# FARMER PERCEPTION OF THE IMPACT OF CLIMATE CHANGE ON RICE PRODUCTION AND THEIR ADAPTATION STRATEGIES IN THE MAYO-DANAY, FAR-NORTH CAMEROON

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***Abstract.*** *A survey was carried out in the Mayo-Danay Division, Far-North Cameroon to assess rice farmer indigenous knowledge of the impact of climate change on rice production, their adaptation strategies. A sample of 140 of rice farmers was chosen at random in four rice growing municipality and was interviewed using a structured questionnaire with open and closed questions. The results showed that farmers clearly perceive climatic variations and their impact on rice production through the delay (89.00%) and decrease (87.00%) of rains, flooding (88.60%) and drought (85.00%). The impact of these climate changes on rice production was directly observed on the variation in yield according to the rice growing seasons and confirmed the perception of farmers. To cope with these climate variations, two types of adaptation strategies have been developed by farmers in area. This concerns varietal adaptation such as the use of improved varieties, and that of cultural practices such as direct seeding, transplanting, construction of protective or anti-erosion bunds and use of the fodder. It was a question of analyzing the farmer perception of the impact of climate change on rice production in Mayo-Danay Division. It appears that the farmers of Mayo-Danay perceived climatic disturbances in irrigated and rainfed rice cultivation. These preliminary results could contribute to sustainable management of rice cultivation.*

***Keywords****: Climatic variability, farmer perception, rice production, adaptation strategy, Mayo-Danay, Cameroon.*

## INTRODUCTION

Among the most significant environmental problems of our time are deforestation, soil degradation, pollution and more recently climate change. The latter is manifested for Africa by the progression of drought, the decline in water resources, the resurgence of floods, the instability of rainfall (ABOSSOLO et al., 2017). In the Sahelian part, the area of the continent most affected by the effects of climate change, observations showed a drop in rainfall since the end of the 1960s, with a recovery in humidity from the beginning of the 1990s (HULME, 2001; LE BARBÉ et al., 2002). In the Far North region of Cameroon, the rate of invasion of fields by caterpillars, the areas devastated by floods, the drop in yields per hectare, the wilting of crops are some of the indicators reported by ANOUGUE et al. (2013) and SAMBO (2018).

Agriculture, which plays a decisive role in meeting the food needs of populations, is the sector of the economy most affected by climate change in the Sahel (IPCC, 2007; Sambo, 2018). Indeed, the extension of arid lands, the considerable drop in water resources and the increase in temperature directly affect the productivity of all crops. In addition, the variation in the rainy seasons seriously affects rainfed agriculture, which accounts for nearly 93% of cultivated land and 80% of cereals consumed in the Sudano-Sahelian part of Africa (ABOSSOLO et al., 2017; SULTAN et al., 2021). A study on climate scenarios and future agricultural yields have shown that by 2025, climate change will lead to a considerable drop in yields of major crops in sub-Saharan Africa by 2025, particularly cassava (-26%), peanuts (-15%) and maize (-11%), while the populations of most of these African countries will double (ZHAO, 2005). This situation would be due to a variability of the agro-climatic indices which directly influence agricultural yields, in particular the humidity index, the drop in which means a reduction in the climatic supply of water due to the deterioration of potential evapotranspiration and the drop in cumulative rainfall (BERGER, 1992; IGLESIAS et al., 2007).

Irrigated agriculture, such as rice cultivation which plays an important role in feeding the population in Africa, will also be affected, not only because of an increase in temperature, but also because of a possible modification of the water availability which can lead to significant yield losses (DINGKUHN, 1995; SAMBO, 2018). However, rice is the essential food for several countries in the world, especially the Sahelian countries (FAO, 1999). It is a source of vitamin B group, nutrients, glutamic and aspartic acid, etc. (GRIST, 1986; JULIANO, 1993)

