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Polygyny and Drought Resilience in Village Economies: Evidence from Rural Mali

Sylvain Dessy, Luca Tiberti, Marco Tiberti, and David Zoundi

Abstract

Rural communities in the Sahel, where livelihoods rely heavily on rainfed agriculture, face recurrent droughts that threaten food security and economic stability. This study examines how drought impacts crop yields across communities with varying levels of polygyny. Using panel data, census records, and meteorological information from rural Mali, this study finds that droughts significantly reduce crop yields in communities with no polygyny, whereas those with higher polygyny prevalence experience a mitigated impact. Our analysis suggests that highly polygynous communities benefit from geographically dispersed kinship networks, which provide crucial support during droughts. These networks facilitate resource sharing, sustaining both agricultural production and off-farm activities, thereby buffering the adverse effects of drought. These findings underscore the need to integrate cultural practices into policy efforts aimed at strengthening risk-management mechanisms in drought-prone regions. Neglecting such factors may inadvertently reinforce the persistence of informal coping strategies.

JEL classification: C12, D12, J12, J13, O55

Keywords: rainfed agriculture, drought, polygyny, crop yields, Mali

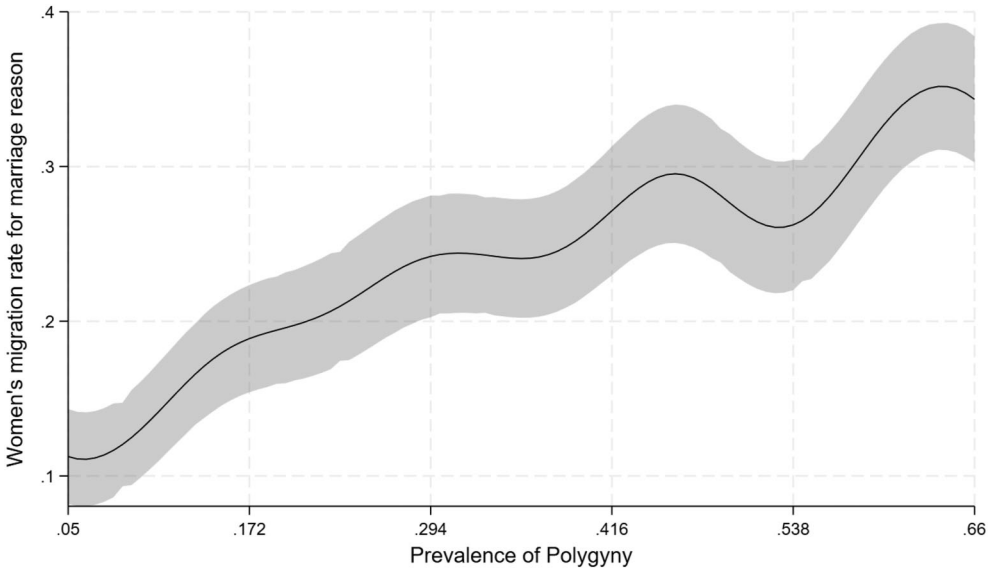
1. Introduction

In the Sahel, where reliance on rainfed agriculture renders livelihoods highly vulnerable to climate variability, a single failed monsoon can have devastating consequences. To mitigate the impacts of climate shocks, rural communities have developed adaptive strategies rooted in social and cultural networks (Daskon and Binns 2010; Daskon and McGregor 2012; Masih et al. 2014; Karunarathne and Lee 2019). While much of the existing literature on drought resilience emphasizes physical and institutional solutions—such as

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Figure 1. Polygyny Prevalence and Women's Migration Rate for Marriage Reasons



Source: Authors' elaboration based on Demographic and Health Survey (DHS) 2018.

irrigation systems, migration, or formal insurance—less attention has been devoted to the role of traditional cultural practices as informal risk-sharing mechanisms (Rosenzweig and Stark 1989; Zimmerman 2003; Akresh 2009; Anderson and Bidner 2015; Rossi 2019; Corno, Hildebrandt, and Voena 2020). In response to such adversities, rural communities prone to drought have developed coping mechanisms deeply rooted in traditional customs and institutions (Daskon 2010; Daskon and Binns 2010; Daskon and McGregor 2012; Karunarathne and Lee 2019). These cultural practices, notably prevalent in areas vulnerable to growing-season droughts, include marriage transfers (Anderson 2007; Anderson and Bidner 2015), migration for marriage (Rosenzweig and Stark 1989), child fostering (Zimmerman 2003; Akresh 2009), child marriage (Corno, Hildebrandt, and Voena 2020), and polygyny—where a man has multiple wives (Rossi 2019). In particular, polygyny, known for its adverse effects on women's outcomes (Tertilt 2005; Rossi 2019), remains prevalent in the Sahel despite its global decline. Understanding its potential role in enhancing resilience to droughts could offer valuable insights into its persistence and inform culturally sensitive policy interventions.

This study investigates the impact of drought on crop yields in rainfed agricultural communities with varying levels of polygyny prevalence. Drought, defined as an unusually dry period in an agricultural area, is a well-documented source of significant income shocks for smallholder farmers reliant on rainfall (Clavel and Clavel 2014; Dinkelman 2017; Kaur 2019). While rural communities often rely on local kinship-based transfers to manage such shocks, this paper hypothesizes that polygyny facilitates access to financial and in-kind support through geographically dispersed kinship networks.

The rationale for this hypothesis is supported by descriptive evidence presented in fig. 1, which highlights higher rates of women's in-migration for marriage in more polygynous communes in rural Mali. For rural polygynous men, marrying multiple women from different geographic areas may establish external, marriage-based kinship networks. These networks can act as channels for financial or in-kind transfers during periods of economic hardship, such as droughts. These non-local kinship-based transfers may en-

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able recipient farmers to hire labor, purchase agricultural inputs, and sustain off-farm activities, thereby enhancing resilience in communities with significant inflows of such support.

While polygyny is often associated with adverse outcomes, including higher fertility rates and gender inequities (Tertilt 2005; Rossi 2019;), its potential community-level benefits in regions where it is highly prevalent warrant attention. These benefits may provide insight into its persistence in one of the world's most drought-prone regions. By fostering geographically dispersed kinship networks, polygyny may strengthen informal insurance mechanisms during ecological shocks, complementing or even substituting formal risk-sharing systems such as microfinance and community-based insurance (Yang and Choi 2007; Morduch 1995; Platteau 1997).

This research bridges the economic dimensions of climate adaptation with the sociocultural analysis of traditional practices, offering a nuanced perspective on how cultural norms intersect with ecological challenges. It sheds light on the role of polygyny as a potential adaptive mechanism in resource-scarce environments, providing valuable insights into the interplay between culture and resilience in drought-prone regions.

Using household-level data from the 2014/15 and 2017/18 Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I), polygyny data from Mali's Fourth General Census of Population and Housing (2009), and meteorological records, this article examines whether the impact of drought on crop yields varies across communities based on polygyny prevalence. Additionally, this paper analyzes how the likelihood of receiving financial and in-kind transfers from geographically dispersed kinship networks varies with the level of polygyny prevalence in the community.

Findings reveal that while drought significantly reduces crop yields in communities with no polygyny, these adverse effects are mitigated in communities with higher polygyny prevalence. Mechanisms analysis indicates that financial or in-kind transfer inflows from geographically dispersed kinship networks are more pronounced in highly polygynous communes, enabling households to sustain both agricultural and off-farm activities during droughts. Importantly, these results are robust across alternative model specifications.

This study makes three key contributions. First, it provides suggestive evidence that polygyny, where it persists, serves as an informal resilience mechanism that facilitates non-local kinship-based transfers. This reframes polygyny not only as a social institution but also as an economic strategy in drought-prone regions (Tertilt 2005; Rossi 2019; Arthi and Fenske 2018). Second, it contributes to the literature on informal risk-sharing mechanisms by complementing existing research on community-based insurance, microfinance, and collective farming, while focusing on culturally specific practices (Rosenzweig 1988; Platteau 1997; Kazianga and Udry 2006; Fafchamps and Gubert 2007). Third, it bridges cultural (Lawson et al. 2015) and economic perspectives (Jacoby 1995) on polygyny, highlighting its socioeconomic role in enhancing resilience to ecological shocks. Moreover, this study offers important insights into how communities adapt to climate shocks like droughts, highlighting how the effectiveness of these adaptation strategies varies by polygyny prevalence. These findings underscore the need to integrate cultural practices into policy efforts aimed at strengthening risk-management mechanisms in drought-prone regions. Without alternative resilience strategies, such as irrigation infrastructure, polygyny may persist, reinforcing high fertility rates and gender inequality (Tertilt 2005; Rossi 2019; Ahinkorah 2021).

The remainder of this paper is structured as follows. Section 2 reviews the literature on the global decline of polygyny and its persistence in Sub-Saharan Africa. Section 3 describes the data and context. Section 4 outlines the empirical framework. Section 5 presents the findings, while Section 6 explores the underlying mechanisms. Finally, Section 7 concludes the study.

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2. Community-Level Polygyny Prevalence and Drought Risks

Polygyny—when a man marries multiple women—was a marriage institution in 80 percent of pre-industrial societies (Lawson et al. 2015). Today, this marriage institution has been outlawed throughout much of the world. In 2000, for example, the United Nations Human Rights Committee moved to ban this marriage institution.[1] Yet it remains legal or generally accepted in 25 of the 46 countries comprising Sub-Saharan Africa (SSA), where the percentage of people living in polygynous households is highest globally, at 11 percent (Kramer 2020).

