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The Cultivation of "Cotton under Corn": Peasant Logic in Question in the Plateaux Region of Togo

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ABSTRACT: Togo's cotton growers have integrated "cotton under maize" into their production system in their quest for innovative solutions. This practice is of heuristic interest insofar as agricultural policies are constantly being improved. The aim of this paper is to analyze the social logics underlying this innovative cultivation practice. Analysis of qualitative data collected from 254 randomly selected cotton growers in the Plateaux region reveals that farmers prioritize the security and social prestige of their households over the financial enrichment provided by cotton. This strategy, although detrimental to the overall performance of the sector, enables them to guarantee the viability of their farms despite their technical and organizational constraints.

KEYWORDS: peasant strategy, maize-cotton, social logics, Togo.

INTRODUCTION

Intercropping has been widely adopted in developing countries to improve agricultural productivity (Singh et al. 2017, Chi et al., 2019). This farming strategy involves growing two or more crops simultaneously in a single field to efficiently utilize light, water, nutrients, heat, land, and other natural resources (Andrews and Kassam, 1976). It improves resource use efficiency, increases soil fertility, and crop yields (Shah et al., 2016; Singh et al., 2017; Kumar et al., 2017; Chi et al., 2019). As a result, it enhances food security through production diversification (Hu et al., 2016; Zhang et al., 2016, Chapagain et al., 2018), reduces dependence on a single crop and the risks of crop losses caused by climatic hazards and crop pests (Smith et al., 2013; Singh et al., 2017).

A strategic crop for Togolese farms and the economy, cotton contributes 20 to 40% to export revenues and between 1% and 4.3% to GDP depending on the year (NSCT, 2012; World Bank, 2022). Seed cotton production in Togo increased from 10,736 tonnes in 1974 to 174,000 tonnes in 2004, after reaching 187,703 tonnes in 1998. However, this performance has not been sustained over time. Yields have fallen from 1,146.4 kg/ha of cotton in 1998 to 662 kg/ha in 2020, or more than 42% in two decades. This situation, which is detrimental to the sustainability of the cotton industry, does not allow producers to obtain maximum profit (NSCT and FNGPC, 2013, NSCT, 2022).

To maximize their profits and ensure food security for their households, cotton farmers in the Maritime and Plateaux regions practice cotton cultivation in relay under corn, a production method that allows them to optimize the use of their land, save on fertilizers, take full advantage of the rainy season, obtain two harvest products (cotton and corn) during the same agricultural campaign and thus increase their income. Schwartz (1985) indicates that the enormous success of cotton cultivation in the years 1981/82 in the Haho and Tohoun area is to be credited solely to this possibility of a perfectly harmonious combination of corn and cotton. Indeed, during this period, the production of the area represented 37.5% of national production on less than 10% of cotton sown with the highest yields per hectare in the country. Analysis of data from the ten-day sowing status sheets from 1999 to 2020 collected from the Nouvelle société cotonnière du Togo (NSCT) reveals that the areas of cotton under maize represent respectively 7 and 12 times those of pure cotton in the Southern and Maritime Plateaux. On the other hand, in the Northern Plateaux, this ratio represents only a third. However, production data for the period 2010 to 2021 reveal low yield levels in these regions. In view of the current results of the sector in this area with a high practice of cotton under maize cultivation, it is important to understand the factors determining the practice of cotton-maize cultivation and the socio-economic advantage of this practice among farmers. Although there are studies analyzing the effects of cotton-wheat and cotton-peanut association on crop yield and economic benefits (Shah et al., 2016; Chi et al., 2019), research on the socio-cultural determinants and socio-economic benefits of cotton-maize cultivation remains limited. The objective of this work is to contribute to the literature on the practice of cotton cultivation under maize. To provide empirical evidence, this research uses on the one hand the analysis of producers' social representations to identify the determining factors of cotton-maize cultivation in Togo, and on the other hand, the linear regression model to assess the effect of this endogenous know-how on the viability of farms. This article is structured around three sections: the methodology, the analysis and discussion of the results and the conclusion containing economic policy recommendations.

1. Materials and methods

This section is devoted to (i) the definition of some key concepts, (ii) the literature review on the economic and agronomic determinants and effects of peasant practices of crop association in cotton systems, and (iii) the theoretical framework of the study.

1.1. Definition of key concepts

1.1.1. Peasant practices

Also known as endogenous know-how or traditional know-how, peasant practices refer to traditional agricultural methods and techniques developed and transmitted over time within rural communities. They are often based on an intimate understanding of the local ecosystem and aim to ensure food security and long-term sustainability (Andrews and Kassam, 1976). These practices are therefore often specific to a particular region or culture, and are adapted to local conditions, available resources and environmental constraints. They encompass a variety of knowledge related to land cultivation, livestock breeding, resource management, conservation, etc.

1.1.2. Farming concept

A farm can be defined as a group of people who live, eat and carry out agricultural activities together (Gafsi et al., 2007). According to Kleene et al. (1989) , a farm can be understood as a family team of workers cultivating together, at least one common main field to which are linked, or not, one or more secondary fields as the case may be and having their respective decision-making centers. For the FAO (1995) , a farm is an economic unit of agricultural production subject to a single management that can be exercised by an individual, by a household, jointly by two or more individuals or households, by a clan or a tribe or by a legal entity such as a company, collective enterprise, cooperative or state body. In southern countries, the farm is of the family type and is characterized by a high level of employment of the workforce of its members and a low level of equipment (Penot et al., 2010). Chombart de Lauwe proposes the following definition taken up by the Memento de l'Agronome: "the agricultural exploitation is an economic unit in which the farmer practices a production system with a view to increasing his profit[1].

1.1.3. Concept of rationality

According to Laramée (2014), this term is used to refer to the coherent systems of thought and action characteristic of given human groups. The definition of this concept is twofold, since it encompasses both means of action and the reflection that underlies them. Indeed, it is, on the one hand, the set of means (actions, practices, strategies) used by an actor, because subjectively judged optimal, to achieve predefined objectives. However, to the extent that these objectives are not given, but rather constructed by each actor according to the contextual possibilities and constraints to which he is subject, we also understand by "rationality" the process of constructing each of the objectives that he wishes to pursue. In the context of this study, we have chosen to focus more particularly on the "social" dimension of rationality, that is to say as it applies to the definition of the relationships that individuals have with each other as well as with the various institutions (economic, political, cultural, etc.) of their universe of reference.

