rights, and that this difference has implications for comparative development.

Additionally, the results demonstrate how underlying institutions and cultural norms regarding land rights are important determinants of the success of land titling reforms. These findings contribute to a growing body of work highlighting the need to tailor development policies to the local institutions and cultural norms (Alsan et al. 2019; Ashraf et al. 2020; Lowes and Montero 2021; Bau 2021). In particular, we highlight that the way property rights over land are understood and how people view their relationship to land may be quite different across W.E.I.R.D. and non-W.E.I.R.D. societies (Henrich 2020). Our results highlight the potential for mismatch between development policies and the underlying institutional and cultural context.

Finally, our paper contributes to a growing literature studying how ecological and environmental forces shape culture and institutions (e.g. Alesina et al. 2013; Fenske 2014; Alsan 2015; Galor and Ozak 2016; Becker 2019; Giuliano and Nunn 2020; Buggle and Durante 2021; Fouka and Schläpfer 2020; Mayshar et al. 2022; Le Rossignol and Lowes 2022). Several of these papers have focused on how ecological factors influence culture and institutions through their effects on pre-industrial agricultural practices of societies (see e.g. Alesina et al. 2013; Galor and Ozak 2016; Mayshar et al. 2017, 2022). We contribute to this literature by focusing on an understudied but prevalent economic institution – communal property rights over land – and show that historical ecological differences in fallowing requirements influence land institutions and development policies.

The rest of this paper is organized as follows. Section 2 provides background on fallow practices, land rights, and the conceptual framework describing our main hypothesis that longer fallow requirements increase the prevalence of communal land rights. Section 3 describes the ecological and ethnographic data we use to test our hypotheses. Section 4 presents our empirical strategy and main results. Section 5 examines the implications of our results for land titling policy success. Section 6 explores the mechanisms behind our results. Section 7 concludes.

2. Background and Conceptual Framework

2.1. *Fallow Land*

The agricultural practice of fallowing land involves allowing land that is usually cultivated to lay idle for periods of time, often for many years, in order to let it recover its fertility. Fallowing is the oldest and most widespread agro-forestry practice for restoring land fertility lost in cultivation (Young 1989). The fallow period replenishes nutrients in the land by allowing other natural vegetation to grow.[1] The length of the necessary fallow period depends on soil types, climate conditions, the inputs applied, and the types of crops cultivated (Fischer et al. 2012).[2] Fallow periods that are shorter than optimal (given local conditions, inputs, and crop choice) lead to low soil fertility and low productivity. Additionally, fallow periods that are too short lead to soil erosion as crops do not develop sufficiently strong root systems to protect against flooding and sliding. Rotating between crop cultivation and fallowing, also known as shifting cultivation,

[1] In more modern agricultural systems, instead of relying solely on naturally occurring vegetation during fallow periods, specific vegetation – such as grasses, a grass-legume mix, or a green-manure crop rotation – are used to further enhance soil fertility during fallow periods (Fischer et al. 2012).

[2] Eventually, all land should be left fallow after a given period of cultivation (Fischer et al. 2012).

remains a common practice in many countries in Sub-Saharan Africa and Latin America to restore soil fertility and limit soil degradation (López 1998).

Allowing land to fallow is key to restoring land fertility, but it is a complex decision for agricultural producers. Letting land fallow, while an investment in future productivity, is a source of potential insecurity for two reasons. First, by letting land fallow instead of cultivating it, individuals may face consumption insecurity in the absence of social insurance or if they lack access to sufficient non-fallow land (De Zeeuw 1997; López 1998). Second, in settings with weak state capacity, fallow land may be subject to expropriation by outsiders or other villagers. The investment and insecurity aspects of the fallowing decision may interact: more security may increase the extent of fallowing, yet fallowing itself may lead to less security (e.g. Goldstein and Udry 2008). For these reasons, rather than letting fallow land remain completely unregulated and open to outsiders (i.e. open-access), villages often defined property rights over fallow land.

2.2. *Property Rights over Land*

Property rights over land are a bundle of rights related to the use, access, and transfer of land. These rights can take various forms, but they almost always involve some regulations regarding how land can be used, if it can be transferred, and who can access it. In other words, land – including fallow land – is not open-access land; instead, groups define a set of land rights to govern and manage agricultural land (Platteau 2000).

In societies with private property rights over land, all land rights for a given plot are held by a sole individual or by a nuclear family (as a single household). In contrast, in societies without fully individual private property rights, villagers manage land communally, where several or all land rights are held and granted by a community (Boserup 1965; Platteau 2000). Communities in these cases are defined as a collective group of people who are either extended families, clans, villages, or members of an ethnic group (Binswanger and McIntire 1987; Platteau 2000). This form of kin-based communal land ownership was the predominant form of property rights in pre-industrial Western societies (Boserup 1965; Goody and Goody 1983; Henrich 2020).

Communal land rights can consist of more or less "communality" depending on how many components of rights (e.g. use, access, transfer) are allocated to the community. However, communal land rights tend to have the following characteristics. First, land that is owned communally by villages or lineages has strict restrictions on its use by outsiders (López 1998).[3] Second, individuals often have exclusive use rights to the land that they are currently cultivating and the crops they produce on the land, but, once the land is left fallow, the land can be reallocated by the community (López 1998; Pande and Udry 2005; Goldstein and Udry 2008).

2.3. *Evolution of Land Rights*

A fundamental debate in anthropology and economics concerns the evolution and emergence of property rights structures. Boserup (1965) highlighted that societies transition across different modes of agriculture in the process of development, often due to increasing population pressures. These modes of agriculture are characterized by differences in their fallowing methods (ranging from long fallow systems to multi-cropping systems). Boserup (1965) posited that as population pressures increase (and, therefore, land becomes more scarce), societies both transition from extensive to intensive agriculture and tend to develop private property rights for land instead of relying on communal rights.[4]

In a similar vein, an influential view in economics has argued that individual and private property rights emerge as resources become more scarce and the benefits of privatization exceed its non-negligible costs. In particular, Demsetz (1967, pg. 350) summarized the view as follows: "It is my thesis that... the emergence of new property rights takes place in response to the desires of interacting persons for adjustment to new benefit-cost possibilities... property rights develop to internalize externalities when the gains from internalization become larger than the costs of internalization." Together, these hypotheses from Boserup (1965) and Demsetz (1967) became known as the evolutionary theory of property rights (ETPR) (Platteau 1996).

One critique of the ETPR is that it implicitly assumes that private land rights grant more tenure security, thereby leading to more investment due to an assurance effect. However, this assumption relies on the existence of a strong state or neutral third-party for enforcement. In many settings, this assumption is unlikely to hold and, in fact, communal rights may provide more tenure security (Atwood 1990; Platteau 2000; Brasselle et al. 2002). As noted by Platteau (2000, pg. 140) "as is apparent from the... survey of the African situation, there is no solid basis for claiming that increased individualization of land rights generates an assurance effect. As it

[3] In other words, communal land is "common property with closed or highly restricted access for external potential users" (López 1998).

[4] See Figure C1 for a summary of Boserup (1965) provided by Datoo (1978).

turns out, in customary land areas basic use rights seem to be sufficient to induce landholders to invest and the adding of transfer rights (with the possible exception of the right to bequeath land) does not appear to significantly improve investment incentives."[5]

Both Boserup (1965) and Demsetz (1967) noted a likely relationship between longer fallowing periods and the presence of communal land rights. Boserup (1965) noted that fallow periods play an important role in the evolution of property rights:

> *"The attachment of individual families to particular plots becomes more and more important with the gradual shortening of the period of fallow and the reduction of the part of the territory which is not used in the rotation... As more and more land is subject to specific cultivation rights little land will be available for redistribution by the chief, and valuable land for redistribution will become available mainly when a family dies out or leaves the territory... Redistribution of land thus becomes a less important and less frequently exerted function of the chief, and in the end it disappears altogether"* (Boserup 1965, pg. 80-81)

In other words, shorter fallow periods are likely associated with more private land rights and less communal land rights.

Similarly, Demsetz (1967) highlighted the relationship between shorter fallow periods and the emergence of private land rights:

> *"Once a crop is grown by the more primitive agricultural societies, it is necessary for them to abandon the land for several years to restore productivity. Property rights in land among such people would require policing cost for several years during which no sizable output is obtained. Since to provide for sustenance these people must move to new land, a property right to be of value to them must be associated with a portable object. Among these people it is common to find property rights to the crops, which, after harvest, are portable, but not to the land. The more advanced agriculturally based primitive societies are able to remain with particular land for longer periods, and here we generally observe property rights to the land as well as to the crops."* (Demsetz 1967)

Thus, both authors highlight the important role of fallow length for the emergence of communal relative to private property rights over land. A longer length of fallow – by affecting the cost of protecting land that is under fallow – makes it more likely that a society will develop communal land rights.

[5] Additional critiques of ETPR are that it ignores cultural practices communities often develop to manage communal resources (e.g. Ostrom 1990), it abstracts from the direct costs of privatization (Baland and Platteau 1998), and often ignores the distributive consequences of privatization (Platteau 2000).

2.4. *Conceptual Framework*

We develop a model to sharpen the intuition for how the ecologically determined length of fallow shapes the structure of property rights, building on the insights of Boserup (1965) and Demsetz (1967). The details of the model are outlined in Appendix B. The intuition of the model is as follows. In the model, the required length of fallow increases the cost of protecting land. The fallow requirement can be interpreted as the share of land under fallow at any given time; thus, a longer fallow requirement means more land must be protected. Land protection is preventing outsiders from squatting on or cultivating the land.

Land can be protected individually in a private property rights regime or as a community in the communal property rights regime. It is costly for individuals to protect land, and individuals vary in how costly it is for them to protect the land. However, for all individuals the cost of protection is increasing in the length of fallow. Under both private property and communal property, individuals choose whether to pay the monitoring cost to protect the land. When individuals pay the monitoring cost, they are successful at protecting their land.

A key assumption of the model is that there are returns to scale in the protection of land if done jointly as a community. If enough individuals cooperate to protect the land, then the cost of protection falls. However, individuals can freeride in the communal regime. Thus, to enforce cooperation in the provision of protection, individuals who freeride can be excluded from the community land in the future. In both regimes, if individuals do not pay the monitoring cost, there is some chance that their land can be expropriated.

Payoffs are determined by: the property rights regime, whether an individual chooses to monitor, the length of fallow, and whether an outsider tries to squat on or expropriate the land. In the private property regime, if an individual chooses to pay the monitoring cost, the payout is a function of benefits from cultivation, the individual cost of providing protection, and the length of fallow. If the individual chooses not to pay the monitoring cost, then their payout is a function of the benefits from cultivation and the probability that the land is expropriated by outsiders, which reduces their payout.

In the communal regime, for an individual who pays the monitoring cost, their payoff is a function of the benefits from cultivation, the individual cost of monitoring, the length of fallow, the share of other individuals who choose to pay the monitoring cost, and a fixed cost of organizing to provide communal protection. If enough individuals participate in the communal

Table 1
Summary of Conceptual Framework Predictions

	Prediction:	*Empirics:*
Main prediction:		
↑ Fallow requirement	↑ Communal land rights	↑ Prevalence of communal land rights
Secondary predictions:		
↑ Fallow requirement:	↓ Interest in private rights	↓ Success of World Bank land titling projects
	↓ Inequality & unrest	↓ Income inequality & conflict events

protection of land, then the cost of protection falls. If an individual chooses not to pay the monitoring cost, their payout is a function of the benefits from cultivation, the probability that the land is expropriated, the share of other individuals who choose to pay the monitoring cost, and a fixed cost of organizing to provide communal protection.

The key insights are as follows. First, the expected payoff in the private regime is decreasing in the length of fallow. Second, the expected payoff in the communal regime is also decreasing in the length of fallow (see Appendix Figure B1). Third, given the advantages of group monitoring, above a certain threshold length of fallow, the communal regime is preferred over the private regime as the returns to scale in monitoring become more valuable (see Appendix Figure B2).

In addition, the model has several other implications. The communal regime reduces inequality; this is because individuals that have high monitoring costs and that choose to freeride can still benefit in the communal regime from group monitoring. In effect, this provides redistribution across members in the communal regime. Additionally, communal land rights may reduce conflict. This is through two channels. First, the redistribution channel described above may lead to a reduction in unrest. Second, more monitoring is provided under the communal regime, reducing conflict. We summarize the set of predictions in Table 1.

Note that our framework abstracts from many important aspects. In particular, the framework assumes that state enforcement of land rights is missing. This stands in contrast to some modern settings where states are effective at arbitrating disputes and enforcing private land rights. Communal land rights are likely to be particularly beneficial when the state is unable to enforce private property rights. Additionally, the framework ignores elite capture, either in state enforcement (Behrer et al. 2021) or in land allocation under communal land rights (Goldstein and Udry 2008).

3. Data Sources

3.1. *Fallow Requirement*

We use FAO GAEZ data and models to construct the extent to which crops in a particular location require fallowing. The FAO estimates fallow requirements for various crop types as a non-linear function of: local soil type, inputs, temperature, crop growth cycles, and climate (Fischer et al. 2012). The FAO models express fallow requirements as the percentage of time during the fallow-cropping cycle the land must be under fallow. For instance, a fallow requirement of 50% means that after three years of cultivation, the land needs to remain fallow for three years; likewise, a fallow requirement of 70% implies that after three years of cultivation, the land needs to remain fallow for seven years.[6] We calculate the fallow requirement for rain-fed agricultural production using low input levels.[7] Using the FAO models, we construct the fallow requirement for the maximum caloric suitability crop (as defined by data from Galor and Ozak 2016) for 5′ x 5′ degree cells across the world (approximately 100 km^2).[8] Figure 1 presents a map of fallow requirements across the world.

3.2. *Ethnographic Data*

We use ethnographic data from the Standard Cross-Cultural Sample (SCCS) (Murdock and White 1969) for information on societies' agricultural practices historically. This data source contains very detailed ethnographic questions – including on land rights – for 186 cultures. The SCCS societies were chosen from the full sample of societies in the Ethnographic Atlas (EA), which provides ethnographic data on 1,265 societies (Murdock 1967); this sample was chosen to be representative of the full EA sample and to be culturally and historically independent from other societies sampled.[9] While the EA covers a larger set of societies than the SCCS, the EA does not contain detailed questions on land rights.

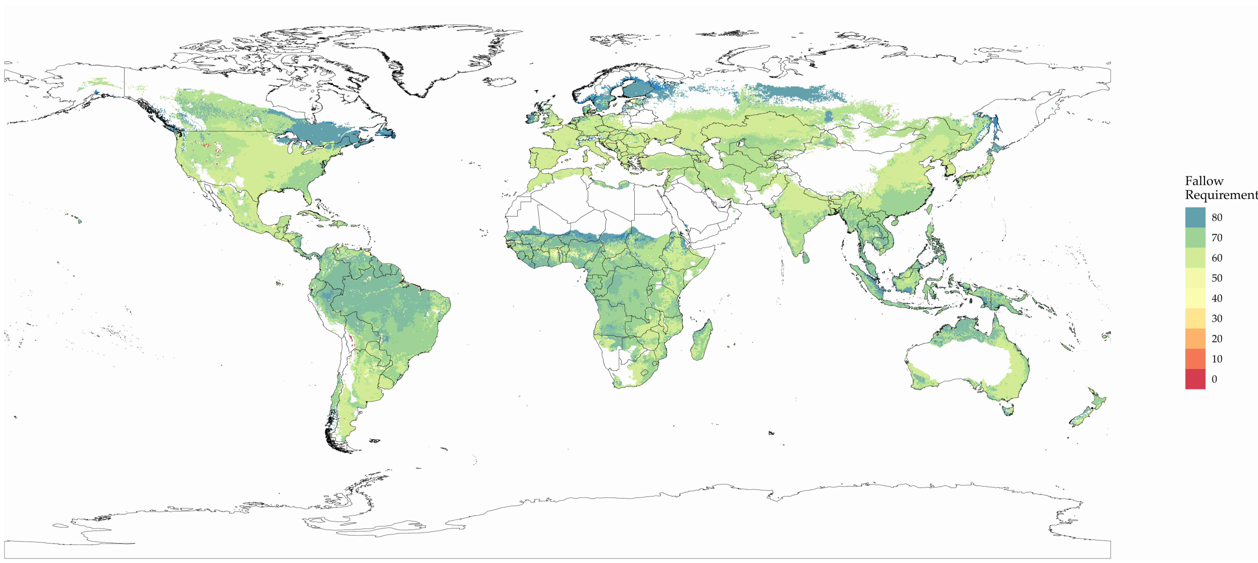
[6] The fallow requirements developed by Fischer et al. (2012) were based on previous work estimating fallow periods across different regions (e.g. Young and Wright 1980; FAO/IIASA 1991).