2.1. On the Persistence of Polygyny in SSA: A Brief Literature Review

Given that the sex ratio in SSA has been near unity for decades (Jacoby 1995), the reason why so many countries in this region still oppose the abolition of polygyny has been a matter of considerable debate. On the one hand, the literature has advanced our understanding of the forces driving its disappearance in the Western world (Jacoby 1995; Gould, Moav, and Simhon 2008), while also contributing evidence of its causal effect on multidimensional poverty in the developing world (Tertilt 2005; Smith-Greenaway and Trinitapoli 2014; Wagner and Rieger 2015; Arthi and Fenske 2018). On the other hand, there is no consensus in this literature on why this marriage institution persists in Sub-Saharan Africa. For example, Jacoby (1995) argues that polygyny persists in SSA because women's comparative advantage in food production increases their value to men as husbands and household heads (Jacoby 1995). However, Arthi and Fenske (2018) provide evidence that this cultural practice is least common in those parts of Sub-Saharan Africa where women have historically been most important in agriculture. This lack of consensus suggests that the socioeconomic forces contributing to the persistence of polygyny in SSA are still not well understood.

2.2. Are Drought-Prone Countries More Polygynous?

Interestingly, the drought-prone area of Sub-Saharan Africa—which stretches from Senegal on the Atlantic coast through parts of Mali, Burkina Faso, Niger, Nigeria, Chad, and Sudan to Eritrea on the Red Sea coast—almost coincides with the polygyny belt—stretching from Senegal to Tanzania. This positive correlation between areas prone to agricultural droughts and those where polygyny is prevalent is quite visible in fig. 2.

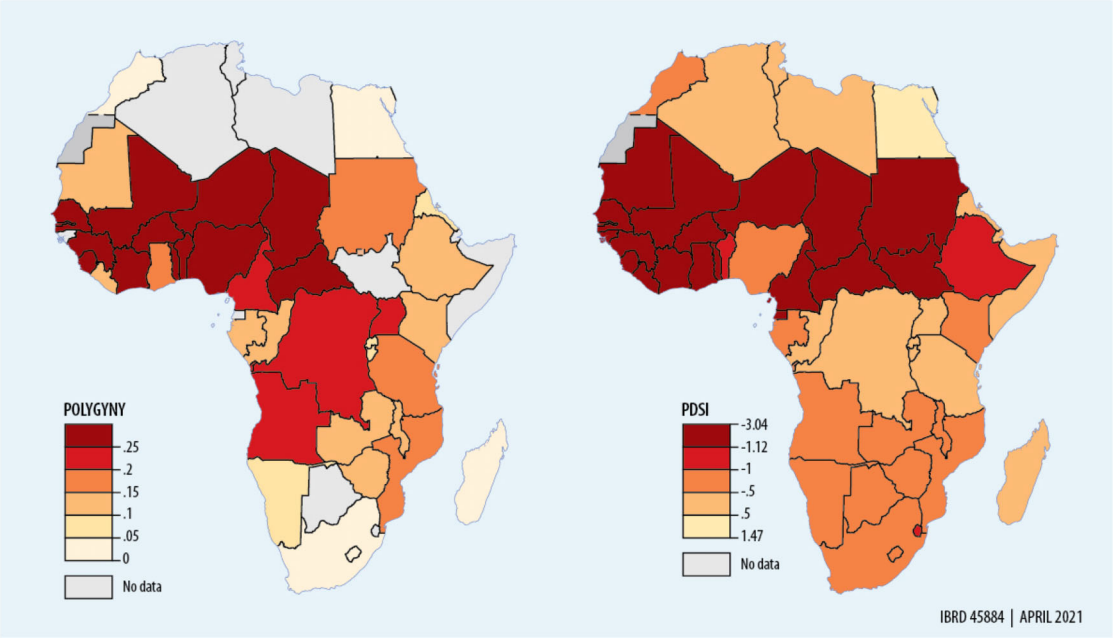
The left panel of fig. 2, built using DHS data, shows the proportion of married women in polygynous unions. The right panel was built using Dai, Trenberth, and Qian (2004) and shows the Palmer Drought Severity Index (PDSI) at the country level, calculated over 50 years, from 1968 to 2018. It should be noted that a PDSI lower than −1 identifies drought episodes.

Countries like Burkina Faso, Mali, Senegal, Niger, and Nigeria, all of which are located in the western African part of the drought-prone Sahel region, report the highest proportions of women in polygynous marriages globally. A common characteristic of these countries is that their rural populations are highly dependent on rainfed production systems for their livelihoods and are highly drought-prone, making them vulnerable to agro-climatic conditions that predominantly affect rainfed production systems. Moreover, despite the high volatility of rainfed agriculture, which has been exacerbated by climate change, drought-prone Sub-Saharan African countries appear to lag others in developing their irrigation subsector (Riddell et al. 2006). At the same time, the use of drought-resistant crop varieties among smallholder farmers also remains low (Frenken 2005). All these factors heighten the risks of chronic food insecurity in drought-prone countries of Sub-Saharan Africa and raise the need for risk-management mechanisms as drought shocks become common occurrences due to climate change. Yet, despite the strong correlation between

1 See Human Rights Committee, General Comment 28, Equality of rights between men and women (article 3), U.N. Doc. CCPR/C/21/Rev.1/Add.10 (2000), available online at http://hrlibrary.umn.edu/gencomm/hrcom28.htm.

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Figure 2. Distribution of Polygyny and Drought in Africa



Source: Authors' elaboration based on Demographic and Health Survey (DHS) 2018 data (for polygyny) and Dai, Trenberth, and Qian (2004) (for drought—defined using the Palmer Drought Severity Index (PDSI), estimated as an average over the period 1968–2018).

drought risks and the prevalence of polygyny, as shown in fig. 2, there has been limited interest in analyzing this relationship more closely. This paper is the first to examine this issue formally.

3. Context, Data, and Descriptive Statistics

Rural Mali was chosen as the setting of our empirical analysis for two reasons. First, Mali is a landlocked, Sahelian country whose agriculture is predominantly rainfed (Birhanu 2016), and drought is a transitory negative shock that affects agricultural productivity in the current year (Kaur 2019). Second, Mali is a country besieged by frequent episodes of drought. Furthermore, it is located in the polygyny belt along the African Sahel region in Sub-Saharan Africa (Jacoby 1995) and has the second highest rate in the world of individuals living in polygynous households at 34 percent (Kramer 2020). Interestingly, our rural Mali data show that about 95 percent of household heads co-reside with their spouse(s), with the remaining 5 percent residing in separate households. This pattern of family residence indicates the importance of measuring polygyny at the commune level in rural Mali to account for non-coresiding cowives.[2]

This paper uses Mali's data to test the hypothesis that drought's impact on crop yields varies with the level of polygyny prevalence in a community. Our data come from various sources, including the Fourth General Census of Population and Housing (2009), the 2014 and 2017 Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I), and climatological data.

2 Indeed, Mali's communes are sufficiently large geographic units that polygynous men with non-coresiding co-wives are highly likely to live within the same commune as all his wives, albeit in separate households, thus increasing the likelihood of these related households being misrepresented as monogamous households.

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3.1. Polygyny Data and Measurement

Polygyny data are from the Fourth General Census of Population and Housing (2009). This census contains information on the demographics and sociocultural characteristics of individuals and the communes in which they live. We use this information to construct our polygyny variable at the commune level, which offers several advantages.[3] First, our theory of change posits a link between the prevalence of polygyny and the scale of non-local transfer inflows, highlighting the positive externalities these transfers generate within communes. Measuring polygyny at the commune level helps capture these externalities and mitigates potential misclassification issues common in micro-level data, particularly when co-wives reside in separate households (Randall et al. 2011; Beaman and Dillon 2012). Second, the absence of household-level panel data in our surveys limits the use of household fixed effects, making a commune-level measure of polygyny crucial for reducing potential estimation biases. Third, census data use all households in a community to construct polygyny rates at this level, while the household survey data are not representative at that specific level. In our data, we regroup households by commune—the smallest administrative unit in Mali—distinguishing one commune from another based on its polygyny prevalence.

Supplementary online appendix fig. S1.1, built using data from Mali's Fourth General Census of Population and Housing (2009), shows that polygyny is much more widespread in southern Mali, which is also where most of the country's population is concentrated. The population density in the northern regions of Tombouctou, Gao, Kidal, Taoudénit, and Ménaka is low. The prevalence of polygyny in southern Mali exceeds 45 percent in some communes. In the north, polygyny is relatively low compared to other regions—the highest prevalence is 15 percent. This could be explained by the fact that northern Mali is predominantly populated by ethnic groups (Sonrai 45 percent and Tuareg 32 percent) that pursue mainly nomadic pastoral livelihoods, including transhumance (Touré et al. 2012). Polygyny in Mali is also predominantly a rural phenomenon. Among married rural dwellers, 22.4 percent were in polygynous unions in 2009, while the corresponding figure in urban centers was lower, at 13.5 percent. The predominance of polygyny in rural areas is interesting because it suggests that rural life characteristics make this cultural practice more resilient.

Our interest in commune-level polygyny stems from its hypothesized interaction with drought risk in communities dependent on rainfed agriculture for their livelihoods. For better comparability between low and high polygynous communities, we standardize the (commune-level) polygyny variable by subtracting it from its (country) mean and dividing by its (country) standard deviation (Iacobucci et al. 2016; Dalal and Zickar 2012). This transformation does not change the interpretation of the coefficient of our interaction term (Allison 1977). Thus, our results can be interpreted in units of standard deviation.