1.2. Brief literature review

1.2.1. DETERMINANTS of adoption of agricultural practices

The literature on technology adoption in agriculture reveals that several factors are likely to influence the use of these technologies. Among the determinants, membership in an organization (Abebaw and Haile, 2013) and the level of education of the head of household (Aslan et al., 2013; Khonje et al., 2015) are common. Aversion to hazards, especially climatic, and therefore the management of climatic risks have also been found to be determinants of adoption (Dercon and Christiaensen, 2011; Arslan et al., 2013; Glenk et al., 2014). Moreover, farmer access to information is a very important factor that has been raised in the literature as one of the most important causes of agricultural technology adoption (Diagne and Demont, 2007; Asuming et al., 2011; Fisher and Quaim, 2012; Khonje et al., 2015). Furthermore, many articles have shown that a farmer adopts an agricultural technology in light of the expectation of profitability (Arslan et al., 2013; Lambrecht et al., 2014; Wollni and Anderson, 2014; Kleemann et al., 2014). The farmer's entourage (Wollni and Anderson, 2014), household size (Adeoti et al., 2002 ; Noltze et al., 2012), age of the head of household (Adeoti et al., 2002 ; Arslan et al., 2013 ; Karim et al., 2014), access to financing, access to extension services (Adéoti et al., 2002) are also adoption factors raised in the literature. Other obstacles include financial

[1] Ministry of Cooperation, *Agronomist's Handbook,* collection "Rural *techniques in Africa"*, 4th edition, 1993, p.1345.

constraints and work intensity (Kijima et al., 2011; Pypers et al., 2011), as well as difficulty in accessing markets (Adéoti et al., 2002). Judging from the results of the literature, the influence of the gender variable on adoption is mixed (Doss and Moris, 2001; Ndiritu et al. 2014, Fisher and Kandiwa, 2014; Hay and Pearce, 2014, Kondylis et al., 2016). For Hay and Pearce (2014), women adopt agricultural technologies three times more than men in order to increase their agricultural productivity. The results of Fisher and Kandiwa, (2014) for example have accentuated this contrast in the influence of the gender variable. Indeed, these results show that the probability of adopting an agricultural technology was 12% lower among women living in households headed by men, and 11% lower among female heads of household, than among male farmers.

1.2.2. Economic and agronomic effects of peasant practices of crop association in cotton systems

Cotton-based intercropping or association cropping is considered as a promising strategy for sustainable cotton production (Tariq et al., 2018). Cotton is suitable for association cropping because of its wide row spacing, slow growth at the initial stage and relatively long cycle (Surendran et al., 2016). Several studies have evaluated the economic and agronomic benefits of farmer-based practice of association cropping in cotton systems. The study by Khan and Khaliq (2005) indicated that wheat and barley sown as intercrops in cotton recorded higher yields of 69% and 23%, respectively, compared to monocropping, although cotton yield was not affected by the intercropping. Wheat sown as a follow-up to cotton recorded a yield of 2964 kg/ha, compared to 1750 kg/ha for wheat sown after cotton. Depending on the cotton planting period, intercropping increased land use efficiency by 81–213% (Hussein, 2005).

Compared with cotton monoculture, intercropping cotton and halophytes increases root mass and density at soil depth of 0–20 cm, and intercropping cotton and mung bean increases total land yield by 16.6%–19.8%, total nitrogen uptake by 27.9%–45.3%, water use efficiency by 17.0%–36.3%, and economic benefits by 31.7%–51.9% (Liang et al., 2020). Intercropping helps reduce insect pest populations (Suman et al., 2020). Intercropping cotton with trap crops such as maize, alfalfa, mung bean, and cowpea can effectively trap and reduce the abundance of pests on cotton (Cook et al., 2007; Luo et al., 2014; Wang, 2015; Suman et al., 2020).

In sum, the total productivity and net income of intercropping systems are much higher than that of monocropping (Feng et al., 2017; Saeed et al., 1999). In cotton-based cropping systems of Mahrashtra, India, intercropping with pigeon pea and mixed cropping with green gram, maize, sesame and pearl millet yielded higher net income than cotton as a single crop (Gahukar, 2017).

1.3. Theoretical framework of the study

To understand the factors determining the adoption of cultural practices, two analysis models were used: (i) the structuring analysis of the social representation of producers through the central core theory developed by Abric (2003), and (ii) the linear regression model inspired by the work of Yegbemey et al. (2014).

1.3.1. Structuring analysis of the social representation of cotton producers

The structuring analysis of social representation first proceeds by validating the corpora of words/themes based on Zipf's law highlighted by the American linguist George K. Zipf. This law describes a general property applicable to the distribution of large sets subject to an enlarged group of diverse causal elements, regardless of the nature of the elements involved (Zipf, 1949). In practice, Zipf's law is valid for the 5000 most frequent words (Kucera et al, 1967). According to this law, the frequencies of appearance of words classified in decreasing order of their frequency of appearance are organized according to a power law. Zipf's law stipulates that the distribution of the frequency of words resulting from free associations around an inductive term, as is the case in our study, can be considered random if at least 5 to 10% of the most frequently cited words represent between 40 and 60% of all evocations.

As part of this analysis, the words obtained at the end of a free evocation process based on an inductor were distributed according to their frequency of citation and then hierarchized according to the decreasing order of these frequencies. The validation of the frequency distribution was done with Zipf's law. This validation consists of ensuring that the corpora that we obtained follow a statistical law and can therefore be subjected to statistical processing. Subsequently, the double analysis of word associations, proposed by Verges (1992), seemed to us the most appropriate to compare the two populations. The data processing was carried out according to two criteria retained by Verges: the frequency of the associated words and their average rank of appearance in the enumeration. According to these two criteria, these words were then distributed in a table with four boxes that have different statuses. The frequency from which a word can be part of the prototype is equivalent to $\ln a$. In other words, for a word to be retained for analysis, its frequency of evocation must be greater than or equal to $\ln a$. According to the structural theory of social representations, the intersection of the frequency of appearance and the average rank of evocation of words gives rise to a four-window table allowing the identification of the central and peripheral elements (prototype) of the social representation:

- the central core area, at the top and left, where the most frequent and most accessible words are found due to their low average rank of appearance. These elements are assumed to belong to the central core;

- the area of the first periphery elements, at the top right, where the elements of frequent appearance are located, but identified as less important;
- the area of contrasting elements, bottom left, which includes elements considered important, but cited by very few individuals;
- the second periphery area, bottom right, which includes elements identified as unimportant and very little cited by individuals.