Agriculture has shown, throughout history, a great capacity to adapt to changing conditions with or without a conscious response from farmers. These modifications have now exceeded self-adaptive limits, which require supportive policies to enable farmers to cope with the adverse effects of climate change, taking into account local traditional knowledge (IGLESIAS et al., 2007). A better understanding of how farmers perceive the variability of climatic factors and their effects on crop production is necessary in order to seek sustainable adaptation methods. Several authors have addressed not only the importance of taking this endogenous knowledge into account as strategies for adapting to climate change, but also as factors that can increase productivity and ensure food security in West Africa (HOUNTONDJI, 2005; TCHETANGNI et al., 2016; OUATTARA et al., 2019; BAMAHOSSOVI et al., 2016; ZOUNGRANA, 2010; DEKOULA et al., 2018). However, this information is scarcely available for Cameroon, particularly in the Far-North region, with the exception of studies of SAHA et al. (2017) on the water deficit on agricultural activity and WATANG (2011) on the effects of climate change on agropastoral systems in the Sahel. The objective of this study is to assess farmer perception of climate variations on rice production in Mayo-Danay Division and their strategies for adapting to climate change, in order to contribute to the sustainable management of rice cultivation.

## MATERIAL AND METHODS

Study sites

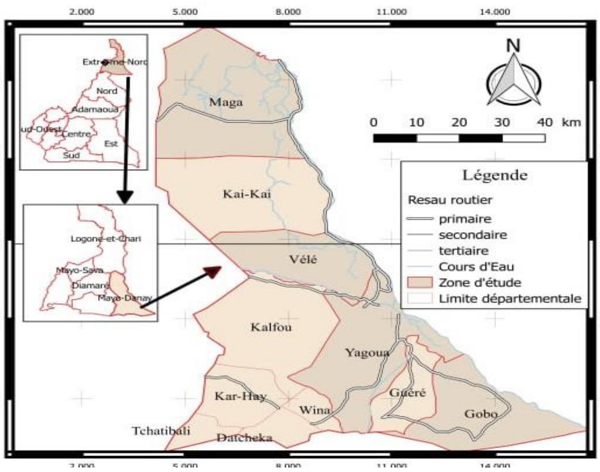


Figure 1. Location of study sites (SOGEFI, 2020)

Study was conducted in four rice production municipalities, namely Gobo, Maga, Vele and Yagoua in Mayo-Danay Division, situated in the Far-North region of Cameroon (Figure 1).

With an area of 5303 km2 and a population of approximately 522782 inhabitants in 2001, the area extends between 10°30’0” latitude North and 15°0’0” longitude East. The relief is fairly uniform and is in the form of a plain of negligible slope, periodically flooded by water mainly from the Logone River. The soil is variable and includes Luvisols, Fluvisols, Planosols, sandy soils (PCD, 2020). The climate is the Sudano-Sahelian type with two seasons: a dry season of 8 to 9 months and a rainy season of 3 to 4 months. The rainfall is low with an annual average of 800 mm and the annual average temperature is 25°C (PCD, 2020). According to data obtained from the Yagoua meteorological station, rainfall and temperatures have fluctuated over the past 10 years in the area and according to the study site (Figure 2). The peaks of rainfall were obtained in 2012, 2017 and 2019 for the four sites, except at Maga in 2017 where low rainfall was recorded (Figure 2a). As for the temperature, there has been a
drop since 2017, with a difference of 2°C over the last 10 years (Figure 2b).

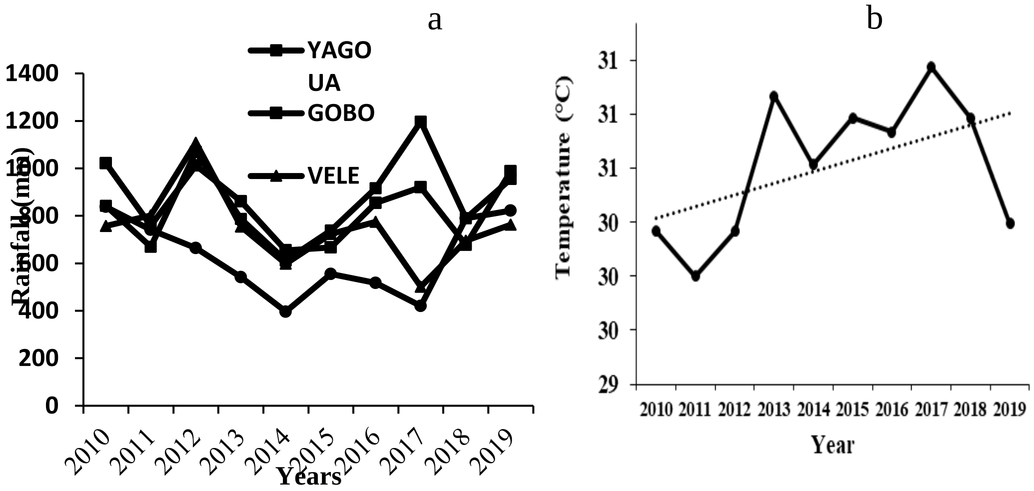


Figure 2. Evolution of main annual rainfall (a) and mean annual temperature (b) in the four municipalities of Mayo-Danay, from 2010 to 2019.

