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Managing the agricultural calendar as coping mechanism to climate variability: A case study of maize farming in northern Benin, West Africa

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ABSTRACT

Nowadays climate variability and change are amongst the most important threats to sustainable development, with potentially severe consequences on agriculture in developing countries. Among many available coping mechanisms, farmers adjust some of their farming practices. This article aims at exploring observed changes in the agricultural calendar as a response to climate variability in northern Benin. Interviews with local experts (agricultural extension officers and local leaders such as heads of farmer and village organisations) and group discussions with farmers were organised. A household survey was also conducted on 336 maize producers to highlight the factors affecting decisions to adjust the agricultural calendar as a coping mechanism against climate variability. As a general trend, the duration of the cropping season in northern Benin is getting longer with slight differences among and within agro-ecological zones, implying a higher risk of operating under time-inefficient conditions. Farmers receive very limited support from agricultural extension services and therefore design their agricultural calendar on the basis of personal experience. Socio-economic characteristics, maize farming characteristics as well as farm location determine the decision to adjust the agricultural calendar. Consequently, providing farmers with climate related information could ensure a rational and time-efficient management of the agricultural calendar. Moreover, research and extension institutions should help in establishing and popularising clear agricultural calendars while taking into account the driving forces of behaviours towards the adjustment of farming practices as a climate variability response.

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Introduction

There is increasing evidence that both climate variability and climate change will strongly affect the African continent and will be among the most challenging issues for future development, particularly in the drier regions (Adger et al., 2007). Several studies have concluded that agriculture in Africa will be negatively affected by climate change (Pearce et al., 1995; McCarthy et al., 2001; Christensen et al., 2007; Müller et al., 2011). In Benin, agriculture depends heavily on rainfall and whether in the short or long term, climate variability is acting negatively on yields and production (Aho et al., 2006). Exploring the relationships between climate and agricultural production in Benin using predictions from high-resolution regional climate model, Paeth et al. (2008) projected a decrease in agricultural production – with respect to most crops – of 5–20%. Adger et al. (2003) and Kurukulasuriya and Mendelsohn (2006) state that adaptation is one of the policy options for reducing the negative impact of climate change, while Mendelsohn et al. (1994) note that farmers will be especially hard hit if they do not adjust at all to new climates.

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli (IPCC, 2001). It helps farmers to achieve their food, income and livelihood security objectives in a context of changing climatic and socioeconomic conditions (Kandlinkar and Risbey, 2000). Common adaptation methods in agriculture include the use of new crop varieties and livestock species that are better suited to drier conditions, irrigation, crop diversification, adoption of mixed crop and livestock farming systems, and changes in agricultural activity dates (Bradshaw et al., 2004; Nhemachena and Hassan, 2007; Gnanglè et al., 2012; Yegbemey et al., 2013). Some of these methods (e.g. changes in agricultural activity dates) undertaken in response to short-term climate variability are classified as coping responses.

Considering the strategies developed by farmers for coping with climate variability, a large number of studies (Nhemachena and Hassan, 2007; Gnanglè et al., 2012; Yegbemey et al., 2013) have reported changes in sowing dates. Nevertheless, there is no literature on how exactly the agricultural calendar is currently moving. Whereas it is acknowledged that seasons and even agro-ecological zones are shifting due to climate change, there is still no investigation with the focus on how farmers adjust their whole agricultural calendar in face of climate variability. Thus, this paper aims at exploring observed changes in the agricultural calendar as a response to climate variability in northern Benin. It also attempts to highlight the factors affecting the farmers' decision to adjust their agricultural calendar as coping mechanism against climate variability.

