ANALYSIS OF THE DETERMINANTS OF LAND SECURITY AMONG WOMEN AGRICULTURAL PRODUCERS IN SENEGAL

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SUMMARY

ABSTRACT

The objective of this study is to determine the factors that influence the security of land rights among women producers in Senegal, as measured by possession of a property document. The data used come from the Integrated Agricultural Survey (AGRIS) of the DAPSA of 2018, 2019 and 2020. Through descriptive analyses and multivariate regression, it emerges that land is mainly cultivated by men regardless of the parcel size or year. The proportion of farmers – among women or men – that holds a property document is very low, less than 6% regardless of the year considered. Among women farmers less than 4% hold a land document in any year. In 2020, more than 90% of women producers operating their own plots were doing so without documentation – in other words their land access relied on informal land rights or verbal agreements without written records. The results show that women land managers who do hold documents are on average older, mostly married, and heads of household, while women owners without documents are younger, and mostly married to male heads of households. Also, women owners with documents have a higher level of education, are more literate, have benefited from more training but operate less land than owners without documents. The land ownership status of women varies according to the agro-ecological zones, each characterized by specific customary practices. Through a multivariate logit model we show that agro-ecological zone and training in agriculture are factors associated with holding a title deed among both women and men, while age, marital status and education level relate to formal documentation of land rights among women producers alone. Finally some other factors including number of plots cultivated, investment in land infrastructure, and the practice of market gardening are only significantly associated with formal land rights among male producers. Knowing that a formal title deed can serve as collateral for obtaining investment credit, the predominance of men in land use as well as the low proportion of farmers holding a document of ownership on the plot for both men and women demonstrate the precariousness of agricultural activity in general but especially for women.

1. Introduction

Like the member countries of the United Nations, Senegal adopted the 2030 agenda in September 2015. This program includes 17 Sustainable Development Goals with 160 targets and 232 indicators. These global goals cover all the challenges of sustainable development in all areas, particularly agriculture and land issues. Target 5a of Objective 5 on gender equality aims in particular to endow women with the same rights to economic resources as well as access to ownership and control of land.

For more than a decade, many low-income countries have been experiencing the phenomenon of large-scale land acquisition. There is an increasing demand for land while the availability of land is declining. In sub-Saharan Africa, land is becoming increasingly scarce. This situation is exacerbating land pressures and access to land has become difficult for many, especially for already disadvantaged populations (small scale farmers, women (Doss & Meizen-Dick, 2020), youth, etc.) due to the economic cost of accessing land and the institutional and regulatory environment surrounding land use rights. Given this state of affairs, a better understanding of barriers to access to land, particularly among vulnerable groups, is essential.

In Senegal, the government has deployed since independence in 1960 multiple legislative efforts seeking to increase the productivity of rural lands, improve land tenure security, decentralize land administration, encourage commercial development. and support the interests of smallholders. Under colonial rule, customary law courts were allowed to coexist with a French-type law code. In 1964, the government passed the National Land Act, which aimed to break the hold of traditional ethnic and religious hierarchies over access to land and encourage more productive uses of land. This law classified 97% of all land as state-owned; the 2-3% that had been registered as free land during the colonial era remained under private ownership. The Law on Rural Communities of 1972 defined the status of elected rural councils and the scope of their jurisdiction. These rural councils have the power to allocate land use rights for state-owned properties, subject to the economically productive use of the land by the landowner (Bruce et al. 1995; Faye 2008; Monkam 2009). Subsequent policies have sought to further clarify processes surrounding the allocation of land rights, including Law No. 96-06 (1996) on decentralization which further formalized the subnational governance structure at the regional and municipal levels (including rural and urban areas) and the 2004 Agro-sylvo-pastoral Development Framework which provided general policy guidance regarding the development of rural lands. The latter in particular recognizes the importance of supporting family farming and secure land tenure.

Most recently, in recognition of ongoing challenges surrounding access to land and persistent low productivity land uses, the government of Senegal passed decree No. 2012-1419 in December 2012, establishing the National Commission for Land Reform (CNRF). Through the CNRF, a land reform policy was defined in 2016. The specific objectives in rural areas were: (i) to ensure land tenure security for farms, people and local communities; (ii) to promote private investment in agriculture for the constitution of more viable farms; (iii) to endow the State and local communities with financial resources, through the management of land resources; and (iv) to alleviate land constraints on agricultural, rural and industrial development.

Despite the clear goal of policies and reforms aimed at improving land management and ensuring tenure security, challenges and constraints persist. The application of the 1964 National Land Act has long faced reluctance and sometimes resistance among rural communities to a law perceived as a dispossession and a surrender of traditional property rights. And more recent land reforms have faced criticism surrounding their complexity and at times lack of clarity around long-term tenure rights. All these factors have led to the creation of a situation of uncertainty and insecurity for the beneficiaries of land allocations, whether they are small farmers or private developers wishing to invest in agriculture.

Along with this general phenomenon of land tenure insecurity, women land users in particular face barriers in access to land, as historically their land access in many countries has already been compromised by significant social and legal constraints (Doss & Meizen-Dick, 2020). Past work on women's access to and control over land in Senegal has highlighted both enabling policies and constraints surrounding women's land tenure, including:

- The Senegalese Constitution, in its Article 15, enshrines the principle of equality between women and men in matters of access and control of land: "The right to property is guaranteed by this Constitution. It can only be violated in the case of legally established public necessity, subject to fair and prior compensation. Men and women also have the right to access possession and ownership of land under the conditions determined by law".
- The de facto preeminence of customary land regimes over modern law, especially in rural communities, tends to limit the scope of the legal principle of constitutional gender equality, because in many areas social, cultural and religious constraints still marginalize women (Enda Pronat, 2011).

- Women have different avenues to access land, either by purchase, by inheritance, or by direct individual request, or by temporary agreements such as loans, or rental, or by exploring indirect land access and use rights, such as through the establishment of Economic Interest Groups (GIE) or other associations.

The 2011 research report of the Gender and Society Group and Research (GESTES) on "Women's rights and access to land: a citizenship to be conquered", funded by the IDRC found that the proportion of women heads of households who own land is very low in Senegal and varies considerably across eco-geographic zones. Estimates ranged from 8.91% in the Senegal River valley, to 8.48% in the sylvo-pastoral zone and 8.36% in Casamance. This proportion was even lower in the Niayes area (4.20%), in Eastern Senegal (3.21%) and in the Groundnut Basin (2.51%).

A number of previous studies in low-income countries have sought to understand barriers to women's land tenure across a variety of agricultural systems. Daniel (2021) examined causes of gender productivity gaps including impacts of land access in Burkina Faso. Their findings suggested that women farm managers were 26% less productive than men, and that one of the key causes of the productivity gap was the lack of access to land among women. Similarly, Abdulai et al. (2011) examined the relationship between land tenure arrangements and household investment in soil improvement and conservation measures using detailed plot-level data from villages in the Brong Ahafo Region of Ghana, finding that differences in land tenure significantly influence farmers' decisions to invest in land improvement and conservation. The results also show that tenure security is positively associated with agricultural productivity.

More recent scholarship on women's access to secure land tenure in Senegal is limited (DAPSA, 2020), but new detailed household survey data through the Annual Agricultual Surveys (AAS) allows for an in-depth exploration of present-day patterns in the allocation of land use rights across the country. A better understanding what factors contribute to and/or constrain women's land rights could support further evidence-based land reform policies

Through this study, the objective is to seek the factors which determine the security of land rights of women producers. Specifically, it will be:

- Analyze the evolution of the proportion of women holding land rights through three waves of the AAS data (2018, 2019 and 2020);
- Describe the profiles of small scale producers who hold secure land tenure versus those who do not;

- Examine the factors associated with the level of security of land rights among women producers;
- Explore patterns across geographical areas in the security of land rights in Senegal.

The paper proceeds as follows. Section 2 describes the conceptual framework for delineating the scope of the study with an emphasis on key elements related to land tenure security for women.

2. Literature review

There have been several past empirical studies on land tenure security, including some focused on women's land access and land use rights, in sub-Saharan Africa.

2.1. Land rights and tenure security

In the Roman law system, land rights can be grouped into three types (Doss & Meinzen-Dick, 2020). The first is *Usus*, or the right to use the land. This right would include both access and withdrawal rights. The second is the *Abusus*, which is the right to modify land. It includes both management and transformation rights (transformation is the right to change the land, so that it has a different use). The third type of right is *Fructus*, which is the right to make profits from the land. Much of the recent literature emphasizes a range of similar propery rights relating to the ability of landholders to control, to use, and to transfer land either through inheritance, gift, or sale, either through formal legal mechanisms (legal tenure) or through customary tenure systems. Customary tenure refers to land rights that are transmitted through social / traditional rules and practices rather than legal mechanisms, the legitimacy of which is rooted in tradition rather than legal status. In Africa, customary land tenure systems are widespread and varied in structure (Grigsby, 2002): specific sets of customary rights may be held by individuals, households, or even entire communities.

Whether under formal legal tenure or customary tenure systems, land tenure security is the assurance that available land rights will not be contested and that, if they are, they will be confirmed by the relevant authorities. Thus, it presupposes legitimate rights and authorities capable of effectively guaranteeing them, whether they are state-based, customary, or hybrid (Lavigne Delville, 2017).

Place et al. (1994) identify three components of general land tenure security:

i) Completeness of land rights;
ii) Duration of land rights; and

iii) Recognition of rights by authorities.

The extent to which a person holds a more comprehensive set of land use, transformation, and transfer rights is often used as an indicator of land tenure security. However duration – i.e., the time horizon over which a person has rights and the extent to which that horizon is certain and known (Doss & Meinzen-Dick, 2020) – and recognition – particularly by legal authorities – are also key components of tenure security. For these reasons formal documentation specifying the extent, durability, and legal status of land rights are often seen as the gold standard of land tenure security.