Vegetation is rich and diversified with steppe tree formations in Yagoua, Maga and Vele, and shrubby savannahs. The tree steppes are dotted with dwarf thorny plants and parasitic grasses, while the shrubby savannahs are rich in mimosaceae made up of different varieties of acacia (PCD, 2020). The main plant species encountered are the soap tree, the tamarind tree, and rôniers, etc. Most of these species enter the local traditional pharmacopoeia. We must add fruit trees such as jujube, mango, etc.

The main ethnic groups encountered are, among others, the Massa, Toupouri, Mousgoum, Moussey, Peulhs, Kanuri. Their main activities are agriculture, generally for self-consumption and marketing, livestock farming, fishing in the Logone and shops. With regard to rice cultivation, it is practiced much more by the natives (Massa), because the other ethnic groups are not interested in it, for lack of land (PCD, 2020). This rice production varies from 7 to 14 t.ha-1 according to data from SEMRY (Company of Expansion and Modernization of Rice Cultivation of Yagoua) of Yagoua (Figure 3).

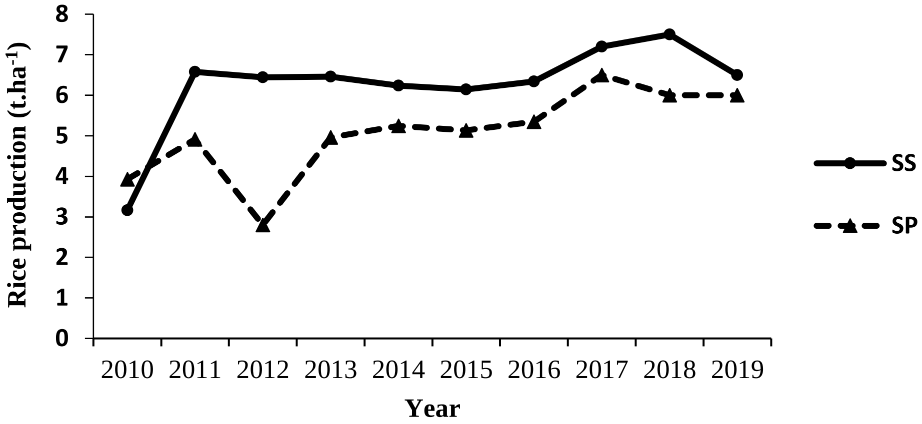


Figure 3. Evolution of rice production in the rainy season (SP) and dry season (SS) in SEMRY from 2010 to 2019.

## Methodology

The research methodology was based on interviews using open-ended questions and on field observations. The survey was conducted in August 2020, period between the dry season rice campaign and that of the rainy season, where the farmers were available. The sample unit was the rice farm household with the head of the household as the respondent. The sample was made up of persons of both sexes (Table 1), distributed over the entire population (particularly the rice farmers): the full-time rice farmers (more than 97%) and part-time farmers, that is, those who associate agriculture to other activities like animal rearing, commerce, fishing. The minimum age of respondents was 35 years old with an experience of at least 20 years in the agriculture field and to be old in rice cultivation. Strangers who had not made up to 10 years in the region were excluded from the sample, because we assumed that they know little or do not know enough about the local cultural systems.