3.2. Main Outcome Data and Measurement

The main data source is the Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I). We use EAC-I's 2014 and 2017 rounds (EAC-I 2014 and EAC-I 2017). EAC-I 2014 and EAC-I 2017 are nationally representative[4] multi-topic household surveys with a focus on agriculture. These surveys were implemented by Mali's Ministry of Agriculture under the Living Standards Measurement Study—Integrated Surveys on Agriculture (LSMS-ISA) program.[5] It contains detailed information on the socioeconomic characteristics of farm households, as well as about the crop production activities (type and quantity of fertilizers, pesticides, seeds, credit, etc.). Information is collected at the level of the cultivated

3 We obtained the polygyny prevalence upon request to the Malian Statistical Office.

4 The sample covers all regions and areas (urban and rural) except the region of Kidal, excluded for security reasons from the sample.

5 The Living Standards Measurement Study—Integrated Surveys on Agriculture (LSMS-ISA) provides financial and technical support to Sub-Saharan African governments in designing and implementing multi-topic, national, panel household surveys with a strong focus on agriculture. The EAC-I data and documentation are publicly available at https://microdata.worldbank.org/index.php/catalog/lsms.

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plots (area, soil quality, etc.), as well as on the seasonal crops produced (quantity harvested, area on which the crop was harvested, etc.).

Enumeration Areas (EA) represent the primary sampling units of the survey. Several socioeconomic indicators used as controls in the estimates (like access to, and quality of, infrastructure and soil characteristics) were collected at the EA level. Moreover, the survey reports the GPS coordinates for each EA; this information is used to match households with weather data. In addition, the 2014 and 2017 EAC-I surveys use the same EAs, thereby providing panel observations at the EA level. Communes, which are one upper geographic level with respect to EAs, are also reported in the micro surveys. Communes represent the observational unit used by the statistical office to estimate the prevalence of polygyny from the census, thereby allowing one to match the two data sources (i.e., household surveys and census) at the commune level. All communes included in the household surveys can be matched to their respective communes in the census.

For each edition of the survey, households were visited twice: the same households interviewed on the first visit were re-interviewed on the second visit, and the visits were planned to match the timing of the post-planting (between August and October) and post-harvest (November and February, with 82 percent of households being interviewed in January) periods of the 2014/15 and 2017/18 agricultural rainy seasons. Households interviewed in the EAC-I 2014 differ from those interviewed in the EAC-I 2017. However, the same EAs were visited during these two surveys. Combining the EAC-I rounds and excluding the urban areas to focus on the rural population, we obtain a final sample of 4,008 farm households (1,961 in 2014 and 2,047 in 2017[6]). Since the main specification is at the household-crop level, the total number of observations is 10,474 (5,387 in 2014 and 5,087 in 2017).[7]

The main variable of interest is crop yield, which was defined as the ratio of the crop output value reported by the household to the area cultivated for that crop. One of the main advantages of the EAC-I data is that the plot size is measured by GPS. This avoids measurement errors that lead to biased results. We aggregate crop yield at the household-crop level. Data indicate that crop yield does not vary according to the extent to which polygyny is practiced in the commune. Indeed, as shown in table 1, crop yield (in inverse hyperbolic sine) is around 11.9 LCU for both households in communes with below and above the median polygyny's prevalence.

Data and Outcome Measures: This subsubsection outlines the variables used to analyze the mechanisms underlying the results. Descriptive statistics for these variables are reported in table 1, disaggregated by households living in communes with below- and above-median polygyny prevalence.[8]

(i) Non-Local Private Transfer Inflows

Non-local private transfer inflows are defined as all cash or in-kind transfers received by a household in the past year from individuals residing outside the commune. The survey distinguishes the origin of these private transfers, enabling a detailed analysis. On average, approximately 10 percent of transfers originated from the same locality, 30 percent from the capital city Bamako, 18 percent from elsewhere in Mali, 20 percent from other African countries, 13 percent from France, and the remaining share from other international locations. Transfers originating within the same locality were excluded from the primary analysis, as the hypothesis focuses on transfers received from other localities as a mechanism to buffer covariant shocks, such as drought.

6 EAC-I 2017 sample is restricted to the sample of households that received the full questionnaire. For a description of the sample and the questionnaire distribution, see the Basic Information Document of EAC-I 2017 at https://microdata.worldbank.org/index.php/catalog/3409.

7 427 observations have been omitted due to lack of information on production and/or outliers on production, yields, acreage, etc.

8 While it would be valuable to test the mediating role of polygyny on household welfare as a direct mechanism of the results, household expenditure data were collected only in the EAC-I 2014 survey, limiting the scope of such an analysis.

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Table 1. Descriptive Statistics

	Whole sample		Commune polygyny rate				
			Below median		Above median		
	Mean	Std dev	Mean	Std dev	Mean	Std dev	*t*-test
Household-crop level	**Obs. 10,474**		**Obs. 5,193**		**Obs. 5,281**		
Yield value (LCU, 2014 prices)[a]	11.8988	0.0278	11.9147	0.0434	11.8816	0.0344	–
Yield, value (LCU, 2014 prices)	275,716	30,430	288,542	20,883	261,877	59,125	–
Commune level	**Obs. 537**		**Obs. 305**		**Obs. 232**		
Standardized commune polygyny[b]	0.3800	0.9400	−0.2300	0.6300	1.1700	0.6300	***
Commune polygyny, rate	0.2300	0.0700	0.1800	0.0500	0.2900	0.0500	***
Household level	**Obs. 3,941**		**Obs. 2,119**		**Obs. 1,822**		
Drought (0,1) (SPEI < −1.5)	0.0723	0.0054	0.0398	0.0058	0.1052	0.0082	***
Household size	12.1735	0.1777	10.6289	0.2028	12.9764	0.2408	***
Share of female members	0.4871	0.0032	0.4880	0.0042	0.4863	0.0039	–
Share of members aged 0–15	0.5185	0.0036	0.5124	0.0054	0.5225	0.0047	–
Wealth index	2.5617	0.0297	2.6039	0.0367	2.5437	0.0361	
Chemical fertilizers use (0,1)	0.3623	0.0114	0.2663	0.0148	0.4177	0.0138	***
Cultivated area (ha)[a]	2.2059	0.0229	1.9119	0.0306	2.2517	0.0280	***
On farm labor per hectare (person-day)	4.7143	0.0254	4.8456	0.0343	4.7273	0.0320	**
Total expenditure for chemicals (LCU, 2014 prices)[a]	3.4929	0.1196	2.7373	0.1428	3.9625	0.1517	***
Total expenditure for improved seeds (LCU, 2014 prices)[a]	1.5587	0.1066	1.6645	0.1390	1.1469	0.0979	***
Total expenditure for hired labor for crop activities (LCU, 2014 prices)[a]	4.1318	0.1054	4.4744	0.1439	3.7566	0.1387	***
Total days of labor worked (family, hired, exchanged labor) for crop activities	374.9604	12.0771	312.9918	15.1954	419.0449	16.1906	***
Total days of family labor for crop activities	333.4410	11.8395	268.5688	14.9539	354.9505	12.7398	***
Total value of production from livestock activities (LCU, 2014 prices)[a]	6.6651	0.1042	6.6336	0.1427	6.7535	0.1531	–
Total expenditure for livestock activities (LCU, 2014 prices)[a]	8.9098	0.0992	8.8242	0.1427	9.0184	0.1349	–
Off-farm income (LCU, 2014 prices)[a]	4.04047	0.1278	4.0003	0.1762	4.0917	0.1567	–
Total days in livestock activities (family)	0.3500	0.0200	0.4100	0.0400	0.2900	0.0300	**
Total days in off-farm activities (family)	0.3700	0.0300	0.4200	0.0400	0.3200	0.0300	**
Total income (from all sources) (LCU, 2014 prices)	692,411	23,973	611,466	29,539	795,652	39,770	***
Non-local private transfers received (0,1)	0.2515	0.0096	0.2434	0.0141	0.2616	0.0128	–
Non-local private transfers received (LCU, 2014 prices)[a]	3.0893	0.1211	2.9938	0.1784	3.2109	0.1572	–

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.

Note: Non-local private transfer inflows include all cash or in-kind transfers a household residing in a given commune received in the past year from non-residents of the commune. LCU stands for local currency unit which, in the case of Mali, is FCFA. [a]In inverse hyperbolic sine. [b]Its mean is not 0 and its s.d. is not 1 because we standardized the polygyny rate variable using the full original sample and not just the sample used for our analyses. Standardized Precipitation-Evapotranspiration Index (SPEI) *** $p<0.01$, ** $p<0.05$, * $p<0$ (p stands for p-value).

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The main analysis of non-local transfers defines them as cash inflows. Separate analyses use different definitions, i.e., cash and in-kind non-food transfers, and all cash and in-kind transfers (results are qualitatively unchanged and are available upon request).

Additionally, we specify the private transfer variable in two ways. First, as a binary indicator equal to 1 if a household reported receiving non-local private transfers and 0 otherwise. Second, as a continuous variable capturing the total monetary value of non-local private transfers received.

(ii) Farm Inputs

Farm inputs play a critical role in enhancing crop yields. To investigate the mechanisms through which polygyny introduces a variation in households' resilience to drought, we analyze the relationship between commune-level polygyny prevalence and households' use of chemical fertilizers, improved seeds, and on-farm labor.

