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Tubers and its Role in Historic Political Fragmentation in Africa

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Abstract

This paper examines the link between historical political fragmentation and surplus agricultural production, and the impact of natural endowments with regards to crop suitability. I show that in sub-Saharan Africa, groups that cultivated tubers, specifically yams, were more likely to have higher levels of local political fragmentation. I show that both tubers and most cereals were positively correlated with historic population density and that there was no historic discrimination in the capacity of crops to produce surpluses and support large populations. I however show that unlike cereal cultivators who were more likely to be centralized, tuber cultivators were likely to have more local political fragmentation. I use crop suitability and the proximity to the area of the domestication of yams to show that cultivating yams did lead to more local political fragmentation. I argue that this is likely due to the biological properties of yams which make them more difficult to expropriate and implies that surpluses stay local. I argue that the experience of keeping surpluses local is associated with contemporary social norms that are against autocracy and unitary accumulation of power. These social norms are an example of the mechanism through which these historical institutional structures transmit to contemporary times.

JEL classification: O10, N47, N57, D72

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1 Introduction

Economists have increasingly looked to history in understanding contemporary development outcomes and challenges. This is more so in sub-Saharan Africa which unfortunately now hosts the majority of least developed countries, and a large share of people living in poverty. Although there have been periods of booms and busts (Jerven (2010)), most African countries have so far been unable to sustain economic growth for a significant period of time, with a few exceptions. One strand of the literature trying to understand these dynamics has focused on the role of historical factors in explaining the relatively poor outcomes. Studies have looked at the effects of historical events like the slave trades (Nunn (2008)), colonialism (La Porta et al. (1999); Acemoglu, Johnson, and Robinson (2001); Huillery (2009)), missionary activity (Nunn (2010)), geography (Sachs and Malaney (2002)) and others. The common theme in this literature is that historical events or processes can explain some of the currently observed variation in outcomes. Whereas it does not imply that countries are locked in some preset path it does help provide a better understanding of some of the outcomes, and how those events transmit through history. The quality of institutions, culture, or social norms are some of the channels that have been suggested.

One area which has been demonstrated in the literature to be important for current development outcomes is the institutional arrangement prior to colonialism, that is the institutional arrangements of various groups prior to the colonial era and the creation of most contemporary modern African states. For instance state centralization, defined as the existence of a structured political order under which people are subject to, is associated with the provision of important public goods like security and infrastructure in some instances(Gennaioli and Rainer (2007); Bandyopadhyay and Green (2016)), and with lower supply of public goods in others (Archibong (2019)). These public goods, and other benefits of state centralization, have been essential for long term development outcomes (Michalopoulos and Papaioannou (2013*a*,*b*); Bockstette, Chanda, and Putterman (2002)). Ethnic fractionalization (Alesina et al. (2003)), class stratification(Fenske (2014)), and even the existence of polygyny, have all been associated with relative contemporary development outcomes.

Studies have attempted to explain the variation in African institutions prior to the colonial period using geographical factors and historical events. Alsan (2015) for instance finds that the presence of tsetse flies, an insect unique to Africa which acts as a carrier for a disease that is fatal to humans and cattle, explains some of the variation in 'precolonial centralization' in Africa. Fenske (2014) shows that prior to the colonial period, states with a more diverse ecological environment had more centralized states. On the historical front, some studies have focused on the effects of the trans-Atlantic slave trade. Lovejoy (2005) argues that the slave trade led to more state centralization while Whatley and Gillezeau (2011) and Obikili (2016) show it led to more fractionalization and local political fragmentation respectively.

In this paper I focus on the role of agriculture in shaping the structure of some of these political institutions in Africa. Some studies have already shed some light on the ways in which agriculture matters. Mayshar, Moav, and Pascali (2022) show that appropriable cereals were necessary for historical state centralization, with surplus cereal production acting as a source of taxation and accumulation of power. However, not all peoples were cereal cultivators. The question I ask is what happened to surpluses of non-cereal cultivators and what type of political structures emerged in places that cultivated other types of crops? I show that in sub-Saharan Africa, both cereals and tubers have the same potential to produce food surpluses and support large populations. Indeed in sub-Saharan Africa, more than half of groups with the highest historic population densities were tuber cultivators. Tubers and most cereals, are correlated with historic population density in the same way. If tuber surpluses were not expropriated to support a centralized authority like those for cereals as argued by Mayshar, Moav, and Pascali (2022), what happens to them?

In this paper I argue that for tuber cultivators, surpluses led to more local politically fragmented institutions, which I define as the number of distinct groups within a local community which hold some political power as in Obikili (2016). Using data from Murdock and Atlas (1967) ethnographic atlas I show that groups that cultivated tubers were more likely to have higher levels of local political fragmentation. I use the environmental suitability for tuber cultivation compared to cereals, and the proximity to the likely location for the domestication of yams, the major tuber cultivated, to show that the relationship between tuber cultivation and political fragmentation is causal.

I argue that groups experience with retaining surpluses and political power locally results in institutions and social norms that persist even after more contemporary forms of expropriation are introduced. I show that people who identify with ethnic groups that were historically tuber cultivators were more likely to reject autocracy or rule by either one man, one party, or the military.

The rest of the paper is organized as follows: section 2 provides the historical context and a theoretical background for the paper. Section 3 describes the data used in the quantitative analysis. Section 4 presents the main empirical findings. Section 5 concludes.

2 Historical Context

2.1 Surpluses and Fiscal Capacity

Theories of state formation are often centered around the idea of expropriating some value from others, either forcefully or willfully, and in exchange providing some protection or other public goods. Olson (1993)'s roving bandits theory argues that bandits roam around expropriating from farmers and over time develop a symbiotic relationship with the raided in exchange for protection. Bates (1987) on the other hand argued that long distance trade necessitated centralized states who existed on taxing this trading activity. The unifying idea for many of these theories is the expropriation of value from the producers of value to some entity which eventually becomes the state.

A couple of things are important in the context of the relationship between the state and the expropriated. The first is the existence of value to expropriate. Occupiers of a territory need to be producing something of value or at the very least something of value needs to exist. In agricultural societies, crops need to be produced which serve as the basis for the relationship between the people and the state. Or perhaps the existence of gold or other valuable natural resource deposits act as the basis for the state. There are multiple other instances such as states that exist based on domination of trade routes, extracting tolls from traders and existing based on it. In more modern states, any economic activity can essentially be turned into money and taxed, which serves as the basis for the states' existence. Either way some value must exist or be created for states to exists.

A second important thing is the accumulation of expropriated value. In a modern context this is assumed to always be the case as money, or taxes, can be accumulated in various forms to an almost unlimited amount. There is virtually no limit to how much value a modern state can stockpile. However, this was not always the case especially in earlier states. States that existed based on expropriating agricultural commodities for instance faced a natural limit to stockpiling in the sense that crops cannot be stored forever. Accumulation of value by states therefore depended crucially on the nature of value that could be expropriated.

No doubt other factors are important for the relationship between state and subject but these two factors create an interesting dynamic of options for the political institutions of the hypothetical state. To understand the dynamic, consider three simplified options for agriculture based societies;

- Option A: the society can't produce any food.
- Option B: the society can produce food but the food cannot be easily expropriated.
- Option C: the society can produce food and the food can be easily expropriated.

All other things being equal, these three options create an interesting dynamic for political institutions around states. States probably cannot exist under option A because there is nothing being produced and therefore no basis for the exchange of value for public goods. As for option C, and as demonstrated by Mayshar, Moav, and Pascali (2022), centralized states are most likely to emerge because they have all the ingredients. There is value that is created and that value can be expropriated, stored, and accumulated. Option B however is not as clear cut. On the one hand, there is value created but that value cannot be easily expropriated. Which means, all things being equal, is that centralized states of the nature of option C are less likely. Whatever surplus value is created is likely to remain localized closer to the actual producers of that value.

If we include two extra conditions incorporating a time dimension, that the nature of political institutions are as a result of power dynamics between the expropriator and the expropriated, and that power is dependent on the existence of surpluses that both parties can use to generate more power, then the trajectories of options B and C can diverge even further. In option C, centralized states can expropriate surpluses and use it to increase the "power" gap between the state and their subjects. For example, an option C state can use some of the expropriated value to employ more soldiers to expand and expropriate even more value and so on. In option B however, surpluses and the resulting "power" production remain localized. Which means the option B state would similarly move on a trajectory with political institutions or social norms that prevent the accumulation of power and that keep political power local and more distributed.

2.2 Theoretical implications

This hypothesis of agriculture produce expropriation has two implications. First, in general more potential for production should imply more potential for surpluses. In areas well endowed with the conditions to produce, the opportunity for surplus production should be higher. The type of crop however should not matter as they should interact with surpluses in the same way.

Second, the type of crop cultivated should matter for the nature of political institutions. Areas naturally endowed with conditions ideal for the cultivation of crops that can be expropriated, such as cereals, should be more likely to host a centralized state. This has been demonstrated already by Mayshar, Moav, and Pascali (2022). However, areas endowed with conditions to cultivate crops that cannot be expropriated, or that are more difficult to expropriate, should have more local distribution of political power, or more fragmented political institutions.