Security of tenure is essential for farmers to invest in productivity-enhancing and environmentally sustainable land use practices. It has been argued that land formalization leads to positive outcomes for owners (Diop, 2020). For example some studies have shown that improving tenure security through the establishment of official title deeds allows farmers to use land as collateral when applying for credit, hence increasing long-term investments (Diop, 2020). Indeed, the application of sustainable land practices, such as increasing soil fertility and controlling erosion, requires long-term planning, of which security of tenure is an essential condition.

Secure title to land also provides an incentive for farmers to invest in their farms so that their chances of accumulating capital for future benefits are increased. This can lead to an increase in long-term investment capacity and purchases of inputs and, in turn, enhanced agricultural productivity (Ballantyne et al., 2000).

2.2. Land tenure in Senegal

In Senegal, the first attempt at a formal national land policy dates back to 1830, when the French colonial government established a legal framework for private and individual property, followed by the creation of a registration system. With this system, some well-connected and educated farmers were able to amass and register large tracts of land (Ballantyne et al., 2000).

In 1960, after independence, a study carried out by the land tenure reform commission showed that attempts by the French to establish individual title to the land clashed with socio-cultural realities. They noted in particular that policy makers needed to take into account Islamic brotherhoods whose leaders farmed large areas using their followers as farm laborers. Subsequently, Law 64-46 of 1964 on land rights was adopted, placing almost all of the land, approximately 95%, in the national domain. Article 2 of the law states that the State “holds the

lands of the national domain with a view to ensuring their rational use and enhancement, in accordance with development plans and planning programs" (UGB-GESTES, 2008). The overall objective of the policy was to create a national domain by excluding the concept of ownership. Under this law, to this day all unregistered land is part of the national domain.

The application of the law on the national domain has however encountered many difficulties, especially in rural areas. Besides the reluctance to apply the law on the part of those who hold traditional power over land resources through customary systems, critics of the law argue that there has been a lack of clear regulation – particularly surrounding the authories of rural councils to allocate and decommission land rights (Enda Pronat, 2011). Faced with these shortcomings of exisitng land policy, in 2004 the government of Senegal promulgated the Agro-sylvopastoral Orientation Law (LOASP) and, in 2006, a new land policy. Objectives of these reforms summarily included:

- Ensuring security of tenure for farms, people and rural communities;
- Encouraging private investment in agriculture;
- Providing State and local communities with sufficient financial resources, as well as making competent personnel available to them, for efficient, equitable and sustainable management of natural resources;
- Alleviating land constraints for agricultural, rural, urban and industrial development.

Unlike the previous law on the national domain, the new land policy sought to take into account "all economic activities in rural areas (cultivation, breeding, inland fishing, forestry, gathering, processing, trade and services) and further explicitly sought to eliminate any discrimination based on gender or age (Enda Pronat, 2011). The State also undertakes to ensure, in particular in rural areas, the parity of the rights of women and men, in particular in farming, and to grant easier access to land and credit to women (Enda Pronat, 2011).

Some property titles have been issued by authorities in rural communities under the new land policies; however, the holding of title deeds remains extremely low, estimated at roughly 4.5% of plot operators in 2020 (DAPSA, 2020). In lieu of formal titles, farmers still commmonly rely on traditional land management systems (Liversagne, 2021). In rural communities in particular, modes of access for agrarian land in Senegal today include inheritance, loan, donation, clearing, rental and allocation (Ndiaye, 2005), but the latter is the only legal form of tenure according to the modern land tenure system (law of the national domain). The other infra-legal practices all fall under traditional land tenure regimes, and more often than not favor land access rather than

land tenure security – i.e., emphasizing use rights rather than ownership rights. In some cases such customary systems provide rights to farmers to occupy land that is left unused by other farmers (Grigsby, 2002), potentially increasing land access for marginalized populations. But the cohabitation of parallel land tenure regimes – some legally recognized and some not – has also been a source of confusion and conflict (Ndiaye, 2005).

2.4. Barriers to land tenure security among women

In spite of changes to national land policy in Senegal, women's opportunities to control and manage land remain limited. Under customary systems, women's rights to land are often derived from their relationship with a man, such as a father, husband or son, which makes them vulnerable to changes in their social status (Enda Pronat, 2011). This challenge is accentuated by the fact that on the whole, women often do not have access to land as owners in the legal sense of the term (with all rights of use, transformation, and transfer), but rather only as users, tenants, workers or as heritage supervisors on behalf of male children who are future heads of household (Enda Pronat, 2011).

Social position and gender norms

Ethnicity, religion, social class or caste are all factors that can shape women's rights to land. Women's land tenure security can also relate to their own socio-demographic characteristics such as age, education or income. The age and sex of their children may also play a role, for example when widows are charged with holding land as caretakers for sons, but have fewer rights if they have daughters.

In Senegal, land remains essentially managed at the household level, and in the majority, it is men who are at the head of these domestic units. Only 6.6% of heads of households are women in rural areas ; women’s social position within the household thus limits their access to land rights (UGB-GESTES, 2008).

Women on average also have less formal education than men, which increases their marginalization in the field of access and management of land in the sense that they may face barriers in filing documents necessary for formal land certification.

In addition, the process of socialization may further reinforce constraints to women’s land ownership. In many communities men and women themselves find the inequality between men and women vis-à-vis land ownership normal – increasing women's access to secure land rights

thus may require changes in social structures surrounding the status of women (Enda Pronat, 2011).

Limited representation in decision-making bodies

Women are also regularly excluded from organizations where land decisions are made. They are poorly represented within local deliberative bodies (UGB-GESTES, 2008), for example. At the national level in Senegal, in a 2011 study there were 1,606 women elected as compared to 13,380 men, i.e., less than 12% of local elected officials (including those responsible for land management) were women (Enda Pronat, 2011). More recently there has been some evidence that women who participate in local politics such as grassroots organizations or rural councils are more likely to obtain access to land (UGB-GESTES, 2008).

Administrative barriers

The process of securing land itself can sometimes be an obstacle. The majority of women land users in Senegal do not know the procedures for securing land tenure, and even among those familiar with the process, low levels of education and limited resources may impede their ability to write a request to the municipal council to legally obtain a title (IPAR, 2019). In addition, security of tenure can be expensive – many women are unable to register their rights due to time, cost, corruption or the need for complementary resources such as identity cards (IPAR, 2019).

In the following sections we draw on newly available nationally representative data to examine the various sociodemographics, farm characteristics, and geographic / institutional factors associated with women holding formal land title in Senegal.

3. Data and methodology

This study uses a quantitative approach based on data from the DAPSA Integrated Agricultural Survey (AGRIS) from 2018, 2019 and 2020. AGRIS is a multi-year modular agricultural survey program. The AGRIS methodology is developed by FAO as part of the global strategy to improve agricultural and rural statistics. AGRIS is a source of data and provides the framework for the design, monitoring and evaluation of agricultural or rural policies or investments, as well as providing direct information for certain SDG indicators.

To meet the objectives of the study, we pursue two methodological approaches: a descriptive approach and an econometric analysis.

- The first essentially descriptive analysis consists of summarizing the profile of producers with and without documentation of secure land tenure, with a focus on gender. Drawing on Multiple Correspondence Analysis (MCA) we consider the interrelationships between several sociodemographic characteristics, farm characteristics, and geographic variables potentially associated with secure land tenure on a factorial plane. It is possible with this method to integrate multiple quantitative variables by grouping them together in classes making it possible to minimize the loss of information.
- The second approach, a multivariate econometric analysis, seeks to better understand the correlates of land tenure security among women and men. The dependent variable is the possession of an ownership document, which is binary. We thus adopt a logit model testing the association of various sociodeomgraphic, farm, and geographic explanatory variables on the level of security of land rights.

The logit model takes the following form:

$$p_i = prob(y_i = 1|x_i) = F(x_i\beta)$$

where :

p_i is the probability of holding a document;

y_i is the dependent variable i.e. the possession of an ownership document;

x_i is the vector of qualitative variables; and

β is the vector of the model parameters and F denotes a distribution function.

The distribution function of the logit model takes the following form.

$$F(x_i\beta) = \frac{e^{x_i\beta}}{1 + e^{x_i\beta}}$$

The data used for the estimation of the multivariate model are those of the most recently available annual agricultural survey (2020), and consist of 12,605 plots of which 11,098 are managed by men and 1,507 by women. There are 6,010 individual operators of these plots, of which 5,015 are men and 995 are women.

The empirical review shows that tenure security seems to be correlated with a set of sociodemographic characteristics, farm characteristics, and geographic variables. Social status is proxied by socio-demographic characteristics including age, relation to the head of household, and marital status, as well as the level of education represented by the level of formal schooling, access to training in agriculture, and basic literacy. The size of the farm is proxied

by the number of plots cultivated, we also consider the level of permanent improvements on the land such as irrigation, windreaks, or other erosion control. We finally consider crop selection as well as agro-ecological zones as possible factors related to the holding of a title deed: areas that benefit from less agricultural investment, or where agricultural activities are primarily carried out for family subsistence may be marginalized in holding document of ownership.

The available data and measured from the 2020 survey are presented in Table 1. The same explanatory variables are also used in the MCA, except literacy which is replaced by level of formal education and agro-ecological zone which is regrouped into 3 categories to preserve sample size.

Table 1: Definition of variables

Variable name	Categories / Measures
Ownership document on a parcel	*With document* *Without document*
Relationship with the head of household	*Head of household* *Spouse* *Other link (son or daughter of CM, father or mother of CM, other link with CM)*
Marital status	*Married* *Single / Divorced* *Widow*
Age	*Under 40 / 40-65 / 66 and over*
Educational level	*None* *Elementary* *Average* *Secondary / Superior*
Training in agriculture	*Yes* *No*
Literacy	*Literate* *Not Literate*
Number of plots operated by owner	*1 plot* *2 to 3 plots* *More than 3 plots*
Practice of sustainable land management (Dikes / bunds; Windbreaks; Hedges; Stone cord; Drainage channels)	*Present* *Not Present*
Primary crop cultivated	*Industrial crops: Peanuts, Cotton, Cowpeas, Watermelon, Sesame, Cassava, Vegetable crops [Eggplant, Diakhatou, Okra, Sweet potato, Onion, Squash, Green onion, Tomato]*
Agro-ecological zone	*Groundnut Basin* *Senegal River Valley* *Niayes Area* *Ferlo Sylvopastoral Zone* *Casamance* *Eastern Senegal*

Source: Author, AGRIS Database (DAPSA).

