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Analysis of the Superposition of Meteorological Data and Maize (*Zea Mays*) Planting Periods in Order to Reduce Production Losses Due to Climate Change in the Dry Savannah Zone of Togo

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ABSTRACT

The purpose of this work is to determine the impacts of climate change on planting periods in the dry Savannah of Togo. To attend this goal, a survey was conducted among 47 maize producers, 23 of whom were in the Kara region and 24 in the Savannah region. The information collected is supplemented by the recommended planting periods in Togo. Also, rainfall data over a period of at least 30 years were processed by Instat+ and R software. The superposition of results obtained in the field and meteorological data shows that in the Kara region, maize planting period starts within the recommended periods and encounters periods of up to 15 days of drought. In the savannah region, however, sowing is done 30 days after the recommended period. In both regions, 30% of the producers surveyed did resow because of the sudden interruption in rainfall. More than 60% of the producers surveyed experienced dry spells of 10 to 15 days during the growth stages of the crop. Resowing certified maize seed costs at least 110,600 f CFA/ha. Yield losses due to spells of drought in the dry savannah area can reach 2 t/ha, representing a financial loss of 500,000 f CFA/ha. Faced with these losses, supplemental irrigation techniques could reduce the effects of climate change on the crop.

INTRODUCTION

Like other West African countries, Togo is a primarily agricultural country that employs more than 70% of the working population and contributes 40% of the GDP. Maize production amounts to 886,630 tons in over 700,000 hectares, or 40% of the food crop area (DSID, 2019). Although endowed with these assets, this agricultural production, which is highly dependent on rainfall, is not spared the adverse effects of climate change, which is one of the causes of food insecurity and agricultural vulnerability, especially in the dry savannah area of Togo (Azouma and Gnon, 2018). As a result, the average yield obtained in maize cultivation continues to decline and is often lower than the 1.1 t/ha achieved nationally (Marteau, 2011; Domegni, 2015; Kasongo *et al.*, 2019). These findings are due to the decrease in rainfall, the number of helpful rainy days, and uncertainties regarding ideal sowing periods (Vissoh *et al.*, 2012; Fadina & Barjolle, 2018). For example, studies by Balme *et al.* (2005) have shown that the delay in the start of the rainy season can be as long as 60 days, sometimes interspersed with dry spells. This situation, combined with the decline in soil fertility, weakens maize production. Also, it should be noted that the lack of accurate information on sowing periods results in reduced productivity, long, lean periods, and the outbreak of famine in farming areas (Azouma and Gnon, 2018; Noufé *et al.*, 2015).

To adapt to climate change, many producers adopt the technique of changing short-cycle maize varieties, crop rotation, overuse of fertilizer, and choosing new sowing periods (Zinyengere *et al.*, 2011; Zinyengere *et al.*, 2014; Amegnaglo *et al.*, 2017). Despite these strategies, sowing periods are still facing not only irregular but also insufficient rainfall.

With such difficulties encountered during the sowing period by producers in the dry savannah area, supplemental irrigation can be one of the solutions to mitigate the consequences of this phenomenon. This research work aims to analyze the superposition of meteorological data and the ideal planting periods in order to help maize producers to improve their production and reduce yield losses due to climate change in the dry savannah of Togo.

MATERIAL AND METHOD

Study area

The geographical setting of the study area is the dry savannah area of Togo. Located between the parallels 9° 25 and 11° North latitude and the meridian 0° and 1° East longitude, it is bordered to the north by Burkina Faso, to the west by Ghana, to the east by Benin, and to the south by the humid savannah. Covering an area of 20,321 km2, its rainfall ranges from 1,000 to 1,300 mm/year (Atato *et al.*, 2010), with a Sudano-Guinean climate in the south and a tropical climate in the north. Temperatures in the dry savannah area of Togo vary from 39° to 17° in the dry season and 34° to 22° in the rainy season (ITRA, 2007a).