Materials and methods

Study zone, sampling and data

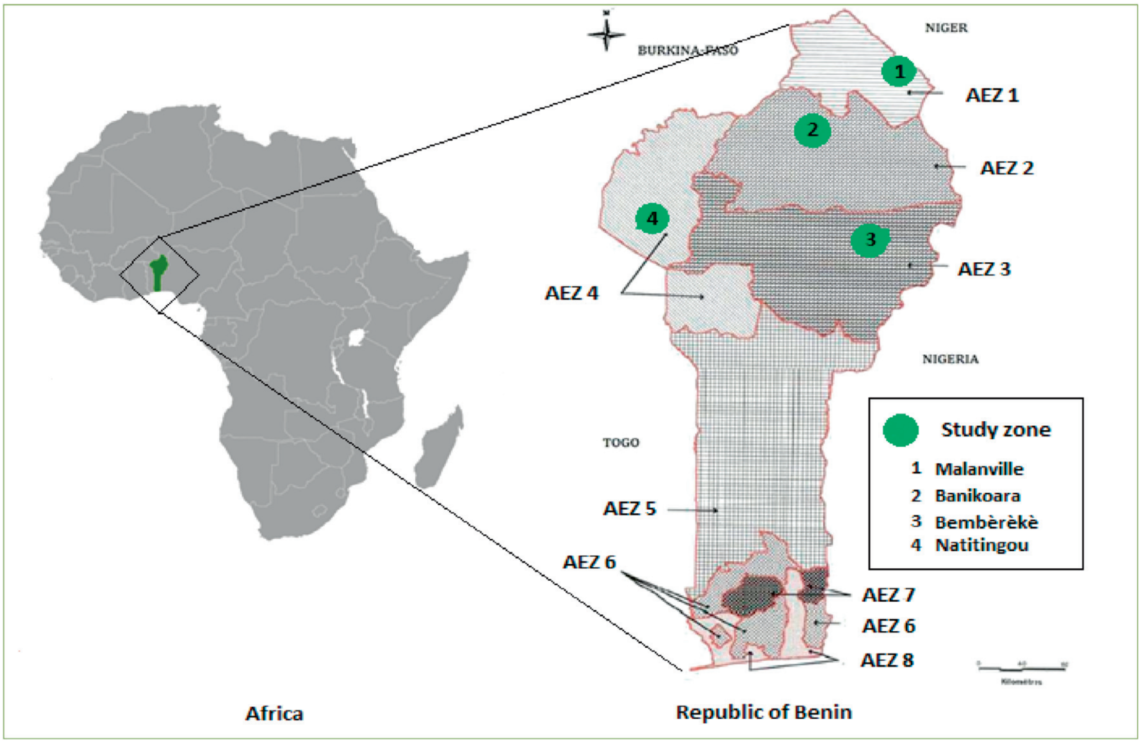
The study took place in northern Benin, located between 8.30° and 12.20° North, and 1.00° and 3.90° East. This region is expected to be more affected by projected climate change than the southern part of the country (MEHU, 2001). There are four distinct agro-ecological zones in northern Benin. The sampling took into account one municipality per agro-ecological zone (Fig. 1) and two villages per municipality. The choice of municipalities and the villages was made with the support of agricultural extension officers, based on the importance of the agricultural production.

The study was conducted through interviews with local experts (agricultural extension officers and local leaders such as the heads of farmers and village organisations), group interviews with farmers, and a household survey. Interviews with local experts were aimed at discussing the suitability of the agricultural calendar adjustment as a climate variability coping mechanism and identifying a list of its major socio-economic drivers. Group interviews with farmers from the selected villages were aimed at cross-checking the information obtained from the local experts and the household interviews, and understanding changes in the agricultural calendar and their drivers.

The household survey, which was conducted with a questionnaire, was aimed at collecting primary data for assessing the factors which influence decisions to adjust the agricultural calendar as coping mechanisms against climate variability. The scope of the questionnaire covered information related to the farmers perceptions of and mechanisms for coping with climate variability, and the decision to adjust the agricultural calendar as a climate variability response. As well, the socio-economic characteristics (i.e. age, educational level, experience in agriculture, contact with extension service, organisation membership, access to credit, and land ownership) and some farming system characteristics, including the farm location were also considered. Since maize is expected to be more affected by climate change (MEHU, 2001), the study respondents were maize producers. A total of 336 maize producers were randomly selected for individual interviews. The collected data were analyzed with the statistical softwares SPSS 19 and STATA 11.

Empirical modelling of farmers' decision to adjust the agricultural calendar

Choices or behaviours towards the decision to adopt agricultural technologies, innovations or new practices are explored by using the Multinomial Logit (MNL) or the Multinomial Probit (MNP) models (Nhemachena and Hassan, 2007; Yegbemey et al., 2013; Hausman and Wise, 1978; Wu and Babcock, 1998). Both models are appropriate for evaluating alternative combinations of choices, including single choices (Nhemachena and Hassan, 2007; Hausman and Wise, 1978; Wu and Babcock, 1998). In these models, the dependent variable is the set of choices (strategies or options) defined as one variable



Note:
AEZ: Agro-Ecological Zone
AEZ 1= Zone extrême Nord-Bénin
AEZ 2= Zone cotonnière du Nord-Bénin
AEZ 3= Zone vivrière zone du Sud-Borgou
AEZ 4= Zone Ouest-Atacora
AEZ 5= = Zone cotonnière du Centre-Bénin
AEZ 6= Zone des terres de barre
AEZ 7= Zone de dépression
AEZ 8= Zone des pêcheries

Fig. 1. Study area.

with multiple modalities. Since this study focuses only on the decision to adjust the agricultural calendar in a context of climate variability, the dependent variable is rather a binary process defined as "1" if the farmer decided to adjust or "0" otherwise. Following Paraïso and Sossou (2012), a simple logistic regression (Logit or Probit) is sufficient to model the probability for a farmer to move from "0" (decision not to adjust) to "1" (decision to adjust).