4. Results

4.1. Characteristics of operators

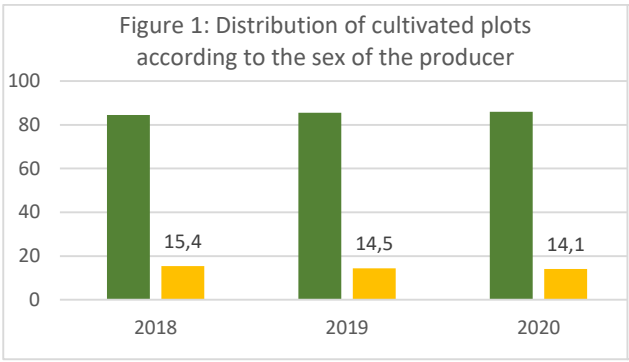
The distribution of plots cultivated according to the sex of the farmer shows that the land is mainly cultivated by men whatever the year. Less than 15% of plots are managed by women in 2018, 2019, or 2020. The proportion of plots managed by women is 14.1% in 2020, down 1.3 percentage points compared to 2018 (Figure 1).

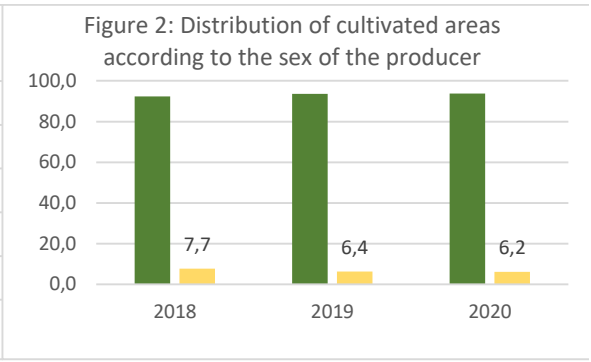
This disparity between men and women, as well as the downward trend in landholding by women over time, is even more pronounced when considering the distribution of cultivated area by sex. The data suggest that only 7.7% of total land area was cultivated by women in 2018, dropping to 6.4% in 2019 and 6.2% in 2020, i.e. a decrease of 1.5 percentage points between 2018 and 2020 (Figure 2).

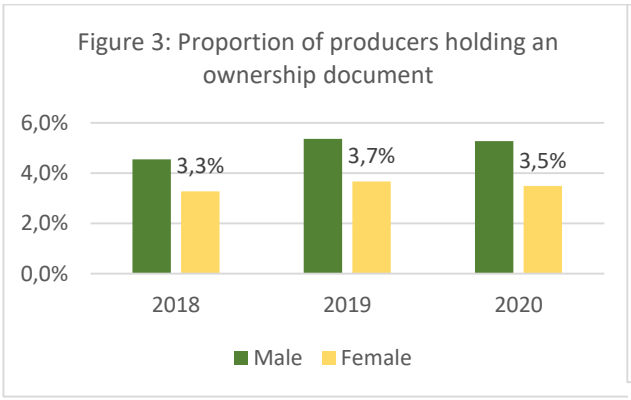
Despite the fact that men manage most of the land, the proportion of farmers who hold a property document is very low – less than 6% of plots - across both women and men, whatever the year considered. The proportion of women's plots with a document of ownership on the plot is even lower (less than 4%). This proportion fell from 3.7% to 3.5% between 2019 and 2020, after a small increase (+ 0.4) between 2018 and 2019 (Figure 3). Borrowed land was more common among women's plots than ownership with documentation – 4.6% of of women's plots were borrowed in 2020.

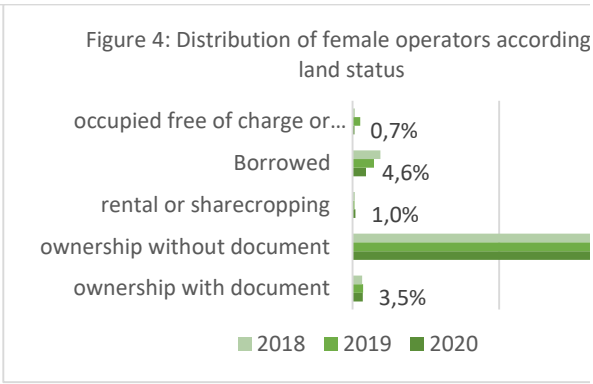
In other words, more than 90% of women's plots in the 2020 survey were operated without formal documentation. The large majority of women's access to land is therefore achieved through informal / customary rules and agreements, without formal legal status (Figure 4). This may reflect many women's plots coming from inheritance, or that the operators do not have the human and financial capital resources necessary to carry out the administrative procedures necessary to protect their heritage.

Knowing that the formal title deed can serve as a guarantee for obtaining investment credit, the predominance of men in the exploitation of the land as well as the low proportion of farmers holding a document of ownership on the plot as well for both men and women demonstrate the precariousness of agricultural activity in general but especially for women.









Source: Authors' calculations.

4.2. Profile of women landowners in 2020

Women landholders with documents are older, mostly married and heads of households compared to women landholders without documents who are younger, mostly married but mostly married to heads of households.

The average age of female plot managers is 44 and more than half (57.8%) are under 46. Women with documents are older compared to those with no documents: the average age of female plot managers with documents is 52 years versus 43 years for plot managers without documents. Also, 58.9% of female plot managers without documents are under 46 years old compared to 36.4% for those with documents.

Women landholders are predominantly married (73.7%), and 51.9% of female landholders are spouses of heads of household. Women landholders without a document are more likely to be married to heads of household (53.1%) than those with a document (25%). Female-headed households are also strongly associated with formal documentation - fully 61.4% of women owners with documents are heads of households.

Divorced women represent 22.4% of female landholders. Single women (1.7%) and widows (2.2%) are rarely landholders in the sample. However in this small sample, the proportion of

divorced female owners among those without documents (34.1%) is higher than that among those with documents (21.9%).

Women owners with documents have a higher level of education, are more literate, and have benefited from more training than owners without documents.

The data show that most female landholders have no formal education (86.6%), though this proportion is lower (72.7%) among women landholders with formal documents. In other words, women landholders with documents have a higher level of education than women landholders without documents. 15.9%, 6.8% and 4.6% of women landholders with documents held elementary, middle and secondary or higher levels against 9.4%, 2.8% and 0.5% for female landholders without documents. Similarly, literate landholders are few in number, at 20.8%, and women landholders with documents are more likely to be literate than those without (40.9% versus 19.9%). Both of these percentages are lower than the national literacy rate which stands at 45.4% according to the results of the last national census in 2013. Few female landholders (3.9%) have received formal training in agriculture. The lack of training is more pronounced among women landholders without documents (96.7%) compared to owners with documents (81.8%).

The land status of women varies according to land management practices and agro-ecological zones, each characterized by specific customary practices.

Women landholders with documents are more likely to have reported sustainable land management installations such as irrigation or erosion control (43.2%) as compared to women without documents (19.5%). However, the average cultivated area is relatively larger for women landholders without documents (0.95 ha) as compared to those with documents (0.8 ha).

We also find that women are more likely to have documentation in the Senegal River Valley (23.3%) and in the Niayes area (15.4%). Women landholders with formal documentation are poorly represented in Casamance (4%), in Eastern Senegal (3.9%) and in the Peanut Basin (2.2%), and there are almost no female-managed plots with documents in the Ferlo.

4.3. Typology of female plot owners using Multiple Correspondence Analysis (MCA)

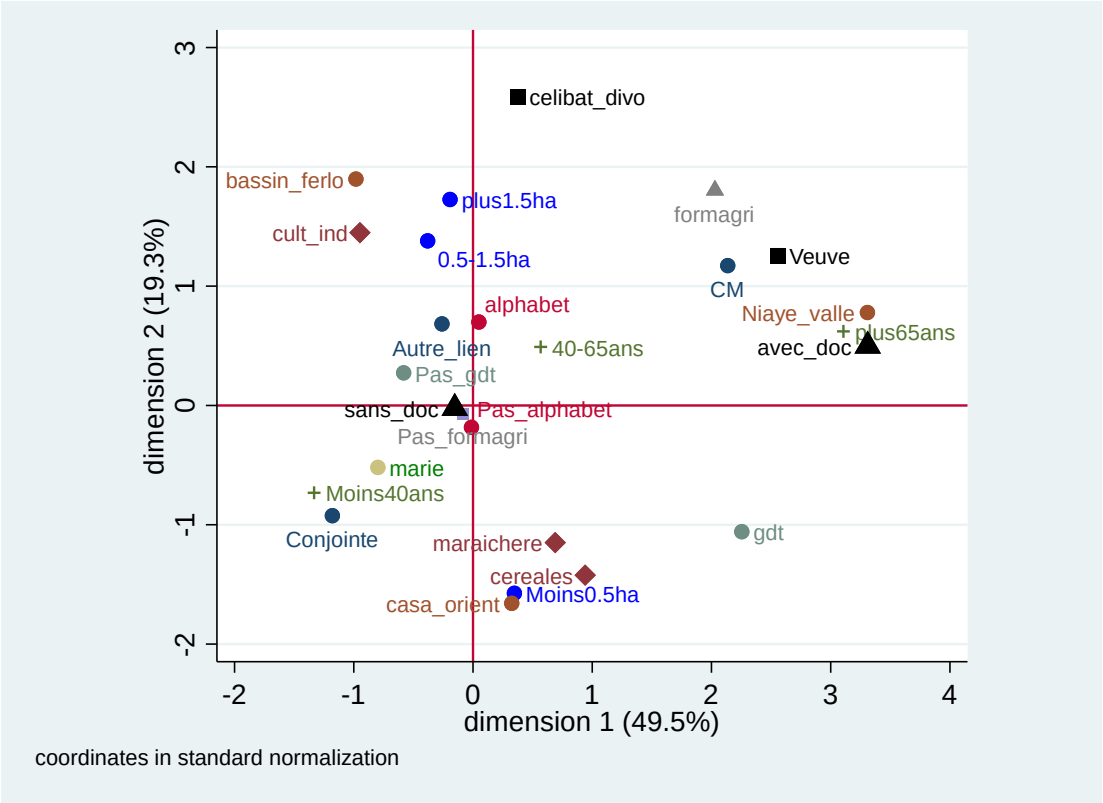
The MCA carried out on women landholders explains nearly 70% of the variation along two axes (49.5% of the variability for the first axis and 19.3% for the second). The first axis (49%

of variability) clearly opposes two types of lanholders: those without documents (to the left of the axis) and those with documents (to the right of the axis). The women landholders without documentation are generally located in the Peanut Basin or the Ferlo and are spouses of the head of household. They did not receive training in agriculture. They generally operate plots of larger surface areas, and do not have infrastructure for sustainable land management.