[7] For intermediate level of inputs, the FAO sets fallow requirements at one third of the fallow period requirement under low input levels. For high input levels, the FAO sets fallow requirements uniformly at 10% (Fischer et al. 2012).

[8] See Galor and Ozak (2016) Figure A.1 for a map showing the maximum caloric suitability crop for 5′ x 5′ degree cells.

[9] To select societies for the SCCS, they first grouped the 1,265 societies from the EA into 186 clusters of closely-related cultures, and then one representative and well-documented society was chosen from each cluster to be part of the SCCS (Murdock and White 1969).

Figure 1
Fallow Requirements Across the World



Notes: The map presents the fallow requirement for the maximum caloric suitability crop for the world in 5′ by 5′ grid cells. The fallow requirement for a crop is defined as the optimal percentage of time during the fallow-cropping cycle that land must be under fallow (Fischer et al. 2012). Cells shaded in white represent regions where the land is not suitable for agriculture.

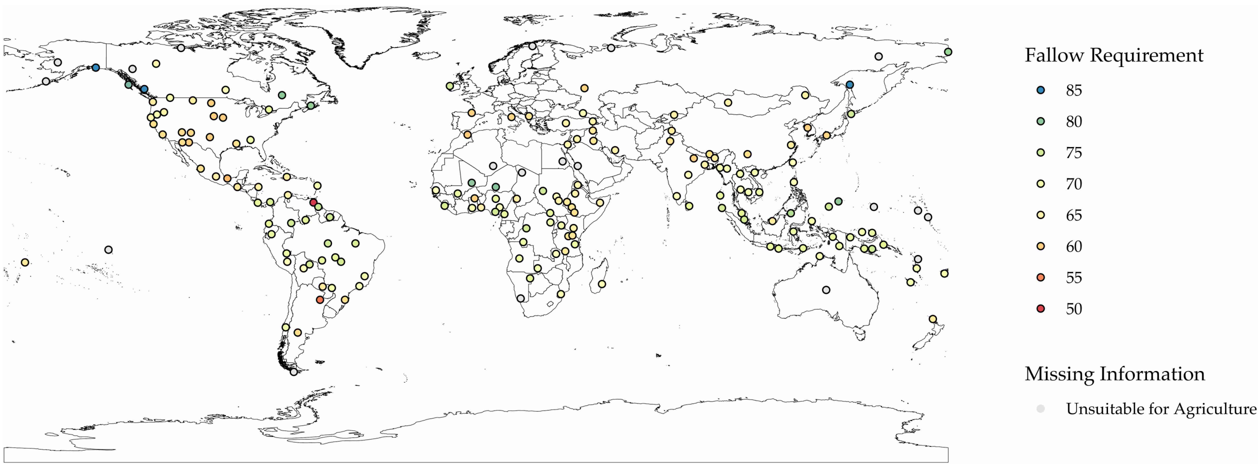
For the ethnographic data in the SCCS, information on each society is coded for the earliest possible period that contains satisfactory ethnographic data.[10] This information has been coded to attempt to reflect conditions prior to industrialization and (where applicable) prior to European contact. Both data sources contain longitude and latitude measures for the centroid of a society's historical location. Figures 2 present a map with the centroids of SCCS societies, and the estimated fallow requirements (described in Section 3.1) for a 100 km buffer around these centroids.

To examine whether a society in the SCCS has communal land rights or private land rights, we use variable 1726 denoted as measuring the "Communality of Land" (Murdock and White 1969). This is a 1 to 3 categorical variable, where 1 = land is predominantly private property, 2 = land is partially communally used, and 3 = communal land use rights only. Figure 3 presents the distribution for the "Communality of Land" variable. 53.06% of SCCS societies had communal land rights use only, 24.49% had partial communal land rights, and 22.45% had predominately private property rights. Figure 4 presents a map of the communality of land measure across SCCS societies. Communal land rights are particularly prevalent in South America, Sub-Saharan Africa, and parts of Asia.

To validate that our measure of fallowing requirements correlates with the historical amount

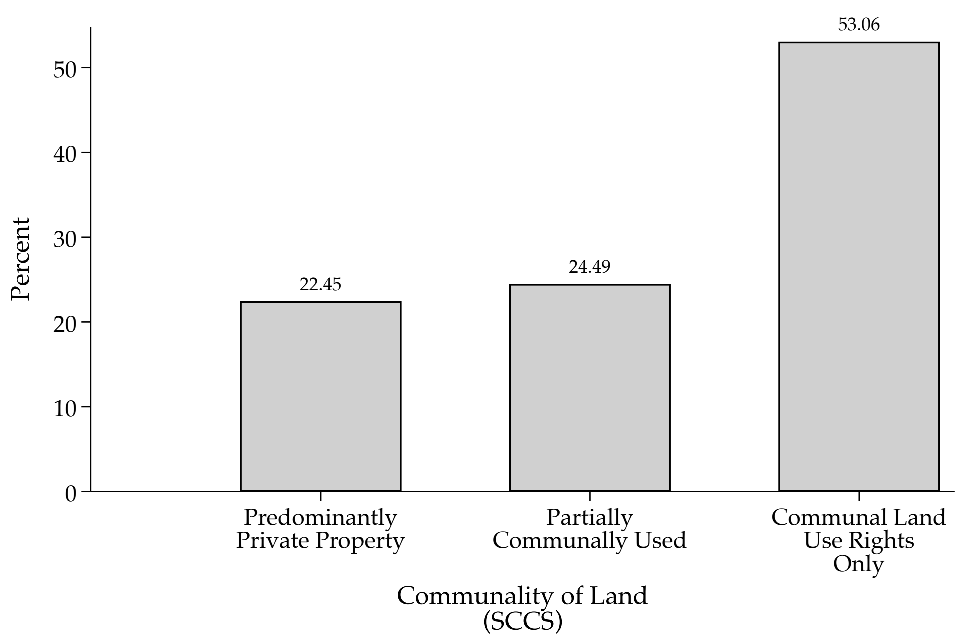
[10]For societies with a written history, the dates of this written history are the observation dates. For groups without written histories, the dates of observation refer to the dates of earliest observation of these cultures by ethnographers.

Figure 2
Fallow Requirements Across SCCS Societies



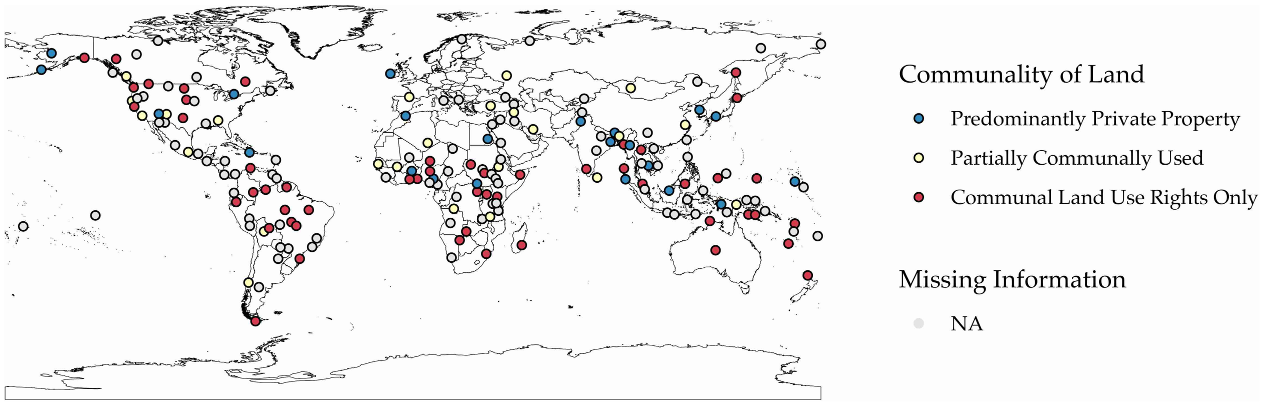
Notes: The map presents the fallowing requirement – percentage of time during the fallow-cropping cycle that land must be under fallow – for the maximum caloric suitability crop for each group in the SCCS. Grey dots represent groups where the land is not suitable for agriculture.

Figure 3
Communality of Land in the SCCS



Notes: The Figure presents a histogram for the "Communality of Land" variable for societies in the SCCS.

Figure 4
Communal Land Rights Across SCCS Societies



Notes: The map presents the extent to which land rights are organized communally in the SCCS.

of fallow land in a society, we use variable 1128 from the SCCS, labeled as the "Cropping Index (Rough indicator of Fallowing) for Major Crops" (Murdock and White 1969). This variable measures the "percentage of total land used for major crops in any given year," where land that is not used is presumed to be fallow land (Pryor 1986).[11] For societies that practiced agricultural production, the variable is a 1-5 categorical variable, where 1= less than 10% of land used per year, 2 = 10% - 29% of land used per year, 3 = 30% - 49% of land used per year, 4 = 50% - 99% of land used per year, and 5 = 100% or more of land used per year.[12]

3.3. *Ethnologue to Link Ethnographic Data to Modern Data*

While some outcomes of interest (such as land rights historically) are available at the society-level, some more modern outcomes of interest are available at more aggregated levels. Thus, for analyses involving these modern outcomes, we construct measures of the fallow requirements at the ethnologue group or country level using the data and methodology developed by Alesina et al. (2013) and Giuliano and Nunn (2018). The ethnologue-level and country-level measures correspond to the average fallowing requirement faced by the ancestors of individuals currently living in a ethnologue group or country. To create this measure, we use data from Giuliano and Nunn (2018) on (i) the location of ethnic groups using over 7,000 different languages or dialects from Ethnologue 16 linked to societies in the EA, and (ii) information on the global population densities (at a one-kilometer resolution) from the Landscan database. By using the link between

[11] It notes that tree crops are considered to have no fallow.
[12] The amount of land used for major crops can be over 100% due to double cropping.

the EA societies and each of the 7,000+ Ethnologue dialects, we create a measure of the ancestral fallowing requirements for all individuals living in a country today. Figure C2 presents a map of the fallowing requirement for the Ethnologue language groups linked to EA societies, and Figure C3 presents a map of the ancestry-adjusted fallow requirements across countries.

3.4. *Additional Data Sources*

We also use the following data sets in our supplementary analyses. We use detailed data on contemporary farming practices and the structure of property rights collected from several sub-Saharan African countries (Waha et al. 2016). To examine the role of local leaders in the allocation of land, we use data from Afrobarometer Round 8 (Afrobarometer 2019). To examine the efficacy of World Bank projects, we use geo-referenced project data from AidData (2017). To analyze effects on wealth and inequality we use data from IPUMS DHS (Boyle et al. 2022). Finally, to examine effects on conflict we use two data sources: ACLED (Raleigh et al. 2010) and UCDP (Uppsala Conflict Data Program 2021). For additional information on the datasets used in the analyses, variable definitions, and for maps displaying the various samples, refer to Appendix A.

4. Results

4.1. *Empirical Strategy*

We examine the relationship between fallow requirements and our outcomes of interest (e.g. communal land rights) in the ethnographic data by estimating the following equation:

$$y_{sc} = \gamma_1 FallowRequirement_{sc} + \mathbf{X}'^{G}_{sc}\mathit{\Gamma} + \mathbf{X}'^{E}_{sc}\mathit{\Phi} + \delta_{r(c)} + \varepsilon_{sc} \tag{1}$$

where y_{sc} is the outcome of interest for society s in country c. We measure the $FallowRequirement_{sc}$ as the average percentage of time during the fallow-cropping cycle that land must be under fallow for the maximum caloric suitability crop of a society s using a 100 km buffer around the society's centroid. We include $\mathbf{X}'^{G}_{sc}$, a vector of geographic covariates at the society-level, and $\mathbf{X}'^{E}_{sc}$, a vector of historical pre-colonial ethnographic covariates. The society-level geographic and ethnographic controls and are described in detail below. We also include continent fixed effects, $\delta_{r(c)}$ (where $r(c)$ is a function that maps countries c to continents $r(c)$), to account for time-invariant differences across regions, and we estimate robust standard errors. We also report Conley standard errors to address spatial correlation. Our coefficient of interest is γ_1: the effect of the fallow requirement on our various outcomes.

We add the following sets of control variables in our analyses to address a wide-variety of potential omitted variables. For geographic covariates ($\mathbf{X}_{sc}^{\prime H}$), we include: temperature (Fick and Hijmans 2017), precipitation (Fick and Hijmans 2017), land suitability (Ramankutty et al. 2002), longitude (Murdock and White 1969), elevation (NOAA National Geophysical Data Center 2009), and suitability for the plough (Galor and Ozak 2016). We also include disease suitability controls: tsetse fly suitability (Alsan 2015) and the malaria ecology index (Kiszewski et al. 2004). In an additional specification, we include fixed effects for the maximum CSI-crop (Galor and Ozak 2016). Finally, we include the following ethnographic controls ($\mathbf{X}_{sc}^{\prime E}$) from the SCCS: pre-colonial centralization, settlement density, presence of large animals, and tropical and sub-tropical climate (Murdock and White 1969).

When using contemporary data to examine the relationship between the fallow requirement and outcomes of interests, we modify equation 1 and estimate the following equation:

$$y_{iesc} = \gamma_2 FallowRequirement_{esc} + \mathbf{X}_{esc}^{\prime G}\Gamma + \mathbf{X}_{esc}^{\prime E}\Phi + \delta_{r(c)} + \varepsilon_{iesc} \qquad (2)$$

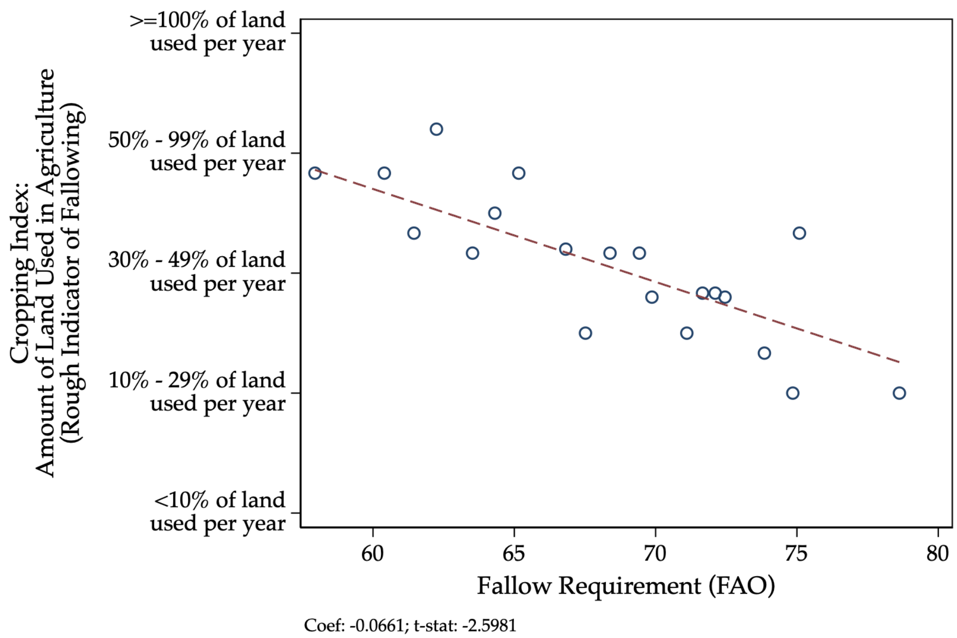
where y_{iesc} is the outcome of interest for observation i belonging to ethnologue group e linked to society s in country c. $FallowRequirement_{esc}$ is the average percentage of time during the fallow-cropping cycle that land must be under fallow for the maximum caloric suitability crop for the Ethnographic Atlas group s linked to ethnologue group e as in Nunn and Guiliano (2018). As in equation 1, we include $\mathbf{X}_{esc}^{\prime G}$, a vector of geographic covariates at the EA society-level, and $\mathbf{X}_{esc}^{\prime E}$, a vector of historical pre-colonial ethnographic covariates. We also include continent fixed effects, $\delta_{r(c)}$, to account for time-invariant differences across regions, and we estimate standard errors clustered at the ethnologue level. In more demanding specifications, we include country fixed-effects, δ_c, to control for time-invariant differences across countries. Our coefficient of interest is γ_2: the effect of ancestral fallow requirements on our various outcomes.