The material used for this study includes of interview guides for producers, rainfall data collected over a period of at least 30 years, R and Instat+ software for processing rainfall data, Kobocollect for collecting survey data, and Microsoft Excel for entering and processing recorded data.

A total of 47 farmers, including 23 in the Kara region and 24 in the Savanes region, were identified and interviewed based on their ability to conduct on-farm tests (Figure 1). The interview topics included maize varieties sowed, sowing times, number of days of dry spells experienced

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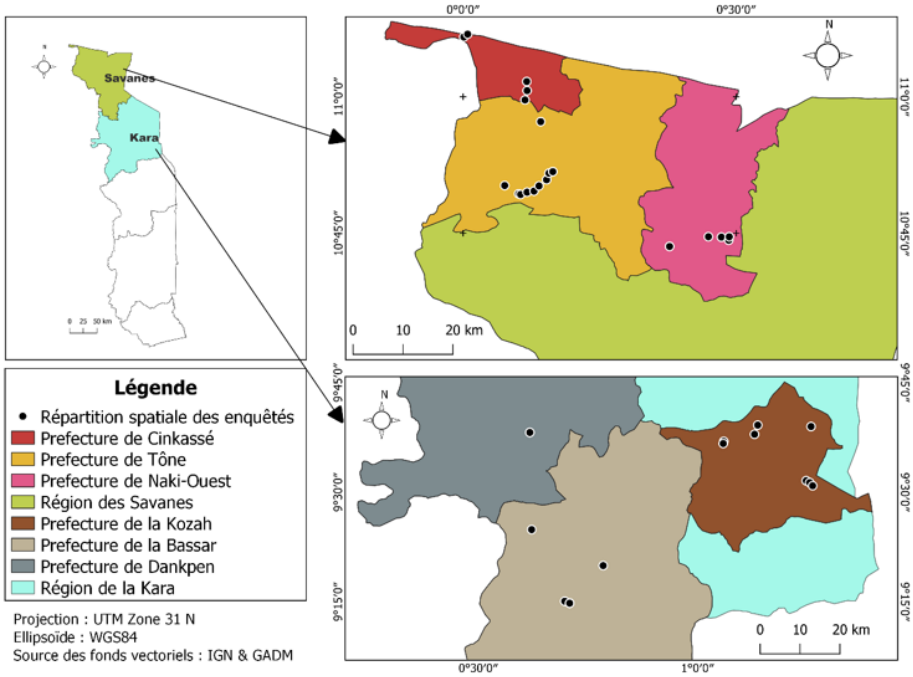

Figure 1: Map of the study area

during the crop year. All this information was collected by Kobocollect in a direct interview with the producer and was used to establish the study area map.

To identify the effects of climate change on sowing periods, we referred to the agricultural extension services (ICAT) to collect information on recommended sowing periods in Togo. These data are cross-referenced with survey results and rainfall data analysis to assess the effects of climate change.

The collected rainfall data were analyzed and processed by the "Normal Ratio Method (NRM)," which made it possible to take into account the missing data. These data, processed in the R and Instat+ software programs, allowed us to obtain the dates of the beginning of the seasons, which can be used to locate the ideal sowing periods, the dry spells at the start of the season, and the likelihood of the occurrence of a dry spell. The recorded survey data were processed using Microsoft Excel.

RESULTS AND DISCUSSION

Maize Varieties Grown

Survey results show that the maize varieties grown by producers in the dry savannah area are: Ikéné, Obatampa, and Sotoubaka. It should be noted that the use of these varieties is not imposed on producers. Only 23.4% of these producers use certified seed. Due to the cost of seeds, producers prefer to select their own maize seeds at the end of the season in order to use them the following season. This practice, coupled with frequent droughts, is the reason for the decline in yields. These results confirm those of Kaboré *et al.* (2010), who showed in their study that despite good adaptation to local conditions, the use of non-certified seed leads to low yield potential.