The other category of landholder corresponds to female landholders with documents. They are more often found in the Senegal River Valley and in the Niayes area. They are more likely to be widowed heads of households, and to have benefited from training in agriculture. They are on average older than the landholders in the first category and more likely to cultivate cereal crops or market gardens.

The second axis (vertical axis) represents 19% of the variability and its interpretation is more difficult. It seems to oppose the owners who are in Casamance or in Eastern Senegal (at the bottom of the graph) to the owners who reside in the Peanut Basin and the Ferlo (at the top of the graph). On the first side are newlyweds who cultivate cereal crops or market gardens ; they are more likely to be illiterate and have not received training in agriculture, though they have some sustainable land management facilities in their plots. This group could represent the rice producers who are very frequent in Casamance, in the south of the country, where there is a strong presence of women in rice plots. In contrast, the other group of landholders represents farmers who are in the Groundnut Basin, where it is more common to cultivate plots of large areas with industrial crops, especially peanuts and cowpeas. These women landholders are more likely to be single or divorced.

Figure 5: Typology of women landowners



Source: Authors' calculations.

4.4. Correlates of land tenure security

Tables 2 and 3 show the results of multivariate logit models for formal land documentation as a function of sociodemographic characteristics, farm characteristics, and geography among the subsample of men (Table 2) and women (Table 3) landholders. The estimated models were validated based on classification rates and ROC curves (see Appendix). The values of the coefficients relate to the log-odds likelihood of a plot having formal documentation; for ease of interpretation we focus on the signs of the coefficients. Odds ratios then show the variation in the probability of holding a document following a change in the level of a given explanatory variable.

Training in agriculture or the agro-ecological zone of residence are associated with the probability of holding a document of ownership among both male and female landholders. The effect of receiving agricultural training is more marked among female landholders;the propensity to have a document among landholders who have received training is multiplied by 3.5 for women and by 2.1 for male owners. The effects of agro-ecological zone suggest that, all else equal, producers in the Senegal River Valley, regardless of gender, are more likely to hold

an ownership document than those in the Groundnut Basin (the reference category). Among male landholders, the fact of residing in Niayes or Casamance rather than in the Groundnut Basin is positively associated with the likelihood of holding a title deed. On the other hand, owners residing in Eastern Senegal and in the Sylvopastoral Zone are less likely to hold a title deed, ceteris paribus.

Certain socio-demographic characteristics such as age, marital status, and level of education are associated with the possession of a property document, but only among women landholders (Table 3). The likelihood of holding an ownership document on a plot is 2.1 times higher if the female landholder is over 65 and 1.2 times higher if she is between 40 and 65 years old relative to younger farmers. Being widowed rather than married is negatively associated with the likelihood of holding a property document. And educational attainment also emerges as an important factor in document ownership: reaching elementary or secondary education increases the probability of having a document. However, the effect of secondary level education is more pronounced than elementary; the propensity to hold an ownership document is nearly 6 times higher if the owner has reached secondary level or above and 2.6 times higher if the owner has completed elementary level.

On the other hand, among male landholders, apart from training in agriculture and the agro-ecological zone, the factors associated with the possession of a property document are the number of plots operated by the owner, the existence of a sustainable land investment (irrigation, erosion control) on plots, and the practice of market gardening. Male owners with a larger number of plots are less likely to have a document of ownership; the fact of operating two plots or three plots decreases the chances of having a document (Table 2) .

On the other hand, the practice of market gardening and the installation of a sustainable land management arrangement on the plots are more favorable to the holding of a title deed, though only among male landholders. These two factors increase the odds of having a property document for men by 3.5 and 1.7, respectively.

Table 2. Correlates of formal documentation among male landholders (2020)

Logistic regression	Number of obs	=	5.015
	LR chi2 (20)	=	331.08
	Prob> chi2	=	0
Log likelihood = -1011.1548	Nickname R2	=	0.1407

doc_prop	Coef.	Odds Ratio	Std. Err.	z	P> z	[95% Conf.	Interval]
nb_parc_class							
2	-0.840 ***	0.432	0.267	-3.140	0.002	-1.364	-0.315
3 and more	-0.923 ***	0.397	0.349	-2.640	0.008	-1.607	-0.239
class_age1							
40-64 years	0.121	1.128	0.186	0.650	0.516	-0.244	0.485
65 and over	0.331	1.393	0.215	1.540	0.124	-0.091	0.753
Relatives link							
Joint	0.700	2.013	1.113	0.630	0.530	-1.482	2.882
Other link	0.198	1.219	0.260	0.760	0.448	-0.312	0.708
sit_mat							
Celibat_divorce	-0.577	0.562	0.421	-1.370	0.171	-1.401	0.248
widow	-0.427	0.652	0.622	-0.690	0.492	-1.647	0.793
form_agri	0.762 ***	2.143	0.183	4.170	0.000	0.404	1.120
school level							
Elementary	-0.193	0.825	0.175	-1.100	0.272	-0.536	0.151
Average	-0.264	0.768	0.272	-0.970	0.331	-0.797	0.268
Secondary / Superior	0.363	1.437	0.256	1.420	0.156	-0.138	0.864
gdt_prop	0.530 ***	1.700	0.149	3.550	0.000	0.238	0.823
cult_ind	0.086	1.089	0.140	0.610	0.540	-0.188	0.359
Market gardening	1.263 ***	3.536	0.263	4.800	0.000	0.747	1.779
zone_agro							
River valley	1.547 ***	4.695	0.180	8.610	0.000	1.194	1.899
Niayes	1.779 ***	5.921	0.300	5.930	0.000	1.191	2.366
Sylvopastoral zone	-0.569 *	0.566	0.329	-1.730	0.084	-1.214	0.076
Casamance	0.785 ***	2.193	0.172	4.560	0.000	0.448	1.123
Eastern Senegal	-1.013 ***	0.363	0.340	-2.980	0.003	-1.680	-0.346
_cons	-3.474	0.031	0.221	-15.720	0.000	-3.907	-3.041

Source: Authors' calculations.

Table 2: Correlates of formal land documentation among female landholders (2020)

Logistic regression	Number of obs	=	938
	LR chi2 (19)	=	74.6
	Prob> chi2	=	0
Log likelihood = -149.2013	Nickname R2	=	0.2

doc_prop	Coef.	Odds Ratio	Std. Err.	z	P> z	[95% Conf.	Interval]
nb_parc_class							
2	-0.589	0.555	0.567	-1.040	0.298	-1.700	0.522
3 and more	-0.809	0.445	0.666	-1.220	0.224	-2.114	0.496
class_age1							
40-64 years	1.265 **	3..541	0.499	2..540	0.011	0.287	2..242
65 and over	2.111 ***	8..254	0.618	3..420	0.001	0.900	3.321
Relatives link							
Joint	-0.283	0.754	0.537	-0.530	0.599	-1.336	0.771
Other link	0.276	1.318	0.547	0.500	0.614	-0.795	1..347
sit_mat							
Celibat_divorce	-0.246	0.781	0.761	-0.320	0.746	-1.738	1..245
widow	-0.803 *	0.448	0.445	-1.810	0.071	-1.675	0.069
form_agri	1..266 **	3..547	0.553	2..290	0.022	0.182	2..351
school level							
Elementary	0.965 **	2.625	0.460	2.100	0.036	0.064	1.866
Average	-0.110	0.896	1.104	-0.100	0.921	-2.273	2.054
Secondary / Superior	1.788 *	5.978 *	0.964	1.850	0.064	-0.102	3.678
gdt_prop	0.155	1.168	0.414	0.380	0.708	-0.656	0.967
cult_ind	-0.366	0.694	0.401	-0.910	0.362	-1.151	0.420
Market gardening	0.324	1.383	0.609	0.530	0.595	-0.870	1.518
zone_agro							
River valley	1.436	4.203 ***	0.548	2.620	0.009	0.361	2.511
Niayes	1.892	6.627	1.335	1.420	0.157	-0.725	4.509
Sylvopastoral zone	0.000	0.000	(empty)				
Casamance	0.010	1.010	0.489	0.020	0.984	-0.949	0.969
Eastern Senegal	0.243	1.275	0.574	0.420	0.672	-0.881	1.367
_cons	-3.816	0.022	0.686	-5.560	0.000	-5.160	-2.471

Source: Authors' calculations.

5. Conclusion

The objective of this study was to explore factors associated with holding title deeds to land among women producers in Senegal. A descriptive analysis based on three years of survey data from 2018-2020 suggests that overall formal documentation of land rights among Senegalese farmers remains rare, at less than 6% of plots operated by men and less than 4% of plots operated by women.