*Table 1*

Characteristics of rice farmers surveyed in the four municipalities of Mayo-Danay.

| Variables | Modalities | Yagoua (%) | Maga (%) | Vele (%) | Gobo (%) |
|---|---|---|---|---|---|
| **Age class (year)** | 18-24 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 25-34 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 35-49 | 37.50 | 40.00 | 55.00 | 55.00 |
| | 40-64 | 52.50 | 52.50 | 40.00 | 40.00 |
| | > 65 | 5.00 | 7.50 | 7.50 | 5.00 |
| **Sex** | Male | 72.50 | 85.00 | 85.00 | 80.00 |
| | Femel | 27.50 | 15.00 | 15.00 | 20.00 |
| **Ethnic group** | Massa | 95.00 | 45.00 | 87.50 | 60.00 |
| | Mousgoum | 2.50 | 50.00 | 7.50 | 0.00 |
| | Peulh | 0.00 | 0.00 | 0.00 | 0.00 |
| | Toupouri | 2.50 | 0.00 | 2.50 | 0.00 |
| | Moundang | 0.00 | 2.50 | 2.50 | 0.00 |
| | Moussey | 0.00 | 0.00 | 0.00 | 40.00 |
| **Marital Status** | Single | 7.50 | 2.50 | 2.50 | 0.00 |
| | Married | 87.50 | 95.00 | 97.50 | 95.00 |

| | | | | | |
|---|---|---|---|---|---|
| | Living together | 0.00 | 0.00 | 0.00 | 0.00 |
| | Widower | 5.00 | 0.00 | 0.00 | 5.00 |
| | Divorced | 0.00 | 2.50 | 0.00 | 0.00 |
| **Religion** | Chretian | 97.50 | 45.00 | 85.00 | 95.00 |
| | Muslim | 2.50 | 50.00 | 15.00 | 5.00 |
| | Animist | 0.00 | 0.00 | 0.00 | 0.00 |
| | Atheist | 0.00 | 0.00 | 0.00 | 0.00 |
| **Study level** | Unschooled | 2.50 | 2.50 | 2.50 | 10.00 |
| | Primary study | 35.00 | 25.00 | 22.50 | 15.00 |
| | Secondary study | 55.00 | 55.00 | 65.00 | 70.00 |
| | High study | 7.50 | 17.50 | 10.00 | 5.00 |
| **Main activities** | Agriculture | 100 | 97,50 | 97.50 | 100.00 |
| | Trade | 7.50 | 15.00 | 10.00 | 10.00 |
| | Fishing | 5.00 | 22.50 | 15.00 | 0.00 |
| **Seniority (year)** | 1 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 10 | 32.50 | 67.50 | 50.00 | 100.00 |
| | > 10 | 67.50 | 32.50 | 50.00 | 0.00 |
| **Crop praticed** | Rice | 100.00 | 100.00 | 100.00 | 100.00 |
| | Maize | 47.50 | 25.00 | 5.00 | 35.00 |
| | Millet | 80.00 | 25.00 | 60.00 | 75.00 |
| | Cassava | 0.00 | 0.00 | 5.00 | 5.00 |
| | Patato | 0.00 | 0.00 | 0.00 | 0.00 |
| | Peanut | 0.00 | 0.00 | 0.00 | 45.00 |
| | Cotton | 0.00 | 0.00 | 0.00 | 95.00 |
| **Training in rice cultivation** | Yes | 20.00 | 27.50 | 10.00 | 0.00 |
| | No | 80 | 72,50 | 90,00 | 100 |
| **Motivation** | Sale | 92.50 | 85.00 | 92.50 | 95.00 |
| | Consumption | 100.00 | 67.50 | 97.50 | 100.00 |
| | Research | 0.00 | 0.00 | 0.00 | 0.00 |

A questionnaire was offered to a semi-random sample of 140 households in the four most crowded and produced rice municipalities, at a rate of 40 households per site and 20 per type of rice cultivation (irrigated and rainfed rice cultivation), except in Gobo where there is no irrigated rice cultivation. The main focus was the farmer's indicators of climate change, the constraints of rice production, the impact of climate change on rice production and the adaptation strategies of farmers to mitigate the effects of climate change. The data of rainfall and temperature variations from 2010 to 2019, obtained at the meteorological station of Yagoua and those of rice production at the SEMRY.

## RESULTS AND DISCUSSIONS

Farmer indicators of climate change, perception of impact of climate change on rice production and consequences in the rice farmer households

The rice farmers interviewed in different study sites perceived climate change throughout their indicators (Figure 4) such as delayed rains (89%), floods (88.60%), reduced rainfall (87%), drought (85%), insolation (44.30%), early cessation (12.90%) and increased rainfall (7.90%), and strong wind (5.70%). Thus, the main farmer indicators of climate change are rainfall through its various manifestations such as the variation in the duration and amplitude of the seasons.