4.2. Validating the Fallow Requirement Measure

We first confirm that the FAO fallowing requirement measure is correlated with observed fallowing practices across societies. We estimate equation (1) for SCCS societies where the outcome variable is the "Cropping Index" – the percentage of total land used in any given year for major crops. If our fallowing requirement measure is a reasonable proxy for agricultural practices historically (and subsequent property rights), then we would expect a strong negative relationship between the fallow requirement measure and the percentage of land used for major crops in a given year.

Figure 5 presents a binscatter between a society's estimated fallow requirement and the cropping index measure. We find a negative and statistically significant relationship between a society's estimated fallow requirement and the cropping index measure, suggesting that the fallow requirement measure captures historical fallowing practices.

Figure 5
Fallow Requirements and Observed Fallowing Intensity: SCCS



Notes: The figure presents a binscatter between the fallowing requirement and the reported share of a land used for major crops (a proxy for the amount of land lay fallow in a given year). The unit of observation is a SCCS group. Regressions control for latitude, longitude, and continent fixed-effects. The bottom-right of the figure presents the estimated bivariate coefficient and t-statistic. Standard errors are clustered at the SCCS group level.

We further investigate the robustness of this relationship to the inclusion of geographic covariates. This addresses the concern the relationship between fallowing requirements and the cropping index might be driven by omitted differences in geographic characteristics. Table 2 presents the estimates for equation (1), where we sequentially add a number of geographic covariates that might affect the amount of fallow land. In particular, we include continent fixed-effects (in columns (2)-(5)); controls for latitude, longitude, average precipitation, average temperature, and agricultural suitability (in columns (3)-(5)); controls for malarial suitability and tsetse fly suitability (in columns (4)-(5)); and, fixed-effects for the maximum caloric crop for each society (in column (5)) to account for unobserved differences across crops (which is an importance concern given recent work on how differences across crops lead to differences in state institutions, Mayshar et al. 2022).[13] Throughout, we continue to find a negative and statistically significant relationship between fallowing requirements and the amount of agricultural land used in a given year: a 10 percentage point increase in fallow requirements is associated with using 4.5% less land in a given year. These results further validate that the fallow requirement measure is a strong proxy for historical fallowing practices.[14] We also present Conley standard errors in brackets to account for spatial auto-correlation within 100 kilometers of an SCCS centroid.

Table 2
Effect of Fallow Requirement on Amount of Land Used For Agriculture in SCCS (Rough Indicator for Fallowing)

	Dependent Variable: *Amount of Agricultural Land Used [1-5]*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	-0.122^{***}	-0.105^{***}	-0.125^{***}	-0.125^{***}	-0.132^{***}	-0.134^{***}
	(0.029)	(0.034)	(0.040)	(0.038)	(0.032)	(0.039)
	[0.007]	[0.006]	[0.013]	[0.015]	[0.012]	[0.011]
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	3.00	3.00	3.00	3.00	3.00	2.98
Adjusted R2	0.179	0.210	0.246	0.238	0.311	0.322
Beta Coef.	-0.438	-0.376	-0.448	-0.449	-0.472	-0.488
Observations	63	63	63	63	63	61

Notes: The unit of observation is a society in the Standard Cross Cultural Sample (SCCS). Robust standard errors in parentheses, and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. The dependent variable *Amount of Agricultural Land Used* is a 1 to 5 categorical variable, where 1=<10% of agricultural land used per year, 2=10-29% of agricultural land used per year, 3=30-49% of agricultural land used per year, 4=50-99% of agricultural land used per year, and 5=≥100% of agricultural land used per year. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[13] All controls aside from latitude and longitude are calculated using a 100 km buffer around an SCCS societies centroid.

[14] Similarly, Boserup (1965) noted that longer fallowing requirements would also be associated with more extensive (less intensive) agricultural production. Table C3 presents estimates for the relationship between longer FAO fallow requirements and the intensity of agriculture across societies in the SCCS. We find evidence consistent with Boserup (1965): longer FAO fallow requirements are associated with more extensive agricultural production. This provides further evidence that the FAO measure of fallow requirements is a strong proxy for historical fallowing practices.

We also examine whether the fallow requirement measure predicts contemporary fallowing practices. In developed countries, the practice of fallowing has decreased over the last century due to increased access to modern inputs. Therefore, we focus on data from Africa to investigate the relation between fallowing requirements and contemporary fallowing practices. For this exercise, we rely on data from an agricultural survey of 9,500 farm households conducted in 11 African countries (Waha et al. 2016). This dataset provides information on the farming system for all the plots in each farm household. For a given plot, respondents answer a question about how the land is used.[15] Respondents can select one of the six following farming systems: (i) shifting cultivation (with long fallow period), (ii) continuous cropping (no fallow period), (iii) continuous cropping with multiple rotations (includes short fallow period), (iv) livestock grazing land, (v) other, and (vi) combination of above.

We focus on the first three categories, which together account for 93% of the farming systems in the sample.[16] We generate a 0 to 2 variable where 0 indicates "continuous cropping (no fallow period)", 1 indicates "continuous cropping with multiple rotations (includes short fallow period)", and 2 indicates "shifting cultivation (with long fallow period)". We estimate a variant of equation (2), where the unit of analysis is a plot. Standard errors are two-way clustered by country and ethnologue group. Table 3 presents the results. The positive coefficient associated with the fallow requirement suggests that longer fallowing requirements are correlated with systems of farming that rely more on the practice of fallowing.

4.3. *Fallow Lengths and Land Rights*

We next test the main hypothesis that longer fallowing requirements are associated with a higher probability that a society has communal land rights instead of private land rights. We estimate equation (1) for SCCS societies where the outcome variable is the "Communality of Land" variable.[17] Figure 6 presents a binscatter examining the relationship between a society's FAO fallowing requirement and the extent to which land rights were communal. Consistent with our hypothesis, we find that societies that had longer fallowing requirements were more likely to have communal property rights over land.

[15]The precise question is: "Please answer the following land use questions with respect to total amount and type of land operated by members of the household: System of Farming".

[16]See Figure C4 for a histogram of the number of plots per category.

[17]This question is only available in the SCCS data and not in the EA data.

Table 3
Effect of Fallow Requirement on Contemporary Fallowing Practices

	Dependent Variable: *Contemporary Fallowing Practices [0-2]*				
	(1)	(2)	(3)	(4)	(5)
Fallow Requirement	0.014**	0.013**	0.012*	0.017**	0.016**
	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)
	[0.006]	[0.007]	[0.006]	[0.007]	[0.007]
Country FEs	Y	Y	Y	Y	Y
Geography Controls	N	Y	Y	Y	Y
Disease Controls	N	N	Y	Y	Y
Crop FEs	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	Y
Outcome Mean	0.70	0.70	0.70	0.70	0.70
Adjusted R2	0.043	0.048	0.052	0.056	0.057
Beta Coef.	0.118	0.112	0.103	0.141	0.133
Observations	8,860	8,860	8,860	8,860	8,860
Clusters	117	117	117	117	117

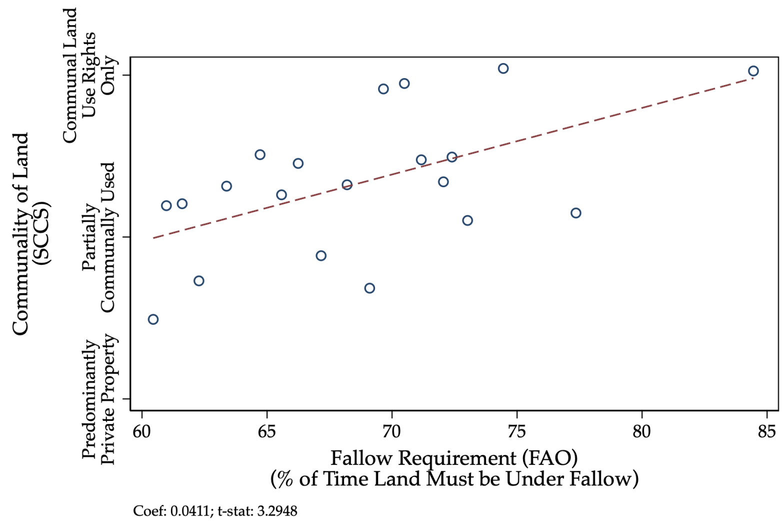
Notes: The unit of observation is a plot in the *An agricultural survey for more than 9,500 African households* survey (Waha et al. 2016). Standard errors that are two-way clustered by country and ethnologue group are presented in parentheses, and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. *Geographic Controls* include longitude, latitude, average rainfall, average temperature, elevation, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development for the ethnologue group of each Enumeration Area. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4
Effect of Fallow Requirement on Communal Land Rights

	Dependent Variable: *Communality of Land Rights [1-3]*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	0.043***	0.039***	0.036***	0.038***	0.037**	0.035**
	(0.013)	(0.014)	(0.013)	(0.014)	(0.015)	(0.015)
	[0.007]	[0.007]	[0.007]	[0.007]	[0.006]	[0.004]
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	2.33	2.33	2.33	2.33	2.33	2.34
Adjusted R2	0.098	0.113	0.130	0.114	0.200	0.267
Beta Coef.	0.329	0.296	0.270	0.287	0.278	0.268
Observations	88	88	88	88	88	86

Notes: The unit of observation is a society in the Standard Cross Cultural Sample (SCCS). Robust standard errors in parentheses, and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. The dependent variable *Communality of Land Rights* is a 1 to 3 categorical variable, where 1=land is predominantly private property, 2=land is partially communally used, and 3=communal land use rights only. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 6
Effect of Fallowing Requirement on Communal Land Rights: SCCS



Notes: The figure present the binscatter between the fallowing requirements and the communality of land property rights. The unit of observation is a SCCS group. Regressions control for latitude, longitude, and continent fixed-effects. The bottom-right of each figure presents the estimated bivariate coefficient and t-statistic. Robust standard errors are clustered at the SCCS group level.

Table 4 presents the estimates for equation (1) while sequentially including geographic and ethnographic covariates. Columns (2)-(5) include the geographic covariates included in Table 2; column (6) adds additional ethnographic controls, including an indicator for the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement complexity (e.g. nomadic vs. settled), and an index of political development (i.e. jurisdictional hierarchy beyond the local level).[18] Across all specifications, we find a positive and statistically significant relationship between longer fallowing requirements and the presence of communal land rights: a 10 percentage point increase is fallow requirement is associated with a 4.1 percentage point higher probability of communal land rights being present.[19] The results suggest that fallowing constraints were an important factor determining how communities organized land ownership.

As a test for how fallow requirements impact contemporary land rights, we use data from the Afrobarometer Round 8 (Afrobarometer 2019). This round of the Afrobarometer has questions on the role of traditional leaders for governing the community and for allocating land. We expect that

[18]Note that many of these variables could also be affected by fallowing lengths and are likely "bad controls". For this reason, we show results with and without their inclusion.

[19]Appendix Table C1 presents estimates from an ordered logit specification to account for the ordinal nature of the measure; the results are robust to this alternative specification.

where fallow requirements are longer and thus communal property rights more likely, that local leaders should also have a greater role in the allocation and management of land. Consistent with this, in Table 5, we find that traditional leaders are more likely to have an active role in governing the community and allocating land where there are longer fallow requirements.

Table 5
Fallow Requirement and Influence of Traditional Leaders

	Dependent Variable:			
	Influence of Traditional Leaders in:			
	Governing Community [0-3]		*Allocating Land [0-3]*	
	(1)	(2)	(3)	(4)
Fallow Requirement	0.013***	0.013***	0.015***	0.014***
	(0.005)	(0.005)	(0.005)	(0.005)
	[0.003]	[0.003]	[0.003]	[0.003]
Country FEs	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y
Geography Controls	Y	Y	Y	Y
Disease Controls	Y	Y	Y	Y
Crop FEs	Y	Y	Y	Y
Ethnographic Controls	N	Y	N	Y
Outcome Mean	2.83	2.83	2.65	2.65
Adjusted R2	0.111	0.111	0.119	0.120
Beta Coef.	0.054	0.056	0.058	0.055
Observations	38,927	38,927	38,803	38,803
Clusters	622	622	622	622

Notes: The unit of observation is a respondent in the Afrobarometer Surveys round 8. Standard errors that are two-way clustered by country and ethnologue group are presented in parentheses and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. All regressions control for a respondent's age, age squared and gender. Enumeration areas' latitude and longitude included in every specification. *Geographic Controls* include longitude, latitude, average rainfall, average temperature, elevation, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development for the ethnologue group of each Enumeration Area. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In Appendix Table C5, we also use present day data on constitutions (Elkins et al. 2009). We examine whether fallow length also affects the codification of property rights in constitutions. We focus on whether a constitution grants individuals rights to transfer property, own property, testate property, and inherit property. We find evidence that longer fallow requirements are associated with less protections for these individual property rights. See Appendix C.3 for additional details.

5. Land Titling Policy Success

We have shown that longer fallow requirements led to the development of more communal land rights. We now ask what are the consequences of communal land rights for development. We explore the implications of communal land rights for the success of land titling policies.

Many scholars have posited that private property rights for land are essential for economic development and, therefore, policies should aim to increase their prevalence in developing economics (e.g. de Soto 2000; de Soto and Cheneval 2006). This influential view led to multiple reforms aimed at titling land, especially in the 1990 and 2000s across Africa and Latin America. For instance, in 2005, the World Bank alone was supervising a portfolio of more than U.S.$1 billion worth of land administration projects (Galiani and Schargrodsky 2011). However, many of these titling reforms have had mixed and often disappointing results (e.g. Platteau 1996, 2000; Jacoby and Minten 2007; Vendryes 2014; Lawry et al. 2017).

Given these lackluster results despite immense foreign investment in titling policies, Easterly (2007) hypothesized that the lack of success may occur because land titling reforms often ignore underlying property rights norms, where land rights are often communal rather than individualistic.[20] For instance, the British colonial land reforms in Kenya sought to privatize land in settings where customary land rights were strong and well-defined; this led to low levels of take-up and, instead, efforts to recognize communal land rights (Easterly 2007; Home 2013). Similar efforts were undertaken by the Belgians in the Belgian Congo, through a scheme called the *paysannat*. The goal was to modernize land tenure systems – transitioning from communal to individually managed land. Ultimately, the effort was not as successful as hoped as it faced substantial resistance from clan leaders.

To explore whether the success of titling reforms interacts with the underlying land right structures, we use World Bank project data provided by AidData (2017). This data covers World Bank funded projects between 1995 and 2014 and includes information on the projects' location, description, and sectors. To examine the success of projects, we explore the outcome rating of projects. A subset of these projects are given an outcome rating based on "the extent to which the operation's major relevant objectives were achieved, or are expected to be achieved, efficiently". The outcome rating is a six point categorical scale ranging from highly unsatisfactory to highly

[20]See also Miceli and Kieyah (2003) for a theoretical model on why titling policies often fail to succeed.

satisfactory project. We limit the sample to those projects that are given a rating.

We use information on project sectors and project description to classify whether projects involved land titling or not. In particular, we define a project as a land titling project if one of its five sector categories or project title refers to land titling. Specifically, the project is labeled as a titling project if the description or sector includes one of the following key words: titling, title, land reform, property right, land administration, land registration, land development project, cadastre, land records, land management. We exclude urban projects by excluding projects that include the following key words: urban or real estate.

We test whether countries that have longer ancestral fallow requirements (and therefore more communal land rights) have less successful land titling projects. In particular, we compare the success of land projects and non-land projects by ancestral fallow requirements. We present the results of a pooled regression of the project outcome on the ancestral fallow requirement measure in Table 6. On average, World Bank projects receive a rating between moderately satisfactory and satisfactory in our sample. For land titling projects, we find a sizable and negative effect of fallow requirements on the rating received: a one standard deviation increase in the fallow requirement is associated with approximately a one point decrease in the project rating (equivalent to moving from moderately satisfactory to moderately unsatisfactory). Reassuringly, this effect for fallow requirements is only found for land titling projects, and not other types of World Bank projects.