Fertilizers are measured using the inverse hyperbolic sine transformation of expenditure on fertilizers applied to farm plots during the agricultural season. Table 1 indicates that households in communes with above-median polygyny prevalence spend significantly more on fertilizers compared to households in low-polygyny communes. This increased expenditure on fertilizers contributes to higher agricultural labor productivity in high-polygyny communes, as supported by prior research (Boserup 1985; Jacoby 1995).

Improved seeds are similarly measured using the inverse hyperbolic sine transformation of expenditure on improved seeds used during the agricultural season. Interestingly, table 1 reveals that expenditure on improved seeds is significantly higher in low-polygyny communes compared to high-polygyny communes, suggesting potential variations in input adoption strategies across communities.

Labor also serves as a key factor influencing crop yields, and polygyny has the potential to affect labor availability through its impact on household size. Polygyny increases fertility rates (Rossi 2019), which often leads to larger households and, consequently, a larger pool of family labor. In the analysis, labor is defined as the total number of days worked on-farm activities, including soil preparation, seeding, weeding, crop treatment and protection, harvesting, and threshing. This measure includes contributions from both family members and hired workers. According to table 1, the average total labor input for crop activities is 374.96 days, with significantly higher labor input in high-polygyny communes (419.04 days) compared to low-polygyny communes (312.99 days).

(iii) Livestock Activities

The detailed data on livestock ownership and production included in the EAC-I is used to calculate the total value of production and costs associated with livestock activities. Table 1 shows no significant differences in livestock production value between households in low- and high-polygyny communes. Livestock sales contribute to family food security by providing financial resources that can be used directly for food or to improve the family's production systems (Schiere and Katere 2001).

To investigate mechanisms, this paper explores the combined effect of weather shocks and commune-level polygyny on animal husbandry, measured by the number of days household members spend on livestock-related activities. Across the entire sample, households in low-polygyny communes spend more days on livestock activities than those in high-polygyny communes. This counterintuitive result is explained by the higher likelihood of households in low-polygyny communes engaging in livestock activities. However, when households not involved in livestock activities are excluded, we find that households in high-polygyny communes spend more days on animal husbandry than those in low-polygyny communes (results not shown here).

(iv) Off-Farm Activities

Like livestock activities, off-farm work serves as a key income source for households. Polygynous households, often with larger family sizes, may send children—especially daughters—to cities for domestic work. Income earned through such labor can be reinvested into farming, such as purchasing fertilizers or modernizing agricultural production systems.

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To investigate this mechanism, we construct two off-farm variables: (a) the value of income earned from off-farm activities and (b) the total number of days household members spend on off-farm work. While there is no significant difference in off-farm income between low- and high-polygyny communes, table 1 shows that households in low-polygyny communes spend more days in off-farm activities. However, similar to the case with animal husbandry, households in high-polygyny communes are less likely to engage in off-farm work. When we consider only households that participate in off-farm activities, we find that households in high-polygyny communes spend more days on such activities than their counterparts in low-polygyny communes (results not shown here but are available upon request).

3.3. Drought Data

Following Harari and Ferrara (2018), Miao and Popp (2014), and Vicente-Serrano, Beguería, and López-Moreno (2010), we use the Standardized Precipitation-Evapotranspiration Index (SPEI) to measure droughts. The SPEI data are sourced from the SPEI Global Drought Monitor, which provides global-scale information on drought conditions. The SPEI offers timescales ranging from 1 to 48 months, with a calibration period extending from January 1950 to the present.

For the analysis, we observe SPEI values during Mali's 2014 and 2017 rainy seasons (June–October). Using GPS information from the EAC-I data, we match each EA to the corresponding SPEI grid cell, allowing us to calculate rainfall shocks at the EA level. A drought is defined as occurring only when the SPEI value falls below −1.5, capturing severe to extreme drought conditions (Vicente-Serrano, Beguería, and López-Moreno 2010). The SPEI index is particularly valuable because it incorporates the combined effects of precipitation, potential evapotranspiration (PET), and temperature. As noted by Vicente-Serrano, Beguería, and López-Moreno (2010), PET is essential for understanding soil moisture dynamics, which are linked to the water cycle and humidity levels. In the SPEI series we used, PET is calculated using the Penman–Monteith estimation, which accounts for several factors, including temperature, humidity, solar radiation, and wind speed.[9] This approach enables the inclusion of weather variables that are strongly correlated with rainfall.

In Mali, seasonal rains are driven by monsoon winds, which transport water vapor into the lower atmosphere (Jean 1985). However, climatic droughts have become almost endemic in recent years. Figure S1.2 illustrates the spatial distribution of drought occurrences across Malian EAs based on SPEI data for 2017. Notably, in 2014, cumulative rainfall levels were normal or above normal throughout Mali, meaning no severe or extreme drought events occurred. In contrast, in 2017, 12.6 percent of the EAs experienced drought episodes, affecting 285 households and yielding 839 observations at the household-crop level.

4. Empirical Strategy

In this section the empirical model is discussed. We use a linear fixed-effect regression model to provide evidence that crop yield losses induced by agricultural droughts vary by commune-level polygyny prevalence. The unit of observation for crop yield is the household-crop. The primary benefit of using crop-specific controls is that they exploit within-household variation in crop yields (Jacoby 1995; Akresh, Chen, and Moore 2012). Crop-specific controls are important for accounting for characteristics such as whether a crop is labor saving or labor intensive, which could be correlated with polygyny. Omitting these controls might introduce bias, primarily if crop choice is systematically related to polygyny.

We specify the following baseline regression model:

$$Q_{chijt} = \beta_1 \text{Drought}_{it} + \beta_2 \text{Drought}_{it} \times \text{Poly}_j + e_h + \rho_c + \eta_t + \lambda_i + \epsilon_{hijt}. \quad (1)$$

9 https://spei.csic.es/database.html

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The dependent variable Q_{chijt} is the natural logarithm of crop c's yields for a household h living in EA i (located in commune j) at time t. The variable Drought_{it} is a time-varying variable measuring drought occurrence at EA i in year t; Poly_j measures polygyny prevalence in commune j. We include e_h and ρ_c to control for household ethnic group and crop-specific invariant effects, respectively, EA fixed effects λ_i to account for the potential correlation between unobserved time-invariant factors at the EA level and polygyny prevalence, and year η_t fixed effects to account for year effect. The term ϵ_{chijt} is a zero-mean error, which captures the effect of unobserved factors that influence crop yield. Robust standard errors are clustered at the EA level.

In the robustness checks discussed in the results section, we control for additional time-varying controls. Yet cultural norms, governance, and historical factors Mungai et al. (2017) may correlate with Drought × Poly and crop yields, violating the conditional independence assumption. Furthermore, farmer-level characteristics, such as skill and experience, which might help farmers adapt better to drought conditions, may impact whether or not they live in polygynous communities (Nchanji et al. 2020), violating the exogeneity of the treatment. Therefore, we acknowledge that time-varying unobservables correlated with both treatment and outcome may still bias the estimates in the absence of a valid instrument for polygyny, thereby precluding a causal interpretation of our findings (Angrist and Pischke 2009; Wooldridge 2010).

Another concern arises if men seeking multiple wives self-select into highly polygynous communes, thereby affecting β_2. However, migration in rural Mali is rare, with an annual rate of just 1.2 percent for men between 2014 and 2016 (Hidrobo, Mueller, and Roy 2022). This alleviates concerns about endogenous selection due to migration and its potential influence on the results.

5. Results

This section presents and discusses the estimation results of the various regression specifications. We also discuss the results of robustness checks and the mechanisms.

5.1. Baseline Estimation Results

The results of the baseline model are reported in table 2. We start with a parsimonious specification where we control only for the year, EA, crop, and ethnicity fixed effects (see column 1). It reports the results of the first specification (equation 1)—the baseline. While the average effect of drought on crop yield in rural Mali is not statistically significant, the results reveal considerable heterogeneity based on commune-level polygyny prevalence. Column 1 indicates that drought occurring in the current agricultural season (t) in non-polygynous communes reduces crop yields by 63.18 percent. On the other hand, such a negative effect is reduced in highly polygynous communes. In other words, in communes that experienced drought episodes, a one standard deviation increase in the commune-level prevalence of polygyny within a given rural commune fully mitigates its adverse effect on crop yields (as reported by the equality test in the table). These results suggest that polygyny prevalence is likely to be associated with coping mechanisms against agricultural droughts. They are consistent with the literature (Akresh, Chen, and Moore 2012; Damon and McCarthy 2019), suggesting that the drought effects on crop yields are higher in more polygynous communes than in less polygynous ones. Column 2 of table 2 accounts for spatial correlation across EAs, column 3 for cultural correlates—by interacting drought with household ethnic identity—and column 4 for time trends of polygyny's prevalence. The coefficients of interest are statistically significant for all specifications and are qualitatively the same.