Previous studies have analyzed factors affecting choices in crop, livestock and mixed crop-livestock production systems in Africa at regional or local levels (Maddison, 2006; Adger et al., 2003; Yegbemey et al., 2013). Following the findings of these studies, farmers' socio-economic characteristics play important roles in the decision-making process. In addition, we assumed that the farming system characteristics (e.g. land under cultivation, labour, and capital) and the farms location (agro-ecological zone for instance) could also determine the decision to adjust the agricultural calendar as a climate variability response. This implies that the decision (D) whether to adjust the agricultural calendar is a function of three major driving forces: the socio-economic characteristics (Z), the characteristics of the maize farming system (Y), and the farms location (W), expressed by:

$$D = f(Z, Y, W) \tag{1}$$

Considering j farmers' socio-economic characteristics, j' characteristics of the maize farming system, and j'' farm locations, the model is represented by the equation:

$$d_i = \alpha_0 + \sum_j \beta_j z_{ij} + \sum_{j'} \delta_{j'} y_{ij'} + \sum_{j''} \theta_{j''} w_{ij''} + u_i \tag{2}$$

where d_i is the decision of the ith farmer to adjust the agricultural calendar as a mechanism for coping with climate variability; α_0 is a constant term; β, δ, and θ are parameters (coefficients of the explanatory variables Z, Y, and W, respectively) to be estimated, and u is the error term. In this model, we note that:

$$d_i = \begin{cases} 1 & \text{if } \alpha_0 + \sum_j \beta_j z_{ij} + \sum_{j'} \delta_{j'} y_{ij'} + \sum_{j''} \theta_{j''} w_{ij''} + u_i > 0 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

The parameters α, β, and δ were estimated by using a Probit model based on the Maximum Likelihood method (Gujarati, 2004). What matter in such estimation are the signs and magnitudes of the parameters and their levels of statistical significance. A positive (or negative) sign indicates that the explanatory variable under consideration is positively (or negatively) correlated with the decision to adjust the agricultural calendar as a mechanism for coping with climate variability. This simply implies that the explanatory variable is a factor that increases (decreases) the likelihood (probability) of a farmer adjusting the agricultural calendar. The level of significance is the probability of rejecting the null hypothesis (e.g. $\beta_j = 0$) when it is true.

Selection of the explanatory variables and hypotheses to be tested

The choice of the explanatory variables (Z, Y, and W) presented in Table 1 was determined by hypotheses stated in the literature and personal observations in the study zone.

The set of socio economic characteristics (Z)

- *Age:* Older farmers produce for self sufficiency. Consequently, they might be less likely to consider climate variability and to cope with it (Walker and Homma, 1996). Thus, we expect that older farmers are less likely to adjust their agricultural calendars as climate variability response.
- *Educational level:* Educated farmers are more likely to respond to climate change by making at least one adaptation (Maddison, 2006; Yegbemey et al., 2013). So, we hypothesize that a higher level of education will be positively correlated with the decision to adjust an agricultural calendar.
- *Experience in agriculture:* Farmers who have many years of farming experience have interacted much with the climate in relation to their farming activities and, therefore, have good knowledge of environmental factors as they relate to their farming operations (Ofuoku, 2011). As well they are more likely to adapt (Yegbemey et al., 2013). Thus we hypothesize that the experience in agriculture will be positively correlated with the decision to adjust an agricultural calendar.
- *Contact with extension service:* Farmers who have benefited from extension services are likely to adapt (MEHU, 2001). Accordingly, we hypothesize that the contact with extension service will affect positively the farmers' decision to cope with climate variability.
- *Farmers organisation membership:* In rural areas, farmers organisations are powerful information channels through which farmers exchange knowledge and experiences. Thus, we hypothesize that membership of a farmers organisation might be positively correlated with the decision to adjust the agricultural calendar.
- *Access to credit:* Access to credit is a key determinant of farmers' decision (Shahidur et al., 2002). We hypothesize that access to credit enhances financial capital and enables famers to cope with climate variability.

Table 1
Explanatory variables considered in the model.

Variables	Types	Modalities
Socio-economic characteristics (Z)		
Age (years)	Continuous	–
Level of education (school years)	Continuous	–
Experience in agriculture (years)	Continuous	–
Contact with extension (0/1)	Discontinuous	No = 0 ; yes = 1
Farmers organisation membership (0/1)	Discontinuous	No = 0 ; yes = 1
Access to credit (0/1)	Discontinuous	No = 0 ; yes = 1
Land ownership (0/1)	Discontinuous	No = 0 ; yes = 1
Maize farming characteristics (Y)		
Land under maize (hectare)	Continuous	–
Household size (person)	Continuous	–
Rotation/association (0/1)	Discontinuous	No = 0 ; yes = 1
Capital (francs cfa)	Continuous	–
Farms location (W)		
Agro-ecological zone 1 (0/1)	Discontinuous	No = 0 ; yes = 1
Agro-ecological zone 2 (0/1)	Discontinuous	No = 0 ; yes = 1
Agro-ecological zone 3 (0/1)	Discontinuous	No = 0 ; yes = 1
Agro-ecological zone 4 (0/1)	Discontinuous	No = 0 ; yes = 1

Table 2
Descriptive statistics of quantitative primary data.