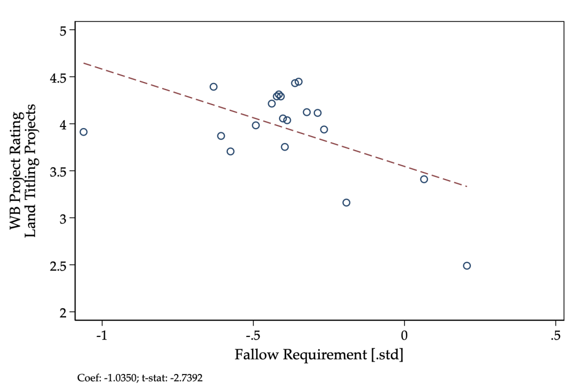
Additionally, in Figure 7, we present binscatters of the relationship between fallow requirements and World Bank ratings for titling and non-titling project separately. The figure shows that land titling projects are significantly less successful in places with longer fallow. We do not find a similar effect when examining other types of projects. These results suggest that the success titling reforms may depend on the underlying property rights regimes. We interpret these results as potential evidence of mismatch between the land-titling policy and the institutional and cultural environment, where changing de jure land rights might not be sufficient to realize the benefits of privatization.

Table 6
Effect of Fallow Requirement on World Bank Project Success

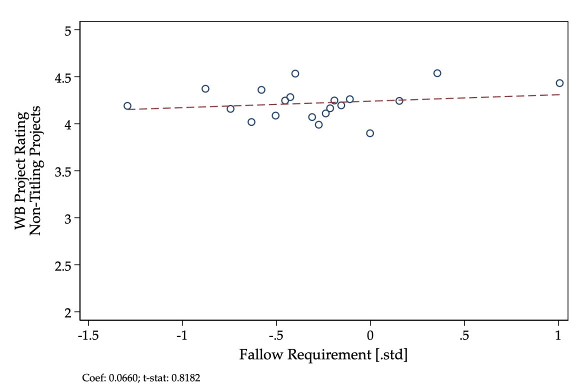
	Dependent Variable: *World bank Project Rating [1-5]*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement × *Land Titling Project*	-0.676^{***}	-0.675^{***}	-0.636^{***}	-0.512^{**}	-0.534^{**}	-0.568^{**}
	(0.227)	(0.238)	(0.229)	(0.228)	(0.231)	(0.231)
Continent FEs	N	Y	Y	Y	Y	Y
Project Sector FEs	N	N	Y	Y	Y	Y
Project Year FEs	N	N	Y	Y	Y	Y
Geography Controls	N	N	N	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	Y	Y	Y
Ethnographic Controls	N	N	N	N	Y	Y
Country FEs	N	N	N	N	N	Y
Outcome Mean	4.21	4.21	4.21	4.21	4.21	4.21
Adjusted R2	0.017	0.036	0.138	0.176	0.183	0.300
Beta Coef.	-0.110	-0.109	-0.103	-0.083	-0.087	-0.092
Observations	18,763	18,763	18,707	18,707	18,707	18,707
Clusters	87	87	87	87	87	87

Notes: The unit of observation is a project-country pair. Standard errors are clustered at the country level and presented in parentheses. The dependent variable *World Bank Project Rating* is a variable ranging from 1 to 5, where 1 = a project was rated as highly unsatisfactory, 2 = unsatisfactory, 3 = moderately unsatisfactory, 4 = moderately satisfactory, and 5 = satisfactory. *Fallowing Requirement* is the country-level population-weighted measure of a country's fallowing requirement. *Land Titling Project* is an indicator variable equal to 1 if the project description mentions land titling. *Geography Controls* include longitude, latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop. *Ethnographic Controls* includes settlement complexity, mean size of local community, political complexity, historical reliance on pastoralism, and historical reliance on agriculture. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 7
Fallow Requirements and World Bank Project Success



a. Land Titling Projects



b. Non-Land Titling Projects

Notes: The figure presents binscatters between the world bank project success rating for projects related to land titling (a.) or projects not related to land titling (b.), and population-weighted fallowing requirement. The unit of observation is a project-country pair. The bottom-left of each figure presents the estimated bivariate coefficient and t-statistic. Standard errors are clustered at the country level.

6. Mechanisms: Social Insurance and Conflict

We examine the implications of fallow length for wealth inequality, wealth, and the incidence of conflict. We also examine heterogeneity by quality of institutions.

6.1. Inequality and Wealth

As highlighted in Section 2.4, communal land rights may be associated with lower income inequality. In the model the mechanism through which communal land rights reduce inquality is that who have high costs of monitoring benefit from the communal provision of protection. Anecdotal evidence suggests that communal land rights may also be more flexible in redistributing land across households.

To examine modern-day inequality and wealth, we use Demographic and Health Survey (DHS) data. We assembled all DHS samples that included geographic coordinates for enumeration clusters. In total, the sample includes 123 surveys spanning 47 countries; Figure A3 presents a map of the location for the DHS clusters in our sample. The DHS data include wealth score measures for each surveyed household. The wealth score is constructed using principal component analysis of household asset ownership within each country-year survey. We use the wealth score measures to examine cluster-level income levels and inequality levels. We link DHS clusters to ethnologue groups based on their location to determine the fallowing requirement for each DHS cluster.

Table 7 presents the regression estimates for the relationship between wealth scores in the DHS data and the fallowing requirements of ethnologue groups. We first examine whether longer fallowing requirements are associated with less income inequality, as proxied by either the standard deviation (columns 1 and 2) or the inter-quartile range (columns 3 and 4) of the wealth score. We find that across both of these measures longer fallow requirements are associated with a reduction in inequality. A one standard deviation increase in the fallow requirement is associated with a .02 standard deviation reduction in the inter-quartile range of the wealth score. These results are robust to a number of geographic and ecological covariates, population density controls, and country-survey-year fixed-effects.[21] Interestingly, we find little evidence that fallowing requirements affect average wealth scores (columns 5 and 6): the point estimates are

[21]See Table C8 for results on each outcome when controls are included sequentially.

statistically insignificant.[22] The results suggest that societies with longer fallow requirements and more communal land rights experience less income inequality.

Table 7
Effect of Fallow Requirement on Income and Inequality:
Demographic Health and Surveys (DHS)

	Dependent Variable: *... of DHS Wealth Score*					
	Inter-Quartile Range		*Standard Deviation*		*Average*	
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	-0.400^{**}	-0.425^{*}	-0.260^{**}	-0.293^{**}	-0.503	-0.628
	(0.192)	(0.223)	(0.126)	(0.146)	(0.536)	(0.540)
	[0.105]	[0.182]	[0.098]	[0.114]	[0.464]	[0.433]
Country-Year FEs	Y	Y	Y	Y	Y	Y
Geography Controls	Y	Y	Y	Y	Y	Y
Disease Controls	Y	Y	Y	Y	Y	Y
Crop FEs	Y	Y	Y	Y	Y	Y
Ethnographic Controls	N	Y	N	Y	N	Y
Population	N	Y	N	Y	N	Y
Outcome Mean	72.59	72.83	60.33	60.68	0.45	2.16
Outcome SD	95.24	97.65	72.21	74.20	156.76	160.13
Adjusted R2	0.538	0.541	0.619	0.621	0.244	0.241
Beta Coef.	-0.021	-0.022	-0.017	-0.018	-0.016	-0.019
Observations	84,937	79,996	82,371	77,430	84,937	79,996
Clusters	122	122	117	117	122	122

Notes: The unit of observation is a DHS cluster. Standard errors that are two-way clustered by country-survey wave and ethnologue group are presented in parentheses and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. In Panel A, the outcome variable is the standard deviation of the DHS wealth score. In Panel B, the outcome variable is the inter-quartile range of the DHS wealth score. In Panel C, the outcome variable is the average DHS wealth score. All regressions control for cluster size and rural-urban status. *Geography Controls* include longitude, latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Population* includes log population for each ethnologue group. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development for the ethnologue group of each DHS cluster. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.2. *Conflict*

Another benefit of communal property rights is that they may reduce the incidence of conflict. In our model, the reduction in conflict is through both the higher level of provision of monitoring and the higher redistribution across members in the communal regime. In practice, it may be that communal land rights are more secure – particularly in a low capacity state.

[22]As an alternative proxy for average wealth levels, we also examine the impacts of fallow requirements on contemporary night light density (Elvidge et al. 2017). The results, presented in Table C7, also suggest that there is no significant relationship between fallowing requirements and night light density.

To explore this mechanism, we use two complementary sources of data. First, we use geo-referenced conflict data from ACLED (Raleigh et al. 2010). These data have a broad coverage, capturing conflict events from 1997-2021 for Africa, 2016-2021 for Latin America, and 2018-2021 for all other countries. However, the ACLED data does not consistently disentangle whether conflict events were land-related or not. To capture whether a conflict event was due to land conflicts, we follow the methodology in Eberle et al. (2020) to construct measures of "land-related" violence using the "notes" recorded for each event to find instances that mention land issues in the description. Second, to complement the ACLED data with a measure of land-specific conflict, we use data from the Institutional Profiles Database (French Ministry for the Economy and Finance 2016) that records the severity of land-related conflicts at the country level. The IPD data was constructed using surveys completed by country or regional Economic Services agents of the French Ministry for the Economy and Finance. The benefit of these data is that they provide high-quality measures from experts. However, the data covers only 95 countries and relies on perceptions rather than on specific reports or instances of conflict.

Table 8 presents the regression estimates for the relationship between the number of conflict events in the ACLED data and the fallow requirement of the ethnologue groups. We find that longer fallow requirements are associated with less conflict. These results are robust to a number of geographic and ecological covariates, population density controls, and country fixed-effects. The results suggest that societies with longer fallow requirements and more communal land rights experience less conflict.

Finally, we examine the relationship between fallowing requirements and land-specific conflict events. Figure C6 presents the binscatter for the number of land-related conflicts in the ACLED data. It shows that areas with longer historical fallowing requirements have lower amounts of land-related conflict. Figure C7 provides the binscatter for the severity of land-related conflict across countries from the IDP data. It shows that countries with longer historical fallowing requirements tend to have less land-related conflict. These results together suggest that communal property rights are associated with lower land-related conflict.

6.3. Heterogeneity by State Capacity

We also examine whether the effects of fallow requirements for income inequality and conflict vary by state capacity. Specifically, we examine this relationship by separately estimating effects

Table 8
Effect of Fallow Requirement on Conflict

	Dependent Variable: *Number of Conflict Events*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	-17.141^{***}	-19.885^{***}	-19.625^{***}	-18.625^{***}	-15.969^{***}	-13.418^{**}
	(6.073)	(5.781)	(5.853)	(6.265)	(5.769)	(5.555)
	[3.702]	[3.449]	[3.491]	[3.674]	[3.671]	[3.470]
Country FEs	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	Y	Y	Y	Y
Disease Controls	N	N	Y	Y	Y	Y
Crop FEs	N	N	N	Y	Y	Y
Population	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	142.46	142.67	142.67	142.67	142.67	152.71
Outcome SD	1460.68	1461.76	1461.76	1461.76	1461.76	1539.15
Adjusted R2	0.157	0.159	0.159	0.163	0.192	0.196
Beta Coef.	-0.051	-0.059	-0.058	-0.055	-0.047	-0.037
Observations	6,718	6,708	6,708	6,708	6,708	5,982
Clusters	6,718	6,708	6,708	6,708	6,708	5,982

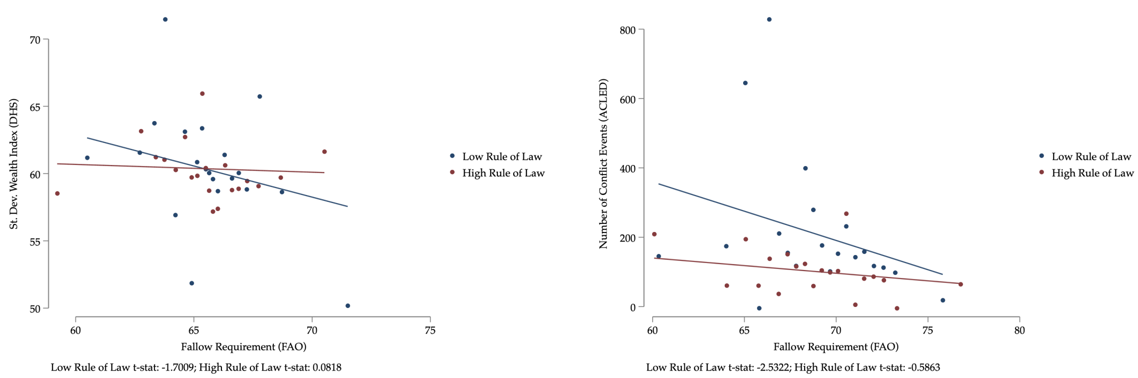
Notes: The unit of observation is an ethnologue group. Standard errors clustered by ethnologue group are presented in parentheses and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. The dependent variable *Number of Conflict Events* is defined as the number of conflict events per ethnologue group in the ACLED data (1997-2021). *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Population* includes log population for each group. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

for countries with high (above median) and low (below median) "Rule of Law" as measured by the World Bank Governance Indicators data (Kaufmann and Kraay 2023).

Figure 8 (a) presents the binscatter for the standard deviation of the wealth score by high and low rule of law countries. We find that the negative relationship between inequality and fallowing requirements is concentrated in low rule of law countries. This provides suggestive evidence that communal land rights might be particularly effective at reducing inequality in settings with weak states.

Figure 8 (b) presents the binscatter for the number of conflict events in the ACLED data by high and low rule of law countries. We find that the negative relationship between conflict and historical fallowing requirements is concentrated in low rule of law countries. This suggests that communal land rights (relative to private land rights) might be particularly effective at reducing conflict in settings with weak states.

Figure 8
Fallowing Requirements & Conflict:
Heterogeneity by Rule of Law



a. Inequality b. Conflict

Notes: The figure presents binscatters between the fallowing requirements and (a) the standard deviation of the DHS wealth score measure and (b) the number of conflict events in the ACLED data. The unit of observation is (a) a DHS cluster and (b) and ethnologue group. The figure presents results separately for groups in countries with low (below median) and high (above median) Rule of Law measures from the World Bank Governance Indicators dataset. Regressions control for country-survey-year fixed effects, geography controls, and disease controls. The bottom-right of each figure presents the estimated bivariate coefficient and t-statistic for each subset of countries. Standard errors are clustered at the ethnologue group level.

7. Conclusion

Most societies have historically had communal land rights rather than private land rights. However, there has been a strong focus on private land rights in development policies, specifically with the implementation of various tilting reforms in developing countries. What explains the disconnect in the prevalence of communal land rights and the importance placed on private land rights?

We show that these communal land rights evolve endogenously and matter for the success of development policies. In particular, we systematically test the hypothesis that communal land rights were more common in areas with longer fallow requirements. This is because fallow land requires community protection, which favors the adoption of communal land rights over private land rights in settings with low state capacity. Combining various ecological and ethnographic data sets, we provide empirical evidence that longer fallowing requirements are strongly associated with communal land rights over private land rights. We then use this variation to show that the underlying property rights over land affect the success of land policies: titling reforms are less successful in places where communal land rights are more common. We provide suggestive evidence that this may be because communal land rights are relatively more effective at reducing inequality and reducing land conflicts in places where states are weak, which is relevant for many of the titling reforms in developing countries.

Our results provide insight into the economics of property rights. Property rights are a bundle of various rights (e.g. use rights, inheritance rights, transfer rights) and these bundles display considerable variation worldwide. Additionally, our results highlight that the success of common development land policies depends on the underlying land rights and cultural norms regarding the ownership of land. These results suggest that tailoring policies to local land rights may be important for the design of development policies.