5.2. Heterogeneous Effect by the Level of Polygyny and by Crop Type

As just shown, drought significantly reduces crop yields in affected communities with no polygyny prevalence, while this negative impact is mitigated in more polygynous communities. In this subsection we

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Table 2. The Effect of Drought on Crop Yield

Yield (inverse hyperbolic sine)	(1)	(2)	(3)	(4)
$Drought_t$	−0.8509***	−0.8509***	−0.8049***	−1.1100***
	(0.2296)	(0.2661)	(0.2344)	(0.2206)
$Drought_t \times$ Polygyny	0.7120***	0.7120***	0.5930***	–
	(0.1894)	(0.2052)	(0.2238)	
$Drought_t \times$ Polygyny *(2nd quartile)*	–	–	–	0.9065*
				(0.5190)
$Drought_t \times$ Polygyny *(3rd quartile)*	–	–	–	0.3605
				(0.3536)
$Drought_t \times$ Polygyny *(4th quartile)*	–	–	–	1.4382***
				(0.3083)
Test: $Drought_t + Drought_t \times Polygyny = 0$	−0.1389	−0.1389	−0.2119	0.3283
	(0.1737)	(0.2011)	(0.1865)	(0.2371)
Year FE	Y	Y	Y	Y
EA FE	Y	Y	Y	Y
Ethnic FE	Y	Y	Y	Y
Crop FE	Y	Y	Y	Y
Spatial correlation	N	Y	N	N
Year × polygyny	N	N	Y	N
Observations	10,474	10,474	10,474	10,474
R-squared	0.3110	0.1292	0.3113	0.3115

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.
Note: In column 2, we account for spatial correlation across the Enumeration Areas (EAs) within a radius of 52 km (the median distance across the EAs) by following Conley (1999). In column 4, the equality test is in the 4th quartile. FE = fixed effects. Standard errors are clustered at the EA level. Y=yes; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

explore whether such a heterogeneous effect is linear and investigate the types of crops that provide a pathway for polygyny prevalence to be associated with lower yield loss in the case of droughts.

5.2.1. Quartile of Polygyny Prevalence

As stressed earlier, the mutual insurance mechanism can materialize only if polygyny is sufficiently large in a commune. If its prevalence is too low, the wage rate for hired labor would likely be too low to allow monogamous households to make the needed investment to enhance crop yield against drought. To test this assumption, we define polygyny quartiles. The average prevalence of polygyny in each quartile is 14.4 percent in the first quartile, 20.9 percent in the second quartile, 24.9 percent in the third quartile, and 32.1 percent in the fourth quartile. Consistent with this argument, we find that the coefficient of the interaction between drought and the first quartile of polygyny prevalence is strongly negative and statistically significant; the interaction coefficient turns out to be positive with the second quartile, with that associated with the fourth quartile being the largest and most statistically significant (see column 4 of table 2).

5.2.2. Type of Crops

We divide crops in the sample into care-intensive crops and care-saving crops. In contrast to care-saving crops, care-intensive crops are labor intensive as they require significant care during the growth cycle. We use the classification of care-intensive crops and care-saving crops provided by Guirkinger et al. (2015). According to this classification, rice, cotton, maize, and vegetables are care-intensive crops. In contrast, sorghum, millet, fonio, and niebe are care-saving crops.

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Crops such as sorghum, millet, fonio, and niebe are traditional crops prevalent in the Sahel region, including Mali. By contrast, cotton, rice, and maize are cultivated in many other geographic areas worldwide, including in developed countries where drought-resistant varieties have been developed (Tirado and Cotter 2010). The availability of drought-resistant cotton, rice, and maize seeds in the international market can enhance the adaptation of rural households in the Sahel region, where droughts are a recurrent phenomenon. Moreover, there is also evidence in Sub-Saharan Africa that inter-cropping maize with a legume tree—small tree, shrub, or undershrub—helps soil hold water longer than in maize monocultures (Makumba et al. 2006). Such inter-cropping also yields a double dividend, particularly for farm households engaged in animal husbandry, as legume trees are an important component of the fodder resources for livestock. According to the Food and Agriculture Organization (FAO), the fodder value of their leaves and fruits is very high. For example, in arid and semi-arid zones, such as the Sahel, legume trees provide the largest part of the protein supply during the driest months (Devendra 1992). The above-mentioned facts suggest that for Mali's farmers, switching to care-intensive crops such as maize and rice may be an effective adaptation strategy to recurrent droughts in the country.

Supplementary online appendix table S1.4 presents the results of our estimations. Column 1 provides the estimation results for care-saving crops, while column 2 focuses on care-intensive crops. The table reveals that the heterogeneous effect of drought by polygyny prevalence is entirely driven by care-intensive crops. Specifically, the coefficient of the drought-polygyny interaction is positive and statistically significant for care-intensive crops but not for care-saving crops.

5.3. Robustness

This paper explores the robustness of the main results around a number of estimation issues.

5.3.1. Time-Varying Characteristics

Communes with high rates of polygyny may exhibit distinct characteristics—such as differences in sociodemographic and economic characteristics including wealth—that could independently influence crop yields and resilience to drought, confounding the observed variation in the impact of drought by polygyny status. To address this concern, we first incorporate into equation (1) time-varying household characteristics (X_{hijt}), such as household head and farm characteristics, including head's sex, household size, the ratio of female household members, the ratio of household members aged 0–15, use of chemical fertilizers, area of cultivated land, labor applied per ha (person-day of labor), and quintile of household's wealth index. We show that our results are qualitatively unchanged (see columns 1 and 2 of supplementary online appendix table S1.1), albeit with lower magnitudes than those reported in table 2.

Second, following Heath, Hidrobo, and Roy (2020), we estimate an alternative model that includes interactions between polygyny prevalence and each time-varying control variable (X_{hijt}) to account for heterogeneity in polygyny's effects based on household characteristics:

$$\begin{aligned} Q_{chijt} = {} & \beta_1 \text{Drought}_{it} + \beta_2 \text{Drought}_{it} \times \text{Poly}_j \\ & + \beta_3 X_{hijt} \times \text{Poly}_j + e_h + \rho_c + \eta_t + \lambda_i + \epsilon_{chijt}. \end{aligned} \tag{2}$$

The results remain qualitatively unchanged (see column 3 of supplementary online appendix table S1.1).

5.3.2. Augmented Specification to Account for Systematic Differences Based on Polygyny Prevalence

Based on table 1, household size, use of fertilizers, cultivated land area, and labor applied per hectare are all variables (identified below with X^*_{hijt}) that differ significantly between high- and low-polygyny communes. To address the potentially confounding effect of these systematic differences, we add their

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interactions with drought to the baseline specification:

$$Q_{chijt} = \beta_1 \text{Drought}_{it} + \beta_2 \text{Drought}_{it} \times \text{Poly}_j + \beta_3 \text{Drought}_{it} \times X^*_{hijt} + e_h + \rho_c + \eta_t + \lambda_i + \epsilon_{chijt}. \quad (3)$$

Here too, the interaction coefficient is unaffected, although drought alone loses statistical significance (see column 4 of supplementary online appendix table S1.1).

5.3.3. Time Trends in Polygyny and Soil Quality

Time-varying trend in soil quality is addressed by interacting this variable with year indicators in the model. Again, results do not change (see column 5 of supplementary online appendix table S1.1)

5.3.4. Interaction with Ethnicity

We control for the interaction between drought and household ethnicity, a proxy for traditional customs (Desmet, Ortuño-Ortín, and Wacziarg 2017):

$$Q_{chijt} = \beta_1 \text{Drought}_{it} + \beta_2 \text{Drought}_{it} \times \text{Poly}_j + \beta_3 \text{Drought}_{it} \times e_h + \beta_4 X_{hijt} \times \text{Poly}_j + e_h + \rho_c + \eta_t + \lambda_i + \epsilon_{chijt}. \quad (4)$$

As shown in column 6 of supplementary online appendix table S1.1, results remain qualitatively unchanged.

5.3.5. Crop-Specific Characteristics

The number and type of crops grown by farmers (e.g., labor-saving or labor-intensive traits) may differ across Mali rural communes based on polygyny status. To account for the possibility that the number of crops correlates with polygyny, we test for correlations between the number of crops grown and polygyny prevalence. Results show no significant relationship at either the commune or household level (supplementary online appendix table S1.2). Additionally, we reweight observations to ensure equal contributions from households growing varying numbers of crops (column 1, supplementary online appendix table S1.3). Finally, we re-estimated the model by clustering the standard errors at the household level rather than the commune level, accounting for the possibility that households with more crops could contribute disproportionately to the observations (see column 2, supplementary online appendix table S1.3). Again, the results remained robust to both checks.

6. Mechanisms

Findings show that the effects of drought on crop yields vary with the prevalence of polygyny in the community. Specifically, the interaction term between polygyny prevalence and drought is positive and statistically significant. This raises an important question: What are the underlying mechanisms driving this relationship?

The literature on climate shocks outlines several resilience strategies for farmers living in drought-prone agricultural communities. This includes the use of modern agricultural inputs (e.g., drought-resistant seeds and drought-tolerant fertilizers), intercropping, diversification of sources of income (including off-farm work), and the use of hired labor (Schiere and Katere 2001; Gitz et al. 2012). However, leveraging these resilience strategies requires farming households to access economic resources. Interestingly, the literature on risk management in village economies finds that community-based risk-sharing mechanisms break down in the presence of spatially covariant risks such as droughts (Townsend 1994; Kazianga and Udry 2006; Fafchamps and Gubert 2007). Indeed, multiple sources and types of risk affecting rural households have been documented in village economies (Townsend 1995; Fafchamps, Udry, and Czukas 1998;

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Kazianga and Udry 2006), and their response to these risks analyzed both at the individual (Rosenzweig 1988; Morduch 1995) and community (Platteau 1997; Fafchamps and Lund 2003; Kazianga and Udry 2006; Fafchamps and Gubert 2007) levels. Two significant findings emerge from this literature. First, risks related to recurrent shocks are widespread in the developing world, making them one of the largest contributors to rural poverty. Second, existing community-based risk-management arrangements are helpful strategies for coping with idiosyncratic shocks but are largely inefficient in the face of systemic covariant shocks such as droughts. Moreover, while households holding non-liquid assets such as livestock might have been viewed as a buffer of this type of shock, evidence rejects this hypothesis (Fafchamps and Lund 2003; Kazianga and Udry 2006; Lange and Reimers 2021). These findings suggest that households in village economies must have access to external sources of risk insurance to cope effectively with droughts. In this context, the struggle to survive may induce farming households to harness traditional institutions to access external sources of cash to enhance livelihood resilience.