Characteristics	Mean	Standard deviation
Age (years)	39.52	11.97
Level of education (school years)	3.27	4.02
Experience in agriculture (years)	21.77	11.65
Land under maize (hectare)	6.98	5.09
Household size (person)	12.59	8.45
Capital (francs cfa)	773888.9	450440.3

Note: Francs CFA 655.95 = Euro 1.

- *Land ownership:* Land ownership provides farmers with land security and has a positive effect on the decision to adapt (Yegbemey et al., 2013). Thus, we assume that the land ownership is positively correlated with the decision to adjust the agricultural calendar as climate variability response.

The set of farm system characteristics (Y)

We made the assumption that with respect to climatic risk, farmers are risk averse agents (Antle, 1987; Bar-Shira et al., 1997; Chavas and Holt, 1990; Hennessy, 1998). In addition, we also assumed that (1) farmers do not have any information on the climate predictions or forecasts and (2) have no alternative activities to meet both food and cash needs. Considering such frame, we derived the hypotheses related to the farming system characteristics as follow:

- *Land under maize cultivation:* We hypothesize that, if farm size is increasing, the maize production is likely to be more exposed to climate variability. Thus, larger farms are more likely to respond to climate variability by adjusting the agricultural calendar.
- *Household size:* Bigger households have more labour available for performing agricultural activities. So, we hypothesize that bigger households are more flexible in terms of undertaking changes of the agricultural calendar.
- *Rotation/association:* Farmers applying crop rotation/association consider the use of more crop varieties in the production system. They are more risk averse and then more likely to cope with climate variability by adjusting the agricultural calendar.
- *Capital:* The more farmers invest capital in the production, the more they will take initiative to secure their investments by coping with climate variability. Thus, we assume that the capital invested is positively correlated with the decision to adjust the agricultural calendar.

The set of farm location variables (W)

Here we consider only the agro-ecological zones, each considered as one dummy variable. Given that climate variability is not occurring only in one particular agro-ecological zone, we expect a positive correlation between each agro-ecological zone and the farmers' decision to adjust the agricultural calendar as climate variability response.

Results

Descriptive statistics of primary data

Descriptive statistics of quantitative and qualitative primary data are summarized in Tables 2 and 3, respectively. On average, the respondents were about 40 years old. The level of education was very low (3 years of primary school on average). The respondents were well experienced in agriculture. Indeed, the average experience was 22 years. The contact with extension dealing with climate variability issue was low (only 18% of the respondents). About 71% and 22% of the respondents belonged to at least one farmers organization and had access to credit, respectively. The number of respondents per agro-ecological zone was about 80.

Considering the maize farming characteristics, the average size of maize farms in the study zones was 6.98 (±5.09) hectares. On average, the household was composed of 13 people (±8.45). The main inputs involved in maize farming were land, labour and capital to access fertilizers, pesticides, additional labour, etc. On average, the respondents spent per year Francs CFA[1] 773,889 (±450,440), which constituted the maize farming capital.

Adjusting the agricultural calendar as a climate variability response

All the respondents mentioned that they have perceived climate variability. The farmers' perception of climate variability was mainly related to changes in rainfall patterns, especially the onset of the rainy season and the temporal distribution of rainfall. To some extent, many strategies are developed by farmers as climate variability coping mechanisms. Among other

[1] Code ISO 4217 : XOF.

Table 3
Descriptive statistics of qualitative primary data.

Characteristics	Absolute frequency	Relative frequency (%)
Contact with extension (0/1)	56	18.18
Farmers organisation membership (0/1)	219	71.10
Access to credit (0/1)	66	21.43
Land ownership (0/1)	267	86.69
Rotation/association (0/1)	202	66.01
Agro-ecological zone 1 (0/1)	86	25.60
Agro-ecological zone 2 (0/1)	84	25.00
Agro-ecological zone 3 (0/1)	83	24.70
Agro-ecological zone 4 (0/1)	83	24.70

Note: Absolute frequency of variable *x* is the number of respondents for which *x* is applicable. Relative frequency of variable *x* is the share of respondents for which *x* is applicable. It is the absolute frequency of *x* normalized by the total number of respondents.