To identify the content of social representations of cotton cultivation, we used the quantitative approach, which consists of a prototypical analysis. Developed by Vergès (1992), it is used in the study of social representations (Bonnec et *al*., 2002; Mariotti, 2001). It consists of processing the corpus obtained using the free association method and is based on the frequencies and ranks of appearance of each evocation. Thus, from the words evoked, we seek the "prototype of the social representation or the identification of the organization of the content by crossing these two indicators: the frequency of appearance of the words within the population questioned with their rank of appearance, defined as the average rank calculated over the entire population (Vergès, 1992; 1994). When these two criteria are congruent for the same item (high frequency and low rank of appearance), the latter is likely to be a central element of social representation.

1.3.2. Analysis of the effect of peasant practices on the viability of farms

The regression model in this section is inspired by recent work by Yegbemey *et al.,* (2014) who used Logit and Probit models of general form:

$A_i = f(Z_i)$ (1)

Where A_i and Z_i represent respectively the performance and a set of demographic and socio-economic characteristics of the same producer i. Considering the hypothesis of the link between performance and adoption of endogenous practices, the simplest way to integrate the practice of endogenous know-how of producers (P) into the previous model is to express it in the form:

$A_i = f(Z_i, P_i)$ (2)

However, the practice of endogenous know-how itself appears as an endogenous variable (function of a certain number of characteristics specific to the individual). Therefore, the estimation of equation [2] presents endogeneity biases. According to Maddison (2007), the practice of endogenous know-how is a prerequisite for performance. In other words, endogenous know-how must be practiced before recording performance on the viability of the farm and its sustainability. There is therefore no longer a problem of endogeneity, but rather of selection: performance if there is practice of endogenous know-how. Thus, as proposed by Maddison (2007) and Gbetibouo (2009), a selection model such as the Heckman Probit model makes it possible to better explore the performance of producers in relation to their practice of endogenous know-how. The general model becomes:

$Vi = f(Zi)$ If and only if $P_i = f(Y_i)$ (3)

The form thus defined is based on two sub-models: the output model or performance model on viability whose dependent variable is viability (V) and the selection model whose dependent variable is the practice of endogenous know-how (P). Considering j demographic and socio-economic characteristics linked to producer i and capable of determining his adaptation decision (characteristics noted z_{ij}) on the one hand, then j demographic and socio-economic characteristics linked to the same producer i and likely to determine his perception (characteristics noted y_{ij}) on the other hand, the econometric model which emerges is:

$v_i = \alpha_0 + \sum_j \alpha_j z_{ij} + u_i$ If and only if:

$p_i = \beta_0 + \sum_j \beta_j y_{ij} + \vartheta_i > 0$ (4)

In this model, v_i is the viability performance (1 = viable; 0 = not viable) of producer i and p_i is its endogenous know-how practice defined as a dummy dichotomous variable; α and β are the parameters to be estimated; u and ϑ are the error terms. Equation [4] amounts to:

$$\begin{cases} V = \alpha Z + U \\ P = \beta Y + \vartheta \end{cases} \quad (5)$$

where Z is a j vector of demographic, socio-economic characteristics and the characteristics of the farm that can influence its viability, Y is a j vector of demographic and socio-economic characteristics that can determine the practice of endogenous know-how, U and ϑ the error terms jointly following a normal distribution, independently of Z and Y, and A and P being linked by the selectivity link A if P > 0. Thus, the dependent variable A is defined as:

A is observed if P > 0. A is missing data if P ≤ 0. (6)

The estimation of the parameters (α and β) was done using the Heckman Probit model. The determinants of the practice of endogenous know-how and the viability of the farm were therefore identified from the signs of the estimated values and the probabilities given by the model. The basic hypothesis of the model being the practice of endogenous know-how as a prerequisite for viability (V if and only if P > 0), a globally significant model (probability < 0.01 or 0.05) reflects not only the adequacy of the theoretical specifications, but also the existence of a relationship (A if P > 0) between the practice of endogenous know-how and the viability of farms.

2. Presentation of the study area, sampling and data collection

2.1. Study area

The empirical phase of the research took place in four (04) prefectures of the Plateaux region, namely Anié, Est-Mono, Moyen-Mono and Haho (figure 1 below).

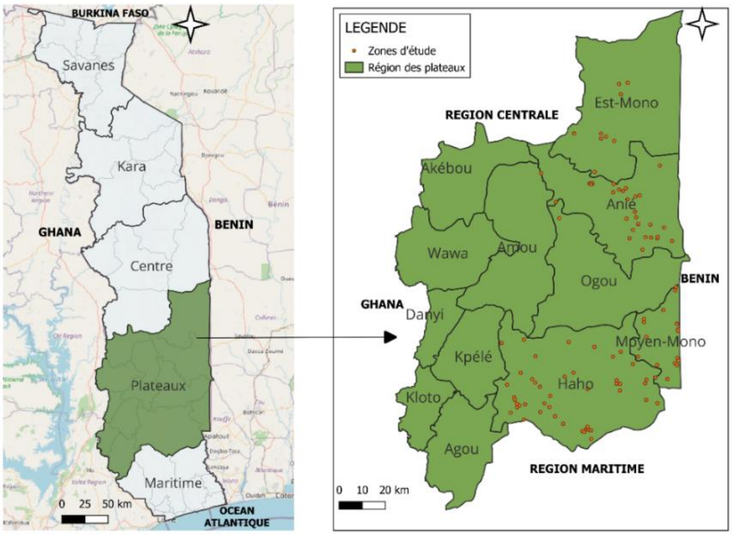

Figure 1: Map of Togo with the location of the study area

The choice of the Plateaux region is justified by the fact that it is part of the areas of high cotton production under corn. Then presents a dichotomy because while the Northern zone of the region is among the regions which obtain the best average yields in seed cotton (Central, Northern Plateaux and Kara), that of the South displays the lowest average yield in the country. At the same time, the data on the areas sown in cotton under corn in the Northern and Southern Plateaux zones represent respectively 3 and 12 times the areas in pure cotton from 1999 to 2022.