Maize Planting Times

The table 1 indicates the sowing periods adopted by producers in each region, and those recommended by the agricultural extension services. The survey results show that maize varieties in the Kara region are sown in the second ten days of May at the earliest and in the second ten days of July at the latest. The sowing period recommended by the extension services in this region covers the first ten days of June to the second ten days of July, which shows that the rains start at least 15 days before the recommended periods (Figure 2). Furthermore, the analysis of rainfall data revealed that sowing should occur from the second ten days of April to the last ten days of May. The overlay of these data showed that the sowing times recorded by producers and recommended by the extension service changed by 30 days. These results align with those of Adewi *et al.* (2010), who found that in the

Table 1: Maize sowing periods in the dry savannah area of Togo

Locality	**Maize Sowing Periods**		
	Sowing period adopted by producers in 2021	Sowing period adopted by 12 producers monitored in 2022	Sowing period recommended by the extension services
Bassar and Dakpen	1st June to 15 July 2021	June 19 to July 29	June 10 to July 15
Kara	May 15 to July 15, 2021	June 20 to July 10	June 1st to July 15
Cinkasse and Dapaong	15 June to 15 July 2021	June 12 to July 05	May 15 to June 15

Source : ICAT, 2021 and farmer survey data

1950s to 1969 and 1970s to 2000, the onset of cropping periods lagged by about one month.

In the savannah region, survey results showed that maize is sown from the second ten days of June to the same period in July, especially in Cinkassé. This is at least 30 days later than the results of the meteorological data analysis and 15 days later than the recommendations of the extension services. Similar results are obtained by Kate (2016), who found in her study that the sowing times shown are those adopted by producers in the savannah region. In addition, during interviews, producers noted a decrease in the number of rainy days. This confirms

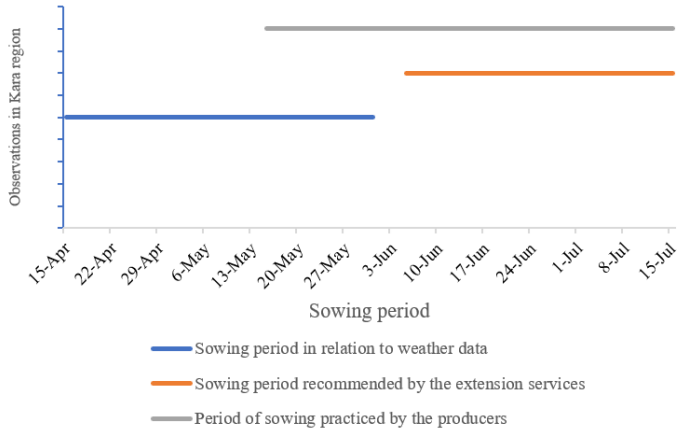

Figure 2: Maize planting period in the Kara region

the work of Desplat and Rouillon (2011), who proved that the observed climate changes are causing prolonged droughts that reduce the number of rainy days. They also added that dry spells are consistently observed in the savannah region regardless of the start of the rains.

Moreover, the analysis of meteorological data (Table 2) showed that in the Kara region, the early season starts earlier in the last ten days of March and, at the latest, in