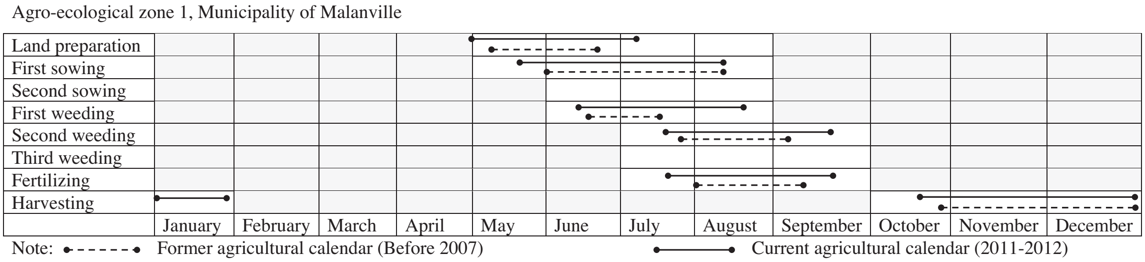


Fig. 2. Agricultural calendar in the village of Isséné (11.73° N; 3.19° E).

strategies, farmers could diversify their crops (87% of the respondents), implement some land use management strategies (15% of the respondents) or adjust some farming practices (93% of the respondents).

The agricultural calendar adjustment belongs to the last group of climate variability coping mechanisms. Implemented by 84% of the respondents, it aims at changing the dates of the farming activities to coincide with the rainy season. In northern Benin, agriculture in general and maize farming in particular are rainfed-based activities. Therefore, adjusting the agricultural calendar becomes an important means to cope with climate variability.

Management of the agricultural calendar as a coping mechanism to climate variability

In terms of agricultural calendar adjustment, farmers mainly change land preparation and sowing dates. Due to the fact that all the remaining activities depend on the sowing date, they also moved the dates of other activities either forward or backward with respect to the former calendar (Figs. 2–9). Because of uncertainties related to climate variability, farmers have to start land preparation activities earlier to be ready in case the onset of the rainy season occurs earlier. As well, they have to use strategies such as double sowing[2] in case they faced dry spells shortly after the first sowing which took place at the onset of the rainy season. Regardless of the type of adjustment, most of the farmers designed their agricultural calendar by themselves, relying on personal experience. Despite the existence of agricultural extension services, farmers receive limited support from them concerning the management of the agricultural calendar in the face of climate variability.

To explore the observed changes in the agricultural calendar as a response to climate variability, the study focused on five agricultural activities defined with local experts (agricultural extension officers and local leaders). These activities are land preparation, sowing (including double sowing in some cases), weeding, fertilizing, and harvesting. Land preparation generally took place at the beginning of the rainy season, with well loosened ridges or furrows 15–30 cm deep, which ensure that maize plants are sufficiently exposed to light in order to obtain higher yields (Escalante-Ten Hoopen and Maïga, 2012). Sowing activities were achieved at 3–4 cm depth, with 0.80 m spacing between rows and 0.50 m between pockets. In northern Benin, maize is sown from late May to early July. In general, the onset and the length of the rainy season, the amount of rainfall and the temporal distribution of rainfall events are highly variable. This requires farmers to make staggered plantings and even to modify their production expectations and forecasts. In this prospect, some farmers practice double sowing.

To ensure good growth and development of maize plants, 2–3 manual weedings are necessary: the first weeding is undertaken 2–3 weeks after sowing, the second, at the time of urea's intake, and the third one before the harvest when the plot is very weedy. Some of the maize growers use herbicides to control weeds on their plots. After sowing and before the lifting of

[2] Double sowing consists of a second round of sowing after the first. This becomes necessary when farmers notice that the first sowing was not successful due water stresses (i.e. lack of rainfall) or other factors such as floods or livestock grazing.

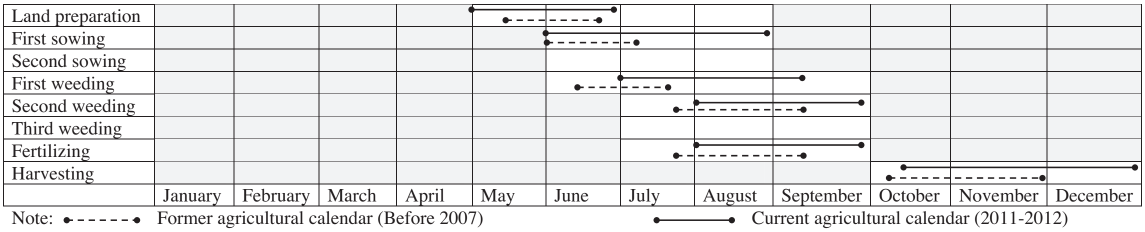


Fig. 3. Agricultural calendar in the village of Kora-Tèdji (11.77° N; 3.23° E).