2.2. Sampling

Sampling was done using the so-called "multi-stage" method or consecutive stages developed to arrive at the selection of basic observation units (here, producers) where the imperatives of representativeness are respected. The sample size (n) in the region is determined using the formula developed by Yamane (1967) with a confidence of 95% and a maximum variability of 50%. This formula widely used by previous studies depends on the size of the population (N) and the level of precision (e) sought.

$$n_i = \frac{N_i}{(1 + N_i \times e^2)}$$

Due to the high degree of homogeneity of the cotton growers in the region according to their common characteristics, the level of precision retained for the calculation of the sample is equal to +/- 7%. For this level of precision retained of +/-7% with a population estimated at 37,961 cotton producers, the sample size (n) is:

$n = \frac{37\,961}{(1+37\,961 \times 0{,}07^2)}$ = 203 producers

By adding 25% margin to absorb losses related to field surveys, we obtain a sample of 254 cotton producers to be surveyed. The sample size per stratum is defined on the basis of the weight of each zone in terms of the number of existing cotton producers. Thus, the sample size of each stratum (cotton production zone) is the product of the overall sample size by the weight of the stratum (Table 6 in the appendix).

The individual survey of 254 producers from four prefectures with a high cotton-on-corn practice (Haho, Anié, Moyen Mono and Est-Mono) was preceded by interviews with Cotton Producer Groups (GPC), Technical-Commercial Agents (ATC) of the NSCT, researchers from the Human Savannah Agronomic Research Center (CRASH) and leading producers to identify the technologies popularized, the difficulties encountered and the commonly used endogenous practices. The information from these interviews was used to develop a structured questionnaire that is submitted to producers individually. Data collection was carried out using the kobocollect mobile application. At the end of data collection, a brief review of the cultivation practices adopted by the producers surveyed and their effectiveness was carried out, followed by an analysis of the reasons for their adoption.

3. Results and discussions

3.1. Technical and economic efficiency of the adopted cultivation practices

The analysis of the cultivation practices adopted by the producers surveyed mainly focused on soil preparation, sowing and spreading fertilizers. The soil preparation operation consists of prior manual cleaning of the plots to remove harvest residues or clear plots left fallow. As soon as the rains start, it is followed by plowing carried out at more than 82% by manual hoeing in the context of pure cotton cultivation. It generally requires about ten days of work per hectare. Producers practicing cotton cultivation as a catch crop under corn proceed with direct sowing.

As for sowing, for better emergence and better development of crops, the sowing dates recommended by the Togolese Institute for Agronomic Research (ITRA) are between June 10 and July 10 in the Northern Plateaux and from June 20 to July 20 in the Southern Plateaux. However, records of sowing dates for the 2022/2023 cotton campaign from producers during the survey show that overall, around 70% of sowing in the area is carried out during the recommended period (62% among producers practicing cotton cultivation under corn compared to 75% among non-practitioners), a quarter of sowing (26.35%) on average is done in the last ten days of July. This reflects a real drift in terms of compliance with the cotton sowing schedule. We note more than 37% of cotton sowings in catch crops under corn after July 20 compared to 23% of cotton sowings in pure. This rate reaches 42% and 37%, respectively in the prefectures of Anié and Est-Mono. This situation is inherent to the late onset of rains and the water deficit during the favorable sowing period. Of all the producers who observed a corn-cotton cohabitation period of less than 30 days, only 18.18% obtained a yield per hectare lower than 800 kg/ha. Beyond 30 days of cohabitation, the proportions of producers with a yield below 800 kg/ha exceed 40%. The highest rates of low yield are thus observed among producers carrying out long-term cohabitation.

With regard to fertilization, particularly with regard to compliance with the doses of NPKSB 12-20-18-5-1 and Urea 46%N fertilizers, it appears that 42.86% of cotton producers in pure cultivation apply a dose of NPKSB 12-20-18-5-1 and Urea 46%N between 200 and 250 kg/ha under the cotton, compared with a proportion of 39.58% observed among cotton producers under corn between doses of 150 to 200 kg/ha. Fertilizer doses greater than 200 kg/ha are applied by 53.06% of cotton producers in pure cultivation, compared with only 35.42% of cotton producers under corn. Thus, the highest doses are applied in pure cultivation.

The analysis of the cultivation practices encountered in the study area shows that constraints inherent in land management, compliance with optimal cotton sowing periods and fertilization doses for better improvement of cotton yields hinder the emergence of the cotton sector in Togo. It is important to understand the determinants of these practices which persist despite the constraints encountered by producers.

3.2. Determinants of the adoption of cotton cultivation under corn

3.2.1. Characterization of social representations of cotton cultivation

3.2.1.1. Validation of word frequency distribution

The method of free word associations around the inductive term "cotton growing" allowed the creation of a corpus of themes for each category of actors involved in the study, in particular producers adopting and non-adopting the practice of growing cotton as a catch crop under corn. Each corpus thus obtained underwent a cleaning which allowed on the one hand to group together synonymous words (for example words such as good, well, beneficial, etc. were considered to be identical) and on the other hand to retain only one word in cases where the same respondent mentioned the same word twice. This work made it possible to have a definitive corpus. The words were then distributed and ranked according to the decreasing order of their frequency of citation. Table 1 below presents the summary of the results of the word association method.

Table 1: Situation of word evocations by respondents

Items	**Producers adopting cotton under corn**	**Producers not adopting cotton under corn**
Sample size	193	59
Total number of words mentioned	650	190
Number of different words	23	15
Number of different words per individual	3.4	3.2
Average frequency of evocations	28.3	12.7
Percentage of most cited words representing at least 40% of all evocations	9%	7%

Source: Results of our surveys, 2023

Table 1 shows that the word frequency distribution resulting from free association is random and can be subjected to a prototypical analysis since it meets the condition that at least 5 to 10% of the most frequently cited words represent between 40 and 60% of the evocations (9% for adopters and 7% for non-adopters). Furthermore, in accordance with the curves in Figure 2, the trend curves present slopes of values close to -1 (-1.302 for adopters and -1.097) for non-adopters. The word corpora obtained for each category of actors can therefore be subjected to prototypical analysis.