A multivariate analysis of correlates of formal tenure status in 2020 suggest that geography (agro-ecological zone) and participation in formal training in agriculture are factors most strongly associated with the possession of a title deed by all landholders, both women and men. On the other hand, socio-demographic characteristics such as age, marital status and educational level are additional factors associated with the possession of property documents among women, while the number of plots controlled, the use of permanent land improvements like irrigation and erosion control, and the practice of market gardening are significantlt associated with documentation but only among male landholders.

Our results corroborate the conclusions of some previous authors who have explored similar questions. UGB (2009) concluded that the level of education is a determining factor of land tenure security, and that women are less likely to have access to eduction, “ which increases their marginalization in the field of access and land management in the sense that they cannot appropriate elements of the content of texts on decentralization and deliberation acts in the land area." They also argue that the position of women within the household limits their land ownership, noting that land is generally a family patrimony managed at the domestic level, and that in most cases it is the men who are at the head of the households and who manage the land holdings.

Other authors (Benerjee et al, 2002; Abdulai et al. 2011; Gniza Innocent Daniel, 2021) have noted that a title deed forum can allow producers to increase their investments. This could explain the positive correlation observed in this study between the possession of a property title and variables such as the practice of market gardening (with high added value crops requiring investment) and sustainable land management practices such as irrigation and erosion control which over time can improve soil fertility and productivity. This suggests that already-marginalized groups with limited access to formal tenure today may be further marginalized over time owing to lower productivity and incomes.

The research report of the Groupe et de Recherche Genre et Société (GESTES) on “Women's rights and access to land: a citizenship to be conquered”, funded by the IDRC in 2011, similarly concluded that the proportion of women heads of households who own land is higher in the Senegal River area and lower in the Groundnut Basin. Our analysis shows such trends remain a decade later, suggesting barriers remain to realizing the Government of Senegal’s policy goals surrounding equity in women’s access to land rights.

Secure tenure is not a panacea, however. Other authors such as Broegaard (2005), Coles-Coghi (1993), Roquas (2002), Jansen (1998) and Wachter (1997) have argued that in some contexts, the possession of a title does not necessarily mean a high level of land tenure security. The importance of the complex relationship between title and enforcement by authorities is increasingly recognized in economic studies of land tenure such as those by Carter and Olinto (2003) and Laiglesia (2004). Such questions are particularly important in situations where institutional pluralism exists, with several institutions offering potentially conflicting recognize of property claims (Lund, 2001).

In Africa, Atwood (1990) has argued that "registration can create rather than reduce uncertainty and conflict over land rights." This perspective is in line with Boserup's (1965) arguments that "every new step on the road to private ownership in land might well create less, not more, security of tenure, and a large number of disputes are the obvious result" (Boserup , 1965). The issue of land tenure security has also been widely addressed in the studies by Lavigne-Delville (2017), who supports the idea that "it is possible to have a land title and be in insecurity". The author gives the following examples: (a) the case where the individual cannot freely exploit a plot if the name of another person had already appeared on the land title of the land; (b) in the event that justice systems are corrupted and arbitrate in favor of more powerful or richer land users; or (c) if the purchase was illegitimate and the land is occupied by those who feel displaced. Insecurity is therefore created not only by the absence of official documents on tenure, but also by inequality, poverty, the absence or unequal application of rights, abuse of power and the use of violence. A study by Broegaard (2005) in southwest Nicaragua reached similar conclusions - that the formal situation of land titles cannot simply be "translated" into a high degree of tenure security. Some farmers without land title perceive their land situation as secure, while others express tenure insecurity despite having an individual land title.

Despite the extensive work on security of tenure, the effect of holding a document of ownership on security of tenure in Africa is controversial. Customary regimes also provide some legitimacy for peasants to use the land, although they are not legally recognized. Rakodi and

Leduka (2004) and Stanfield (1990) also observed that tenure security can be high in informal tenure systems without formally established property rights. In some cases informal (customary) institutional arrangements can be more cost effective and involve a certain degree of social recognition in the processes of occupation and access to land (Benjaminsen et al., 2009).

Further study is needed to better understand the roles of formal and customary tenure in supporting rural livelihoods in Senegal, among women and men alike.

Acknowledgements

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References

Abdulai, A., Owusu, V., and Goetz R. (2011). [[[[Title]]]]. *Journal of Development Economics*, 96(1): 66-78.

Ahmadou Coumba Ndiaye (2005) The issue of access to land resources for the populations of the Lake Guiers area. Case of the rural community of Mbane. Thesis, ENEA.

Ballantyne, B., Bristow, M., Davison, B., Harrington, S., & Khan, K. (2000). How can land tenure and cadastral reform succeed? An inter-regional comparison of rural reforms. *Canadian Journal of Development Studies*, 21 (3): 693-723.

Broegaard, R.J. (2005). Land tenure insecurity and inequality in Nicaragua. *Development and Change*, 36(5): 845-864.

Doss, C., Meinzen-Dick, R. (2020) Land tenure security for women: A conceptual framework. *Land Use Policy*, 99(###): 105080.

DAPSA (2020), Annual agricultural survey report, P32-35

Diop, M. (2020). To Formalize or Not: Investigating Drivers of Landholders' Decisions for Land Formalization in Rural Sub-Saharan Africa, the Case of Senegal (Doctoral dissertation, University of Maryland, Baltimore County).

ENDA Pronat (2011) - IMPROVING AND SECURING WOMEN'S ACCESS TO LAND IN SENEGAL

Ghebru, H., Hyacinth, E., Ali, D., Deininger K., Okumo, A., & Woldeyohannes, S. (2014). Tenure security and demand for land tenure regularization in Nigeria - Publication - IFPRI | Land Portal. International Food Policy Research Institute, (25).

Grigsby, W.J. (2002). Subsistence and land tenure in the Sahel. *Agriculture and Human Values*, 19 (2): 151-164.

Grigsby, William J. (2004) The Gendered nature of subsistence and its effect on customary land tenure. *Society and Natural Resources*, 17(3): 207-222.

Gniza Innocent Daniel (2021), Modes of Access to Land and the Gender-Linked Productivity Gap in Burkina Faso, Policy Paper No. 750

IPAR (2019), Action research project: “Promotion of inclusive land governance by improving women's land rights in Senegal”. Comparative summary of the key findings of the baseline study

IPAR (2019) “Promotion of inclusive land governance by improving women's land rights in Senegal”

Ine Cottyn, El Hadji Faye, Romy Santpoort and Griet Steel, (2018) For securing women's land rights, stimulating interventions for a lasting impact in Senegal, Working document 3: Securing women's land rights in Africa

Landac (2018), For Stimulation for Impact: Building a Women's Land Rights Movement in Senegal, Guidance Notes 3: Securing Women's Land Rights in Africa

Platteau, JP. (1996). The evolutionary theory of land rights as applied to sub-saharan Africa: A critical assessment. Development and Change, 27, 29-86.

Gaston Berger University (UGB) and Gender and Societies Study and Research Group (GESTES), (2008), Women's rights and access to land: a citizenship to be conquered

Figures and Tables

Figure A1: Distribution of women landholders by age and tenure status

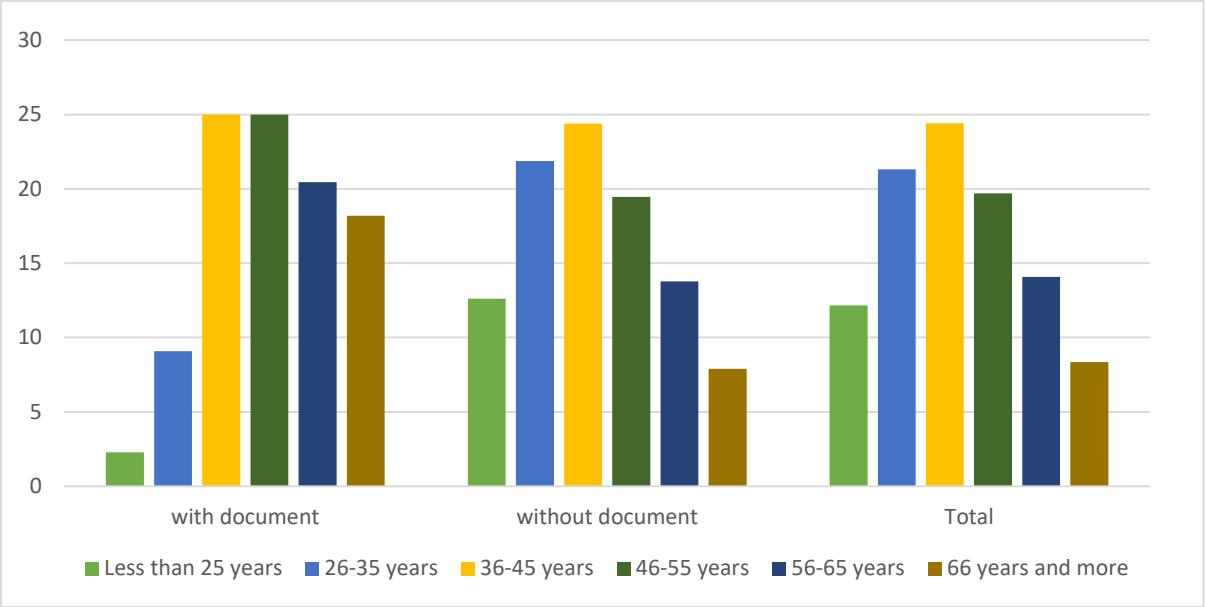

Figure A2: Distribution of female landholders according to their relationship with head of household and tenure status