Agro-ecological zone 2, Municipality of Banikoara

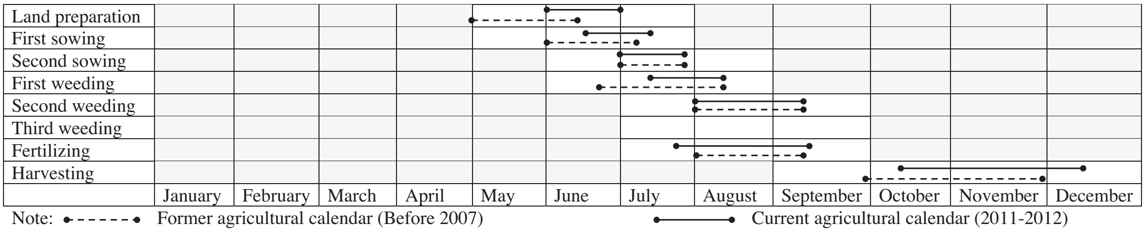


Fig. 4. Agricultural calendar in the village of Bouhanrou (11.36° N; 2.47° E).

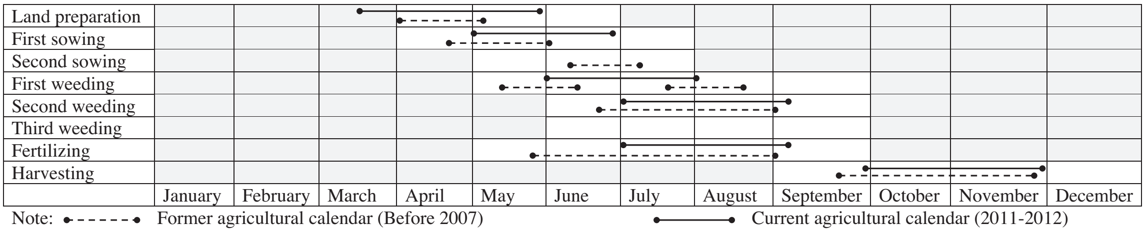


Fig. 5. Agricultural calendar in the village of Ounet (11.22° N; 2.40° E).

Agro-ecological zone 3, Municipality of Bembèrèkè

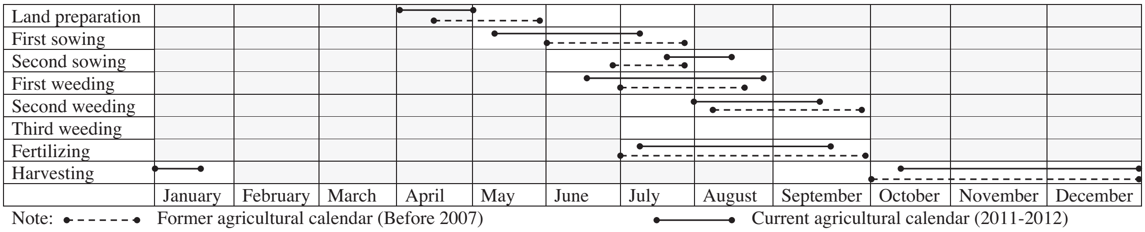


Fig. 6. Agricultural calendar in the village of Guéré (10.23° N; 2.67° E).

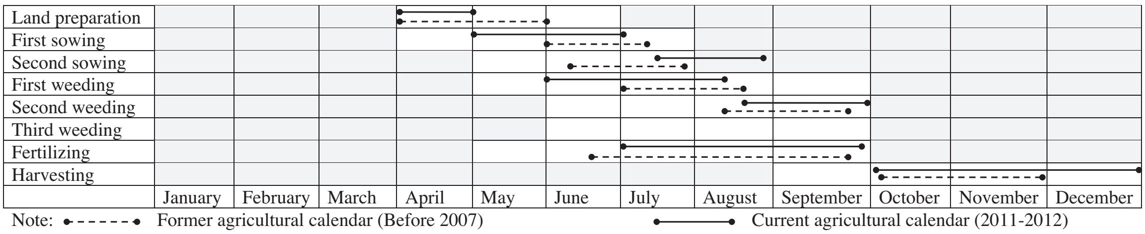


Fig. 7. Agricultural calendar in the village of Pédarou (10.30° N; 2.70° E).

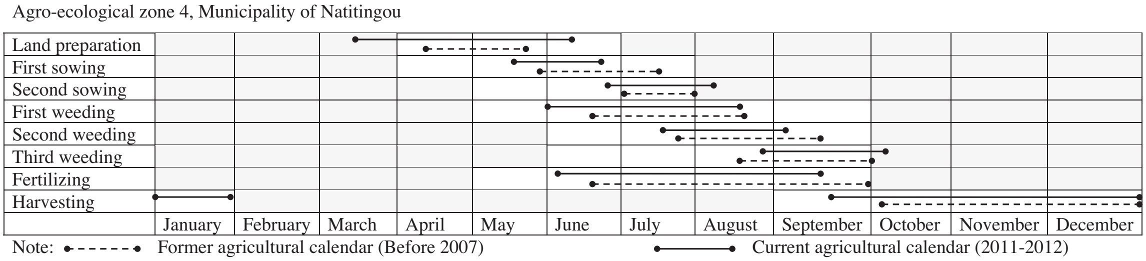


Fig. 8. Agricultural calendar in the village of Pam-Pam (10.08° N; 1.48° E).