2.3 African Food History

The focus of this paper is on contributing to the literature on the role of agriculture in the nature of political institutions in Africa. I argue that groups that were tuber cultivators had more local political fragmentation.

To this I focus on the crops that have an early history of cultivation in Africa and that could have been a staple food. The staple food status means these are crops that would have had to be consumed in order for populations to survive. Various authors have explored the crop history of Africa, documenting evidence of staple foods in different parts (Alpern (2008, 1992); Clark (1962); Morgan (1962)). Ohadike (1981) for instance documents the role of yams as a staple food in eastern Nigeria. Indeed it has been argued that yams were first domesticated in West Africa and served as a staple food for many indigenous populations (Coursey (1975)). Carney (2001) also documents the cultivation of "African rice" which she argues was domesticated in parts of West Africa and served as a staple food. Millet (Neumann (2005); Manning et al. (2011); Brunken, de Wet, and Harlan (1977)) and Sorghum (De Wet and Harlan (1971); Neumann (2005)) have also been shown to have a history of early cultivation in Africa.

The nature of crops cultivated has changed significantly over the centuries. Africa like other parts of the world was exposed to new crops imported during the Columbian exchange (Alpern (1992)). Crops such as maize, cassava and potatoes have gone on to become important parts of the diets in many countries, and cash crops such as palm oil and cocoa have become sources of revenue for many farmers. In this paper I however focus on staple food crops that were cultivated in Africa prior to the Columbian exchange. I do this partly because they are relatively new entrants into the African agriculture scene and are therefore less likely to be responsible for some of the longer-term drivers of political organization. Secondly, these crops were introduced during a period when other factors in the political institutional story were dominant. The cultivation of cassava in Nigeria for instance only takes off rapidly around 1918-1919 (Ohadike (1981)), a period when almost every African territory was subject to colonization and effectively forced under a centralized state. Similar patterns are apparent for other new world crops like maize (McCann and McCann (2009)) and newly traded crops like palm oil (Lynn (2002)). For this reason I focus only on crops that have a history of cultivation as a staple food before the Columbian exchange.

Focusing on pre-Columbian exchange crops leaves me with six key crops cultivated in Africa; yams, coco-yams, green gram, African rice, sorghum, and pearl millet (Galor and Özak, 2016). In terms of crop classifications, these crops can be grouped into two: tubers and cereals. Tubers and cereals have important distinctions in how they are cultivated. The edible portions of tubers tend to grow below the ground while those for cereals are above the ground. Tubers also tend to have a much shorter shelf life in terms of storage after harvesting as opposed to most cereals. Yams, for instance, have a short shelf life and can be stored for roughly six months after harvesting (Diop and Calverley, 1998). Cereals on the other hand can be stored for much longer especially when dried. Rice, for instance can be stored for years with basic drying and storage techniques. Cereals, like rice, sorghum, and millet, are therefore inherently easier to expropriate than yams, coco-yams, and other tubers.

Another important distinction between cereals and tubers is the planting and harvesting periods. Cereals have a relatively fixed planting to harvesting cycle, as once it is time for the harvest, the entire crop needs to be harvested at about the same time. Tubers are however a lot more flexible with regards to when they are harvested. They can be left in the soil for a relatively longer period of time and harvested when needed.

The implications of these differences between cereals and tubers in general are that cereals should be more suitable for expropriation than tubers. The harvested crop tends to last longer than tubers and therefore the incentives for accumulation should be greater. Cereals also have the advantage (or disadvantage) of having to be harvested at roughly the same time which should reduce the costs of expropriation. An expropriator would only need to enforce "taxes" during the harvest period as opposed to tubers which would require continuous collection by the expropriating party (Scott, 2017). I therefore would expect that areas endowed with climatic conditions for growing yams and coco-yams (tubers) relative to rice, millet or sorghum (cereals) to be more likely to have more local political fragmentation.

This paper is not the first to argue for a relationship between the types of crops grown or the agricultural endowment and political structures. (Scott, 2017) argues that one of the conditions for the rise of centralized authority and the city state is the growing of cereals. He argues that, amongst other factors, cereals and the relative ease with which "taxes" could be expropriated from cereal farmers made them a necessary condition for state formation in early Mesopotamia. Mayshar, Moav, and Pascali (2022) similarly show that cereals are easier to expropriate and therefore explain differences in hierarchy and formation of states. In this paper I however argue not that cereals are good for state centralization but that tuber cultivators move along a different trajectory developing more local politically fragmented institutions that distribute political power. Tuber cultivators don't remain at a hypothetical zero with others becoming more centralized, but in a sense move sideways, developing more complex but more localized and distributed political institutions.

2.4 Path dependence: Attitudes towards autocracy

The basic argument in this paper is that groups that cultivate crops that are difficult to expropriate have more fragmented political institutions. I argue that these political institutions persist but it is also likely that the retention of non-expropriated surpluses results in other cultural practices and social norms that reinforce the idea of keeping surpluses and political power local and distributed. Consider a hypothetical example where producers use surpluses to buy weapons to defend their spaces. Producers in more politically fragmented areas should have a larger cache of weapons that are more evenly distributed to defend their spaces either against an external centralizing authority or other local power grabbers, compared to areas where the surpluses have always been expropriated by a centralizing authority. The reinforcing dynamic of locally retained surpluses may not apply only to physical stuff like weapon stockpiles but may apply to other social norms around accumulation of power. People in areas who have a history of keeping their surpluses and distributing political power may have developed social norms that are more favorable to the even distribution of power. In essence there may be some path dependence in terms of attitudes towards political power even after the type of crop cultivated and surpluses cease to be directly relevant.

Many financial innovations, such as the creation of money, mean that more avenues for value expropriation beyond crops have existed for some time. If there was no path dependence in the nature of political fragmentation then I would expect the politically fragmented states to quickly converge towards the cereal cultivating centralized states. Evidence of differences in contemporary outcomes however must imply that there are factors that develop in these areas which allow them to be different from other centralized states, perhaps not forever but at least for some time. Social norms are one way through which historical events and scenarios can have long run persistent effects even after those events have passed (David (2007)). Social norms geared towards the localization of power may persist within communities even after the agricultural conditions around expropriation of value are no longer valid. Social norms have long been argued to be a key factor underlying observed differences in economic outcomes (North et al., 1990; Keefer and Knack, 2008).

2.5 Research questions

My hypothesis on the importance of the type of crop cultivated and its importance for local political fragmentation and subsequent social norms around political power leads to three major questions.

- Is there a positive correlation between the capacity to produce crops, regardless of type, with historic surplus production.
- Does the type of crop cultivated matter for local political fragmentation? Specifically, did tuber cultivators have more local political fragmentation?
- Are groups that historically cultivated tubers associated with contemporary social norms favoring distribution of political power or retaining surpluses?

3 Data

In this section I outline the data used in the paper with explanations of why I use these particular data sets.

3.1 Historic Local Political Fragmentation

Data on political fragmentation is taken from the Ethnographic Atlas by Murdock and Atlas (1967). This is a database of characteristics of various ethnic groups around the world including ethnic groups in Africa. The data in the case of Africa was compiled by George p. Murdock with care taken to describe African societies before European colonization.

One of the characteristics Murdock measures is the political structure within the villages and towns, what he calls the jurisdictional hierarchy within the local community. With this variable he is trying to capture the political structure not of the ethnic group as a whole but the political structure within the villages and towns of people of the same ethnic group. I argue that this variable to some extent measures political fragmentation within these villages and towns (Obikili, 2016). This variable is an ordered variable ranging from 2 to 4. A score of 2 represents ethnic groups with the simplest political structure. Ethnic groups under this category had villages and towns with independent nuclear or polygynous families and some kind of village leadership. At the other end ethnic groups with a score of 4 represents groups with at least four distinct political hierarchies within the village or town. For instance such a town may have some kind of organized political leadership within the extended family, another set of leaders for members of the same kin, and another set of leaders for the entire town. I describe this duplicity of political structures within the villages and towns as more fragmented political institutions.

The Angas tribe from Central Nigeria with a score of 2, for example, had all local political authority vested in a hereditary headman. In essence there was only one political institution outside the family in charge of their individual villages and towns. I argue that the Angas were less politically fragmented. On the other hand, villages and towns for the Isoko ethnic group also in Nigeria were organized in a very different manner. Isoko villages are recorded as having four distinct political levels. There was a local headman, described as the leader of his extended family, a council of elders, and then an age-grade organization. All these politically organized units operated independently within the same villages and towns. I argue that ethnic groups such as the Isoko were more politically fragmented.

In general I argue that ethnic groups with villages and towns with a score of two are less politically fragmented. Ethnic groups with towns with a score of four are more politically fragmented. As shown in Figure 1, there is a decent amount of variation in the level of political fragmentation across ethnic groups.