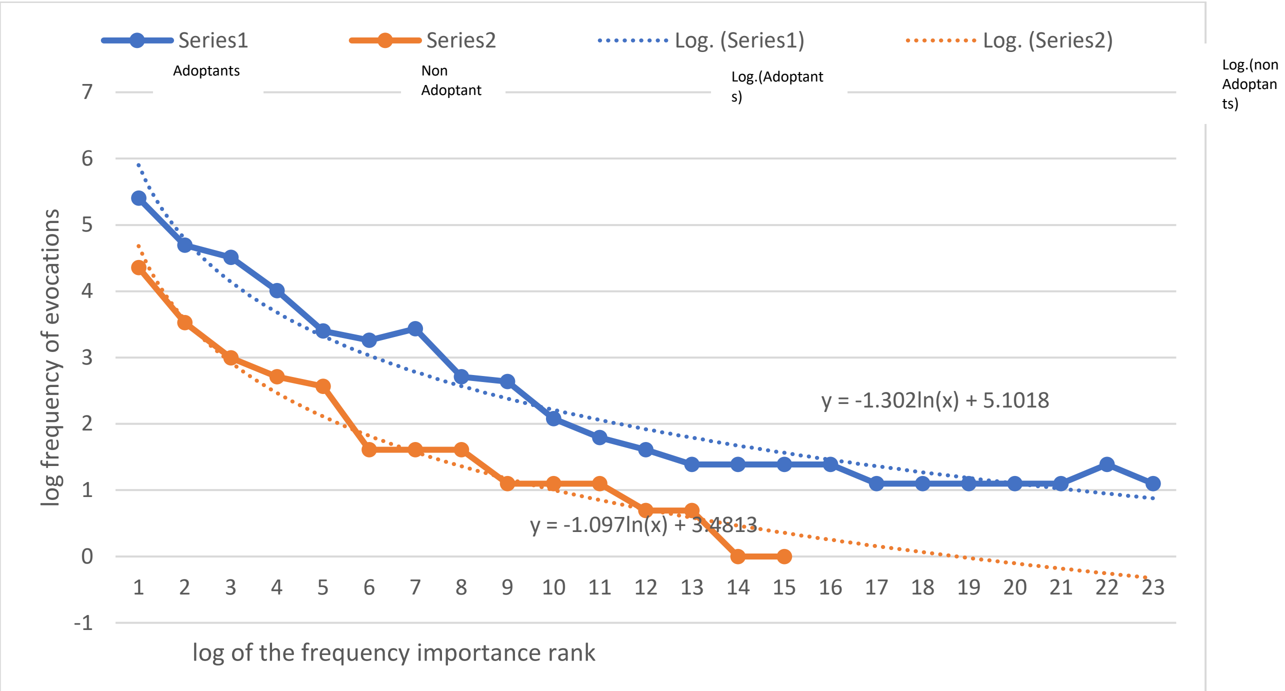

Figure 2: Zipf curves of the frequency distribution of evoked words

3.2.1.2. Identification and analysis of social representations

The prototypical analysis of associations consisting of crossing the rank and frequency of appearance of the words mentioned during the interviews makes it possible to produce a double-entry table containing in rows the frequency of citation of the evocations and, in columns, their average rank. The prototype of the social representations of cotton cultivation is presented as follows:

Table 2: Average frequencies and ranks of evocations by category of actors

Items	**Cotton growers under corn**	**Non-cotton practitioners under corn**
Sample size	193	59
Total number of words mentioned	650	190
Number of different words	23	15
Number of different words per individual	3.4	3.2
Medium Frequency (FM)	28.3	12.7
Minimum frequency (Fm)	5	3
Average Rank Mean (MRM)	2.36	2.26
Number of words included in the prototype (frequencies below average frequency)	12	8
Percentage of words included in the prototype	94%	92%
Percentage of retained words compared to all different words	52%	53%

Source: Survey results, 2023

Notes: $\mathrm{FM} = \frac{1}{\mathrm{n}}\sum_{i=1}^{n} \mathrm{fiand}$ $\mathrm{MRM} = \frac{1}{\mathrm{n}}\sum_{i=1}^{n} \mathrm{rm}$

For each category of actors, f_i represents the absolute frequency of each different word i, n the total number of different words and rm the average citation rank of each word across all individuals.

The minimum frequencies obtained from the equations of the trend lines of the Zipf curves in Figure 2 above correspond to the lower limit from which the words were retained for the production of the prototype. In other words, for each category of actors, the words retained for the prototypical analysis are those that were mentioned at least f_m times, i.e. at least 5 times by producers adopting cotton growing under corn and at least 3 times by non-adopters. The 193 producers practicing cotton growing under corn mentioned a total of 650 words, i.e. an average of 3.4 words per person with 23 different words.

The 59 producers who did not adopt this practice mentioned 190 words (3.2 words per person on average) from a universe of 15 different words. As indicated in the methodological analysis framework, the analysis table presents four zones that constitute the prototype of social representations: the central zone, peripheral zones I, II and III. The prototypical analysis of the evocations by producers adopting cotton cultivation under corn is summarized in Table 3 below.

Table 3: Prototypical analysis of word evocations among producers practicing cotton cultivation under corn

	Average rank < 2.36			**Average rank ≥ 2.36**		
Freq ≥ 28.3	**Words evoked**	**Frqce**	**Rg avg**	**Words evoked**	**Frqce**	**Rg avg**
	PROFIT	109	2.28	MONEY	222	2.43
	SAFETY/FOOD	91	2.30	PRIORITY	30	2.37
	CLOTHES	55	2.15	HARD	31	2.58
				INPUTS	26	2.73
Freq < 28.3	REALIZATION	14	2.14	WEALTH	15	2.47
	FIBER	6	2.17	PRIVILEGE	8	2.50
				LOAN GUARANTEE	5	3.00

Source: Survey results, 2023

The observation of the first box on the left of Table 3 above clearly reveals that the elements likely to structure the representation of all the subjects are: the benefit provided by cotton, security and clothing. These three (3) items would therefore be generators and organizers of their representation. They are characterized by the highest frequencies of evocation with lower average ranks of appearance. The peripheral elements are essentially: money, the arduousness of the work, the priority nature of the culture, the facilities granted for inputs, achievements and fiber production. The reference to pecuniary gain and privilege is only very rarely mentioned and this by few respondents.

Table 4: Prototypical analysis of word evocations among producers not practicing cotton cultivation under corn

	Average rank < 2.26			**Average rank ≥ 2.26**		
Freq ≥ 12.7	**Words evoked**	**Frqce**	**Rg avg**	**Words evoked**	**Frqce**	**Rg avg**
	CLOTHES	20	2.20	MONEY	78	2.51
	SAFETY / FOOD	15	2.07	PROFIT	34	2.38
Freq < 12.7	PASSION	5	1.80	PRIORITY	13	1.69
	HARD	5	1.80			
	INPUTS	5	2.40			
	DEVELOPMENT	3	2.00			
	GUARANTEE FOR LOAN	3	2.00			
	LEGACY	3	2.00			

Source: Survey results, 2023

Reading this table 4 reveals the elements of the representational field of non-adopter producers in relation to the inductive term "cotton cultivation". Indeed, the central core of the representational field of the following elements: clothing and security. We could add the benefit that non-adopter producers derive from cotton cultivation. The peripheral elements include money, passion for cultivation, the arduousness of the work, the guarantee for loans (trust), and its contribution to the development of the country and production areas, its obligatory nature inherited from parents.