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Online Appendix for:

Fallow Lengths and the Structure of Property Rights

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Appendix A. Data Sources, Variable Definitions, and Samples

A.1. Data Sources and Variable Definitions

Geographic Data:

- Elevation: NOAA National Geophysical Data Center (2009)
- Fallow requirement: Fischer et al. (2012)
- Land suitability: Ramankutty et al. (2002)
- Longitude: Murdock and White (1969)
- Malaria ecology index: Kiszewski et al. (2004)
- Maximum caloric suitable crop: Galor and Ozak (2016)
- Precipitation: Fick and Hijmans (2017)
- Suitability for the plough: Galor and Ozak (2016)
- Temperature: Fick and Hijmans (2017)
- Tsetse fly suitability: Alsan (2015)

Ethnographic Data:

- Ethnologue: Giuliano and Nunn (2018)
- Standard Cross Cultural Sample: Murdock and White (1969)
- Ethnographic Atlas: Murdock (1967)

Additional Data Sources:

- ACLED: Raleigh et al. (2010)
- Afrobarometer: Afrobarometer (2019)
- Agricultural survey for more than 9,500 African households: Waha et al. (2016)
- Comparative Constitutions Project: Elkins et al. (2009)
- Demographic and Health Surveys: Boyle et al. (2022)
- Institutional Profiles Database: French Ministry for the Economy and Finance (2016)
- Rainfall: Schneider et al. (n.d.)
- World Bank Project Data: AidData (2017)
- UCDP Uppsala Conflict Data Program (2021)
- Legal Origins: La Porta et al. (2008)
- Rule of Law: Kaufmann and Kraay (2023)

Variable Definitions:

- **Fallow requirement**: We use FAO models to construct the fallow requirement for the maximum caloric suitability crop as defined by data from Galor and Ozak (2016) for $5' \times 5'$ degree cells across the world. The FAO estimates fallow requirements for various crops as a non-linear function of local soil types, temperature, crop growth cycles and moisture. The fallowing requirement is measured as the percentage of time during the fallow-cropping cycle the land must be under fallow.

- **Communality of Land**: We measure the communality of land using data from the Standard Cross-Cultural Sample. The data take three values: where 1 stands for "land is predominantly private property", 2 stands for "land is partially communally used" and 3 "communal land use rights only".

- **Contemporary Fallowing Practices**: We use data from Waha et al. (2016) to measure contemporary fallowing practices. The dataset provides information on the farming system for all plots held by farm households. The exact survey question is "Please answer the following land use questions with respect to total amount and type of land operated by members of the household: System of Farming". For each plot, respondents could select one of the following six farming systems: (i) shifting cultivation (with long fallow period), (ii) continuous cropping (no fallow period), (iii) continuous cropping with multiple rotations (includes short fallow period), (iv) livestock grazing land, (v) other, and (vi) combination of above. We generate a 0 to 2 variable where 0 stands for "continuous cropping (no fallow period)", 1 stands for "continuous cropping with multiple rotations (includes short fallow period)", and 2 stands for "shifting cultivation (with long fallow period)".

- **Influence of Traditional Leaders in Governing Community**: We use data from Afrobarometer (2019) to measure the role of traditional leaders in governing the community. The exact survey question is "Now let's talk about traditional leaders and their role in politics and government in this country. How much influence do traditional leaders currently have in each of the following areas: Governing your local community". Respondents could select one of the following four responses: (i) "A lot", (ii) "Some", (iii) "A small amount", (iv) "None", or "Don't know". We construct a 0 to 3 variable where 0 stands for "None", 1 stands for "A small amount", 2 stands for "Some", and 3 stands for "A lot".

- **Influence of Traditional Leaders in Allocating Land**: We use data from Afrobarometer (2019) to measure the role of traditional leaders in allocating land. The exact survey question is "Now let's talk about traditional leaders and their role in politics and government in this country. How much influence do traditional leaders currently have in each of the following areas: Allocating land". Respondents could select one of the following four responses: (i) "A lot", (ii) "Some", (iii) "A small amount", (iv) "None", or "Don't know". We construct a 0 to 3 variable where 0 stands for "None", 1 stands for "A small amount", 2 stands for "Some", and 3 stands for "A lot".

- **Right to Transfer Property in Constitution**: We use data from Elkins et al. (2009). The exact question is "Does the constitution mention the right to transfer property freely? 1 = Yes; 2 = No; 96 = other". We create a dummy variable labelled Transfer Property which equals to one if the the constitution of a given country in a given year grants the right to transfer property, zero otherwise.

- **Right to Own Property in Constitution**: We use data from Elkins et al. (2009). The exact survey question is "Does the constitution provide for a right to own property? 1 = Yes; 2 =

No; 90 = left explicitly to non-constitutional law; 96 = other." We create a dummy variable labelled Own Property which equals to one if the constitution of a given country in a given year grants the right to own property, zero otherwise.

- **Right to Testate Property in Constitution**: We use data from Elkins et al. (2009). The exact survey question is "Does the constitution provide for a right of testate, or the right to transfer property freely after death? 1 = Yes; 2 = No; 96 = other. Testate or testacy refers to the right to give property". We create a dummy variable labelled Testate Property which equals to one if the constitution of a given country in a given year grants the right to testate property, zero otherwise.

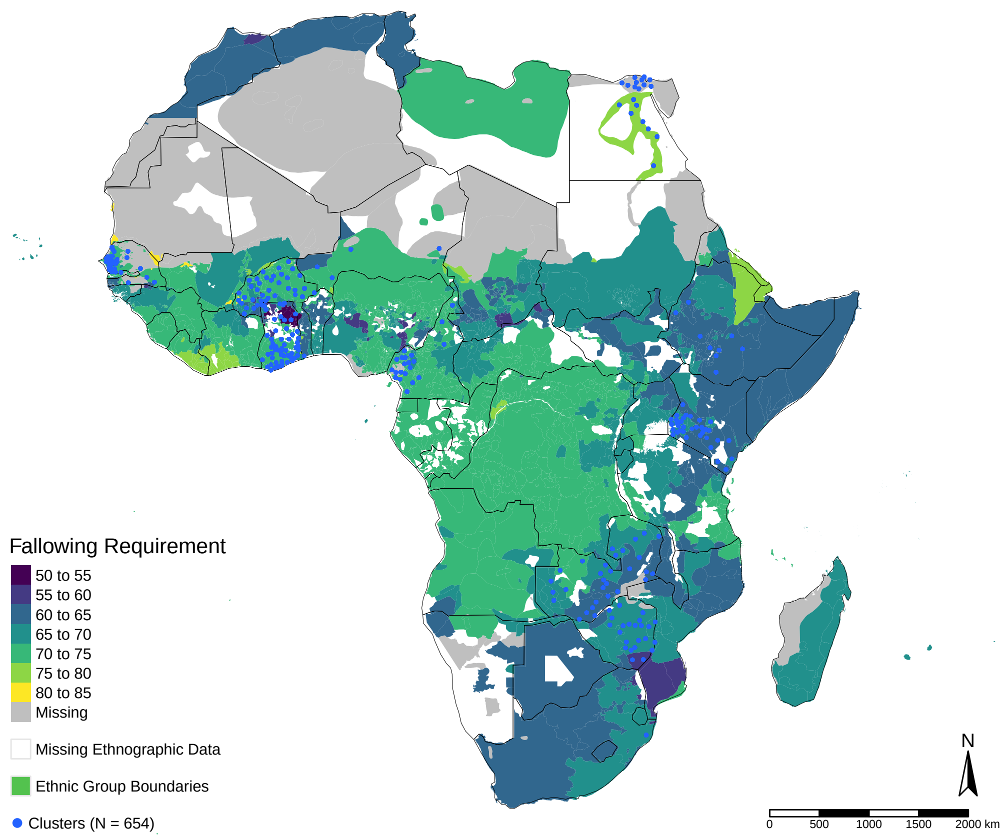
- **Right to Inherit Property in Constitution**: We use data from Elkins et al. (2009). The exact survey question is "Does the constitution provide for inheritance rights? 1 = Yes; 2 = No; 96 = other. Inheritance refers to the right to receive property". We create a dummy variable labelled Inherit Property which equals to one if the constitution of a given country in a given year grants the right to inherit property, zero otherwise.

- **Index of Property Rights**: We compute an index of Property Rights with data from (Elkins et al. 2009) as the mean of Transfer Property, Own Property, Testate Property, and Inherit Property.

A.2. Samples

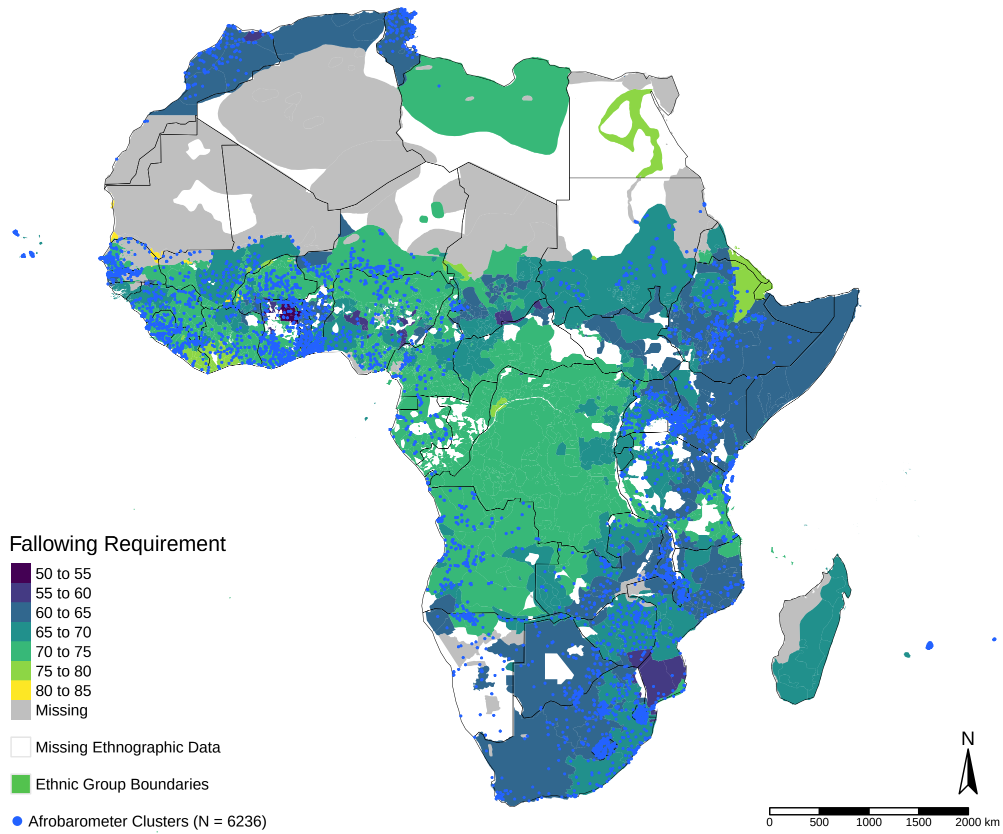
Table A1 provides a description of the datasets and samples we use for our main analysis.

Figure A1
"An agricultural survey for more than 9,500 African households" Sample



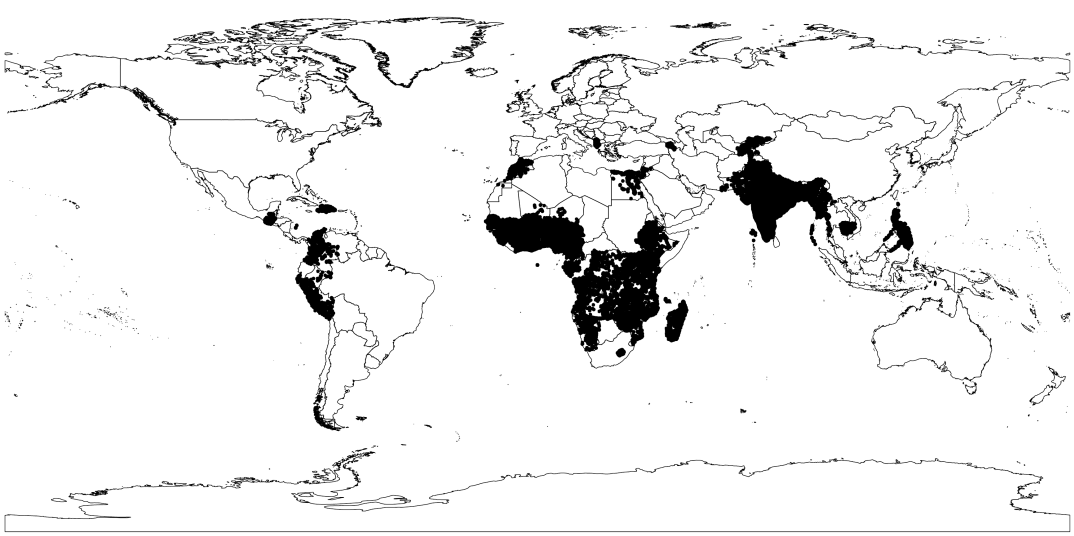
Notes: The map presents the cluster location for the agricultural survey for more than 9,500 African households survey data sample from Waha et al. (2016). In addition, the map also presents the fallow requirement measured across ethnologue boundaries (Fischer et al. 2012).

Figure A2
Afrobarometer Round 8 Sample



Notes:

Figure A3
IPUMS DHS Sample



Notes: The map presents the cluster location for the Demographic and Health Survey (DHS) data sample.

Table A1
Samples

Sample	Acronym	Outcome(s)	Number of Observations in: Raw Data	Our Tables	Exclusion Criteria
Standard Cross Cultural Sample	SCCS	Amount of Agricultural Land Used	186	145	Exclusion of missing values
Murdock and White (1969)		Communality of Land Rights	186	88	Exclusion of missing values
Comparative Constitutions Project	CCP	Transfer Property			
Elkins et al. (2009)		Own Property			
		Testate Property			
		Inherit Property			
		Index of Property Rights			
World Bank Project	-	World bank Project Rating		18,763	
AidData (2017)					
Armed Conflict Location &	ACLED	Number of Conflict Events			
Event Data Project		Land-Related Conflicts			
(Raleigh et al. 2010)					
Institutional Profiles Database	IDP	Land-Related Conflicts	95	95	Not Applicable
French Ministry for the Economy and Finance (2016)					
IPUMS Demographic and Health Survey	IPUMS DHS	Wealth Score			
Boyle et al. (2022)					
Worldwide Governance Indicators	WGI	Rule of Law Score			
Kaufmann and Kraay (2023)					

Appendix B. Theoretical Framework

In this section, we detail the economic model for how fallowing lengths impacts property right choices that guide the empirical results. In the model, fallowing requirements lead to higher protection costs. These costs could be paid individually (in private land rights) or jointly (in communal land rights). Communal protection has returns to scale but also involves the potential to free ride. We discuss the model setup, payoffs, and predictions below.

B.1. Model structure

1. Fallowing requirement, $f \in [0,1]$, is given by nature. It is exogenous and perfectly observable to all citizens. The fallowing requirement f represents the fraction of land that must be kept fallow each period. The rest of the land $1-f$ can be cultivated and provides the same cultivation payoff c irrespective of f.[1]

2. Citizens are part of a property rights regime – either private or communal. If communal property rights are the regime, an organizing cost k is paid by every citizen. Private and communal property rights are referred to as individual (I) and group monitoring (G) respectively.

3. Nature assigns each individual a type (monitoring ability) $e_i \in [0,1]$ to every citizen $i \in [0,1]$ (a continuum of citizens). Monitoring ability e is a joint-uniform distribution in [0, 1]. Individuals know only their own type and the joint distribution from which types are realized.[2]

4. In either property rights regime, every citizen plays simultaneously and has two options – to monitor $(a_i = 1)$ or not $(a_i = 0)$. If citizens choose to monitor, they pay a monitoring cost dependent on their type e_i. Higher the type e_i, higher the monitoring cost. The monitoring

[1]This is intentional since FAO models don't show that land with higher (lower) fallowing periods are less (more) productive on average if the land is being cultivated.

[2]The mapping $e()$ of individual $i \in [0,1]$ to monitoring type $t \in [0,1]$ is one-to-one, and onto. Let $p_i(t)$ be the probability of individual i being assigned type t. Formally,

$$\forall i,j \in [0,1], p_i(t) = p_j(t)$$
$$\forall i,j \in [0,1], e(i) = e(j) \implies i = j$$
$$\forall t \in [0,1], \exists i \in [0,1] \text{ s.t. } e(i) = t$$

There will always be a distribution of monitoring abilities in the society. It is only unclear what an individual's ability is relative to others. For simplicity, we refer to $e(i)$ as e_i.

cost scales with f – the fallowing requirement: higher the fallowing requirements imply higher total monitoring cost ($e_i f$).