3.2 Type of Crop Cultivated

Murdock and Atlas (1967) also compiled data on the major crop cultivated by ethnic groups. Groups are categorized based on if they mostly cultivated roots and tubers, cereals, tree crops, or if there is no record of cultivation. I use this to create a binary variable that reads as 1 if the group mostly cultivated tubers and 0 otherwise. As shown in figure 2 there is also a significant variation in the type of crops cultivated, although the majority of tuber producers are located in West and Central Africa. As an alternative, I interact this with a measure of intensity of agriculture also reported by Murdock and Atlas (1967). This variable ranges from 0, no intensity, to 100, high intensity.

3.3 Suitability for crop cultivation

I use the climatic conditions suitable for different crops to measure the potential for food surpluses. To determine the conditions for agriculture I use data from the Global Agro-ecological zones (GAEZ)[1] system computed by the International Institute for Advanced System Analysis and the Food and Agriculture Organization(FAO). The GAEZ system computes suitability conditions for a variety of crops as well as other agriculture related conditions. These conditions are computed using information on soil type, slopes, environmental conditions like rainfall and temperature, and crop-specific conditions. The data is provided in 1km square grids for the entire world with a range from 0 to 100, with 0 being not suitable for the production of a crop, and 100 being the best conditions for that crop.

Specifically, I use the agro-ecological suitability and productivity using low inputs and only rain-fed water supply[2]. I use this to best replicate the conditions for early agriculture without modern farming techniques. I also use the baseline model which uses data from 1961 to 1990 to compute suitability. This raises the question of if modern data represents historical climatic conditions. I argue that, even though climatic conditions could have changed, the variation across space should be roughly constant. Therefore the conditions in the baseline period of 1961 to 1990 should represent the long run conditions for growing crop in particular places.

The GAEZ data is provided at the grid level. To convert this to suitability for each ethnic group and each crop I use a map of ethnic groups in Africa Murdock and Atlas (1967), and take the average suitability within areas occupied by each ethnic group. This results in an ethnicity-level measure of suitability for each crop and each ethnic group. As is apparent, the suitability for each crops varies across the space occupied by each ethnic group.

The suitability index for each crop is converted into caloric yield using data from the

[1] Accessed from http://www.gaez.iiasa.ac.at on the 26th of July 2018

[2] Details available at http://pure.iiasa.ac.at/id/eprint/13290/1/GAEZ_Model_Documentation.pdf

USDA Nutrient Database for Standard Reference as used by Galor and Özak (2016). This creates a measure of potential calories per kilogram for each of the crop types and makes it more directly comparable. Figures 3 and 4 show the potential caloric yield for yams and millet for each ethnic group as examples.

As mentioned earlier, in this paper I use as a baseline only crops cultivated in Africa prior to the Columbian exchange as in Galor and Özak (2016) and for which suitability data is available. I compute suitability indices by ethnic group for yams and coco-yams, green gram, wetland and indigo rice, sorghum, and millet.

3.4 Historical Food Surplus

In this paper I argue that the crop production and food surpluses are a key component of the dynamics of historical political institutions. There are however no measures of historical foods surpluses across Africa. To get around this challenge I use historical population density as a proxy for food surpluses. Theories in economics and political science (Ashraf and Galor, 2008) argue that more food production tends to imply higher population density. Higher population density therefore implies the conditions to sustain such density in terms of crop production must have been present.

To measure historical population density I use data from Murdock's ethnographic atlas (Murdock and Atlas, 1967) which captures the population of each ethnic group in the period shortly before the colonial era. I divide this by the size of the land area occupied by each ethnic group to get an ethnicity-level measure of population density.

The population data from Murdock and Atlas (1967) was mostly collected in the 1850s, long after the columbian exchange, and may capture population changes due to reasons other than crop suitability. For example, there are instances of migration and resettlement of groups such as the Ngoni (Thompson, 1981). As an alternative I used estimated population density from the History Database of the Global Environment (HYDE) 3.0 in 1500(Klein Goldewijk, Beusen, and Janssen, 2010). Population densities for ethnic groups are computed by taking the average population densities of areas occupied by groups as in Murdock and Atlas (1967).

As a final alternative I use gridded population data in 1990 from the Socioeconomic Data and Applications Centre [3]. The data provides estimates of the population in each 1km square grid across the world. I take the average population density in the area occupied by each ethnic group. Although this data is relatively modern, it should roughly capture the relative population density across ethnic groups.

3.5 Attitudes towards the state

I argue that the transmission mechanism through which some of the consequences of historic political fragmentation are still relevant today works through social norms which are embedded for ethnic groups.

To measure this I use data from the sixth round of the Afrobarometer survey in 2016. Specifically I use the battery of questions which evaluates respondents attitudes towards autocracies. The question asks respondents the following question. “There are many ways to govern a country. Would you disapprove or approve of the following alternatives”:

1. Only one political party is allowed to stand for election and hold office?

2. The army comes in to govern the country?

3. Elections and Parliament are abolished so that the president can decide everything?

The respondents code their responses on a five point scale from strongly disagree to strongly agree. I argue that this question captures respondents view on the distribution of political and their opposition to its accumulation by singular authorities. The ethnicity of respondents is reported in the Afrobarometer survey and this is matched to Murdock’s ethnographic atlas.

[3] Accessed from http://sedac.ciesin.columbia.edu/data/set/gpw-v3-population-density/data-download on the 19th of November, 2018

3.6 Other data

I use other data as control variables in the regressions. Data on forest cover and terrain ruggedness are taken from the GAEZ data project. Dependence on agriculture, intensity of agriculture, and animals and plow cultivation are taken from Murdock's ethnographic atlas Murdock and Atlas (1967). Malaria suitability is taken from the malaria suitability index by Sachs and Malaney (2002). Tsetse fly suitability index is taken from Alsan (2015). Slave export data and presence of gold is from Nunn (2008). Ecological diversity is taken from Fenske (2014).

4 Results

4.1 Food Surpluses and Potential Crop Production by Type

The first part of this paper focuses on the potential for crop produce expropriation and the role of the climatic conditions in explaining the likelihood that any given area will have the fundamental resources that can be produced but may or may not be expropriated. Here I argue that, due to the absence of early historical crop production data, the historic population density can serve as a proxy for areas with food surpluses. In essence, I argue that areas more suitable for crop production in general can produce more food surpluses and host more people, and that this is independent of the type of crop. As shown in figure 5, there is a positive correlation between population density and maximum caloric yield. Figure 5 also labels the ethnic groups with the highest population densities (densities of 150 people per square km or more). Importantly, the groups with the highest population densities are distributed between both tuber and cereal cultivators. The Ekiti, Ife, and Ibo groups for instance are tuber cultivators but have relatively high population densities. Similarly, the Kikuyu and Luo are cereal cultivators but also have high relatively high population densities. Figure 5 suggests that the crop type is not really a key factors.

To investigate this further I run a simple regression of the form

$$PD_e = \alpha_1 + \beta_0 CY_e + \beta_1 c_e + \epsilon_e \tag{1}$$

where PD_e is the population density of ethnic group e. CY is the potential caloric yield for the area occupied by ethnic group e, c is a vector of control variables and ϵ is a random error term. I run this regression for each crop that was cultivated in Africa prior to the Columbian exchange, as well as for the cereal with highest caloric yield. The results are presented in Table 2. In each of the columns the CY represents a different crop.

Each regression also includes controls for other geographic factors which may influence population density. I control for the forest cover of the are occupied by ethnic groups. As shown in figure 5, few dense groups are located in areas close to maximum suitability. This I suspect is because these areas tend to be dense forests which are not the most suitable for dense populations. I also control for the ruggedness of the terrain of the ethnic group. Finally I control for the distance to the Sahara desert and the distance to the coast. I control for distance to the Sahara to ensure that the large spaces in the Sahara are not driving the results. I also control for distance to the coast to account for other possible external sources of food supply.

The results in almost all cases are qualitatively identical with a positive relationship between potential caloric yield and population density. The exception is for pearl millet which shows a negative but insignificant relationship with population density. The results support the idea that in terms of their capacity to produce surpluses, in this case proxied by population density, tubers and cereals are not different. Indeed the coefficient on yams is higher than most of cereals with the exception of Green Gram.

As mentioned earlier, historic population density taken from Murdock's ethnographic atlas does not capture many ethnic groups, were compiled from estimates mostly from the 1850s after the columbian exchange, and are rough estimates as opposed to precise counts. I use two alternative data to nullify these problems as driving the observed correlations. First

I use gridded population density estimates from the HYDE 3.0 in 1500. Secondly, I use more modern gridded population data. This allows me to capture all ethnic groups in my sample as well as to use alternative historical sources of population density. Table 3 and table A1 replicates table 2. The results are qualitatively identical. This shows that the correlations between potential caloric yield and population density are not due to possible measurement errors in Murdock and Atlas (1967).

The results in table 2 show that climatic conditions for crop production are positively correlated with food surpluses proxied by historic population density. Importantly, the correlations are of similar direction for both tubers and cereals implying no systematic difference in the capacity of crop type to support populations. In the next subsection I explore how the type of crop cultivated influenced political fragmentation.