In this subsection, the paper examines two key patterns. First, it investigates whether the level of non-local private cash transfer inflows into a commune varies with the prevalence of polygyny. The rationale behind this is rooted in the concept of patrilocal marriage.[10] In such settings, married women are often migrants from different geographic areas (Rosenzweig and Stark 1989), which makes them potential sources of non-local private transfers for their marital households. Supporting this idea, fig. 1, constructed using DHS data, illustrates a positive correlation between the prevalence of polygyny in a commune and the proportion of married women who have migrated into it. Consequently, in environments prone to ecological stress that threatens livelihoods, men may turn to polygyny as a form of risk insurance, increasing the likelihood of receiving non-local private cash transfers during a drought. Based on this reasoning, we hypothesize that communes with higher levels of polygyny will receive more non-local private transfers during droughts compared to communes with lower levels of polygyny.

Second, it examines whether the adoption of resilience strategies against drought varies with the prevalence of polygyny in affected communes. Specifically, the paper focuses on two resilience strategies: the use of commercial farm inputs and participation in off-farm activities. The empirical strategy explores whether communes with higher levels of polygyny, compared to their less polygynous counterparts, are more likely to receive non-local private cash transfers, spend more on fertilizers, and hire labor during periods of drought.

Furthermore, to explore whether drought induces households in more polygynous communes to engage more in off-farm activities than their counterparts in less polygynous communes, the article focuses on participation in livestock activities (such as transporting livestock to selling points) and in non-agricultural work (such as transporting charcoal, wood, or water for drinking and other domestic use). The idea here is that because drought tends to induce livestock starvation, households may engage in "a fire sale" (Kazianga and Udry 2006) or sell energy products and water, traveling to nearby cities to sell them. To do this, they may need to pay for transportation or hire extra workers to cater to their livestock, charcoal, wood, or water during the journey to the market. Thus, the more non-local private transfer inflows a community receives, the more opportunities for off-farm work within the community during drought.

To conduct these investigations, the paper replicates the model in equation (1) for each outcome mentioned. Except for total and family labor, the data on the above-mentioned variables are left-censored as they have many zero values. If censoring is ignored, the effect of the explanatory variables would be underestimated. Therefore, the paper uses the semiparametric method for censored estimation developed by Honoré (1992), which, unlike typical maximum likelihood estimators for censored variables, accounts for fixed effects in a consistent way. We estimate the following censored model:

$$Y^{*}_{hijt} = \beta_1 \text{Drought}_{it} + \beta_2 \text{Drought}_{it} \times \text{Poly}_j + e_h + \eta_t + \lambda_i + \epsilon_{hijt}, \quad (5)$$

10 Estimates based on the Murdock ethnographic atlas reveal that 100 percent of ethnic groups in Mali are patrilocal, meaning that newly married couples reside with or near the husband's parents.

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with $Y_{hijt} = \max\{0, Y^*_{hijt}\}$, and where Y_{hijt} represents the outcome mechanism, i.e., non-local private transfer inflows into the community, expenditure on fertilizers, improved seeds, and on-farm hired labor; on-farm total and hired labor in days; the value of production and costs from livestock activities and the days of work spent by household members in livestock activities; income from off-farm activities and the number of days of work spent by household activities in off-farm activities for household h, Y^*_{hijt} represents their unobserved latent variables. In separate estimations, non-local private transfer inflows are also defined in a dichotomous way, identifying whether a household received such transfers or not; in such a case, a linear probability model with time and spatial fixed effects was used.

6.1. Do Non-Local Transfer Inflows Vary by Polygyny Status?

To effectively leverage the resilience strategies discussed above during droughts, households must have access to external economic resources. These resources include funds to purchase fertilizers, hire labor, pay user fees for water access, or transport livestock. However, this raises a critical question: Given that community-based risk insurance mechanisms, as the literature suggests, tend to break down in the presence of covariant shocks such as drought, and farm households lack access to formal financial institutions for loans, how do they finance the resilience strategies identified above? Our results provide an answer to this question.

To start with, we discuss the coefficient of drought interacted with the same continuous definition of the polygyny prevalence used in the baseline specification presented earlier. As shown in columns 1 and 5 of table 3, there is no difference in the inflows of non-local private transfers (defined as continuous and binary variables, respectively) by polygyny prevalence following a drought. However, to account for non-linearity in the drought-transfers nexus by polygyny prevalence, we categorize the commune-level polygyny variable into quartiles and interact them by drought. The results, presented in table 3, indicate that the coefficient for the interaction between drought and polygyny is positive and statistically significant only from the second quartile of polygyny prevalence, while strongly negative for the lowest quartile. As a robustness check not reported here but available upon request, we augmented the specification with several community- and household-level controls. The results show that the positive effect of drought is driven by the highest quartile only. This suggests that communes with high polygyny prevalence receive significantly more private transfer inflows during drought compared to communes with lower prevalence levels. Finally, as a placebo test, we define private transfers as local transfers (see columns 4 and 8). As expected, findings show no significant effects irrespective of the level of polygyny prevalence.

6.2. Does Resilience to Drought Vary by Polygyny Status?

The results of the different estimations are reported in tables 4, 5, and 6. We separate the estimation results of polygyny's effects on households' resilience strategies into three groups: (i) farm inputs, (ii) diversification of income sources from livestock, and (iii) off-farm activities.

(i) Farm Inputs Use and Polygyny Prevalence

In table 4, we present the results for the hypothesis that the use of improved crop variety and fertilizers as a resilience strategy during drought is more significant in more polygynous communes compared to those with a low prevalence of polygyny.

Starting with intermediate farm inputs, we find drought has no statistically significant effect on household expenditures on either chemicals (column 1) or improved seeds (column 2) in less polygynous communes. The result in column 2 was expected because agricultural drought takes place after seeds have been bought and planted (Li et al. 2013). However, compared to less polygynous communes, households in more polygynous communes increase their fertilizer expenditures in response to drought (column 1). This is expected because the use of drought-resistant fertilizer enhances crop recovery from drought. We

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Table 3. Mechanism: Effect of Drought on the Inflows of Private Transfers

	Inflows, received or not (1/0)				Inflows, amount (inv. hyp. sine)			
	Non-local		Local		Non-local		Local	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Drought_t$	0.0086	−0.2928***	−0.0064	−0.0159	−0.1161	−3.4010***	−0.0609	−0.1747
	(0.1050)	(0.0684)	(0.0187)	(0.0098)	(1.2242)	(0.8123)	(0.9933)	(0.1099)
$Drought_t$ × Polygyny	0.0258	–	−0.0116	–	0.4842	–	−0.1151	–
	(0.1050)		(0.0209)		(1.0502)		(0.2431)	
$Drought_t$ × Polygyny *(2nd quartile)*	–	0.3518**	–	0.0517	–	3.9201**	–	0.5646
		(0.1511)		(0.0364)		(1.7733)		(0.4001)
$Drought_t$ × Polygyny *(3rd quartile)*	–	0.3300***	–	−0.0118	–	3.4633**	–	−0.0944
		(0.1142)		(0.0221)		(1.4516)		(0.2230)
$Drought_t$ × Polygyny *(4th quartile)*	–	0.3624***	–	−0.0146	–	4.3025***	–	−0.1333
		(0.1127)		(0.0310)		(1.3342)		(0.3575)
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
EA FE	Y	Y	Y	Y	Y	Y	Y	Y
Ethnic FE	Y	Y	Y	Y	Y	Y	Y	Y
Mean outcome	0.2450	0.2450	0.0213	0.0213	3.0121	3.0121	0.2376	0.2376
Observations	4,008	4,008	4,008	4,008	4,008	4,008	4,008	4,008
R-squared	0.3469	0.3579	0.2790	0.2798	0.3579	0.3592	0.2566	0.2573

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.