3.2.1.3. Analysis of the semantic content of the core of social representations of cotton producers

The words and/or expressions stated by the producers during the interviews, far from being isolated, are integrated into a coherent whole, revealing their conception or vision of cotton cultivation. Indeed, the representations, although constituting a reference and a determinant of the behaviors and actions of individuals of the same social group, only exist through the structuring discourses that both give them substance and re-elaborate them (Serra, 2000). Consequently, the different words and expressions (benefit, security, clothing) that emerge from the social representations of the producers must be understood and analyzed in light of the sociocultural characteristics of these communities in order to better understand the way in which these representations affect their behavior in the face of alternative cotton production systems. Hence the need to better explain the meaning of the semantic content of the cores of the social representations of these producers and to highlight the way in which they provide information on the meaning that these communities give to cotton cultivation.

The observation of these results shows that the two sub-populations have almost identical representations of cotton. The social representation that producers have of cotton is centered around three main referents, which refer to the common experiences of the latter concerning the culture: its production function, its inherent link with nature, and its production context. These three aspects recall the three dimensions of professional representation, as defined by Blin (1997), namely the functional dimension, the contextual dimension, and the identity dimension. The functional dimension refers to the function of production of raw materials, in particular for the textile industry and for human and animal food. The contextual dimension mainly refers to the arduousness of the work and the deterioration of the economic context of the sector. The identity dimension is actualized within what founds the attraction and the choice of the culture, namely the obligatory (inevitable) nature of the culture in the life of the farmer and inherent in its contribution to the fight against precariousness. These dimensions would act as generating principles of professional representation, thus giving farmers common points of reference in their strategy towards the sector.

This emergency strategy, based on the imperatives of survival, then limits their capacities for future prevention. The structural weakness of cotton yields, if it refers to the errors of extension (poor control of information and agrometeorological forecasting in particular), cannot in fact be understood without a detour through the crop calendars, and through the counter-random choices that punctuate them. Thus, the technical itinerary advocated by extension workers is only rarely applied by farmers; we note in particular the rarity of early sowing, however presented as a sine qua non condition for good yields. This "obstinacy in doing badly" does not arise from the usual and convenient explanation in terms of "farmer archaism", but finds its explanation in the existence of peaks that put cotton, food crops, and non-agricultural activities in competition (Yung, 1989). These calendar shocks are thus met by "peasant" choices, which put the objective of food self-sufficiency before that of cotton income. Thus, at the start of the rainy season, the importance of clearing work delays food sowing, which in turn delays cotton sowing. In addition, sowing cotton as a catch crop under corn obviously reduces cotton yields, but certainly not the overall productivity of the plot, nor therefore the hope of having enough to eat (Lallau, 2005).

This ultimately leads to the notion of opportunity cost developed by Dufumier (2006). Poor farmers faced with the choice of crops will not think of genetic potential, price ratio, but first of all of opportunity cost, proven or possible: what risk do we take by giving up the variety or the "rustic" pattern, and are we able to face this risk? Thus, the obstinacy in practicing cotton cultivation under corn can then be interpreted as a trade-off in terms of risk management: favoring social capital (guarantee of survival, physical, but also social) to the detriment of the productive type opportunity, "social" investment rather than technical innovation in order to best guarantee their survival. Indeed, if investing means increasing the stock of capital, we must consider the capital of small producers in its different forms: human, social and political capital, natural capital, material capital and monetary capital. The decisions and behaviors of these producers in adopting an innovation, as is the case with the choice of a production system, cannot therefore be understood without effectively taking into account their objectives. The farmers' adherence to cotton-corn cultivation alternatives is part of a strategy of avoiding or minimizing risk through crop diversification in order to achieve their maintenance, growth and reproduction objectives.

3.2.2. respondents ' operating systems

As before, the objective here is to analyze the viability of the farms. Thus, after explaining the determinants of this viability, we will analyze the effect of the adoption of cotton cultivation under corn on viability.

3.2.2.1. Effect of endogenous know-how and viability of cotton farms

The results presented in the table reveal a significant dependence between the practice of crop association and the viability of cotton farms. The Wald test being significant and positive, expresses that the adoption of crop association positively explains the viability of farms. Thus, farms on which cotton-corn association is practiced were more viable than those that did not experience association (Kih [2]).

Furthermore, it also appears that male gender, agricultural advice in the group and the amount of urea used (100 to 150 kg per hectare) significantly explain the viability of cotton farms. Agricultural advice in the group plays an important role in the viability of cotton farms. The positive effect of agricultural advice can be explained by the advantages and opportunities it offers to cotton producers. Indeed, agricultural advice allows producers to master the best agricultural practices, management techniques, use of agricultural inputs, etc. By adopting these improved practices, producers increase their productivity, optimize the use of resources (land, financial, inputs, labor, etc.) and reduce losses, which contributes to the viability of their farms. The amount of urea used (100 to 150 kg per hectare) also plays a determining role in the viability of cotton farms. Urea is a nitrogen fertilizer commonly used to stimulate crop growth. When adequate amount of urea is applied appropriately, plants can benefit from an additional source of nitrogen, which promotes their growth and development. Better crop growth can lead to increased agricultural productivity, which is essential to ensure the economic viability of farms. Objective capital such as male gender has been identified as a factor that negatively influences the viability of cotton farms at the 10% threshold. This result can be explained by the fact that women have better economic performance in cotton farms.