4.2 Political Fragmentation and Crop Type

The key argument in this paper is that groups in areas endowed with conditions for growing a crop that is not suitable for expropriation and likely to have more political fragmentation. Specifically, I argue that groups that cultivate tubers should have more political fragmentation compared to groups that cultivate other things.

To investigate this relationship between tuber cultivation and political fragmentation I estimate a regression of the form:

$$PF_e = \alpha_1 + \beta_1 TC_e + \beta_x X_e + \epsilon_e \qquad (2)$$

Where PF is the measure of political fragmentation of ethnic group e. TC is a binary variable if group e cultivates tubers. X is a vector of control variables that may influence political fragmentation for group e. ϵ is a random error term. The results are reported in table 2.

Column (1) runs an OLS regression without any control variables. The coefficient on

Tubers is positive and significant and supports the hypothesis on the impact of the type of crop on political fragmentation.

In column (2) I include some characteristics of ethnic groups which may influence political fragmentation independent of the effect of crop type. I control for the level of state centralization as defined by Gennaioli and Rainer (2007). I control for the dependence of the ethnic group on agriculture. This is ranked on a scale of 1 to 5. I control for the intensity of agriculture. Finally I control for the use of animals and plows in cultivation. The inclusion of these control variable does not change the result of the relationship between tuber cultivation and political fragmentation.

In column (3) I control for other geographic variables which may influence political fragmentation. I control for proximity to a major river which may have an influence as rivers may serve as a space for expropriation. I control for the level of forest cover as forests may make avoiding a potential expropriating actor easier. I control for the ruggedness of the terrain for the same reason. Finally I control for malaria suitability as in Sachs and Malaney (2002) to account for the impact of the disease environment. Controlling for all these factors does not change the relationship between tuber cultivation and political fragmentation.

In column (4) I include other potential determinants of political fragmentation. Population density in itself may increase the likelihood of some type of political order as more people implies more production. The impact of tsetse flies has also been demonstrated to be important for political development and state centralization through its impact on animals (Alsan (2015)). The use of animals may make it easier to extend the reach of potential parties trying to expropriate value. I also control for the presence of gold which provides an independent source of revenue which may increase the likelihood a different form of political organization. I control for the slave exports of the ethnic group during the trans-Atlantic slave trade period. The slave trade also provided a non-agricultural source of revenue which may increase (Lovejoy (2005)) or decrease the likelihood of state centralization and political fragmentation Whatley and Gillezeau (2011); Obikili (2016). Finally, I control for the ecological diversity of the area occupied by ethnic groups as this may provide alternative crops and a more diverse source of revenue Fenske (2014). The results are qualitatively identical to other instances with tubers being positively correlated with political fragmentation.

In table 5 I use the alternative measure of tuber cultivation, i.e. tuber cultivation interacted with the intensity of agriculture. I do this to incorporate some other unobserved reasons why some groups may produce more surpluses than others. Table 5 replicates table 2. The results are qualitatively identical with a consistent positive relationship between tuber cultivators and political fragmentation.

Finally, a run a falsification test using cereal cultivators. If the hypothesis that the presence of political fragmentation is driven by food surpluses that are more difficult to expropriate then there should be no relationship between cereal cultivators and political fragmentation. I create a similar binary variable coded as '1' if the group cultivates cereals and '0' if not. I repeat the set of regressions as with the tuber cultivators in table 2. The results are shown in table 6. In each of the cases there is no significant relationship between cereal cultivators and political fragmentation. This strengthens the argument that cultivating tubers, and not just any crop, is key for understanding the dynamics of political fragmentation.

4.2.1 Causality and Omitted Variable Bias

The regression results presented so far are simple OLS regressions which say nothing about the direction of causality or the potential for omitted variable bias. The tacit assumption in this paper is that tuber cultivation causes political fragmentation. However it is also possible that political fragmentation causes tuber cultivation in the sense that it influences the crops that groups choose to grow. Indeed there are cases of groups faced with choosing to grow tubers instead of cereals as a tactic for evading expropriation. There is also the possibility of some omitted variable that influences both crop choice and political fragmentation.

To demonstrate that tuber cultivation did indeed cause political fragmentation I exploit the variation in suitability for producing different kinds of crops. As is clear from figures 3 and 4 different areas are more or less suitable for growing different crops. A group in an area than cannot produce any yams for instance is unlikely to have chosen to grow yams. Similarly, a group in an area where it is significantly more advantageous to grow millet over other crops is likely to do so. This is similar to the case made by Mayshar, Moav, and Pascali (2022).

However, unlike Mayshar, Moav, and Pascali (2022) I argue that groups are not given an 'a la carte' menu of options in which to choose from. Rather, they start with a first crop and then switch if a new crop comes along that is significantly more superior in terms of caloric yield. In the context of this paper I argue that groups who started off with tubers and that have climatic conditions that make tubers more beneficial than cereals are more likely to cultivate tubers. On the other hand, groups that either did not start off with cereals, or that have climatic conditions in which cereals are superior did not cultivate tubers. These variations in climatic conditions and the "starting" crop thus create exogenous variations in tuber cultivation.

A key challenge, however, is I do not know what crop each group started cultivating first or which groups started off cultivating tubers. As an alternative I use the proximity of each group to the likely location for the domestication of yams, the most cultivated tuber in Africa. Scarcelli et al. (2019), using whole-genome resequencing and statistical models, show that yams were likely domesticated approximately between latitude 11.1° ± 4.4°N and longitude 2.8° ± 8.9°E which is somewhere around the northern parts of contemporary Benin Republic. I therefore use the proximity to that location as a proxy for the likelihood that a group started off cultivating tubers first. Figure 6 shows the location of the domestication of yams and the caloric advantage of the cereals with the highest potential caloric yield versus the potential caloric yield for yams.

I use the interaction between the proximity to the domestication of yams and the caloric advantage of the best cereals over yams to instrument for tuber cultivation. The first stage of the results are reported in table 7 column (1). The result shows that groups that were closer to the location of domestication and with a low or negative caloric advantage for cereals were likely to cultivate yams. On the other hand groups that were far away from the location of domestication and that had a higher caloric advantage for cereals were less likely to cultivate tubers. Table 7 column (1) shows that the associated relationship between tuber cultivation and political fragmentation remains and that causality runs from tuber cultivation to political fragmentation. The magnitude of the coefficient is also significantly larger than in the OLS regressions.

In column (2) of table 7 I use the interaction of the proximity to the location of domestication of yams and the potential caloric yield of yams, without accounting for the potential caloric yields of cereals. The results are identical to those in column (1). In column (3) I use only the caloric yield of yams without including the proximity to the location of domestication of yams. In this instance the size of the coefficient on tuber cultivation and political fragmentation reduces and is no longer significant. This serves as further justification that the potential caloric yield is not impacting crop choice uniformly but depends the initial crop choice.

All together the results show that tuber cultivation did cause increased political fragmentation.

4.2.2 Robustness Tests

I run a couple of robustness tests to better understand the results. The prior regressions include only groups in sub-Saharan Africa. In table 8 column (1) I include groups in North Africa. Alternatively, in columns (2) to (5) I exclude groups in East Africa, West Africa, Southern Africa, and Central Africa respectively. This would capture some region specific factors, such as the mass migration of groups, that may be driving the results observed. The results remain positive and significant in most cases with the exception of the exclusion of West Africa. This might be because the majority of groups with the highest level of fragmentation are in West Africa. It may also be because this is the location of the domestication of yams and therefore central to the results.

In table 9 I replace data from Murdock and Atlas (1967) with data from the Standard Cross Cultural Sample (SCCS). Although the SCCS uses some data from the same sources as Murdock and Atlas (1967) ethnographic atlas, it contains much more detailed information on ethnic groups and is sometimes regarded as more precise in categorizing groups. This, however comes with the significant downside of describing much fewer groups. Table 9 replicate the results using OLS with no controls, OLS with controls, and using the instruments in columns (1), (2), and (3) respectively. The results remains positive and significant in each case even though the number of observations drops from 314 in the ethnographic atlas to 31.

4.3 Tubers, Fragmentation, and Contemporary Social Norms

The final part of this paper discusses possible channels of path dependence of the relationship between tuber cultivation and political fragmentation. The basic argument in this paper is that tubers are more difficult to expropriate and its surpluses are retained locally which results in more fragmented political institutions. The question however remains on how and if this political fragmentation lasts beyond an era when crop produce is the main source of expropriation. Many financial innovations, such as the creation of money, means that more avenues for value expropriation beyond crops have existed for some time. If there was no path dependence in these political structures then I would expect theses groups to quickly converge with other non-tuber cultivators. Evidence of differences in contemporary outcomes however must imply that there are factors that develop in these tuber cultivating groups which allow them to be different from others, at least for some time after the crop cultivated stops being relevant for political institutions.