Note: The outcomes include inflows of private transfers, by which we mean cash transfers a household residing in a given commune received in the past year from non-residents (columns 1–2 and 5–6) or residents (columns 3–4 and 7–8) of the commune. FE = fixed effects. Standard errors are clustered at the Enumeration Areas (EA) level. Y=yes; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Table 4. Mechanism: Effect of Drought on Farm Inputs

	Expenditure (inverse hyperbolic sine)			Farm labor (total days)	
	Chemicals (1)	Improved seeds (2)	Hired labor (3)	Full (4)	Household (5)
$Drought_t$	−1.0137	1.3704	−1.5505**	−327.8468***	−241.2039**
	(1.4530)	(4.1306)	(0.7440)	(93.1938)	(104.5518)
$Drought_t \times Polygyny$	4.8953***	2.1209	1.5679**	193.2482***	176.2878**
	(1.1894)	(2.7393)	(0.7298)	(71.2649)	(76.6808)
Additional controls	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
EA FE	Y	Y	Y	Y	Y
Ethnic FE	Y	Y	Y	Y	Y
Mean outcome	3.1387	1.1812	4.0910	372.9484	315.0768
Observations	3,941	3,941	3,941	3,941	3,941
R-squared	–	–	–	0.6048	0.6990

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.
Note: Additional controls are head's sex (1=female), household size, area of cultivated land, and quintile of household's wealth index. Labor is defined as the total number of days worked on the farm at the household level. "Full" does not distinguish between household and hired labor. In columns 1, 2, and 3, the censored model presented in equation (5) is used. Columns 4 and 5 are estimated through the linear probability model described by equation (1). FE = fixed effects. Standard errors are clustered at the Enumeration Areas (EA) level. Y=yes; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. Mechanism: Effect of Drought on Livestock Activity

	Livestock value	Livestock costs	Days of family work in livestock activities		
	(1)	(2)	Age ∈ [12, 60] (3)	Age ∈ [12, 18] (4)	Age ∈]18, 60] (5)
$Drought_t$	−0.5164	−0.9511	0.6092	2.2278*	−0.3923
	(0.8665)	(1.0037)	(1.2453)	(1.3417)	(1.3389)
$Drought_t \times Polygyny$	1.5691**	1.6065*	1.4045	0.0224	1.9134*
	(0.6306)	(0.8593)	(1.1256)	(1.1201)	(0.9784)
Additional controls	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
EA FE	Y	Y	Y	Y	Y
Ethnic FE	Y	Y	Y	Y	Y
Mean outcome	6.6339	8.8170	0.3228	0.1832	0.2564
Observations	3,228	3,229	3,645	2,784	3,641

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.
Note: Additional controls are the head's sex (1=female), household size, and the household's wealth index quintile. Livestock value is the total value of production from livestock activities. The censored model presented in equation (5) is used for all columns. FE = fixed effects. Standard errors are clustered at the EA level. All outcomes are transformed in the inverse hyperbolic sine. Livestock value is the value of production from livestock activities. Y=yes; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

do not expect polygyny to play a role in improved seed use in the event of drought because their purchase and use usually precede drought (Li et al. 2013), and the results in column 2 of table 4 concur.

Regarding the use of labor, we find that drought decreases expenditures on hired labor. However, compared to households living in communes with a lower prevalence of polygyny, households living in more polygynous communes spend more on hired labor during droughts. In addition, drought decreases the number of days of farm work by roughly 328 for total labor used and by roughly 241 for family labor. However, compared to their counterparts in less polygynous communes, households in more polygynous communes increase their number of days of farm work by 193 days for the total farm labor used and by 176 for family labor. This suggests that polygyny buffers the negative effect of drought on a household's farm labor use at the intensive margin.

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Table 6. Mechanism: Effect of Drought on Off-Farm Activity

	Off-farm income	Days of family work in off-farm activities		
		Age ∈ [12, 60]	Age ∈ [12, 18]	Age ∈]18, 60]
	(1)	(2)	(3)	(4)
$Drought_t$	−2.5359**	0.9766	0.2695	0.8435
	(1.1909)	(0.8143)	(1.7123)	(0.7717)
$Drought_t \times$ Polygyny	−0.0310	2.2801**	1.1119	2.0825*
	(1.0594)	(1.1307)	(2.1620)	(1.1011)
Additional controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
EA FE	Y	Y	Y	Y
Ethnic FE	Y	Y	Y	Y
Mean outcome	4.1242	0.3763	0.1289	0.3468
Observations	3,955	3,644	2,784	3,641

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.
Note: Additional controls are head's sex (1=female), household size, and quintile of household's wealth index. The censored model presented in equation (5) is used for all columns. FE = fixed effects. Standard errors are clustered at the Enumeration Areas (EA) level. All outcomes are transformed in the inverse hyperbolic sine. Y=yes; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

(ii) Diversification of Income Sources and Polygyny Prevalence?

Diversification of income sources is also a well-documented resilience strategy in drought-prone rural regions (Wan et al. 2016). By diversification of income sources, we mean the addition to the household's farm income of earnings from off-farm work. This includes households' simultaneous involvement in crop production, animal husbandry, non-agricultural employment, and non-local private transfer inflows.

Here, we examine whether the effort to diversify into livestock production is more pronounced among farm households in polygynous communes compared to those in less polygynous communes. The results of this analysis are presented in table 5. Findings indicate that households in more polygynous communes significantly increase the value of production from livestock activities following a drought compared to households in less polygynous communes (column 1). Additionally, these households also increase their expenditures on inputs for livestock activities, including hired labor (column 2).[11]

Furthermore, we find that droughts lead to increased participation in livestock activities among children aged 12–18 (column 3) in less polygynous communes. However, compared to less polygynous communes, more polygynous communes allocate a greater share of family labor to farming during droughts, particularly among adult family members aged 18–60 (column 5).

These results suggest that communities with higher levels of polygyny are better able to leverage diversification into livestock production as a resilience strategy during droughts, compared to less polygynous communities.

(iii) Participation in Non-Farm Employment and Polygyny Prevalence

Another potential mechanism through which the prevalence of polygyny can enhance farm households' resilience to drought is the diversification into non-agricultural employment. Non-agricultural activities can flourish in rural areas if and only if there is a local market for non-agricultural goods. Such activities may include using wheeled carts pulled by horses or donkeys for long-distance transport of charcoal, wood, livestock, or water for drinking and other domestic use (Starkey 2004). We explore this mechanism

11 Our data do not allow for a detailed disaggregation of household expenditures between hired labor and other inputs for livestock activities. Such disaggregation is only available in the 2017 round of data, which shows that expenditures on hired labor accounted for approximately 25 percent of total livestock input expenditures.

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by estimating the effect of the interaction between drought and polygyny prevalence on farm households' participation in non-agricultural employment.

Table 6 presents the results of this estimation. First, we find that drought reduces income from off-farm activities among farm households (column 1) in less polygynous communes. More importantly, compared to their less polygynous counterparts, farming households in more polygynous communes show a greater increase in participation in off-farm activities during droughts (column 2), particularly among active adults (column 4).

Since, during droughts, the prevalence of polygyny is associated with the volume of non-local private transfer inflows into the community, findings suggest that these inflows help create local employment opportunities. In turn, this allows transactions involving non-agricultural goods to persist during periods of drought, thereby supporting greater income diversification in more polygynous communities compared to those that are less polygynous.

7. Conclusion

This paper contributes to the literature on risk coping in village economies by investigating whether the impact of drought on crop yields varies with the prevalence of polygyny in affected communities. The analysis focuses on rural Mali—a drought-prone country situated within the polygyny belt of the West African Sahel region.

This paper finds that highly polygynous communities are more effective at mitigating the adverse effects of drought on crop yields compared to their less polygynous counterparts. This resilience can be attributed to a sequence of adaptive responses observed in more polygynous communities. First, more polygynous communities attract greater non-local private transfer inflows—serving as a form of informal risk insurance—during drought periods. The fact that the adverse effects of drought are mitigated in highly polygynous communes, therefore, suggests that these private transfers generate broader spillover effects, benefiting not only polygynous households but also non-polygynous households within the same community. Second, more polygynous communities employ more commercial farm inputs, hire additional labor, and diversify income sources in response to drought. This further supports the conjecture that inflows of non-local private transfers generate positive externalities in the receiving community.

This paper's findings offer a new perspective on the impact of droughts in rainfed agricultural areas by showing that these effects differ across communities depending on the prevalence of polygyny. In particular, we highlight how highly polygynous communities are better able to mobilize financial and in-kind support from geographically dispersed kinship networks during times of drought. This suggests that polygyny can serve as a mechanism of economic and ecological adaptation, shifting the focus away from its commonly emphasized negative effects on women's social outcomes. These insights open new directions for research and encourage more nuanced policy debates that consider cultural practices as part of strategies for economic and climate resilience.

Data Availability Statement

The data used for this study are all available in the public domain, except for commune-level polygyny data. Links and explanations to these are included in the Data Section.

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Supplementary Online Appendix

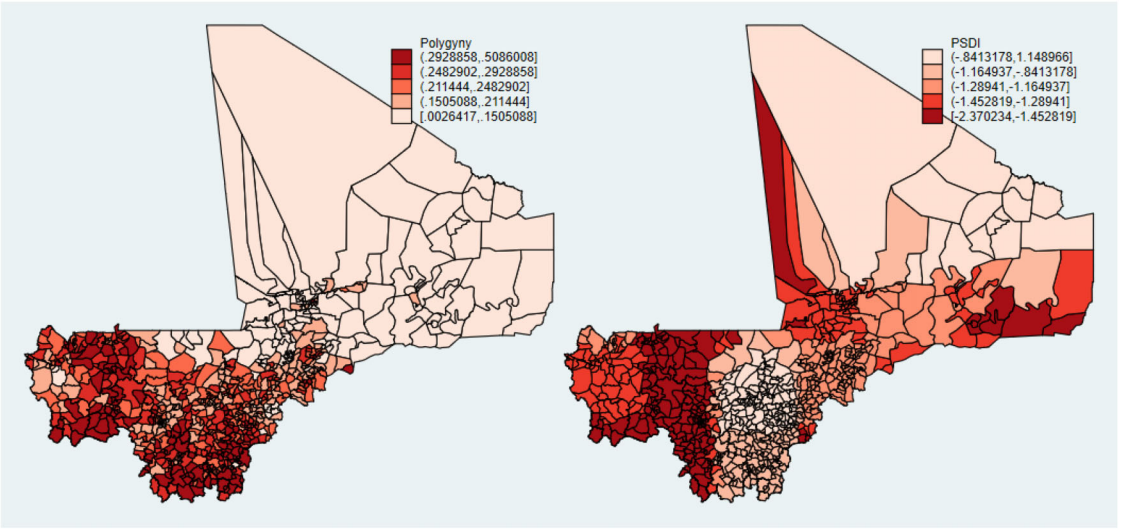
Polygyny and Drought Resilience in Village Economies: Evidence from Rural Mali

Sylvain Dessy, Luca Tiberti, Marco Tiberti, and David Zoundi

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S1. Appendix

Figure S1.1. Historical Distribution of Polygyny's Prevalence and PDSI by Commune



Source: Authors' elaboration based on Mali's Fourth General Census of Population and Housing (2009) (for polygyny's prevalence) and Dai, Trenberth, and Qian (2004) (for drought—defined using the Palmer Drought Severity Index (PDSI), estimated as an average over the period 1968–2018).