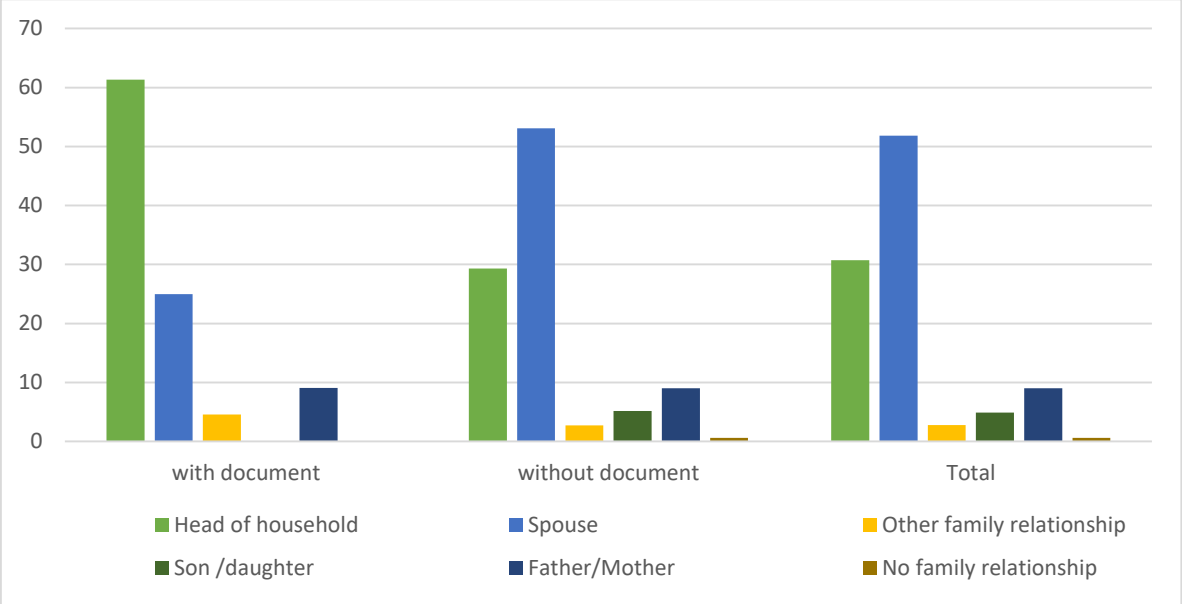

Figure A3: Distribution of women landholders according to marital status and tenure status

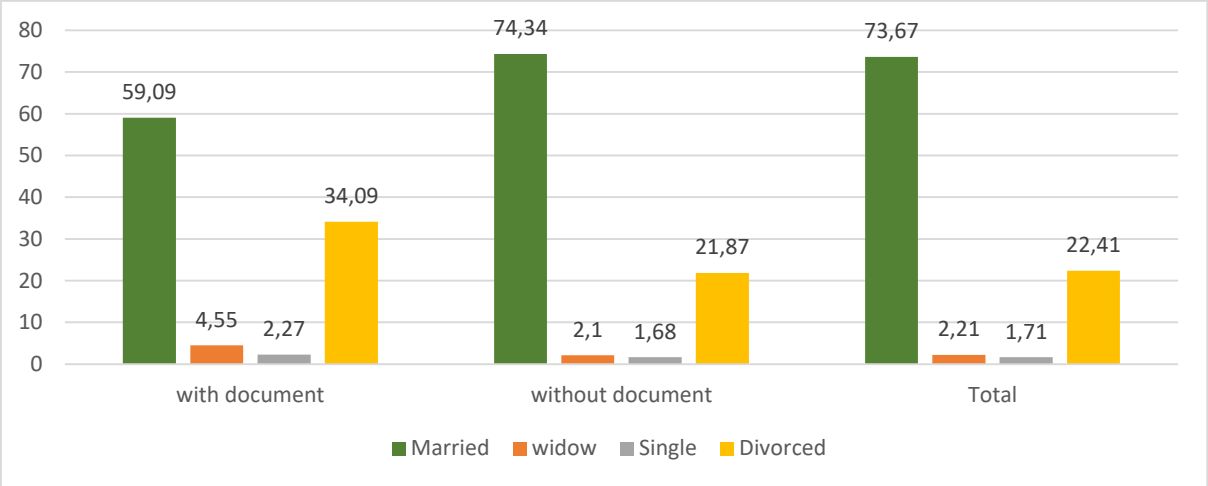

Figure A4: Distribution of women landholders according to educational level by land status

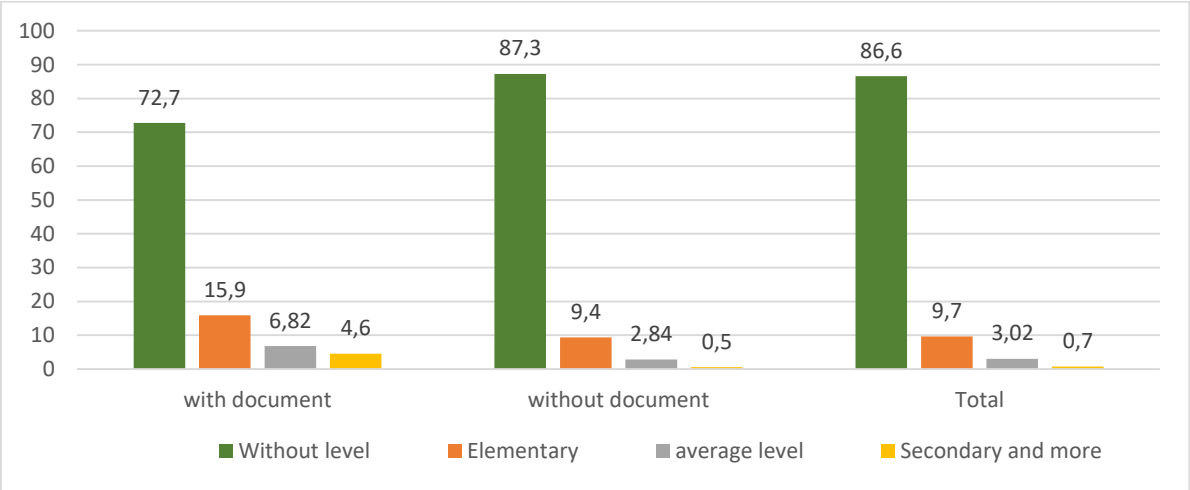

Figure A5: Proportion of women landholders literate by tenure status

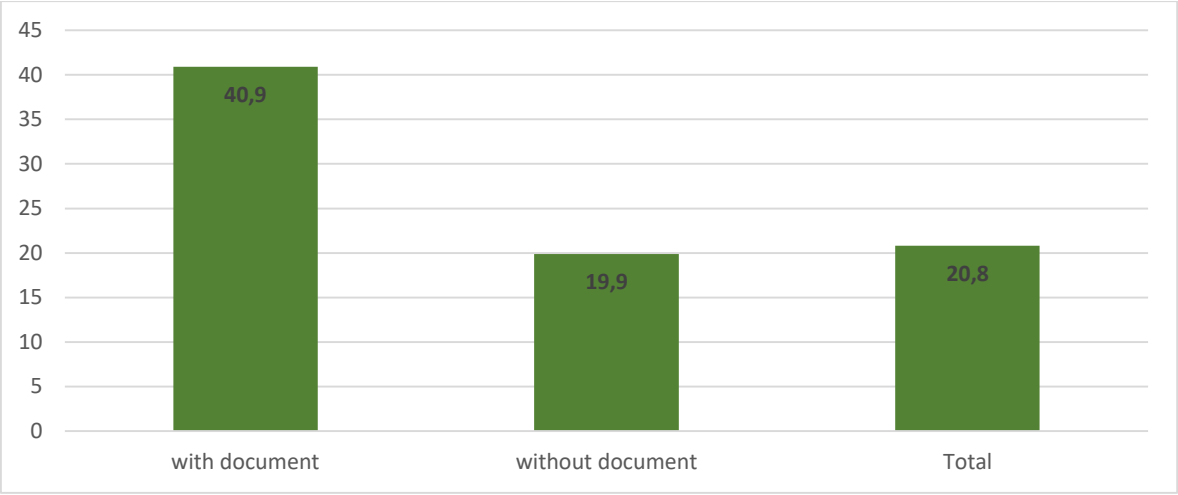

Figure A6: Proportion of women landholders who have received training in agriculture by tenure status

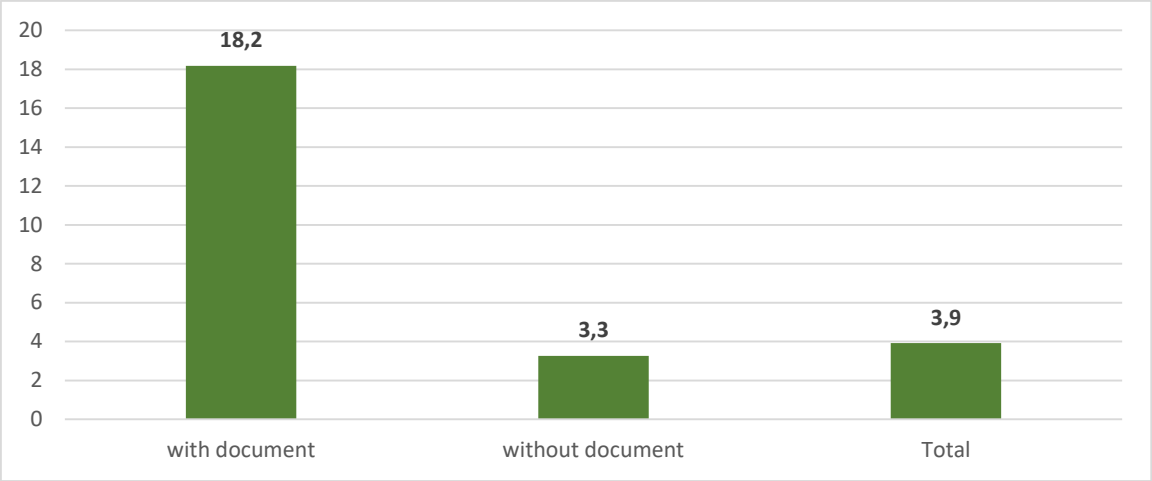

Figure A7: Proportion of women landholders who have installed sustainable land management on plots by tenure status