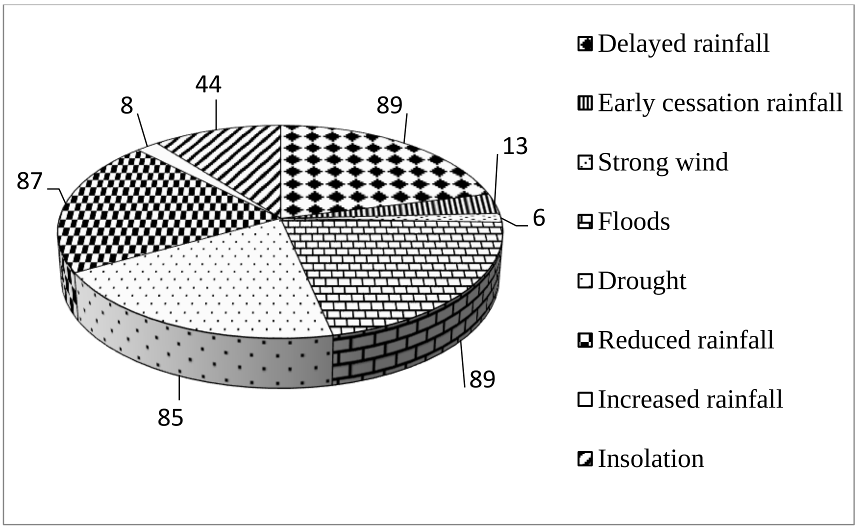


Figure 4. Farmer indicators of climate change in Mayo-Danay.

The populations surveyed are all aware of the impact of climate change on rice production and affirmed with certainty that the impact of climate change is directly manifested on rice production through the variation in yields (24.20%) such as rising (62.4%) or falling (16.40%) yields.

The consequences of climate change in the household of rice farmers in Mayo-Danay are numerous (Figure 5), but the main ones are famine (91.40% of responses), poverty (70.71%) and rural exodus (55.71%). The other consequences, not of lesser importance, are weakly cited by respondents, such as unemployment (8.57%), under-education (2.14%) and diseases (5.71%).

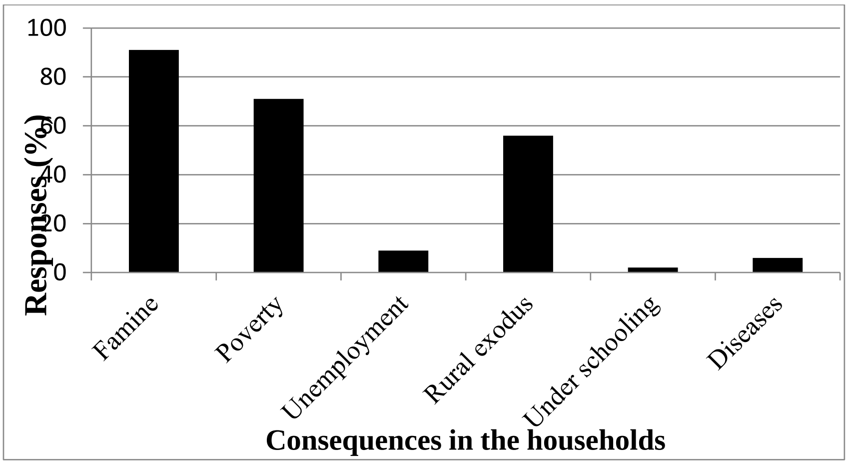


Figure 5. Consequences of climate change in the rice farmer households in Mayo-Danay.

**Period of the influence of climatic parameters on rice production cycle**

Climatic parameters such as temperature, rainfall, humidity and wind influence the rice production cycle according to the seasons and the phases of the cycle (Table 2). The influence of temperature on the rice production cycle is much more pronounced during the phase of fertilizer application (82%) and heading (52%) in the rainy season and heading (53.12%) in the dry season, while rainfall affects this rice production cycle during the sowing phase in the rainy seasons (100%) and in the tillering period in the dry season (40.00%). As for humidity, it affects the rice production cycle during the caryopsis maturation phase in the dry (56.67%) and rainy (57.50%) seasons and during the heading phase in the dry seasons (35.00%). The wind has an influence on the rice production cycle during the fertilization phase in dry season (60.00%) and during the caryopsis maturation period in dry season (43.33%). For the other periods, these influences of the climatic parameters are weak.