Table 5: Heckman selection model estimating the determinants of the viability of cotton farms

EXPLANATORY VARIABLES	(1) Viability	(2) Adoption	(3) /mills
Male	-0.450**	2.625*	
	(0.207)	(1.595)	
Non-schooled	-0.394	2.778*	
	(0.431)	(1.525)	
	(0.436)	(1.519)	
TailledumC)nage	0.006	0.058**	
	(0.005)	(0.028)	
agricultural_advice_inourgroup	0.283***	-0.243	
	(0.075)	(0.322)	
training_agriculture	0.007	-0.628**	
	(0.066)	(0.318)	
medium exploitation	-0.078	-0.655**	
	(0.074)	(0.305)	
ModedaccC(sC terrere_HC)ritage	-0.098	-1.028***	
	(0.102)	(0.335)	
ModedaccC(sC laterre_Purchase	0.116	-0.157	
	(0.095)	(0.470)	
ModedaccC(sC laterre_Don	-0.013	-1.377***	
	(0.089)	(0.344)	
ModedaccC(sC laterre_Location	-0.080		
	(0.090)		
Quantity ofNPKC per hectareBetween 150 and	-0.036		
	(0.073)		
QuantityofurC)eBetween 100and150KGha	0.273**		
	(0.108)		
Use of the main work(salariC)	0.037		
	(0.093)		
ChefdevotremC)nage_MeC*me		-1.831	
		(1.377)	
AnnC)esdexpC)rience		-0.016	
		(0.024)	
Motivation_choice_cotton_MarchC)dis		1.341***	

		(0.512)	
motivation_choice_cotton_finance_		-6.355	
		(0.000)	
		(0.000)	
Theclimate isfavorableC larC)ussited		2.912***	
		(0.550)	
lambda			-0.093
			(0.112)
Constant	1,938**	-4.714*	
	(0.774)	(2,640)	
Forest test	54.21***		
Observations	255	255	255

*Standard errors in parentheses; ***p<0.01, **p<0.05, *p<0.1*

Source: *Survey results, 2023*

3.2.2.2. Determinants of the viability of cotton farms

The results obtained showed that male gender, uneducated, household size, agricultural training and average farm size are the factors that significantly determine the adoption of endogenous know-how by cotton producers. The gender of the head of household plays a role in the decision to adopt endogenous know-how. Indeed, the results show that men are more likely to adopt endogenous know-how compared to women. This may be due to socio-cultural factors, gender inequalities or different opportunities and incentives for the adoption of these practices. Similarly, producers without formal education are more likely to adopt endogenous know-how than educated producers, explaining their increased dependence on local knowledge and traditional practices in their agricultural activities. Conversely, trained farmers are more exposed to modern methods that may encourage them to favor more conventional agricultural practices and less linked to traditional know-how. In addition, larger households are more likely to adopt endogenous know-how because they have more labor available to implement these practices. The larger the farm size, the more producers favor modern technologies and practices that require large capital investments, rather than turning to local know-how that is considered less productive or less efficient for large farms.

Land is another factor that influences the decision to adopt endogenous know-how. The negative effect of inheritance and the gift of land indicate that producers who inherit or receive land favor modern and intensive practices in agricultural inputs to the detriment of more traditional practices in order to maximize the profitability of their farms. However, producers with uncertainty about property rights, that is, those using purchase or rental, are less motivated to make investments and will be less willing to adopt a modern practice that requires additional investments (Udry, 2010; Lambrecht et al. 2014; Hailu et al, 2014). Favorable climatic conditions determine the adoption of endogenous know-how by producers because they would encourage them to use these proven practices adapted to their environment. Finally, producers adopt crop association for market guarantee reasons.

3.3. Discussions

Farms, like all businesses, pursue very specific production objectives. More specifically, African family farms, in order to achieve their production and social reproduction objectives, are called upon to perform certain functions that Gastellu (1980) groups into production, consumption and accumulation functions. The decisions and behaviors of producers in rural Africa in adopting an innovation, as is the case with the choice of a cotton production system, cannot therefore be understood without effectively taking into account their objectives.

Theoretically, the adoption of cotton cultivation under corn implies a renunciation of the pure cotton production system and can be perceived as a risk-taking by the farmer with regard to his farm. It is therefore important to highlight the advantages and disadvantages linked to the production of pure cotton, to compare them with the advantages and disadvantages of the new systems of cotton production in relay under corn. This will allow on the one hand to appreciate under which conditions these alternatives to pure cotton can validly replace the latter and on the other hand to better understand the logic and strategies that producers develop in the adoption of this production system and the achievement of their capital formation objectives within the framework of this commercial crop. As Benoit-Cattin (2012) indicated in "Investments by small agricultural producers in developing countries", these objectives correspond to *livelihood* strategies for "a good life" including more food security, better and more stable income, less vulnerability to shocks, better well-being with assets transferable to descendants. If investing means increasing the capital stock, we must consider the capital of cotton farmers in its different forms: human, social and political capital, natural capital, material capital and monetary capital. However, human capital and social capital remain priorities. It appears that farmers' adherence to alternatives to conventional cotton seems to be part of a strategy of avoiding or minimizing risk through crop diversification in order to achieve their objectives of maintenance, growth and reproduction. These elements of human or social capital therefore determine the social representation that cotton farmers have of the cotton sector and which justifies their decision and shapes their production strategy. It is a strategy oriented towards the survival of their household (priority given to the nutritional and health status of the members) and the maintenance of social capital characterized on the one hand by a professional dimension developed within cotton producer groups (giving cotton cultivation its obligatory character among producers), and a non-professional dimension through kinship groups and neighborhood relations within religious organizations.

Thus, the old question of the rationality of the peasants of the "Third World" hardly arises any more, and as Landy (1998) said, the peasants of the Third World are neither fatalistic or bigoted brutes nor entrepreneurs necessarily maximizing income - except in individual cases - but must be situated in an in-between that makes them comparable to the forms of logic of an average Parisian or New Yorker. Similarly, the quarrels between Marxists and idealists are almost futile, to know which of the economy or ideological representations founds tropical societies, since the answer is undoubtedly: "Neither one nor the other, and both at the same time". Godelier (1984) is probably the one who best explained this alliance between "the ideal and the material": skillfully merging, in order to better surpass them, the theories of Marx and the idea of Polanyi (1957) according to which the rural economy is "embedded" in traditional societies, he suggests that religion, or ideology, or kinship relations, can very well be the true "infrastructures" of a society if they function at the same time as relations of production, if they serve as economic vectors. We can see an illustration of this theory in the maintenance of the caste system that subsists in contemporary Africa: has this system based on the Hindu religion not survived because it also functions as an economic structure? Each caste, to which a certain degree of religious purity is attached, traditionally corresponds to an economic (or politico-religious) activity: the caste system, however hierarchical it may be, is therefore also an economic system based on a certain unequal complementarity.

This leaves room for cultural factors, while explaining that peasant logic cannot go in a fundamentally anti-economic direction. Peasants in tropical countries are now truly hybrid: cultural beings, they are also economic beings, in other words, human beings. Their objectives, if they do not necessarily correspond to "rationality" as it is too quickly defined in the West, are always pursued in a way that is entirely rational. This is what Elster (1986) calls "formal rationality", that is to say the adaptation of means to the desired end, the only rationality that can be defined without too much subjectivity. Homo *economicus* can therefore coexist with Homo *hierarchicus,* and conversely Western entrepreneurs, subject to the imperfection of their knowledge, to the pressures of fashion, advertising, and the need for leisure, are much less economically rational beings than has been said. The limits of “utilitarian” models are therefore real.