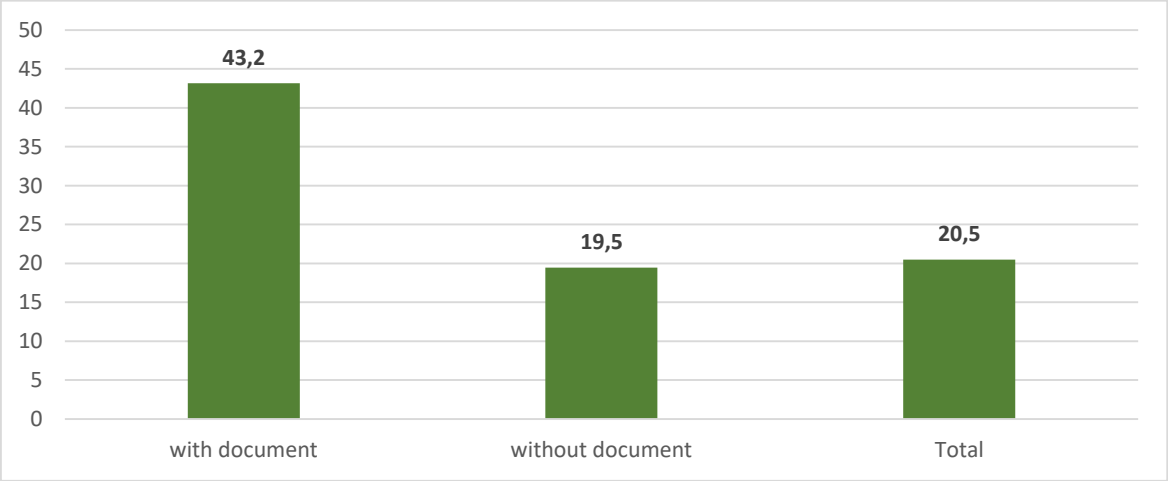

Figure A8: Distribution of women landholders by agroecological zone and tenure status

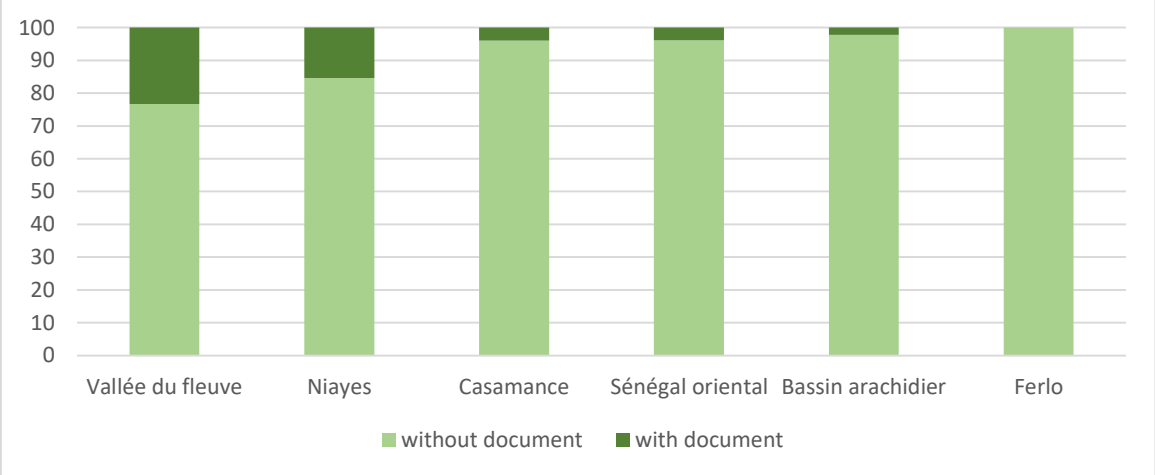

Figure A9: Average area of plots in ha cultivated by female landholders by tenure status

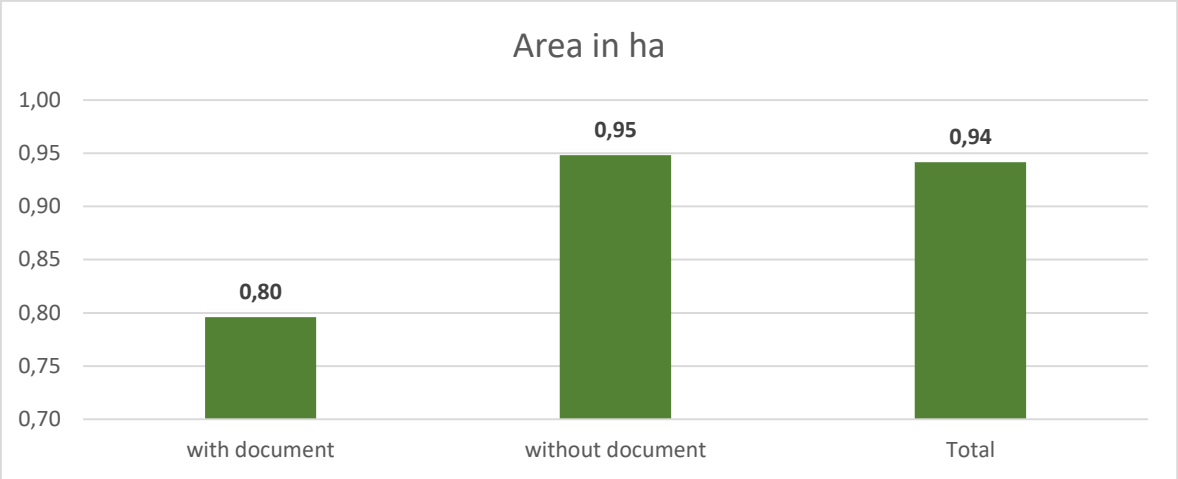

Figure A10: ROC curve

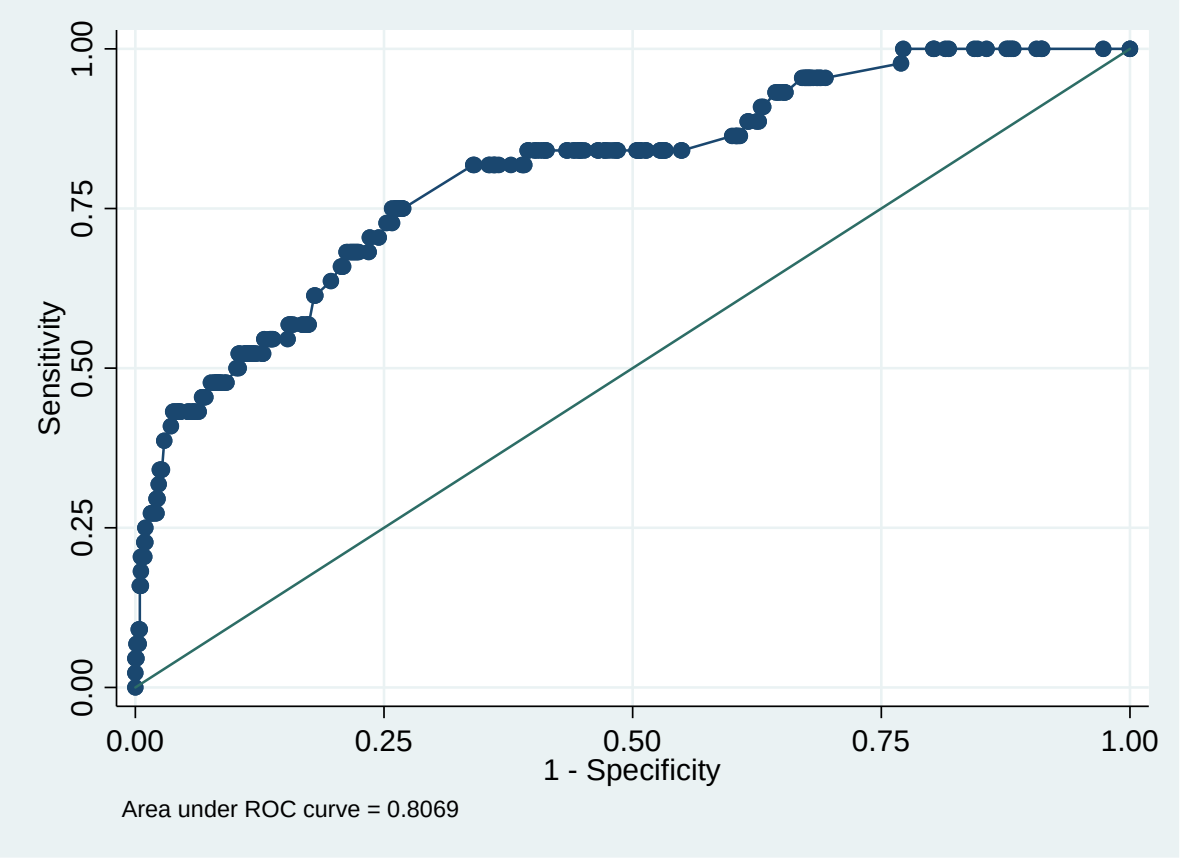

Table 4: Difference test of the proportion of female landholders between 2019 and 2020

```
. prtest prop_femme , by(annee)

Two-sample test of proportions                    2019: Number of obs =     5095
                                                  2020: Number of obs =     5777
```

Group	Mean	Std. Err.	z	P>|z|	[95% Conf.	Interval]
2019	.1672228	.0052281			.156976	.1774696
2020	.1672148	.0049097			.157592	.1768376
diff	7.95e-06	.007172			-.0140489	.0140648
	under Ho:	.007172	0.00	0.999		

```
       diff = prop(2019) - prop(2020)                z =   0.0011
   Ho: diff = 0

   Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.5004         Pr(|Z| > |z|) = 0.9991          Pr(Z > z) = 0.4996
```