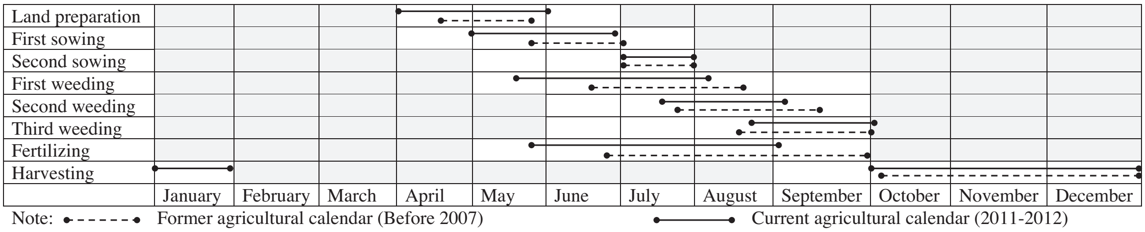


Fig. 9. Agricultural calendar in the village of Takonta (10.03° N; 1.34° E).

maize, the field is treated with a pre-emergent herbicide as Primagram Gold 660 SC (S-metolachlor 290 g/l + atrazine 370 g/l) at a dose of 3 l/ha. During the development of the plants, roundup (glyphosate 360 g/l) is used at 1 l/ha dose, while preserving the leaf system of the plant against the product. Fertilization depends on the requirements of the variety and the soil conditions. Immediately after the first weeding, it brings 200 kg/ha of NPK and 50 kg or 25 kg of urea and just after the second weeding 50 kg/ha of urea. Chemical insecticides are used to control pests. However, preventive protection by appropriate farming practices such as regular weeding or the seedling of resistant varieties is preferable.

Ears of maize are harvested fresh or dry with the husks or feldspars according to the use. Dry ears are harvested when the husks of the spur have yellowed and the leaves are drying. The ears are collected from 60–75 days after planting for early varieties and 75–85 days for late varieties. Yields varied from 0.8 T/ha to 1.5 T/ha for traditional culture; 2–3 T/ha for the improved culture and 4–6 T/ha in research stations. These activities lead to an extension of the cropping season.

Table 4
Results of the Probit model.

Variables	Coefficient	Std. Err.	Z	P > z
Socio-economic characteristics (Z)				
Age (years)	−0.036**	0.018	−2.03	0.042
Level of education (years)	−0.246	0.154	−1.59	0.111
Experience in agriculture (years)	−0.001	0.018	−0.11	0.914
Contact with extension (0/1)	1.361**	0.639	2.13	0.033
Farmers organisation membership (0/1)	−0.807	0.559	−1.44	0.149
Access to credit (0/1)	0.090	0.376	0.24	0.810
Land ownership (0/1)	0.235	0.374	0.63	0.530
Maize farming characteristics (Y)				
Land under maize (hectare)	−0.114**	0.057	−1.98	0.047
Household size (person)	0.245	0.277	0.89	0.376
Rotation/association (0/1)	0.908**	0.390	2.32	0.020
Capital (francs cfa)	2.43e-06***	9.66e-07	2.52	0.012
Farms location (W)				
Agro-ecological zone 1 (0/1)	1.728***	0.554	3.12	0.002
Agro-ecological zone 2 (0/1)	2.123***	0.613	3.46	0.001
Agro-ecological zone 3 (0/1)	1.309**	0.607	2.16	0.031
Agro-ecological zone 4 (0/1)	(Omitted)	–	–	
Constant term	0.503	0.941	0.53	0.593
Model summary	LR $chi^2(14) = 51.38$; Probit > $chi^2 = 0.0000$; Pseudo $R^2 = 0.3251$			

*, **, ***: Significant at 10% ($0.05 < P < 0.10$), 5% ($0.01 < P < 0.05$), and 1% ($P < 0.01$), respectively.

Driving forces of the decision to adjust the agricultural calendar

The key factors determining the decision to adjust the agricultural calendar are reported in Table 4. The results show the Probit regression model to be highly significant ($P < 0.01$), implying an appropriate goodness of fit. About 33% of the variations in the decision to adjust the agricultural calendar were explained by variations in the explanatory factors used in the model. Age, contact with extension services, land under maize, crop rotation/association, capital, and the agro-ecological zones were the main factors determining the adoption of agricultural calendar adjustment as a mechanism for coping with climate variability. Variables such as level of education, experience in agriculture, farmers' organisation membership, access to credit, land ownership and household size had no significant effects on the farmers' decision to cope with climate variability.

Discussion

The history of agriculture reflects that farmers have undertaken a series of adaptations to a wide range of climate, social and agronomic factors (Wall and Smit, 2005). They have been able, to a large extent, to develop their livelihood strategies in a way that enables them to constantly cope with climate variability, severe pest attacks, and changing policies at local, national, and global levels (Mertz et al., 2009).