*Table 2*

Effects of climatic parameters (temperature, rainfall, humidity and wind) on rice production cycle according to season and phase of cycle in Mayo-Danay. Responses (%).

| Period of | Temperature | Rainfall | Humidity | Wind |
|---|---|---|---|---|
| | DS(%) | RS(%) | DS(%) | RS(%) |
| **Sowing** | 0.00 | 4.00 | 0.00 | 100.00 |
| **fertilizer application** | 25.00 | 82.00 | 3.33 | 0.00 |
| **Tillering** | 5.20 | 8.00 | 40.00 | 11.25 |
| **Fertilization** | 0.00 | 0.00 | 0.00 | 0.00 |
| **Heading** | 53.12 | 52.00 | 1.67 | 0.00 |
| **caryopsis maturation** | 0.00 | 0.00 | 16.67 | 16.25 |

Dry season (DS) and rainy season (RS)

**Farmer itinerary and rice production constraints**

The variables related to production itinerary are numerous (Table 3). Majority of surveyed (80-90%) have farm areas between 0.5 and 1 hectare. The most cultivated varieties are IR46 and NERICA because of their ecological plasticity in these areas. The sowing period for the dry season was during December and that of the rainy season was June. Direct and indirect sowings were practiced during the rainy season and indirect sowing during the dry season. In the municipality of Gobo, 100% of farmers practiced direct seeding, while in the other municipalities, between 67.5 and 97.5% of farmers practiced indirect seeding. Almost all farmers fertilized the soil with chemical inputs (95-100% of responses). The fertilizer application period differs according to the two types of sowing practiced. In the municipalities of Maga, Vele, and Yagoua, 100% of respondents spread fertilizer in the field between 14th and 21st day after transplanting during the two rice growing seasons and 90% of respondents in the municipality of Gobo applied their fertilizer between 28th and 35th day after transplanting.

*Table 3*

Itinerary rice production in the four municipalities of Mayo-Danay. Response (%).

| *Variables* | *Modality* | ***Yagoua*** | ***Maga*** | ***Velé*** | ***Gobo*** |
|---|---|---|---|---|---|
| *Field area (ha)* | 0.5 – 1 | 80.00 | 85.00 | 80.00 | 90.00 |
| | 1.5 – 2 | 12.50 | 12.50 | 15.00 | 10.00 |
| | 2.5 – 3 | 7.50 | 2.50 | 5.00 | 0.00 |
| *Plot preparation* | Protective bunds | 100.00 | 100.00 | 100.00 | 65.00 |
| *Variety of cultivated rice* | IR46 | 75.00 | 75.00 | 72.50 | 40.00 |

| | | | | | |
|---|---|---|---|---|---|
| | NERICA | 62.50 | 55.00 | 57.50 | 95.00 |
| | TOX | 2.50 | 0.00 | 2.50 | 0.00 |
| *Type of sowing* | Direct sowing | 37.50 | 12.50 | 10.00 | 100.00 |
| | Indirect sowing | 90.00 | 97.50 | 67.50 | 15.00 |
| *Sowing period* | December | 50.00 | 50.00 | 50.00 | 0.00 |
| | May | 15.00 | 15.00 | 32.50 | 5.00 |
| | Jun | 77.50 | 85.00 | 67.50 | 95.00 |
| *Fertilization* | Yes | 100 | 100 | 97.50 | 95.00 |
| *Type of fertilizer* | Organic fertilizer | 0.00 | 10.00 | 5.00 | 0.00 |
| | Chimical fertilizer | 100.00 | 90.00 | 95.00 | 100.00 |
| *Fertilizer application period (Day after sowing)* | 14-21 | 100.00 | 100.00 | 100.00 | 0.00 |
| | 21-28 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 28-35 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 14-21 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 21-28 | 5.00 | 0.00 | 0.00 | 10.00 |
| | 28-35 | 2.50 | 0.00 | 0.00 | 90.00 |