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Table S1.1. The Effect of Drought on Crop Yield: Robustness Checks

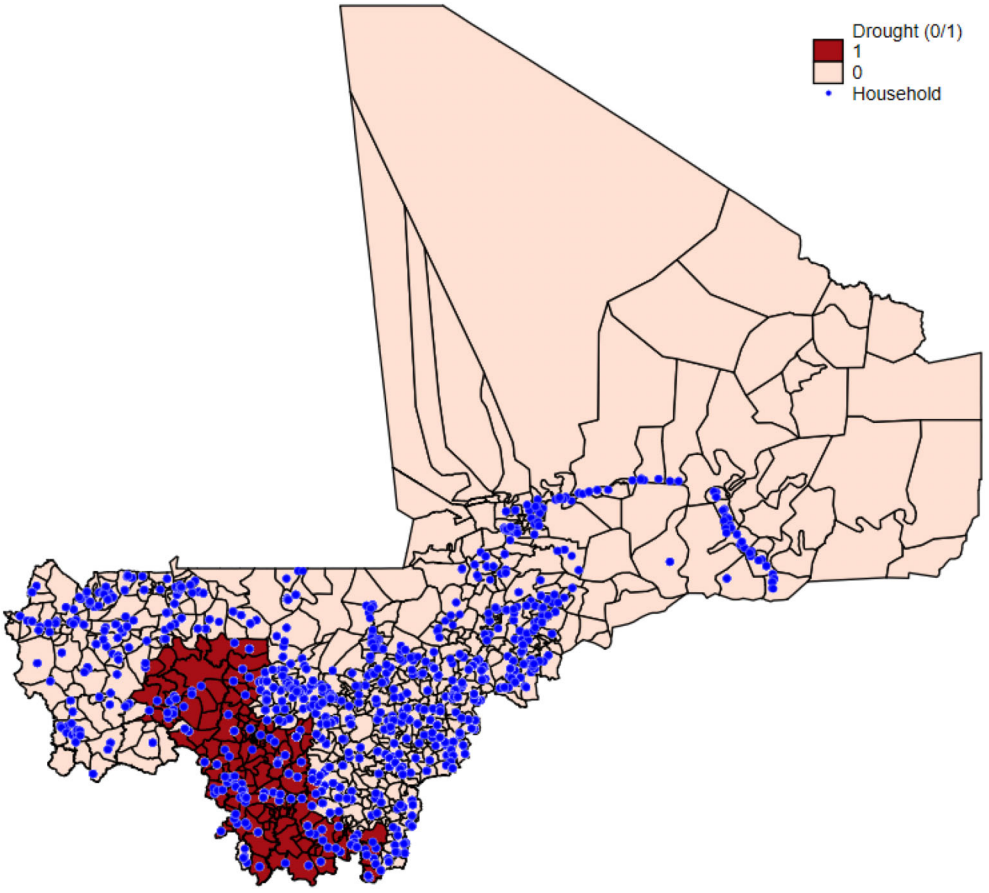
Yield (inverse hyperbolic sine)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Drought_t	−0.6318***	−0.6444***	−0.5489***	−1.7317	−0.6516***	−0.7712***	−0.7623***
	(0.1869)	(0.1753)	(0.1980)	(1.1067)	(0.2004)	(0.2097)	(0.1623)
$\text{Drought}_t \times$ Polygyny	0.6175***	0.6170***	0.5041***	0.6027***	0.6463***	0.5817***	–
	(0.1641)	(0.1382)	(0.1778)	(0.1827)	(0.1714)	(0.1673)	
$\text{Drought}_t \times$ Polygyny *(2nd quartile)*	–	–	–	–	–	–	0.5628
						(0.4493)	
$\text{Drought}_t \times$ Polygyny *(3rd quartile)*	–	–	–	–	–	–	0.2764
						(0.3044)	
$\text{Drought}_t \times$ Polygyny *(4th quartile)*	–	–	–	–	–	–	1.1284***
						(0.2731)	
Test: $\text{Drought}_t + \text{Drought}_t \times \text{Polygyny} = 0$	−0.0143	−0.0274	−0.0448	−1.1290	−0.0053	−0.1895	0.3661
	(0.1603)	(0.1512)	(0.1632)	(1.0722)	(0.1611)	(0.1604)	(0.2357)
Additional controls	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
EA FE	Y	Y	Y	Y	Y	Y	Y
Ethnic FE	Y	Y	Y	Y	Y	Y	Y
Crop FE	Y	Y	Y	Y	Y	Y	Y
Infrastructure controls	N	Y	N	N	N	N	N
Additional controls × polygyny	N	N	Y	N	N	N	N
Additional controls × drought	N	N	N	Y	N	N	N
Year × soil quality	N	N	N	N	Y	N	N
Ethnic × droughts	N	N	N	N	N	Y	N
Observations	10,474	10,474	10,474	10,474	10,474	10,474	10,474
R-squared	0.3354	0.3362	0.3384	0.3352	0.3368	0.3372	0.3355

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.

Note: Additional controls are head's sex (1=female), household size, ratio of female household members, ratio of household members aged 0–15, use of chemical inputs such as fertilizers, area of cultivated land, labor applied per ha (person-day of labor), and quintile of household's wealth index. In column 2, infrastructure controls include the average distance (in km) to the nearest border crossing, to the nearest road, and to the district's capital town (all measured at the EA level), and whether the household has access to an irrigation system in a given plot. In column 5 we account for the interaction of year and soil quality. Soil quality is represented by the following variables computed at the EA level: nutrient availability, nutrient retention capacity, rooting conditions, oxygen availability to roots, excess salts, toxicity, and workability (constraining field management). In column 7, the equality test is in the 4th quartile. FE = fixed effects. Standard errors are clustered at the EA level. Y=yes; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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Figure S1.2. Distribution of Droughts in 2017



Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2017 and Standardized Precipitation-Evapotranspiration Index (SPEI) Global Drought Monitor.

Table S1.2. Correlation Between Polygyny and Number of Crops Grown by Households

	N. of crops	
	(1)	(2)
Polygyny	0.6433	0.0027
	(0.8428)	(0.0861)
Year FE	Yes	Yes
Mean outcome	2.7053	
Observations	3,941	
R-squared	0.4403	0.4397

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.

Note: Observations are at the household level. In column 1, Polygyny is defined as the prevalence of polygyny at the commune level as measured in the census data 2009; in column 2, polygyny is defined at the household level and is measured as a binary indicator that identifies whether the household is polygynous or not. Controls are the same as those reported in the notes of table S1.1 referring to column 2. Standard errors are clustered at the EA level.

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Table S1.3. The Effect of Drought on Crop Yield, with Sampling Weights Adjusted by the Number of Crops in the Household and Different Clustering Level

Yield (inverse hyperbolic sine)	(1)	(2)
Drought_t	−0.5582**	−0.6318***
	(0.1927)	(0.1656)
$\text{Drought}_t \times$ Polygyny	0.5505***	0.6175***
	(0.1627)	(0.1557)
Test: $\text{Drought}_t + \text{Drought}_t \times \text{Polygyny} = 0$	−0.0077	−0.0143
	(0.1880)	(0.1362)
Additional controls	Y	Y
Year FE	Y	Y
EA FE	Y	Y
Ethnic FE	Y	Y
Crop FE	Y	Y
Clustering level	EA	HH
Re-weighting	Y	N
Observations	10,474	10,474
R-squared	0.3964	0.3354

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.

Note: Additional controls are head's sex (1=female), household size, ratio of female household members, ratio of household members aged 0–15, use of chemical inputs such as fertilizers, area of cultivated land, labor applied per ha (person-day of labor), and quintile of household's wealth index. In column 1, we used weights that account for different numbers of crops across households. FE = fixed effects. HH = household. Y=yes; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table S1.4. The Effect of Drought on Crop Yields—Care-Saving Crops vs. Care-Intensive Crops

Yield (inverse hyperbolic sine)	Care-saving crops (1)	Care-intensive crops (2)
Drought_t	−0.1561	−0.7218***
	(0.2697)	(0.2468)
$\text{Drought}_t \times$ Polygyny	0.1705	0.7808***
	(0.2860)	(0.2230)
Test: $\text{Drought}_t + \text{Drought}_t \times \text{Polygyny} = 0$	0.0144	0.0589
	(0.2163)	(0.2201)
Additional controls	Y	Y
Year FE	Y	Y
EA FE	Y	Y
Ethnic FE	Y	Y
Crop FE	Y	Y
Observations	4,512	5,785
R-squared	0.3675	0.3136

Source: Authors' elaboration based on Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (EAC-I) 2014/EAC-I 2017, rural areas.

Note: Additional controls are head's sex (1=female), household size, the ratio of female household members, the ratio of household members aged 0–15, use of chemical fertilizers, area of cultivated land, labor applied per ha (person-day of labor), and quintile of household's wealth index. FE = fixed effects. Standard errors are clustered at the Enumeration Areas (EA) level. Y=yes; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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