5. After citizens choose a_i, they cultivate their land and get a cultivation payoff c. However, with probability p, any individual's land gets attacked.
   - In the private regime, whether or not they can protect their land depends on their individual choice a_i. If $a_i = 1$, since the citizen already paid a monitoring cost fe_i, they successfully protect their land. If $a_i = 0$, the citizen did not pay a monitoring cost and they lose the cultivation payoff c. The payoff from $a_i = 1$ is $c - fe_i$, and from $a_i = 0$ is $c - pc$.
   - In the communal regime, whether or not they can protect their land depends on their individual choice a_i and others' choices ($\int_{i=0}^{1} a_i di$). The communal regime has a returns-to-scale component to group-monitoring. If the fraction of people monitoring is greater than or equal to β, group-monitoring is successful and everybody's land is protected. Also, if group-monitoring is successful, the cost of monitoring gets halved to $\frac{fe_i}{2}$ for all the people that chose to group-monitor. There is an incentive to free-ride in the communal regime because if group-monitoring is a success, everybody's land is protected even if only some pay the individual monitoring cost in group-monitoring – $\frac{fe_i}{2}$. The payoff from $a_i = 1$ is $c - \frac{fe_i}{2} - k$ if group-monitoring is a success, and $c - fe_i - k$ if group-monitoring is a failure. The payoff from $a_i = 0$ is $c - k$ if group-monitoring is a success, and $c - pc - k$ if group-monitoring is a failure.

B.2. Payoffs

- Private regime payoffs

$$\begin{cases} \underbrace{c}_{1} - \underbrace{fe_i}_{2} & a_i = 1 \\ \underbrace{c}_{1} - \underbrace{pc}_{3} & a_i = 0 \end{cases}$$

- Communal regime payoffs

$$\begin{cases} \underbrace{c}_{1} - \underbrace{fe_i}_{2} + \underbrace{\mathbb{1}\left(\int_0^1 a_i di \geq \underbrace{\beta}_{7}\right) \times \frac{fe_i}{2}}_{4} - \underbrace{k}_{6} & a_i = 1 \\ \underbrace{c}_{1} - \underbrace{pc}_{3} + \underbrace{\mathbb{1}\left(\int_0^1 a_i di \geq \underbrace{\beta}_{7}\right) \times pc}_{5} - \underbrace{k}_{6} & a_i = 0 \end{cases}$$

$$f, \beta \in [0,1];\ c, k \geq 0; e \sim U[0,1]$$

Explanation for terms in payoffs:

1. Cultivation payoff
2. Monitoring cost
3. Probability of attack
4. Returns-to-scale halving monitoring cost
5. Returns-to-scale allowing free-riding
6. Organizing cost
7. Fraction of people required for success of group-monitoring

B.3. Analysis

We compare choices and ultimate payoffs across the two types of private regimes, private (I) or communal (G). In both regimes, citizens (with types) choose to monitor or not based on their type-dependent payoff. To compare payoffs across regimes, given that types are realized after regime choice, we compare the ex-ante expected payoffs in equilibrium – same for every citizen – for both regimes for a given f.[3]

[3] Alternatively, one can have individuals chose on regimes prior to types being assigned. In other words, they solve the game backwards and choose the regime with the higher expected payoff (which will be the same for all individuals prior to types being assigned). To simplify, we directly compare ex-ante expected payoffs instead of specifying this additional step.

B.3.1. Private Regime: Expected Payoffs

Given the payoffs above, individuals in the private regime will choose to monitor ($a_i = 1$) only if $e_i > \frac{pc}{f}$. Thus:

- The expected payoff in the private regime if $\frac{pc}{f} < 1$ is

$$
\begin{aligned}
&= \int_0^{\frac{pc}{f}} (c - fe_i)de_i + \int_{\frac{pc}{f}}^1 (c - pc)de_i \\
&= c\left(\frac{pc}{f}\right) - \frac{f}{2}\left(\frac{pc}{f}\right)^2 + c\left(1 - \frac{pc}{f}\right) - pc\left(1 - \frac{pc}{f}\right) \\
&= c - pc + \frac{(pc)^2}{2f}
\end{aligned}
$$

- The expected payoff in the private regime if $\frac{pc}{f} \geq 1$ is

$$
\begin{aligned}
&= \int_0^1 (c - fe_i)de_i \\
&= c - \frac{f}{2}
\end{aligned}
$$

The expected payoff in the private regime is decreasing in f in both cases:

$$
\begin{aligned}
&= c - \frac{f}{2} && f \leq pc \\
&= c - pc + \frac{(pc)^2}{2f} && f > pc
\end{aligned}
$$

B.3.2. Communal Regime: Expected Payoffs

To simplify the analysis, we group people in three.

- Group I is the set of people such that $c - fe_i \geq c - pc \implies e_i \in [0, \frac{pc}{f}]$. These people are willing to do individual monitoring regardless of whether group-monitoring is a success or failure.

- Group II is the set of people such that $c - fe_i < c - pc \ \wedge \ c - fe_i/2 \geq c - pc \implies e_i \in (\frac{pc}{f}, \frac{2pc}{f}]$. These people can help in group-monitoring (if they expect enough people to monitor, i.e. the share of people monitoring is $> \beta$) but would choose to not do individual monitoring (if they expect too few people to monitor).

- Group III is the set of people that cannot do either group-monitoring or group-monitoring because it is too costly for them. $c - \frac{fe_i}{2} < c - pc \implies e_i \in (\frac{2pc}{f}, 1]$ [4]

With the notation for different groups above, we solve the model:

- Suppose $\beta \leq \frac{2pc}{f}$. In this case, there exist multiple Nash equilibria of the one-shot game where group-monitoring is a "success" (i.e., $> \beta$ share of individuals choose $a_i = 1$). In any equilibrium, Group III always chooses $a_i = 0$. In equilibria where group-monitoring is a success, any set of 'size'/measure β consisting of members from Group I or II chooses group-monitoring. The rest of the people from Group I and II choose to free-ride.

  Why is it a Nash equilibrium? In this equilibirum, for people who are choosing group-monitoring, they know the actions of everybody and they do not wish to deviate because group-monitoring fails without them. There is no incentive to deviate because $c - \frac{fe_i}{2} - k \geq c - pc - k$. Also, the people who are free-riding cannot do better than a payoff of $c - k$. In the most efficient Nash equilibrium, the lowest β choose group-monitoring and everybody else free-rides.[5] We assume that the most efficient equilibrium is chosen, because it is the risk-dominate equilibrium. (We discuss this in more detail in section B.4.) The expected payoff in equilibrium is

$$= \int_0^\beta \left(c - \frac{fe_i}{2} - k\right) de_i + \int_\beta^1 (c-k) de_i = c - k - \frac{\beta^2 f}{4}$$

- Suppose $\beta > \frac{2pc}{f}$. In this case, there exists no Nash equilibrium of the one-shot game where group-monitoring is a success. Group I chooses monitoring and Groups II and III choose free-riding/$a_i = 0$. The expected payoff in equilibrium is

$$\begin{aligned} &= \int_0^{\frac{pc}{f}} (c - fe_i) de_i + \int_{\frac{pc}{f}}^1 (c - pc) de_i - k \\ &= c - pc + \frac{(pc)^2}{2f} - k \end{aligned}$$

Thus, the expected payoffs in the communal regime are also decreasing in f

$$\begin{aligned} &= c - k - \frac{\beta^2 f}{4} && f \leq \frac{2pc}{\beta} \\ &= c - pc + \frac{(pc)^2}{2f} - k && f > \frac{2pc}{\beta} \end{aligned}$$

In what follows, we focus on equilibria where free riding is possible. That is, we assume that $f \leq \frac{2pc}{\beta}$.

[4]Of course, it need not be the case that all the groups are present for every possible set of parameter values. For example, $\frac{2pc}{f} > 1 \implies$ Group III does not exist.

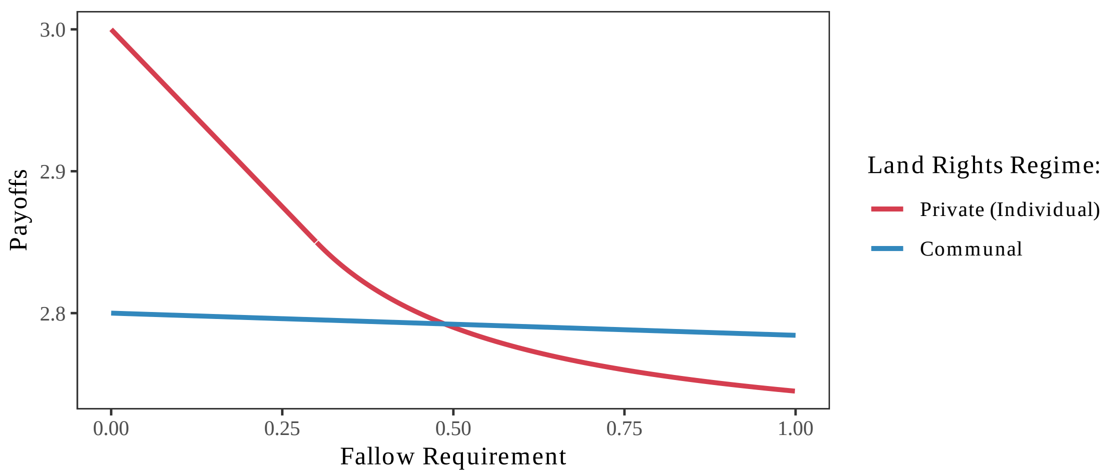
[5]Efficiency is defined using the sum of all individuals' payoffs, or equivalently, the ex-ante expected payoff for any individual for a regime.

B.3.3. *Model Predictions*

Prediction 1: There is an increasing preference for communal land rights as f increases

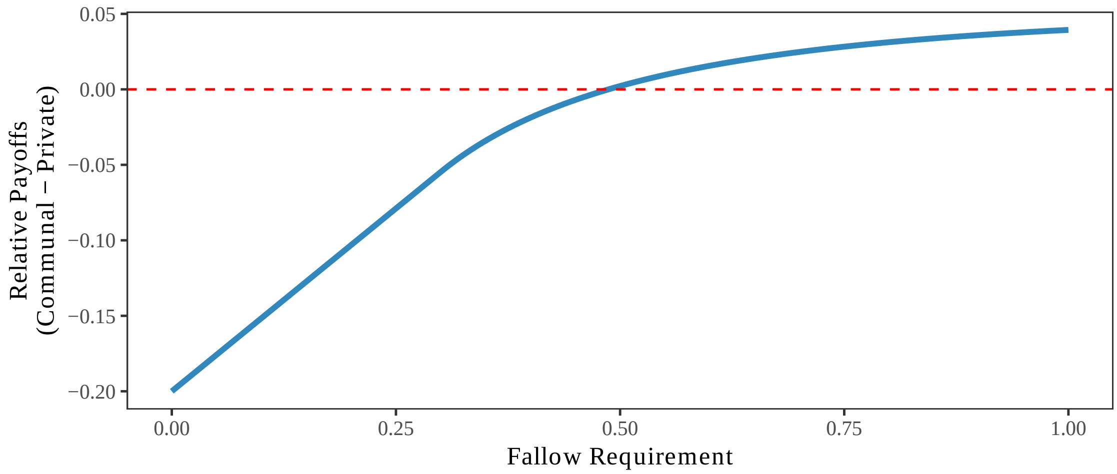
Figure B1 presents the expected payoffs as a function of f for individuals in the private regime vs the communal regime and Figure B2 presents the difference in expected payoffs between communal and private regimes under specific parameter values for (p, β, c, k).[6] We find that, for high enough fallowing requirements f, individuals' expected payoffs are higher in the communal regime than in the private regime.

Figure B1
Payoffs as a Function of Fallow Requirement f



[6]The plots assume $p = 0.10$, $\beta = 0.25$, $c = 3$, and $k = 0.2$.

Figure B2
Relative Payoff of Communal over Private Land Rights
as a Function of Fallow Requirement f



Prediction 2: There is an increasing preference for communal land rights as p increases

- If $pc > 1 \implies p > \frac{1}{c}$,

  Relative payoff (communal - private) as a function of f is

  $$= -k + \left(\frac{2-\beta^2}{4}\right) f \qquad \forall f \in [0,1]$$

  and $\forall p > \frac{1}{c}$ relative payoff is independent of p

- If $pc \leq 1 \implies p \leq \frac{1}{c}$,

  Relative payoff as a function of f is

  $$\begin{aligned} &= -k + \left(\frac{2-\beta^2}{4}\right) f && f \leq pc \\ &= -k + pc - \frac{(pc)^2}{2f} - \frac{\beta^2}{4} f && 1 \geq f \geq pc \end{aligned}$$

  Relative payoff as a function of p is

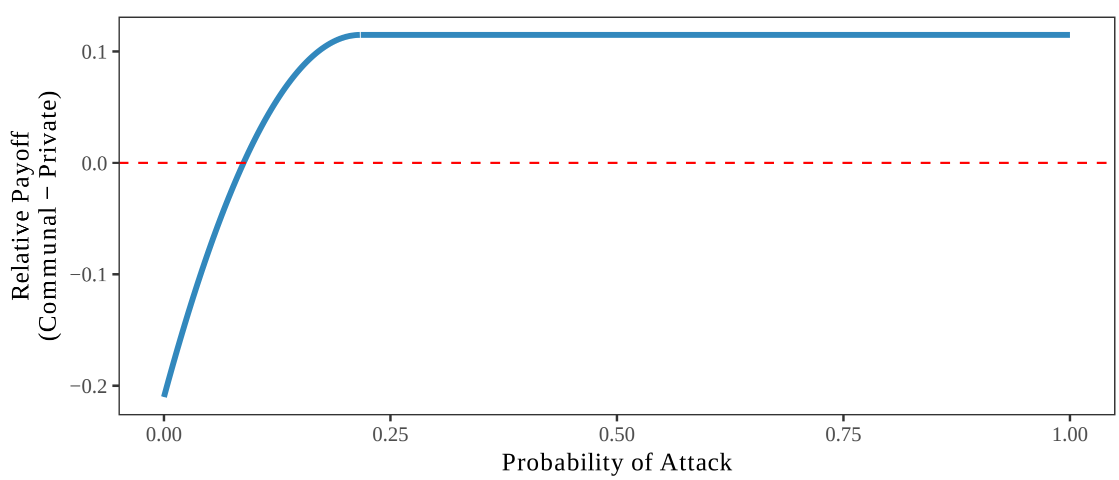
  $$\begin{aligned} &= -k + pc - \frac{(pc)^2}{2f} - \frac{\beta^2}{4} f && p \leq \frac{f}{c} \\ &= -k + \left(\frac{2-\beta^2}{4}\right) f && \frac{1}{c} \geq p \geq \frac{f}{c} \end{aligned}$$

Thus, relative payoff $R(p)$ as a function of p is,

$$
\begin{aligned}
&= -k + pc - \frac{(pc)^2}{2f} - \frac{\beta^2}{4}f && p \leq \frac{f}{c} \\
&= -k + \left(\frac{2-\beta^2}{4}\right)f && p \geq \frac{f}{c} \\
R'(p) &= c - \frac{pc^2}{f} && p \leq \frac{f}{c} \\
&= c\left(1 - \frac{pc}{f}\right) \\
&\geq 0 \iff \frac{pc}{f} \leq 1 \text{ which is always true } \forall\, p \leq \frac{f}{c}
\end{aligned}
$$

Thus, $R(p)$ is an increasing function of p within the range $[0, \frac{f}{c}]$. This suggests that for a given combination of (f, β, c, k) as p – the probability of attack – increases, the preference for communal regime increases. Figure B3 shows the relative payoffs as a function of p.[7]

Figure B3
Relative Payoff of Communal over Private Land Rights
as a Function of Probability of Attack p



Prediction 3: Inequality is lower in the communal regime

We define inequality of payoffs in a regime $IE_r = \max(u_{ir}) - \min(u_{ir})$ where u_{ir} is the payoff of individual i of type e_i in regime r.

For individual rights, $IE_i = c - (c - pc) = pc$.