Table 5: Test of difference in average age according to land status

```
Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	947	43.15523	.4802064	14.77757	42.21283	44.09762
1	42	51.66667	2.023	13.11054	47.58114	55.7522
combined	989	43.51668	.4707577	14.80456	42.59288	44.44048
diff		-8.51144	2.319918		-13.06398	-3.958902

```
    diff = mean(0) - mean(1)                                  t =  -3.6689
Ho: diff = 0                     degrees of freedom =       987

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0001         Pr(|T| > |t|) = 0.0003          Pr(T > t) = 0.9999
```

Table 6: Difference test of the proportion of plots under sustainable land management (SLM) according to land status

```
. prtest gdt, by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |    .1945321    .012836                      .169374    .2196902
           1 |    .4318182   .0746737                     .2854604     .578176
-------------+----------------------------------------------------------------
        diff |   -.2372861   .0757689                     -.3857904   -.0887818
             |   under Ho:   .0622551    -3.81   0.000
------------------------------------------------------------------------------
        diff = prop(0) - prop(1)                                  z =  -3.8115
    Ho: diff = 0

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(Z < z) = 0.0001         Pr(|Z| > |z|) = 0.0001          Pr(Z > z) = 0.9999
```

Table 7: Difference test of the proportion of literate landholders according to land status

```
. prtest alphabet, by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |    .1987382   .0129401                      .173376    .2241003
           1 |    .4090909   .0741215                     .2638155    .5543663
-------------+----------------------------------------------------------------
        diff |   -.2103527   .0752425                     -.3578254   -.0628801
             |   under Ho:   .0625922    -3.36   0.001
------------------------------------------------------------------------------
        diff = prop(0) - prop(1)                                  z =  -3.3607
    Ho: diff = 0

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(Z < z) = 0.0004         Pr(|Z| > |z|) = 0.0008          Pr(Z > z) = 0.9996
```

Table 8: Difference test of the proportion of landholders trained in agriculture according to land status

```
. prtest form_agri , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |   .0325973   .0057584                      .021311    .0438836
           1 |   .1818182   .0581456                     .0678548    .2957816
-------------+----------------------------------------------------------------
        diff |  -.1492209   .0584301                     -.2637418      -.0347
             |   under Ho:  .0299249    -4.99   0.000
------------------------------------------------------------------------------
    diff = prop(0) - prop(1)                                      z =  -4.9865
  Ho: diff = 0

  Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.0000    Pr(|Z| > |z|) = 0.0000     Pr(Z > z) = 1.0000
```

Table 9: Difference test of the proportion of landholders in the groundnut basin according to land status

```
. prtest zone_agro_1 , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |   .3680336   .0156387                     .3373824    .3986849
           1 |   .1818182   .0581456                     .0678548    .2957816
-------------+----------------------------------------------------------------
        diff |   .1862155    .060212                     .0682021    .3042288
             |   under Ho:  .0740088     2.52   0.012
------------------------------------------------------------------------------
    diff = prop(0) - prop(1)                                      z =   2.5161
  Ho: diff = 0

  Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.9941    Pr(|Z| > |z|) = 0.0119     Pr(Z > z) = 0.0059

. prtest zone_agro_2 , by( document )
```

Table 10: Difference test of the proportion of landholders in the river valley according to land status

```
. prtest zone_agro_2 , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |    .0483701   .0069572                      .0347343    .0620059
           1 |    .3181818   .0702175                       .180558    .4558057
-------------+----------------------------------------------------------------
        diff |   -.2698117   .0705614                     -.4081094    -.131514
             |   under Ho:   .0367074    -7.35   0.000
------------------------------------------------------------------------------
       diff = prop(0) - prop(1)                                  z =  -7.3503
   Ho: diff = 0

   Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.0000         Pr(|Z| > |z|) = 0.0000          Pr(Z > z) = 1.0000
```

Table 12: Difference test of the proportion of landholders in Niayes according to land status

```
. prtest zone_agro_3 , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |    .0115668   .0034673                       .004771    .0183625
           1 |    .0454545   .0314022                     -.0160927    .1070018
-------------+----------------------------------------------------------------
        diff |   -.0338878   .0315931                     -.0958091    .0280335
             |   under Ho:   .0175105    -1.94   0.053
------------------------------------------------------------------------------
       diff = prop(0) - prop(1)                                  z =  -1.9353
   Ho: diff = 0

   Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.0265         Pr(|Z| > |z|) = 0.0530          Pr(Z > z) = 0.9735
```

Table 13: Difference test of the proportion of landholders in the ferlo according to the land status

```
. prtest zone_agro_4 , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
```

Group	Mean	Std. Err.	z	P>|z|	[95% Conf.	Interval]
0	.0588854	.0076337			.0439236	.0738471
1	0	0			0	0
diff	.0588854	.0076337			.0439236	.0738471
	under Ho:	.0355385	1.66	0.098		

```
       diff = prop(0) - prop(1)                                  z =   1.6569
   Ho: diff = 0

   Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.9512         Pr(|Z| > |z|) = 0.0975          Pr(Z > z) = 0.0488
```

Table 14: Difference test of the proportion of landholders in Casamance according to land status

```
. prtest zone_agro_5 , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
```

Group	Mean	Std. Err.	z	P>|z|	[95% Conf.	Interval]
0	.3817035	.0157533			.3508276	.4125793
1	.3409091	.0714604			.2008492	.480969
diff	.0407944	.0731762			-.1026284	.1842171
	under Ho:	.0748446	0.55	0.586		

```
       diff = prop(0) - prop(1)                                  z =   0.5451
   Ho: diff = 0

   Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
Pr(Z < z) = 0.7071         Pr(|Z| > |z|) = 0.5857          Pr(Z > z) = 0.2929
```

Table 15: Difference test of the proportion of landholders in eastern Senegal according to land status

```
. prtest zone_agro_6 , by( document )

Two-sample test of proportions                    0: Number of obs =      951
                                                  1: Number of obs =       44
------------------------------------------------------------------------------
       Group |       Mean   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           0 |    .1314406   .0109566                      .1099661    .1529151
           1 |    .1136364   .0478452                      .0198615    .2074112
-------------+----------------------------------------------------------------
        diff |    .0178042   .0490837                     -.078398     .1140065
             |  under Ho:    .0519699     0.34   0.732
------------------------------------------------------------------------------
       diff = prop(0) - prop(1)                                      z =  0.3426
    Ho: diff = 0

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(Z < z) = 0.6340         Pr(|Z| > |z|) = 0.7319          Pr(Z > z) = 0.3660
```

Table 16: Difference test of the average surface area according to land status

```
. ttest sup_prop, by(document)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     951    .9481978    .0480412    1.481509    .8539187    1.042477
       1 |      44    .7958606    .1749136    1.160246    .4431137    1.148608
---------+--------------------------------------------------------------------
combined |     995    .9414613    .0465593    1.468648    .8500956    1.032827
---------+--------------------------------------------------------------------
    diff |            .1523372    .2265335               -.2922021    .5968765
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.6725
Ho: diff = 0                     degrees of freedom =      993

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7493         Pr(|T| > |t|) = 0.5014          Pr(T > t) = 0.2507
```

Table 16: Additional results of the MCA on the first two axes

	dimension_1			**dimension_2**		
Categories	coord	Sqcorr	contrib	coord	sqcorr	contrib
document1						
with doc	3.31	0.709	0.048	0.499	0.006	0.001
no doc	-0.153	0.709	0.002	-0.023	0.006	0
zone_agro1						
ferlo basin	-0.982	0.302	0.04	1,898	0.44	0.15
Niaye valle	3.308	0.71	0.08	0.779	0.015	0.004

casa orient	0.325	0.061	0.005	-1.658	0.619	0.14
sitmat1						
married	-0.798	0.601	0.047	-0.52	0.099	0.02
celibacy di ~ r	0.378	0.017	0.001	2,588	0.306	0.026
Widow	2,556	0.649	0.146	1,255	0.061	0.035
form_agri1						
formagri	2,029	0.269	0.016	1.804	0.083	0.013
Not formagri	-0.083	0.269	0.001	-0.074	0.083	0.001
alphabet1						
alphabet	0.049	0.001	0	0.699	0.086	0.01
Not alphabet	-0.013	0.001	0	-0.184	0.086	0.003
gdt1						
gdt	2,255	0.796	0.104	-1.058	0.068	0.023
Not gdt	-0.581	0.796	0.027	0.273	0.068	0.006
area						
Less05ha	0.347	0.084	0.006	-1.575	0.673	0.12
05-15ha	-0.38	0.124	0.005	1,379	0.636	0.07
more15ha	-0.193	0.016	0.001	1,726	0.49	0.044
age						
Under 40	-1.333	0.671	0.073	-0.732	0.079	0.022
40-65years	0.567	0.483	0.016	0.491	0.141	0.012
over 65	3.107	0.776	0.081	0.621	0.012	0.003
culture						
cult ind	-0.949	0.407	0.044	1,448	0.37	0.103
cereals	0.941	0.388	0.04	-1.423	0.346	0.09
vegetable grower	0.69	0.13	0.003	-1.15	0.141	0.009
link_paren1						
CM	2,136	0.671	0.14	1.172	0.079	0.042
Spouse	-1.18	0.565	0.072	-0.924	0.135	0.044
Other link	-0.26	0.04	0.001	0.683	0.108	0.008

Table 17: Ranking rate of the logit model

Classified + if predicted Pr(D) >= .5
True D defined as document != 0

Sensitivity	Pr(+| D)	6.82%
Specificity	Pr(-|~D)	99.89%
Positive predictive value	Pr(D| +)	75.00%
Negative predictive value	Pr(~D| -)	95.61%
False + rate for true ~D	Pr(+|~D)	0.11%
False - rate for true D	Pr(-| D)	93.18%
False + rate for classified +	Pr(~D| +)	25.00%
False - rate for classified -	Pr(D| -)	4.39%
Correctly classified		95.53%