For evidence of such path dependence I focus on the impact of social norms. Social norms are one way through which historical events and scenarios can have long run persistent effects even after those events have passed. In this paper I focus specifically on the attitudes of people of different ethnic groups towards autocracy, or the monopolization of power by a single individual or a single political authority. Tuber cultivating groups as demonstrated above, have more political fragmentation and therefore should be more opposed to the idea of a single entity holding political power. Since the colonial era, almost all of Africa has been coerced into living under centralized authorities of different forms as the colonially created states have become the defacto state institution. However, if the attitudes to power influenced by fragmentation or tuber cultivation are still present then it serves as an example of how the historical dynamics persist.

To test for this relationship I use data from the Afrobarometer survey as described in section 3 above. I run a regression of the form:

$$A_{i,e,d,c} = \alpha_1 + \beta_i C_e + \beta_x X_{i,e,d,c} + \epsilon_{i,e,d,c} \tag{3}$$

where A represent the attitude of individual i of ethnic group e in administrative district d and country c towards autocracy. C represent a vector of ethnicity level characteristics of interest for ethnic group e. X represents a vector of control variables for individual i and ethnic group e in administrative district d and country c. ϵ is a random error term.

The results are reported in table 11. In each case I control for characteristics of the individual such as age, age-squared, sex, and if the individual is in a rural or urban location. I include fixed effects that capture the living conditions, education, religion, and occupation of the individuals. I control for the level of centralization of the ethnic group. I control for the level of ethnic fractionalization in the administrative district. Finally, I also include country fixed effects in all regressions. I do this to isolate the effect of country-specific attitudes from ethnicity based relationships.

Columns (1) and (2) reports results for the question "Only one political party is allowed to stand for election and hold office". In column (1) include only the level of historic political fragmentation while in column (2) I include both historic political fragmentation and an indicator if the ethnic group was a tuber cultivating group. In column (1) the coefficient on political fragmentation is negative but not significant. The same is repeated in column (2) although in this instance the coefficient on tuber cultivators is negative and significant. Individuals in areas who historically are tuber cultivators are more opposed to situations in which only one political party is allowed to stand for elections.

Columns (3) and (4) report results for the question “The army comes in to govern the country?”. The regressions mimic those for columns (1) and (2) respectively. Qualitatively the results are identical although the coefficient on political fragmentation is significant in column (1). The introduction of the tuber cultivators indicator, which is negative and significant, however weakens the significance of fragmentation. This supports the thesis that the observed effects on resistance to autocracy are driven by a history of tuber cultivating.

Columns (5) and (6) report results for the question “Elections and Parliament are abolished so that the president can decide everything”. The structure mimic columns (3) and (4) respectively. The results are also qualitatively identical. In general, the results in table 11 provide evidence of the persistence the historical dynamics between tuber cultivation and political fragmentation. Groups with higher historic political fragmentation are associated with more resistance to autocracy, and the relationship appears to be driven by a history of tuber cultivation. It shows that these dynamics continue to influence contemporary social norms.

5 Conclusion

This paper tests the hypothesis of links between historical tuber cultivation, political fragmentation, and the role of the environment. I show that almost all of the crops cultivated in sub-Saharan Africa prior to 1500 had the potential to produce food surpluses proxied by historic population density. However, I show that the tuber cultivators, whose surpluses were more difficult to expropriate, were more likely to develop more locally complex and fragmented political institutions. I use the potential caloric yield for cereals versus tubers based on the environmental conditions and the proximity to the likely location of the domestication of yams to show that tuber cultivation caused more political fragmentation. I also show that these dynamics persist to contemporary times through social norms. Individuals from groups that were tuber cultivators and that had higher historical political fragmentation were more opposed to various measures of autocracy.

The paper adds to the literature that attempts to understand the nature of state formation and organization in Africa. It also contributes to the literature on historical factors behind the development of social norms. Finally, this paper opens up questions for further research on the impact of agriculture and climatic conditions in shaping the nature of African institutions prior to the colonial period and the continuing impact on attitudes towards politics and governance.

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Figure 1: Historic Political Fragmentation in Africa