The changes in farming activities dates, especially the sowing date is widely reported in the literature on climate change adaptation (Nhemachena and Hassan, 2007; Gnanglè et al., 2012; Yegbemey et al., 2013; Maddison, 2006). Once the sowing date has been changed, the whole agricultural calendar is adjusted. The observed changes in the agricultural calendar as a response to climate variability reveal that the cropping season is getting longer because farmers have to start the land preparation activities earlier while the onset of the rainy season might occur later than usual. In Benin and Sub-Saharan West Africa in general, farmers indeed tend to sow maize after the first main rainfall (>20 mm) occurring at the start of the rainy season (Akponikpè et al., 2010; Agbossou et al., 2012). Given the high climate variability, farmers usually face dry spells after the first sowing. To deal with this lack of rains, they practice a second sowing. As a result, the duration of the cropping season lasts longer than usual, posing the issue of time-inefficiency.

At present, adjustments to the agricultural calendar do not seem consistent across locations. This finding could be explained by the fact that the villages belong to different agro-ecological zones. Nevertheless, even within the same agro-ecological zone, the adjustments are sometimes slightly different. Indeed, the distribution of rainfall is not likely to be spatially homogeneous across a given agro-ecological zone (e.g. it rains on farmer-A's farm but not on farmer-B's although the 2 farms are less than 10 km far away from each other and in the same agro-ecological zone). This also explains the observed adjustment differences either among or within agro-ecological zones. The findings indicate also that there are no guidelines towards the management of the agricultural calendar under climate variability conditions as reported by the agricultural extension officers.

Socio-economic characteristics and behaviours towards the agricultural calendar adjustment

The farmers' socio-economic characteristics affect their decision to cope with climate variability through the adjustment of the agricultural calendar. The farmer's age for instance is negatively correlated ($P < 0.05$) with the decision to adjust the agricultural calendar. Older farmers have less land and most of the time, produce for self sufficiency (Walker and Homma, 1996). Thus, they show less interest in coping with climate variability. Additionally, they rely on external support (e.g. food and cash) through their relatives. As expected, farmers who benefited from extension services are likely to adjust their agricultural calendar. Indeed, contact with extension was positively correlated to the farmer's decision to adjust the agricultural calendar ($P < 0.05$).

Maize farming characteristics and behaviours towards the agricultural calendar adjustment

The land under maize cultivation was negatively correlated with the farmer's decision to adjust the agricultural calendar ($P < 0.05$). This unexpected result might be explained by the fact that larger maize producers keep the former agricultural calendar and use the double sowing strategy which limits the potential losses after the first sowing. Farmers applying crop rotation/association are likely to adjust their agricultural calendar to cope with climate variability ($P < 0.05$). By adopting the rotation/association system, farmers are more constrained to adapt to rainfall variability in order to reduce the risk of losing the production of all crops.

The total amount of capital invested in maize farming was positively correlated with the farmer's decision to adjust the agricultural calendar ($P < 0.01$). Following the producer theory, farmers aim at maximising the output under the inputs constraints. The more farmers invest in the production, the more they are likely to adjust their system to climate variability. Again, farmers are not likely to be neutral to risk and actually tend to be risk averse agents (Serra et al., 2006; Yesuf and Bluffstone, 2007). Therefore, as long as farmers increase the capital invested in the production process, they set out strategies (e.g. adjustments to the agricultural calendar) so that they could be able to make the maximum profit at the end of the production.

Farms location and behaviours towards the agricultural calendar adjustment

All the agro-ecological zones had positive and significant effects on the farmers' decision to adjust the agricultural calendar, which was due to the fact that climate variability was occurring in all agro-ecological zones.

Level of education, experience in agriculture, farmers' organisation membership, access to credit, land ownership, and household size are mixed socio-economic characteristics with different but no significant effects on the farmer's decision to adjust the agricultural calendar ($P > 0.10$).

Conclusion

Given climate variability, farmers develop coping mechanisms such as adjusting some of their farming practices. Farmers in northern Benin adjust among other measures, the agricultural calendar as a response to climate variability. They design their agricultural calendar by relying on personal experience. Due to climate variability, the duration of the cropping season is getting longer with slight differences among or within agro-ecological zones. As a result, the risk for farmers to be operating under time inefficient calendar conditions becomes higher. Socio-economic characteristics, maize farming characteristics and farm location are found to be driving forces of the decision to adjust the agricultural calendar as mechanism for coping with climate variability. These findings suggest that providing farmers with climate related information could help to ensuring rational and time-efficient management of the agricultural calendar. As well, research and extension institutions should help in designing clear agricultural calendars to be based on the driving forces of farmers' behaviours towards the adjustment of their farming practices as a climate variability response.

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