CONCLUSION

The major concern of this study was to analyze the socio-cultural factors of adoption of the practice of cotton in relay under corn in Togo. It emerges fundamentally that the adoption of peasant practices in the case of the present study is mainly determined by socio-cultural elements such as cultural practices, social considerations, and even the social identity of the community. Furthermore, the rational nature of the peasants studied is revealed. The logic pursued is not the maximization of profit as evoked by classical economics, the peasants react in an environment specific to them with well-defined purposes. This is what can be called adjusted rationality. This is focused on risk minimization and household survival.

Indeed, it appears that the social representation that producers have of cotton is centered around three main referents, which refer to the common experiences of the latter concerning the culture: its production function, its inherent link with nature, and its production context, in accordance with the three dimensions of professional representation defined by Blin (1997), namely: the functional dimension, the contextual dimension, and the identity dimension. These dimensions would act as generating principles of professional representation, thus giving farmers common points of reference in their strategy with regard to the sector. However, this emergency strategy, based on the imperatives of survival, limits their capacities for future prevention. The structural weakness of cotton yields cannot in fact be understood without a detour through the crop calendars, and by the counter-random choices that punctuate them due to the lack of control of agrometeorological information and forecasting by both producers and public technical support services. Thus, the practice of cotton under corn negatively influences cotton productivity and positively corn production. Farmers who adopt it lose 569 kg of cotton per hectare to gain 958 kg of corn and ensure the viability of their farms.

The observed underperformance can however be corrected if measures are taken to promote peasant know-how in terms of crop association. This will involve providing producers with better weather forecasting and better technical supervision in order to facilitate their compliance with technical itineraries to guarantee an optimum cotton-maize cohabitation time (less than three weeks) and encourage them to reduce or avoid late sowing, underuse and misuse of inputs (fertilizers and phytosanitary products), then facilitate access to food inputs for cotton growers.

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Annexes

Table 6: Complete sampling plan

Prefecture	No.	Production area	Number of producers in the area	Area weight (%)	Number of producers to be surveyed
Is Mono	1	Badin	10	0.03	0
	2	Elavagnon	865	2.28	6
	3	Gbadjahe	413	1.09	3
	4	Kamina	35	0.09	0
	5	Kpessi	64	0.17	0
	6	Moretan	920	2.42	6
	7	Nyamasila	434	1.14	3
Anie	1	Adogbenou	1431	3.77	10
	2	Anie	542	1.43	4
	3	Atchinedji	2363	6.22	16
	4	Djama	63	0.17	0
	5	Glitto	2796	7.37	19
	6	Kolo-cope	902	2.38	6
	7	Ountivou	22	0.06	0

Prefecture	No.	Production area	Number of producers in the area	Area weight (%)	Number of producers to be surveyed
	8	Palakoko	514	1.35	3
Medium Mono	1	Ahassomé	1,300	3.42	9
	2	Katahoe	108	0.28	1
	3	Katome	450	1.19	3
	4	Kpekpleme	776	2.04	5
	5	Kpodoudji	59	0.16	0
	6	Saligbe	1,406	3.70	9
	7	Tado	909	2.39	6
	8	Tohoun	1,521	4.01	10
Haho	1	Agbavé	42	0.11	0
	2	Akpakpakpe	538	1.42	4
	3	Alati Market	45	0.12	0
	4	Amakpape	50	0.13	0
	5	Asrama	4,885	12.87	33
	6	Attached	1,452	3.82	10
	7	Ayito	587	1.55	4
	8	Bako	11	0.03	0
	9	Dalia	1,623	4.28	11
	10	Djemeni	97	0.26	1
	11	Haho	42	0.11	0
	12	Hahomegbe	3 121	8.22	21
	13	Koukpe copé	38	0.10	0
	14	Kpedje	56	0.15	0
	15	Kpedome	3,397	8.95	23
	16	Kpove	15	0.04	0
	17	Notse	1,525	4.02	10
	18	Wahala	2,534	6.68	17
Total			**37,961**	**100**	**254**

Source: Survey results, 2022

Table 7: Main descriptive statistics

ANOVA	**Yield**		**Adoption**	
Variables	F	Sig.	F	Sig.
Male	,382	1,000	2,160	,143
Female	,382	1,000	2,160	,143
Age	,827	,848	,354	,552
Married polygamously	,947	,621	3,690	,056
Married monogamous	,904	,710	1,732	,189
Single/never married	3,219***	,000	5,915**	,016
Not in school	,868	,779	6,154**	,014
Primary	1,009	,491	,012	,914
Secondary	1,019	,470	3,669**	,057
Higher (University)	1,390**	,048	6,525***	,011
Household size	1,446**	,031	12,370***	,001
Religion_Christianity	,975	,561	14,965***	,000
Traditional_Religion (animism)	,990	,530	8,461***	,004

ANOVA	Yield		Adoption	
Main activity_Agriculture	,832	,840	,005	,942
Secondary activity_Agriculture	,832	,840	,005	,942
Years of experience	,754	,937	,002	,960
Motivation for choosing cotton cultivation _Having access to inputs	1,191	,188	,023	,880
Motivation for choosing cotton cultivation_Available market	1,058	,394	2,224	,137
Agricultural advice_From the ATCs	1,385	,050	13,198***	,000
Agricultural advice _In our group (GPC)	1,165	,221	4,058**	,045
Agricultural advice_For parents	1,636***	,007	,134	,715
Training in agriculture	1,133	,265	,004	,951
Land access mode_Purchase	1,274	,110	3,807**	,052
Land access mode_Location	,964	,586	11,001***	,001
Type of plowing_Manual hoeing using dabas	,726	,958	,141	,707
Type of plowing_Ploughing with animal traction	,295	1,000	1,274	,260
Type of plowing_Ploughing carried out with a tractor	,703	,972	,297	,586
Fertilizer Saving Perception_Pure Cotton	,751	,939	12,919***	,000
Perception of fertilizer savings_No difference	,962	,590	21,014***	,000
Number of ATC visits	,870	,777	52,855***	,000
The climate is favourable for the success of this system	1,203	,175	104,232***	,000

Source: *Survey result, 2023*