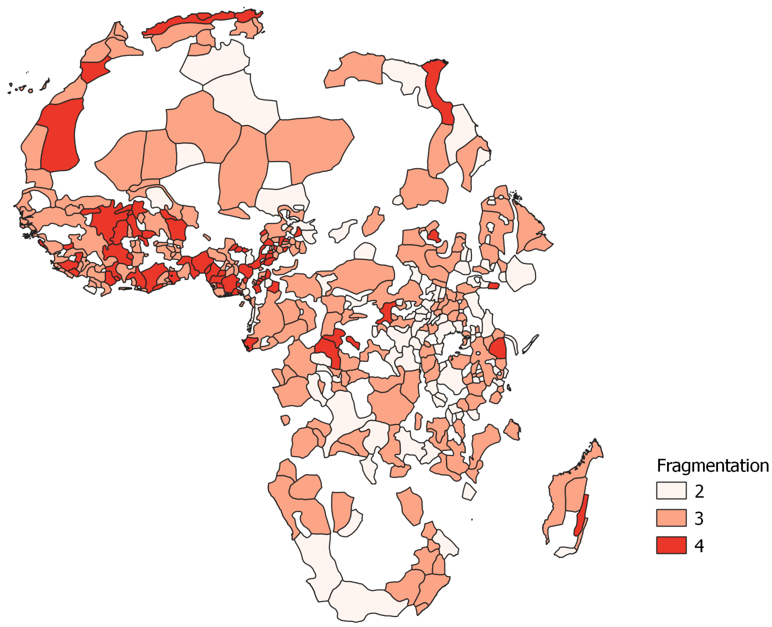

Figure 2: Major Crop Types

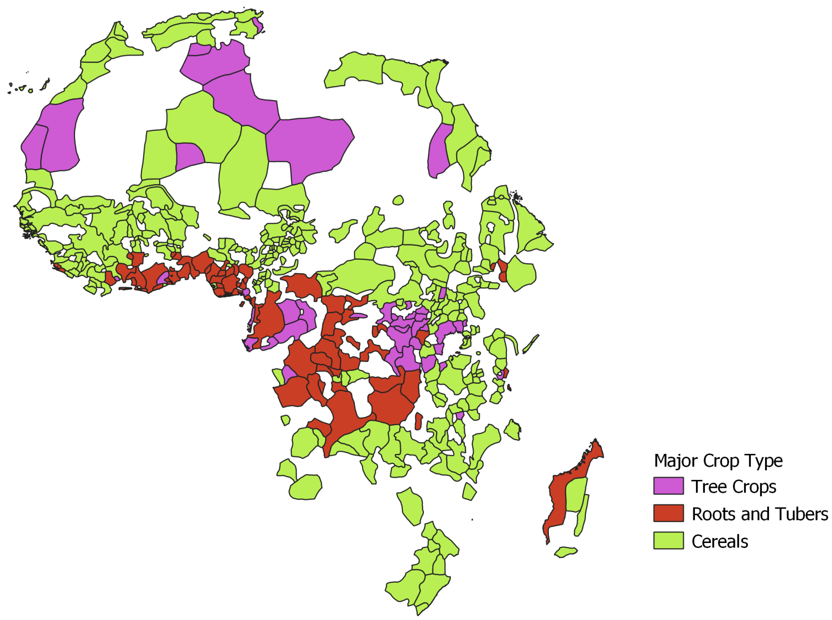

Figure 3: Potential Caloric Yield: Yams

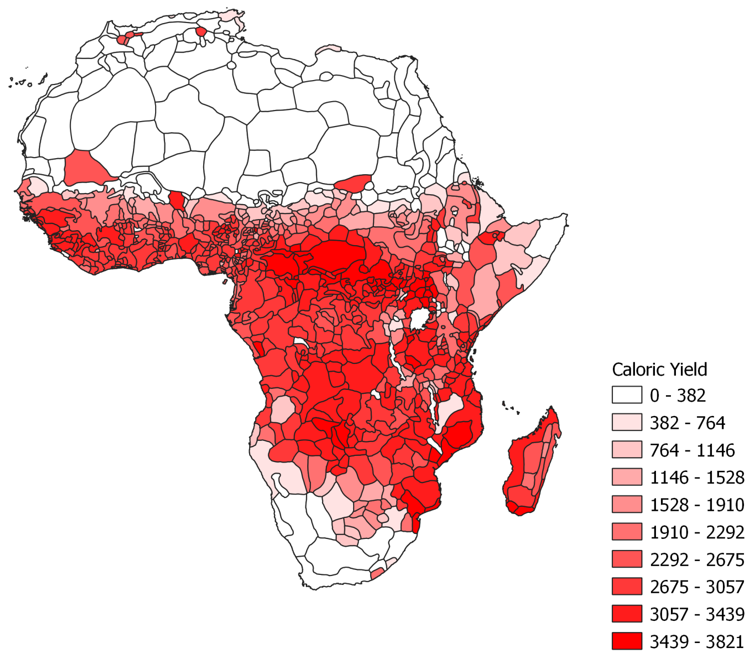

Figure 4: Potential Caloric Yield: Millet

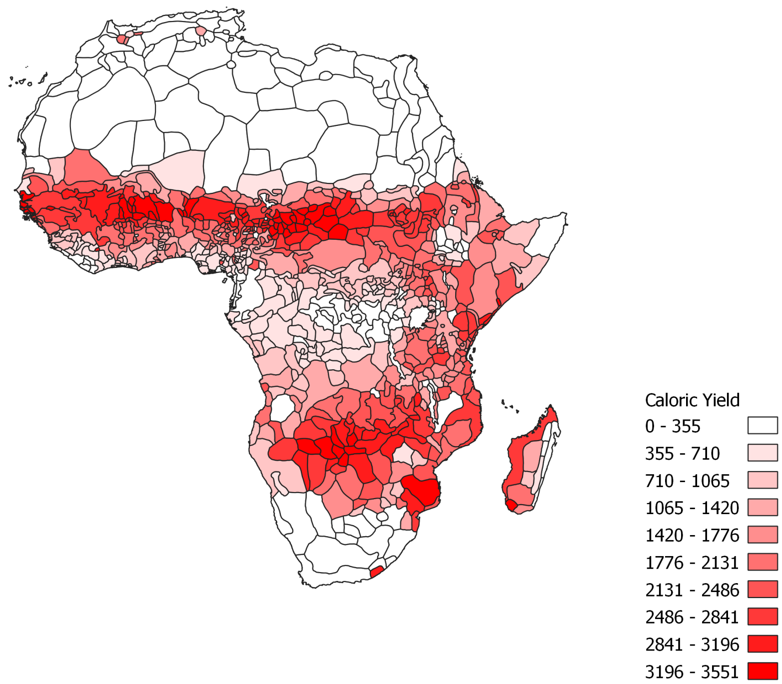

Figure 5: Population Density and Caloric Yield

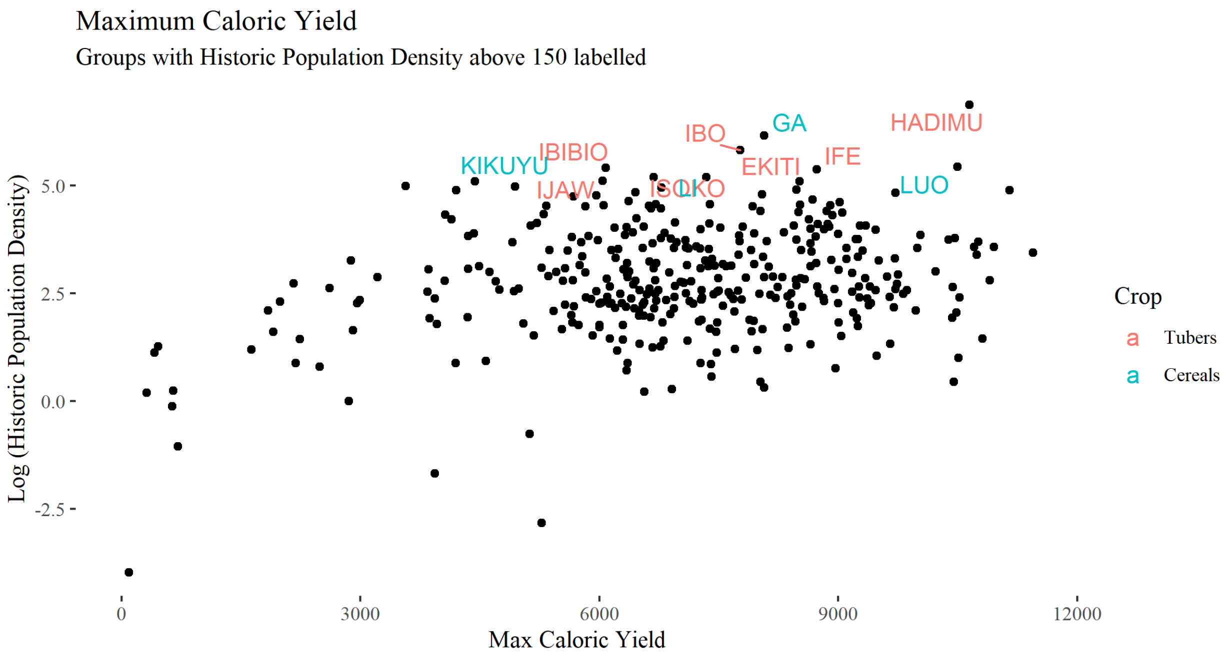

Figure 6: Caloric Yield: Best Cereal vs Yams

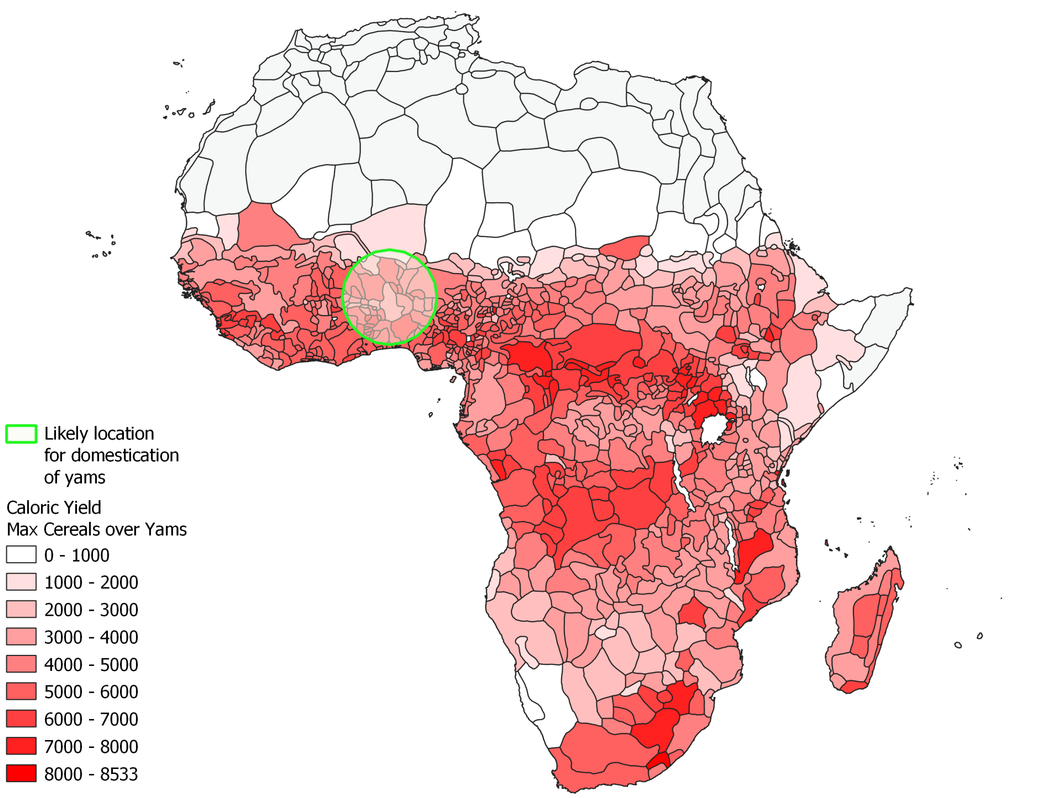

Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Political Fragmentation	364	2.926	0.662	2	4
Major crop: tubers	764	0.094	0.292	0	1
Major crop: cereals	764	0.334	0.472	0	1
Yams*	764	2,348.497	1,037.232	0.000	3,820.753
Max Cereals*	764	6,814.736	2,289.150	0.000	11,443.750
Green Gram*	764	2,234.917	933.708	0.000	3,725.328
Indigo Rice*	764	3,974.415	1,723.273	0.000	6,666.405
Pearl Millet*	764	1,544.355	1,003.075	0.000	3,551.117
Sorghum*	764	4,154.565	2,207.506	0.000	8,655.169
Wetland Rice*	764	5,319.455	3,583.685	0.000	11,443.750
Historic Population Density	363	35.341	67.907	0.019	963.057
Population density 1990	764	42.220	75.471	0.154	1,362.988
Population density 1500 - HYDE	764	5.140	12.357	0.0003	194.856
Intensity of agriculture	764	27.734	24.826	0.000	88.931
Average Forest Cover	363	66.074	68.765	1.064	423.467
Ruggedity Index	764	3.398	1.108	1.347	7.089
Distance to the Sahara	764	0.639	0.449	0.00002	1.784