For communal rights, $IE_g = (c - k) - (c - \frac{f\beta}{2} - k) = \frac{\beta f}{2}$

[7]The plots assume $f = 0.65$ and, as before, $\beta = 0.25$, $c = 3$, and $k = 0.2$.

Our previous assumption that $\forall f \in [0,1]\ \beta \leq \frac{2pc}{f} \implies pc \geq \frac{\beta f}{2}$. This means that the communal regime reduces inequality by reducing the spread of possible payoffs.

B.4. Risk-dominant equilibrium choice as the efficient equilibrium

We briefly discuss why the risk-dominant equilibrium choice corresponds to the efficient equilibrium choice for group monitoring (where individuals with the lowest monitoring costs up to β perform the monitoring).

Consider a two player between types e_1 and e_2 such that both belong to either Group I or II – they can contribute in group-monitoring. Assume β is such that only one individual is sufficient for group-monitoring success. The below two-player game has payoffs similar to our model. $(a_1, a_2) = (1, 0)$ and (0, 1) are the two Nash equilibria. However, can we motivate the choice of one over the other?

Type e_2

Type e_1		$a_2 = 1$	$a_2 = 0$
	$a_1 = 0$	$c \quad , \quad c - \frac{fe_2}{2}$	$c - pc \quad , \quad c - pc$
	$a_1 = 1$	$c - \frac{fe_1}{2} \quad , \quad c - \frac{fe_2}{2}$	$c - \frac{fe_1}{2} \quad , \quad c$

Following the formal definition of risk dominance, in a two player game between types e_1, e_2 with $e_2 > e_1$, $(1,0) \succ (0,1)$ where $\succ$ stands for "risk-dominates". This is because $(1,0) \succ (0,1)$ if and only if the product of payoff deviations from (1, 0) is greater than the product of payoff deviations from (0, 1):

$$\left(-pc + \frac{fe_1}{2}\right)\left(-\frac{fe_2}{2}\right) > \left(-pc + \frac{fe_2}{2}\right)\left(-\frac{fe_1}{2}\right)$$
$$\frac{pcfe_2}{2} > \frac{pcfe_1}{2}$$
$$e_2 > e_1$$

If we extrapolate this logic to a continuum of types, every equilibrium where a lower type chooses $a_i = 1$ risk dominates the sister equilibrium where a higher type chooses $a_i = 1$ instead. Thus, it is plausible that in equilibrium, the lowest types in the set $[0, \beta]$ will choose $a_i = 1$ and the rest will free-ride to result in the most efficient Nash equilibrium.

Appendix C. Additional Tables and Figures

C.1. Additional Results: Robustness of Ethnographic Results

Table C1
Effect of Fallow Requirement on Communal Land Rights: Ordered Logit

	Dependent Variable: *Communality of Land Rights*					
	(1)	(2)	(3)	(4)	(5)	(6)
Communality of Land *Fallow Requirement*	0.127***	0.112**	0.095**	0.101**	0.115*	0.116**
	(0.046)	(0.050)	(0.044)	(0.047)	(0.064)	(0.057)
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	2.33	2.33	2.33	2.33	2.33	2.34
Pseudo R2	0.063	0.097	0.147	0.150	0.248	0.334
Observations	88	88	88	88	88	86

Notes: The unit of observation is a society in the Standard Cross Cultural Sample (SCCS). Robust standard errors in parentheses. The dependent variable *Communality of Land Rights* is a 1 to 3 categorical variable, where 1=land is predominantly private property, 2=land is partially communally used, and 3=communal land use rights only. Estimated using ordered logistic regression. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C.2. Additional Results: Other Ethnographic Variables

Table C2

Effect of Fallow Requirement & Land Suitability on Communal Land Rights

	Dependent Variable: *Communality of Land Rights*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	0.043^{***}	0.039^{***}	0.036^{***}	0.038^{***}	0.037^{**}	0.035^{**}
	(0.013)	(0.014)	(0.013)	(0.014)	(0.015)	(0.015)
	[0.007]	[0.007]	[0.007]	[0.007]	[0.006]	[0.004]
Land Suitability			−0.147	−0.105	0.120	0.297
			(0.349)	(0.357)	(0.362)	(0.348)
			[0.076]	[0.079]	[0.081]	[0.066]
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	2.33	2.33	2.33	2.33	2.33	2.34
Adjusted R2	0.098	0.113	0.130	0.114	0.200	0.267
Beta Coef.	0.329	0.296	0.270	0.287	0.278	0.268
Observations	88	88	88	88	88	86

Notes: The unit of observation is a society in the Standard Cross Cultural Sample (SCCS). Robust standard errors in parentheses and Conley (1999) standard errors calculated using a 100 km cut-off window are presented in brackets. The dependent variable *Communality of Land Rights* is a 1 to 3 categorical variable, where 1=land is predominantly private property, 2=land is partially communally used, and 3=communal land use rights only. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

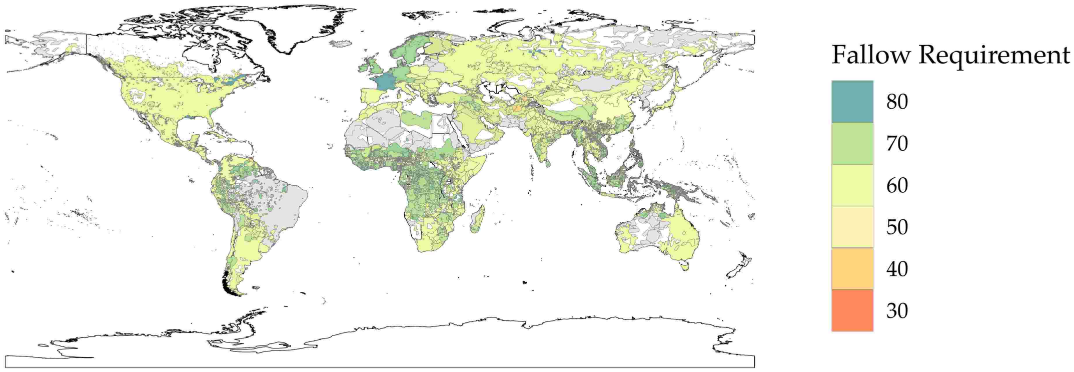
Figure C1
Fallow System, Agricultural Mode, and Institutions

FALLOW SYSTEMS				AGRICULTURAL TECHNIQUES				SOCIO-ECONOMIC STRUCTURES			
AGRICULTURAL STAGE	YEARS CULTIVATION	YEARS FALLOW	FALLOW LANDSCAPE	AGRICULTURAL TOOLS	FERTILISATION METHODS	LAND IMPROVEMENTS	LABOUR INPUT	LAND TENURE	SETTLEMENT FORM & TRANSPORT NETWORK	DIVISION OF LABOUR & EXCHANGE	SOCIAL & POLITICAL ORGANISATION
MULTI-CROPPING	2—3 per year	Negligible	None	Mechanised equipment including tractors	Chemical fertilisers. Green manuring. Marling. Composts. Silt etc.	Irrigation, Terracing	Long hours of regular, daily work	Permanent ownership	As below, more intensive, more feeder roads	Out-migration	Shift of power to (remote) urban centre
ANNUAL CROPPING	Yearly	Several months	None	As in multi-cropping	As in multi-cropping	Irrigation (in dry regions), Terracing		Peasant ownership, small farms (freehold)	Urbanised to some extent	Long work hours, greater division of labour, landless/wage labourer group	Differentiated forms of social organisation, domain over land
SHORT FALLOW	1—2	1—2	Grass	Hoe, plough, drought animals	Manure from droppings of draught animals	Rare	Pronounced seasonal peak	Individual usufructory tenure, pledging to retain control	Permanent settlements, roads	Some professional artisans and traders	Differentiated forms of social organisation, domain over people
BUSH FALLOW	From 1—2 to 6—8	6—10	Bush	Hoe, axe, fire	Ash, supplemented by burnt or unburnt vegetable materials from outside	None		Specific right to cultivate a given plot subject to authority	Stable and larger settlements	Some division of labour, village markets with part-time artisans	A little more central authority
FOREST FALLOW	1—2	20—25	Forest	Digging stick axe fire	Ash in situ	None	Few hours of irregular work	General right to cultivate land, no permanent occupation of plots	Unstable, dispersed settlements, trails	Rudimentary	No central authority

Fig. 1. Boserup's Theory of Agricultural Change. (Modified after an unpublished paper by P. Porter.)

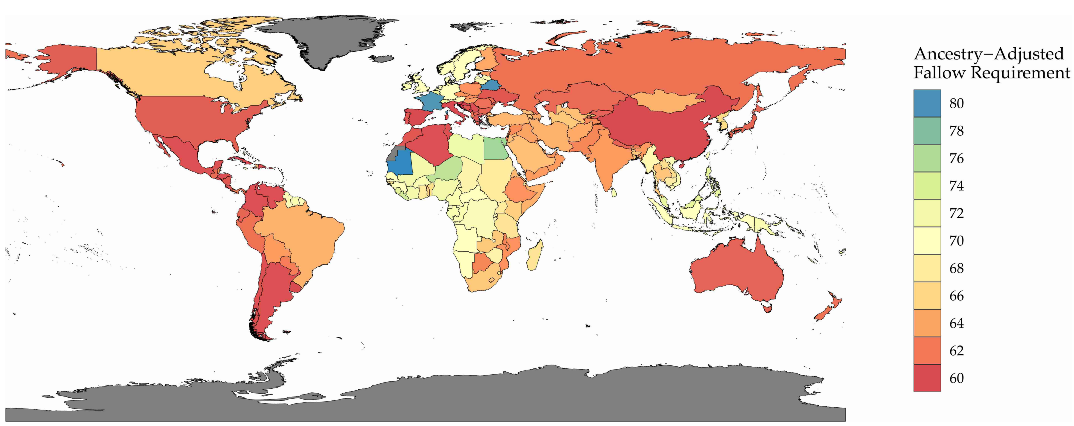
Figure shows Datoo (1978)'s summary of Boserup (1965) theory.

Figure C2
Fallow Requirements Across Language Groups



Notes: Map presents the fallowing requirement – percentage of time during the fallow-cropping cycle that land must be under fallow – for the maximum caloric suitability crop for each language group in the Ethnologue linked to the EA (Giuliano and Nunn 2018). Grey areas represent groups where the land is not suitable for agriculture.

Figure C3
Ancestry-Adjusted Fallow Requirements



Notes: Map presents the ancestry-adjusted fallowing requirement – percentage of time during the fallow-cropping cycle that land must be under fallow – for the maximum caloric suitability crop for each country using the methodology from (Giuliano and Nunn 2018). Grey areas represent groups where the land is not suitable for agriculture.

Table C3
Effect of Fallow Requirement on Intensity of Agricultural Production

	Dependent Variable: *Intensity of Agriculture*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	-0.052^{**}	-0.058^{***}	-0.052^{**}	-0.057^{***}	-0.035	-0.027
	(0.023)	(0.020)	(0.021)	(0.022)	(0.025)	(0.027)
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	3.47	3.47	3.47	3.47	3.47	3.46
Adjusted R2	0.029	0.199	0.194	0.186	0.207	0.490
Beta Coef.	-0.186	-0.206	-0.186	-0.203	-0.123	-0.094
Observations	167	167	167	167	167	154

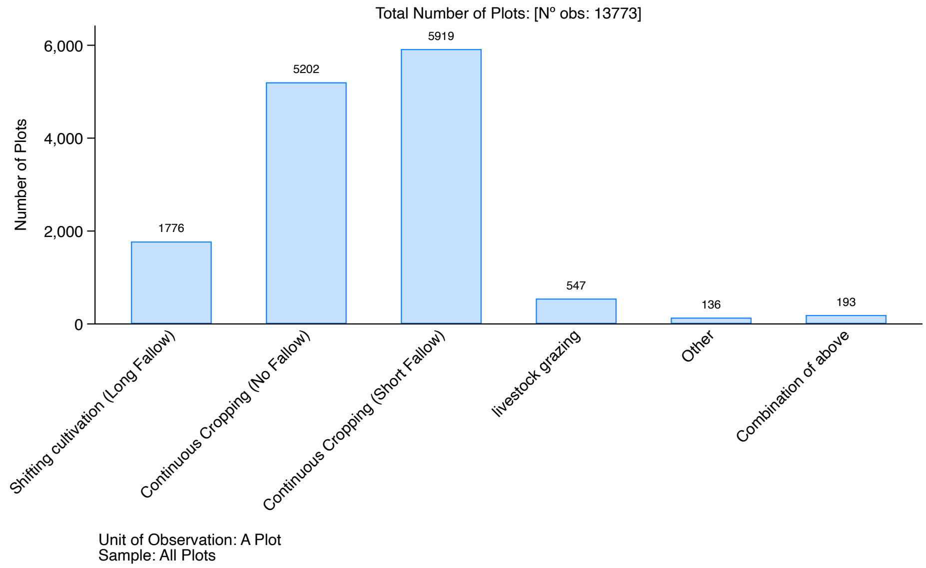
Notes: The unit of observation is a society in the Standard Cross Cultural Sample (SCCS). Robust standard errors in parentheses. The dependent variable *Intensity of Agriculture* is a 1 to 6 categorical variable, with higher values related to more intensive agricultural production. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C4
Effect of Fallow Requirements on Jurisdictional Hierarchy

	Dependent Variable: *Extent of Jurisdictional Hierarchy*					
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: SCCS Societies					
Fallow Requirement	−0.026	−0.021	0.009	0.015	0.031*	0.026
	(0.016)	(0.013)	(0.016)	(0.017)	(0.017)	(0.016)
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	2.14	2.14	2.14	2.14	2.14	2.14
Adjusted R2	0.009	0.247	0.274	0.288	0.316	0.456
Beta Coef.	-0.124	-0.097	0.040	0.071	0.145	0.118
Observations	165	165	165	165	165	152
	Panel B: EA Societies					
Fallow Requirement	−0.005**	−0.005**	−0.004	−0.001	−0.001	0.000
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Continent FEs	N	Y	Y	Y	Y	Y
Geography Controls	N	N	Y	Y	Y	Y
Disease Controls	N	N	N	Y	Y	Y
Crop FEs	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	0.24	0.24	0.24	0.24	0.24	0.24
Adjusted R2	0.004	0.204	0.221	0.247	0.251	0.290
Beta Coef.	-0.067	-0.061	-0.049	-0.010	-0.007	0.001
Observations	1,023	1,023	1,023	1,023	1,023	1,005

Notes: The unit of observation is a society in the Standard Cross Cultural Sample (SCCS) in Panel A or the Ethnographic Atlas (EA) in Panel B. Robust standard errors in parentheses. The dependent variable *Extent of Jurisdictional Hierarchy* measures the degree of jurisdictional hierarchy beyond the local level, ranging from 0=no levels, to 5=four levels. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure C4
Distribution of Farming Systems *An agricultural survey for more than 9,500 African households survey* Sample (Waha et al. 2016)



C.3. Additional Results: Constitutions

The results in Section 4.3 show that longer fallowing requirements are associated with a historically higher prevalence of communal land rights and a lower prevalence of private land rights. We now explore whether this relationship continues to hold in more contemporary measures of land rights. We use data from the Comparative Constitutions Project (hereafter CCP) (Elkins et al. 2009). The CCP database is a systematic codification of the characteristics (form and content) of all the world's constitutions, both past and present. The database covers country-year pairs for most independent countries since 1789. In addition, the database records all changes made to the constitution of a country over time (amendments, new constitutions, reinstatement, interim constitution). In the following analysis, the unit of observation is the constitution in force in a given country on December 31st of a given year since that country has had a written constitution. We examine five different measures of property rights; each measure a different dimension of property rights. We define indicator variables equal to one if a constitution grants individual rights to: (1) transfer property, (2) own property, (3) testate property (right to give property at death), and (4) inherit property. We view each of these measures as proxies for stronger private property rights. Additionally, we combine all four measures in a index for private property rights that is computed as the average of the other four variables.