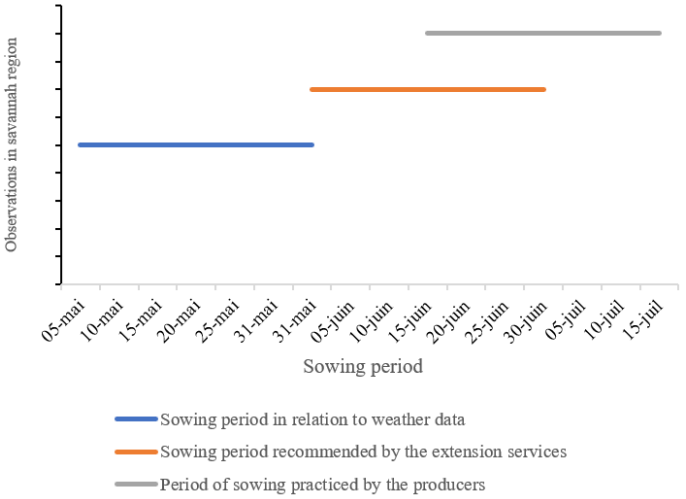

Figure 3: Maize planting season in the Savannah region

the first ten days of June. The first rains that could allow sowing start in the first ten days of June. These results align with information from producers whose sowing spans from 15 May to 15 July. In the savannah region, these meteorological analyses showed that the early and late seasons start in almost the same period. In this region, the favorable rains for sowing begin in June. These results show significant variation in favorable rainfall periods in the savannah region.

Table 2: Summary of Results of Variability Analysis of Key Seasonal Parameters (1981 To 2020) For the Different Stations Studied

Locality	Season parameters	Beginning of the season
Dapaong	Earlier date	19-March
	Later date	03-June
	Average	03-May

Mango	Earlier date	27- March
	Later date	11-June
	Average	30-April
Kara	Earlier date	16- March
	Later date	06-June
	Average	21-April
Niamtougou	Earlier date	16- March
	Later date	04- June
	Average	20- April
Pagouda	Earlier date	23- March
	Later date	10- June
	Average	23- April

Source : data analysis 2022

Dry spells during production

Of all the producers surveyed, more than 60% stated that they had observed dry sequences of more than 07 days during the cropping period just after sowing. The same proportion of producers revealed the appearance of dry sequences of 10 to 15 days during the development stages of the crop. The proportion of producers who did not observe dry spells of several days that could affect the crop to the point of reseeding in the savannah region is those who actually sowed outside the periods recommended by the extension services. Most producers who sowed within the recommended periods come from the Kara region, where rains are practically regular, even if they are interspersed from time to time with dry spells.

Resowing of maize due to the occurrence of dry spells

The results of the surveys showed that due to a false start caused by the cessation of rains, 30% of the producers surveyed reseeded maize in the weeks following sowing. During the crop's development stage, 60% of producers in the Savannah region stated that they observed two dry periods each year, ranging from seven (7) to twenty-one (21) days, the first of which occurred in August and the second in September. Most producers who have resowed come from the savannah region, where the periods recommended for sowing have take a profound variation. In the Kara region, producers who sowed after the periods recommended by the government services did not resow. This justifies the modification of the initial sowing periods. Resowing certified maize seed costs at least 110,600 FCFA /ha.

Effect of climate variability on production

The change in maize sowing times has had a negative effect on maize production in the dry savannah area. Indeed, climate variations and their consequences on rainfall have led to prolonged dry spells of 15 to 21 days or even 30 days. These dry spells led to the wilting of the plants and resowing of 30% of the fields in the dry savannah area. Resuming this agricultural activity entails additional costs. Yield losses due to spells of drought in the dry savannah area of Togo can reach 2 t/ha (KOFFI-TESSIO, 2010). Under these conditions, financial losses would amount to 500,000 f CFA/ha, given that the average selling price of maize is 250 fCFA/kg (Togofirst, 2022).

CONCLUSION

The analysis of the superposition of meteorological data and maize sowing times showed that ideal sowing times are uncertain. This variability leads to decreasing yields. Rainfall during the sowing period is insufficient to meet the needs of the maize crop, often resown within 30 to 45 days after the first sowing. Under these conditions, financial losses due to the frequent occurrence of dry spells are estimated at 500,000 FCFA /ha. To minimize losses due to resowing, it is necessary to use supplemental irrigation from an easily accessible water source, especially during sowing periods. Such practice will compensate for possible water deficits that occur in critical phases of maize development. This study did not address the effects of climate change on the variety of maize grown by dry savanna farmers. In perspective, research must be conducted to experiment supplemental irrigation method so that to reduce yield losses due to climate change to improve the farmers' income in maize production.

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