*Caloric Yield

Table 2: Population Density and Suitability: Individual Crop Effects

	Yams	Max Cereals	Green Gram	Indigo Rice	Pearl Millet	Sorghum	Wetland Rice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crop Suitability	1.168***	0.751***	1.340***	0.713***	−0.222	0.358***	0.290***
	(0.230)	(0.107)	(0.317)	(0.131)	(0.246)	(0.135)	(0.066)
Crop Suitability Squared	−0.238***	−0.041***	−0.275***	−0.073***	0.109	−0.034**	−0.017***
	(0.060)	(0.008)	(0.080)	(0.020)	(0.069)	(0.016)	(0.006)
Average Forest Cover	0.030***	0.010	0.035***	0.021**	0.048***	0.040***	0.008
	(0.010)	(0.010)	(0.009)	(0.010)	(0.009)	(0.009)	(0.011)
Average Forest Cover squared	−0.0004***	−0.0002*	−0.0004***	−0.0003***	−0.001***	−0.0004***	−0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ruggedity Index	−0.014***	−0.014***	−0.015***	−0.018***	−0.015***	−0.012**	−0.013***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
Distance to Sahara	−0.560***	−0.625***	−0.629***	−0.543***	−0.605***	−0.639***	−0.524***
	(0.066)	(0.062)	(0.067)	(0.065)	(0.068)	(0.072)	(0.067)
Distance to the Coast	−0.550***	−0.695***	−0.678***	−0.646***	−0.669***	−0.764***	−0.700***
	(0.149)	(0.139)	(0.146)	(0.142)	(0.149)	(0.151)	(0.145)
Constant	4.766***	3.482***	4.786***	4.856***	5.885***	5.108***	5.230***
	(0.521)	(0.544)	(0.558)	(0.485)	(0.499)	(0.536)	(0.486)
Observations	363	363	363	363	363	363	363
R^2	0.306	0.383	0.290	0.332	0.252	0.260	0.309
Adjusted R^2	0.292	0.371	0.276	0.319	0.238	0.246	0.295

Note: *p<0.1; **p<0.05; ***p<0.01

Dependent Variable is Historic Population Density. Caloric yield scaled per thousand

Table 3: Population Density and Suitability: Individual Crop Effects

	Yams	Max Cereals	Green Gram	Indigo Rice	Pearl Millet	Sorghum	Wetland Rice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crop Suitability	0.910***	0.594***	1.401***	0.441***	−0.278	0.372***	0.253***
	(0.221)	(0.102)	(0.302)	(0.126)	(0.227)	(0.129)	(0.062)
Crop Suitability Squared	−0.181***	−0.029***	−0.323***	−0.031*	0.073	−0.044***	−0.011*
	(0.057)	(0.008)	(0.075)	(0.019)	(0.065)	(0.015)	(0.006)
Average Forest Cover	0.044***	0.022**	0.047***	0.031***	0.055***	0.049***	0.015
	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.010)
Average Forest Cover squared	−0.0005***	−0.0002**	−0.001***	−0.0003***	−0.001***	−0.0005***	−0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ruggedity Index	0.0002	0.0004	−0.0002	0.001	−0.0005	−0.0004	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Distance to Sahara	−0.681***	−0.731***	−0.715***	−0.672***	−0.702***	−0.696***	−0.634***
	(0.066)	(0.061)	(0.066)	(0.064)	(0.067)	(0.070)	(0.064)
Distance to the Coast	−0.760***	−0.917***	−0.818***	−0.878***	−0.828***	−0.910***	−0.910***
	(0.142)	(0.132)	(0.138)	(0.135)	(0.141)	(0.142)	(0.135)
Constant	2.146***	1.032***	1.957***	2.072***	3.308***	2.553***	2.515***
	(0.329)	(0.381)	(0.351)	(0.321)	(0.315)	(0.326)	(0.266)
Observations	363	363	363	363	363	363	363
R^2	0.350	0.430	0.349	0.376	0.310	0.324	0.389
Adjusted R^2	0.337	0.419	0.336	0.364	0.297	0.310	0.377

Note: *p<0.1; **p<0.05; ***p<0.01

Dependent Variable is Population Density in 1850 from HYDE. Caloric yield scaled per thousand

Table 4: Political fragmentation and Tubers - Ordered Logistic Regression

	Political Fragmentation			
	(1)	(2)	(3)	(4)
Tubers	0.739***	0.629**	0.911***	0.726**
	(0.260)	(0.267)	(0.298)	(0.317)
Centralization		0.008	0.054	0.064
		(0.108)	(0.114)	(0.121)
Dependence on Agriculture		0.245***	0.302***	0.252***
		(0.064)	(0.062)	(0.066)
Intensity of Agriculture		0.048	−0.067	−0.035
		(0.153)	(0.152)	(0.165)
Animals and Plow Cultivation		0.944**	1.026***	1.273***
		(0.457)	(0.242)	(0.254)
Geographic Controls	No	No	Yes	Yes
Other Controls	No	No	Yes	Yes
Observations	364	363	349	341

Note: *p<0.1; **p<0.05; ***p<0.01
Full control coefficients are reported in the appendix.

Table 5: Political Fragmentation and Tuber Producers Interaction

	Political Fragmentation			
	(1)	(2)	(3)	(4)
Tubers X Intensity	0.100***	0.081**	0.110***	0.088**
	(0.031)	(0.032)	(0.036)	(0.038)
Centralization		0.005	0.053	0.061
		(0.108)	(0.114)	(0.121)
Dependence on Agriculture		0.235***	0.289***	0.242***
		(0.064)	(0.063)	(0.067)
Animals and Plow Cultivation		0.045	−0.073	−0.039
		(0.153)	(0.151)	(0.164)
Major River		0.948**	1.032***	1.281***
		(0.458)	(0.242)	(0.255)
Geographic Controls	No	No	Yes	Yes
Other Controls	No	No	Yes	
Observations	364	363	349	341

Note: *p<0.1; **p<0.05; ***p<0.01
Ordered logistic regression model used.

Table 6: Political Fragmentation and Cereal Producers

	Political Fragmentation			
	(1)	(2)	(3)	(4)
Cereals	0.135	0.095	−0.194	0.065
	(0.219)	(0.221)	(0.267)	(0.285)
Centralization		0.024	0.091	0.097
		(0.108)	(0.112)	(0.120)
Dependence on Agriculture		0.257***	0.319***	0.248***
		(0.063)	(0.063)	(0.069)
Intensity of Agriculture		−0.016	−0.099	−0.022
		(0.151)	(0.151)	(0.166)
Animals and Plow Cultivation		0.940**	0.977***	1.232***
		(0.454)	(0.249)	(0.264)
Geographic Controls	No	No	Yes	No
Other Controls	No	No	Yes	Yes
Observations	364	363	349	341

Note: *p<0.1; **p<0.05; ***p<0.01
Ordered logistic regression model used.

Table 7: Political fragmentation and Tuber Producers - IV

	Political Fragmentation		
	(1)	(2)	(3)
Tubers	9.09***	7.73***	2.01
	(2.42)	(2.03)	(3.55)
Centralization	−0.21	−0.15	−0.02
	(0.25)	(0.23)	(0.19)
Dependence on Agriculture	−0.21	−0.26	−0.23
	(0.0.27)	(0.27)	(0.23)
Animals and Plow Cultivation	1.76**	1.88**	1.48**
	(0.97)	(0.93)	(0.69)
Major River	−0.30	−0.26	0.06
	(0.50)	(0.46)	(0.40)
IV	Max Cereals - Yams	Yams	Yams
Weighted Distance	Yes	Yes	No
Full Controls	Yes	Yes	Yes
Observations	341	341	341
	First Stage Regressions		
Caloric Yield	−0.001***	−0.002***	−0.057**
	(0.0003)	(0.0005)	(0.025)
	F-Statistic		
	17.68	24.66	5.42
IV	Max Cereals - Yams	Yams	Yams
Weighted Distance	Yes	Yes	No
Full Controls	Yes	Yes	Yes
Observations	341	341	341

Note: *p<0.1; **p<0.05; ***p<0.01

Note: First and second stages use ordered logistic regressions.

Table 8: Political fragmentation and Tuber Producers - IV: Excluding Regions

	Political Fragmentation				
	(1)	(2)	(3)	(4)	(5)
Tubers	2.56***	1.75**	0.62	2.57***	2.65***
	(0.58)	(0.69)	(0.57)	(0.62)	(0.60)
Centralization	−0.08	−0.08	0.02	−0.08	−0.10
	(0.07)	(0.08)	(0.05)	(0.07)	(0.08)
Dependence on Agriculture	−0.04	−0.06	−0.03	0.02	−0.09
	(0.09)	(0.11)	(0.06)	(0.11)	(0.09)
Animals and Plow Cultivation	0.55**	0.16	0.40**	0.61*	0.48*
	(0.27)	(0.49)	(0.16)	(0.33)	(0.25)
Major River	2.25**	3.76**	1.54***	1.97*	2.26**
	(0.94)	(1.81)	(0.58)	(1.06)	(0.92)
Excluding	North	East	West	Southern	Central
IV	Yes	Yes	Yes	Yes	Yes
Full Controls	Yes	Yes	Yes	Yes	Yes
Observations	341	238	194	327	264
R^2	−1.25	−0.62	0.03	−1.30	−0.98
Adjusted R^2	−1.35	−0.72	−0.05	−1.40	−1.09