Table C5 presents the estimates for the relationship between these outcomes and the ancestry-adjusted fallowing requirement measure (described in Section 3.3). Even columns only condition on continent fixed-effects, while odd columns also include the same ancestry-adjusted geographic, disease and ethnographic covariates that are in Table 4. We find that higher ancestral fallowing requirements have a negative and statistically significant relationship with most of these measures of individual property rights. The exception is "inherit property", where the coefficient is negative but not significant. For the index of property rights (columns (9) and (10)), a 10 percentage point increase in the ancestry-adjusted fallow requirement is associated with a 1.4% reduction in the index of property rights measure. These results provide evidence that ancestral fallowing requirements continue to shape the organization of property rights today.

Table C5
Fallowing Requirements and Property Rights in National Constitutions

	Dependent Variable: *Right to [...] in Constitution*								*Index of*	
	Transfer Property		*Own Property*		*Testate Property*		*Inherit Property*		*Property Rights*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fallow Requirement	-0.017^{***}	-0.015^{**}	-0.012^{**}	-0.018^{***}	-0.008^{**}	-0.010^{*}	-0.011	-0.013	-0.014^{***}	-0.017^{***}
	(0.005)	(0.007)	(0.006)	(0.007)	(0.004)	(0.005)	(0.009)	(0.009)	(0.003)	(0.004)
Continent FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Disease Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Crop FEs	N	Y	N	Y	N	Y	N	Y	N	Y
Ethnographic Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Outcome Mean	0.22	0.22	0.82	0.82	0.10	0.10	0.26	0.26	0.35	0.35
Adjusted R2	0.164	0.209	0.159	0.232	0.054	0.100	0.137	0.215	0.132	0.196
Beta Coef.	-0.212	-0.194	-0.168	-0.238	-0.146	-0.179	-0.136	-0.153	-0.297	-0.360
Observations	8,262	8,262	8,098	8,098	8,362	8,362	8,153	8,153	8,707	8,707
Clusters	123	123	123	123	122	122	122	122	124	124

Notes: OLS estimates with robust standard errors clustered at the country level are reported in parentheses. The unit of observation is a country's constitution in a given year. Data are from the *Comparative Constitutions Project* (Elkins et al. 2009). Across specifications, outcomes are dummy variables equal to one if a constitution grants rights to (1-2) transfer property, (3-4) own property, (5-6) testate property, and (7-8) inherit property. The outcome variable in columns 9 and 10 is a property rights index computed as the average of the other four variables. Odd columns control for ancestry-adjusted geographic characteristics (latitude, longitude, elevation, land suitability, malaria) and ethnographic controls (settlement complexity, mean size of local community, political complexity, historical reliance on pastoralism and historical reliance on agriculture). Every specification controls for the log number of years since a constitution was first written, the total number of amendments made to each constitution, year dummies and continent fixed effects. The sample is restricted to countries where all groups practiced agriculture to varying degrees and for which information on fallow time is available. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In Table C6 we include additional control variables. Because constitutions of previously colonized countries may be influenced by former colonizers (La Porta et al. 2008) we include controls for the legal origin of the law. We also show our results are robust to controlling population density in 1500 and GDP per capita in 2000.

Table C6
Fallowing Requirements and Property Rights in National Constitutions: Endogenous Controls

	Dependent Variable: Right to [...] in Constitution								Index of	
	Transfer Property		*Own Property*		*Testate Property*		*Inherit Property*		*Property Rights*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fallow Requirement	-0.018^{***}	-0.012	-0.014^{*}	-0.019^{*}	-0.007	-0.008	-0.002	-0.008	-0.012^{***}	-0.016^{***}
	(0.007)	(0.008)	(0.009)	(0.010)	(0.004)	(0.006)	(0.008)	(0.009)	(0.004)	(0.005)
Continent FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Disease Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Crop FEs	N	Y	N	Y	N	Y	N	Y	N	Y
Ethnographic Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Outcome Mean	0.23	0.23	0.82	0.82	0.11	0.11	0.27	0.27	0.36	0.36
Adjusted R2	0.171	0.232	0.192	0.247	0.065	0.116	0.309	0.358	0.156	0.217
Beta Coef.	-0.215	-0.149	-0.190	-0.245	-0.114	-0.136	-0.024	-0.092	-0.249	-0.317
Observations	7,545	7,545	7,358	7,358	7,597	7,597	7,418	7,418	7,942	7,942
Clusters	109	109	109	109	108	108	108	108	110	110

Notes: OLS estimates with robust standard errors clustered at the country level are reported in parentheses. The unit of observation is a country's constitution in a given year. Data are from the *Comparative Constitutions Project* (Elkins et al. 2009). Across specifications, outcomes are dummy variables equal to one if a constitution grants rights to (1-2) transfer property, (3-4) own property, (5-6) testate property, and (7-8) inherit property. The outcome variable in columns 9 and 10 is a property rights index computed as the average of the other four variables. Odd columns control for ancestry-adjusted geographic characteristics (latitude, longitude, elevation, land suitability, malaria) and ethnographic controls (settlement complexity, mean size of local community, political complexity, historical reliance on pastoralism and historical reliance on agriculture). Every specification controls for the log number of years since a constitution was first written, the total number of amendments made to each constitution, year dummies and continent fixed effects. The sample is restricted to countries where all groups practiced agriculture to varying degrees and for which information on fallow time is available. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C.4. Additional Results: Nighttime Light Density

Table C7
Effect of Fallow Requirement on Night Light Density

	Dependent Variable: *Log(Night Light Density + 1)*					
	(1)	(2)	(3)	(4)	(5)	(6)
Fallow Requirement	-0.003	-0.001	-0.001	-0.001	0.001	0.001
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]
Country FEs	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	Y	Y	Y	Y
Disease Controls	N	N	Y	Y	Y	Y
Crop FEs	N	N	N	Y	Y	Y
Ethnographic Controls	N	N	N	N	Y	Y
Population Controls	N	N	N	N	N	Y
Outcome Mean	0.22	0.22	0.22	0.22	0.22	0.22
Adjusted R2	0.318	0.332	0.332	0.334	0.355	0.355
Beta Coef.	-0.026	-0.012	-0.010	-0.012	-0.007	-0.006
Observations	3,825	3,825	3,825	3,825	3,734	3,734
Clusters	143	143	143	143	142	142

Notes: The unit of observation is an ethnologue group. Standard errors clustered by ethnologue group in parentheses. The dependent variable *Log(Night Light Density + 1)* is defined as the log of the mean night light intensity plus one in the VIIRS data per ethnologue group in 2018. *Geography Controls* include centroid longitude, centroid latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. *Population Controls* includes log population density for each group. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

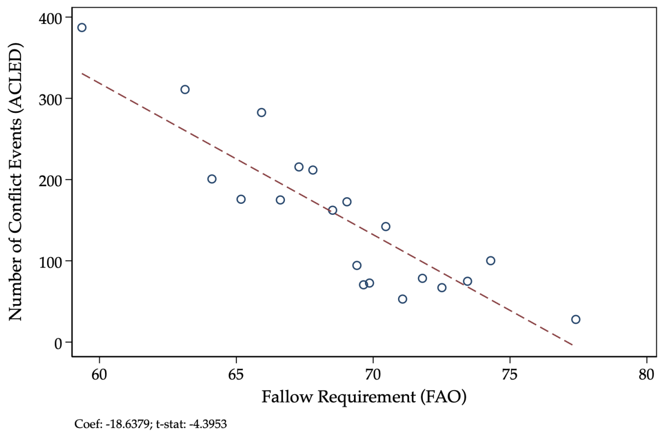
C.5. Additional Results: Income Inequality and Conflict

Table C8
Effect of Fallow Requirement on Income and Inequality:
Demographic Health and Surveys (DHS)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable:					
	Panel A: Dep. Var.: Standard Deviation of Wealth Scores					
Fallow Requirement	-0.106	-0.273^{**}	-0.250^{**}	-0.260^{**}	-0.273^{**}	-0.291^{*}
	(0.173)	(0.113)	(0.117)	(0.126)	(0.123)	(0.148)
Country-Year FEs	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	Y	Y	Y	Y
Disease Controls	N	N	Y	Y	Y	Y
Crop FEs	N	N	N	Y	Y	Y
Population	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	60.31	60.33	60.33	60.33	60.33	60.68
Outcome SD	72.18	72.21	72.21	72.21	72.21	74.20
Adjusted R2	0.609	0.619	0.619	0.619	0.619	0.621
Beta Coef.	-0.007	-0.018	-0.016	-0.017	-0.018	-0.018
Observations	82,451	82,371	82,371	82,371	82,371	77,430
Clusters	117	117	117	117	117	117
	Panel B: Inter-Quartile Range of Wealth Scores					
Fallow Requirement	-0.212	-0.407^{**}	-0.370^{**}	-0.400^{**}	-0.418^{**}	-0.423^{*}
	(0.248)	(0.171)	(0.176)	(0.192)	(0.186)	(0.225)
Country-Year FEs	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	Y	Y	Y	Y
Disease Controls	N	N	Y	Y	Y	Y
Crop FEs	N	N	N	Y	Y	Y
Population	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	72.56	72.59	72.59	72.59	72.59	72.83
Outcome SD	95.20	95.24	95.24	95.24	95.24	97.65
Adjusted R2	0.527	0.537	0.537	0.538	0.538	0.541
Beta Coef.	-0.011	-0.021	-0.019	-0.021	-0.022	-0.021
Observations	85,017	84,937	84,937	84,937	84,937	79,996
Clusters	122	122	122	122	122	122
	Panel C: Average Wealth Score					
Fallow Requirement	-0.696	-0.585	-0.504	-0.503	-0.682	-0.630
	(1.134)	(0.482)	(0.494)	(0.536)	(0.504)	(0.545)
Country-Year FEs	Y	Y	Y	Y	Y	Y
Geography Controls	N	Y	Y	Y	Y	Y
Disease Controls	N	N	Y	Y	Y	Y
Crop FEs	N	N	N	Y	Y	Y
Population	N	N	N	N	Y	Y
Ethnographic Controls	N	N	N	N	N	Y
Outcome Mean	0.43	0.45	0.45	0.45	0.45	2.16
Outcome SD	156.69	156.76	156.76	156.76	156.76	160.13
Adjusted R2	0.017	0.243	0.243	0.244	0.245	0.241
Beta Coef.	-0.022	-0.019	-0.016	-0.016	-0.022	-0.019
Observations	85,017	84,937	84,937	84,937	84,937	79,996
Clusters	122	122	122	122	122	122

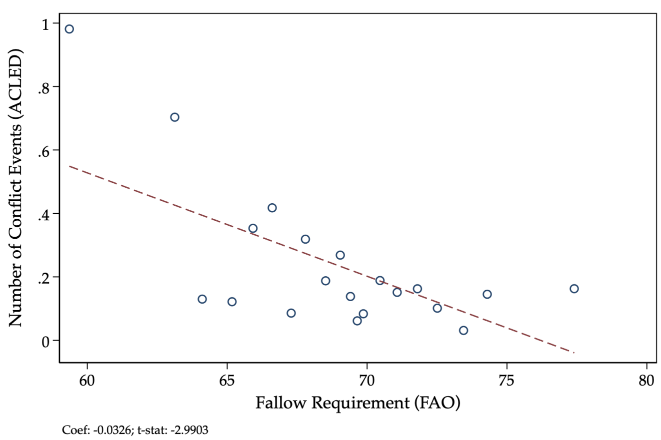
Notes: The unit of observation is a DHS cluster. Standard errors in parentheses are two-way clustered by country-survey wave and ethnologue group. In Panel A, the outcome variable is the standard deviation of the DHS wealth score. In Panel B, the outcome variable is the inter-quartile range of the DHS wealth score. In Panel C, the outcome variable is the average DHS wealth score. All regressions control for cluster size and rural-urban status. *Geography Controls* include cluster longitude, cluster latitude, average rainfall, average temperature, elevation, plough suitability, and agricultural suitability. *Disease Controls* include malaria suitability and tsetse suitability. *Crop FEs* are fixed effects for the maximum caloric suitability crop in each society. *Population* includes log population for each ethnologue group. *Ethnographic Controls* includes the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development for the ethnologue group of each DHS cluster. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure C5
Fallowing Requirements & Conflict: All Conflicts



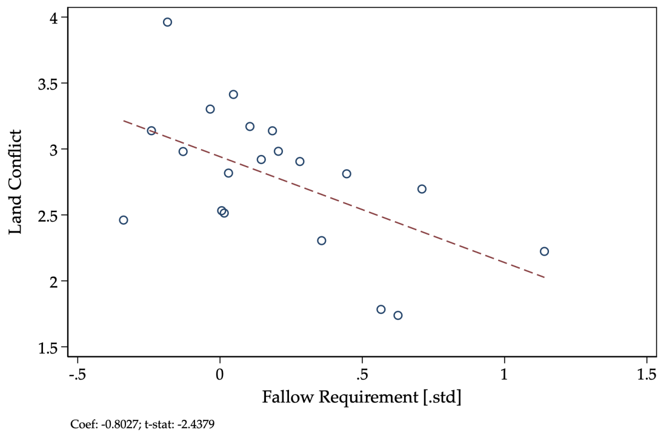
Notes: The figure presents binscatters between the fallowing requirements and the number of conflicts in the ACLED data. The unit of observation is a ethnologue group. Regressions control for latitude, longitude, and continent fixed-effects. The bottom-right of each figure presents the estimated bivariate coefficient and t-statistic. Standard errors are clustered at the ethnologue group level.

Figure C6
Fallowing Requirements & Conflict: Land-Related Conflicts



Notes: The figure presents binscatters between the fallowing requirements and the number of land-related conflict events in the ACLED data. The unit of observation is a ethnologue group. Regressions control for latitude, longitude, and continent fixed-effects. The bottom-right of each figure presents the estimated bivariate coefficient and t-statistic. Standard errors are clustered at the ethnologue group level.

Figure C7
Fallowing Requirements & Land-Related Conflict: IPD Data



Notes: The figure presents binscatters between the fallowing requirements and the severity of land-related conflict in rural areas in the IPD data. The unit of observation is a country. Land conflict is a 0 to 4 categorical variable, where 0 = No land-related conflict in rural areas, and 4 = Serious land-related conflict in rural areas. Regressions control for latitude, longitude, and continent fixed-effects. The bottom-right of each figure presents the estimated bivariate coefficient and t-statistic. Standard errors are clustered at the country level.

Appendix D. Resilience to Rainfall Shocks

Table D1
Negative Rainfall Growth and Conflict

	Dependent Variable: Conflict						
	UCDP			ACLED			
	ln(Any)	ln(State)	ln(Non-State)	ln(Any)	ln(State)	ln(Non-State)	ln(Land)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Negative Rainfall Growth (t)	0.6123**	0.5452**	0.0672**	2.3362**	1.1769*	1.1672***	0.0399**
	(0.274)	(0.257)	(0.029)	(1.027)	(0.681)	(0.386)	(0.019)
Negative Rainfall Growth (t) $\times$ *Fallow Requirement*	$-$0.0069**	$-$0.0061**	$-$0.0008**	$-$0.0291**	$-$0.0144*	$-$0.0148***	$-$0.0006**
	(0.003)	(0.003)	(0.000)	(0.013)	(0.009)	(0.005)	(0.000)
Cell FEs	Y	Y	Y	Y	Y	Y	Y
Year FEs	Y	Y	Y	Y	Y	Y	Y
Outcome Mean	0.193	0.174	0.019	1.218	0.671	0.547	0.022
Observations	1,214,112	1,214,112	1,214,112	234,764	234,764	234,764	234,764
Climate-Zone-Year Clusters	864	864	864	410	410	410	410
Cell Clusters	37,941	37,941	37,941	27,701	27,701	27,701	27,701

Notes: The unit of observation is a .5-degree $\times$ .5-degree grid-cell and year. Standard errors are clustered by climate zone year and .5-degree $\times$ .5-degree grid-cell. Across columns the outcome variables are continuous variables measuring the number of violent conflict at time $ingridcell$. The data is from the Uppsala Conflict Data Program (UCDP) in columns (1) to (3) and from the Armed Conflict Location & Event Data Project (ACLED) in columns (4) to (7). *N(Any)* is the number of violent conflict in cell $attime$. *N(State)* is the number of violent conflict involving the state in cell $attime$. *N(Non-State)* is the number of violent conflict not involving the state in cell $attime$ and zero otherwise. *N(Land)* is the number of land-related conflict in cell $attime$ and zero otherwise. Every specification includes .5-degree $\times$ .5-degree grid-cell fixed effects and country trend. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.