Note: *p<0.1; **p<0.05; ***p<0.01

Table 9: Political fragmentation and Tuber Producers: Using SCCS

	Political Fragmentation		
	OLS		*instrumental variable*
	(1)	(2)	(3)
Tubers	0.92***	0.78**	3.11*
	(0.31)	(0.34)	(1.61)
Centralization		−0.20*	−0.19
		(0.10)	(0.17)
Agriculture Contribution		0.25	0.01
		(0.16)	(0.32)
Animals Domesticated		0.02	−0.19
		(0.08)	(0.19)
Water Transport		−0.05	−0.25
		(0.15)	(0.28)
Constant	2.88***	2.88***	3.89***
	(0.12)	(0.48)	(1.05)
IV	No	No	Yes
Controls	No	Yes	Yes
Observations	31	31	31
R^2	0.23	0.38	−0.78
Adjusted R^2	0.21	0.25	−1.14
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 10: Summary Statistics: Afrobarometer round 6

Statistic	N	Mean	St. Dev.	Min	Max
One party rule	31,707	1.951	1.305	1.000	5.000
Military rule	31,541	1.909	1.248	1.000	5.000
One-man rule	30,165	1.701	1.080	1.000	5.000
Age	32,321	25.317	15.175	1	88
Urban	32,321	1.633	0.482	1	2
Gender	32,321	2.505	0.500	2	3
Ethnic Fractionalization	32,321	0.707	0.282	0.082	4.414

Table 11: Attitudes to autocracy

	A	B	C	D	E	F
Fragmentation	−0.027	−0.008	−0.084*	−0.041	−0.061+	−0.043
	(0.030)	(0.030)	(0.039)	(0.035)	(0.031)	(0.033)
Tubers		−0.116*		−0.267***		−0.115*
		(0.049)		(0.055)		(0.048)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered S.E	Yes	Yes	Yes	Yes	Yes	Yes
No. of Clusters	142	142	142	142	142	142
Num.Obs.	24 461	24 461	24 341	24 341	23 114	23 114

A and B: One party rule. C and D: Military Rule. E and F: One-man rule
Responses range from strongly dissaprove (1) to strongly approve (5)
Significant: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

I Appendix

* Supplementary Tables

Table 1: Population Density and Suitability: Individual Crop Effects

	Yams	Max Cereals	Green Gram	Indigo Rice	Pearl Millet	Sorghum	Wetland Rice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crop Suitability	0.879***	0.542***	1.043***	0.498***	−0.400**	0.280***	0.190***
	(0.150)	(0.065)	(0.201)	(0.084)	(0.161)	(0.085)	(0.045)
Crop Suitability Squared	−0.236***	−0.035***	−0.231***	−0.064***	0.117***	−0.023**	−0.015***
	(0.040)	(0.005)	(0.050)	(0.013)	(0.045)	(0.010)	(0.004)
Average Forest Cover	0.044***	0.024***	0.034***	0.033***	0.044***	0.037***	0.028***
	(0.007)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Average Forest Cover squared	−0.001***	−0.0004***	−0.001***	−0.001***	−0.001***	−0.0005***	−0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ruggedity Index	−0.018***	−0.019***	−0.019***	−0.021***	−0.018***	−0.020***	−0.019***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Distance to Sahara	−0.339***	−0.384***	−0.359***	−0.341***	−0.369***	−0.396***	−0.322***
	(0.039)	(0.038)	(0.040)	(0.039)	(0.040)	(0.041)	(0.041)
Distance to the Coast	−0.914***	−0.995***	−1.022***	−0.985***	−1.037***	−1.079***	−0.982***
	(0.100)	(0.096)	(0.099)	(0.098)	(0.100)	(0.100)	(0.100)
Constant	5.337***	4.538***	5.290***	5.565***	6.312***	5.689***	5.798***
	(0.345)	(0.356)	(0.369)	(0.330)	(0.336)	(0.350)	(0.330)
Observations	762	762	762	762	762	762	762
R^2	0.351	0.390	0.347	0.354	0.326	0.339	0.338
Adjusted R^2	0.345	0.385	0.341	0.348	0.320	0.333	0.331

Note: *p<0.1; **p<0.05; ***p<0.01

Dependent Variable is Contemporary Population Density. Caloric yield scaled per thousand

Table 2: Political fragmentation and Tubers

	Political Fragmentation			
	(1)	(2)	(3)	(4)
Tubers	0.248***	0.208**	0.307***	0.249**
	(0.086)	(0.087)	(0.094)	(0.100)
Centralization		−0.001	0.003	0.011
		(0.037)	(0.038)	(0.040)
Dependence on Agriculture		0.083***	0.100***	0.086***
		(0.020)	(0.021)	(0.022)
Intensity of Agriculture		0.022	−0.017	−0.002
		(0.050)	(0.054)	(0.057)
Animals and Plow Cultivation		0.335**	0.339**	0.398**
		(0.156)	(0.158)	(0.162)
Geographic Controls	No	No	Yes	Yes
Other Controls	No	No	Yes	
Observations	364	363	349	341
R^2	0.022	0.077	0.128	0.156
Adjusted R^2	0.020	0.064	0.102	0.117

Note: *p<0.1; **p<0.05; ***p<0.01
Full control coefficients are reported in the appendix.

Table 3: Political fragmentation and Tubers: Full Results Part 1/2

	Political Fragmentation			
	(1)	(2)	(3)	(4)
Tubers	0.739***	0.629**	0.911***	0.726**
	(0.260)	(0.267)	(0.298)	(0.317)
Centralization		0.008	0.054	0.064
		(0.108)	(0.114)	(0.121)
Dependence on Agriculture		0.245***	0.302***	0.252***
		(0.064)	(0.062)	(0.066)
Intensity of Agriculture		0.048	−0.067	−0.035
		(0.153)	(0.152)	(0.165)
Animals and Plow Cultivation		0.944**	1.026***	1.273***
		(0.457)	(0.242)	(0.254)
Major River			0.091	0.066
			(0.237)	(0.242)
Forest Area			−0.030	−0.044
Forest Area squared			0.0002	0.0003
Ruggedness			−0.003**	−0.003*
			(0.002)	(0.002)
Geographic Controls	No	No	Yes	Yes
Other Controls	No	No	Yes	
Observations	364	363	349	341

Note: *p<0.1; **p<0.05; ***p<0.01
Ordered Logistic Regression Model used.

Table 4: Political Fragmentation and Tubers: Full Results Part 2/2

	Political Fragmentation			
	(1)	(2)	(3)	(4)
Tubers	0.739***	0.629**	0.911***	0.726**
	(0.260)	(0.267)	(0.298)	(0.317)
Malaria			0.017	0.015
			(0.012)	(0.012)
Population Density				0.003
				(0.003)
Tsetse Suitability				0.323**
				(0.147)
Gold				0.447
				(0.395)
Slave Exports				0.019
				(0.045)
Ecological Diversity				−0.022
				(0.111)
Geographic Controls	No	No	Yes	Yes
Other Controls	No	No	Yes	
Observations	364	363	349	341

Note: *p<0.1; **p<0.05; ***p<0.01
Full control coefficients are reported in the appendix.

Table 5: First Stage: Political fragmentation and Tuber Producers

	Tubers		
	(1)	(2)	(3)
Caloric Yield	-0.001^{***}	-0.002^{***}	-0.06^{**}
	(0.0003)	(0.0005)	(0.03)
Centralization	0.03	0.03	0.03
	(0.02)	(0.02)	(0.02)
Dependence on Agriculture	-0.001	-0.01	-0.01
	(0.03)	(0.03)	(0.03)
Animals and Plow Cultivation	0.01	-0.02	-0.02
	(0.09)	(0.09)	(0.09)
Major River	-0.12	0.03	0.08
	(0.29)	(0.29)	(0.30)
F-Stat	15.87	22.79	6.81
IV	Max Cereals - Yams	Yams	Yams
Weighted Distance	Yes	Yes	No
Full Controls	Yes	Yes	Yes
Observations	341	341	341
R^2	0.31	0.32	0.28
Adjusted R^2	0.28	0.29	0.25

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
Caloric Yield scaled / 1000

Table 6: Political fragmentation and Tuber Producers - IV

	Political Fragmentation		
	(1)	(2)	(3)
Tubers	2.93***	2.60***	1.10
	(0.80)	(0.62)	(0.90)
Centralization	−0.09	−0.07	−0.02
	(0.08)	(0.07)	(0.06)
Dependence on Agriculture	−0.03	−0.03	−0.03
	(0.10)	(0.09)	(0.06)
Animals and Plow Cultivation	0.52*	0.51*	0.44**
	(0.29)	(0.27)	(0.18)
Major River	1.94**	1.95**	1.96***
	(0.96)	(0.88)	(0.60)
IV	Max Cereals - Yams	Yams	Yams
Weighted Distance	Yes	Yes	No
Full Controls	Yes	Yes	Yes
Observations	341	341	341
R^2	−1.74	−1.31	−0.07
Adjusted R^2	−1.86	−1.41	−0.11
Note:	*p<0.1; **p<0.05; ***p<0.01		