Rice production constraints varied according to the sites and type of rice cultivation (Figure 6). The main constraints for farmers in the four study sites of Mayo-Danay are diseases and crop pests, since more than 90% of farmers in Gobo, Maga and Yagoua and 60% of those in Vele mentioned these constraints. Then comes the variation of the seasons which is strongly mentioned by the farmers of Yagoua (90-100%) and Maga (55-75%), and moderately by the farmers of Gobo (50%) and Velé (30-45%). Poor access to equipment and the high price of inputs are constraints for rice farmers in Gobo who practice rainfed crops (70%) and in Yagoua for irrigated crops (70%). The lack of water in boreholes is not a major constraint, particularly for irrigated rice cultivation (0-10%)

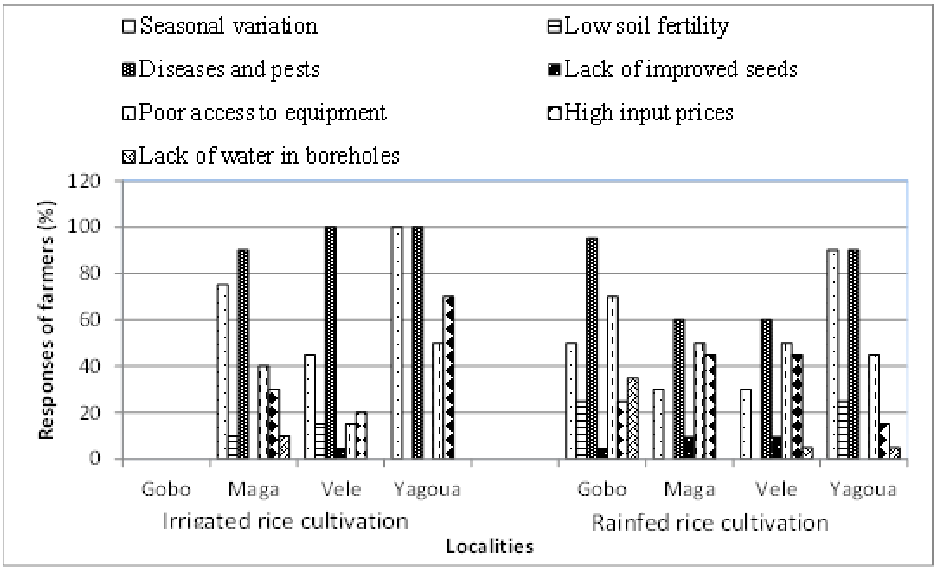


Figure 6. Constraintes of rice production in the four study sites of Mayo-Danay.

### Adaptive strategies of farmers to climate change

Majority of farmers (87.90%) took adaptative measures to cope with the impact of variations in climatic parameters on rice production in Mayo-Danay, against a small number of inactive farmers (12.10 %). These adaptation measures used by farmers vary according to the seasons (Table 4). The main measures adopted by farmers are respecting the rice-growing calendar in dry season (75%) and in rainy season (50%), the practice of transplanting seedlings in dry season (35%) and in rainy season (47.50%), the practice of direct sowing in rainy season (38.75%) and the use of improved varieties in rainy season (30.00%). Other strategies were weakly adopted such as the establishment of drilling (1.67 and 17.50%) and afforestation (1.67 and 2.50%). Agroforestry is not yet adopted by rice farmers in Mayo-Danay.

*Table 4*

Adaptative strategies of farmers in Mayo-Danay. Responses (%).

| **Measures** | **Dry season** | **Rainy season** |
|---|---|---|
| Respect of agricultural calender | **75.00** | **50.00** |
| Improved varieties | 16.67 | 30.00 |
| Direct sowing | 5.00 | **38.75** |
| Transplantation | **35.00** | **47.50** |
| Protective bunds | 15.00 | 26.25 |
| Drilling | 1.67 | 17.50 |
| Agroforestry | 0.00 | 0.00 |
| Afforestation | 1.67 | 2.50 |

**Relationships between rice production and climatic parameters**

Figure 7 presents the linear regressions between rice production and climatic parameters. The correlation between rainfall and rice production during the rainy season in the study sites is significant ($P<0.05$) only in the Vele site, with a coefficient of determination of 0.67 (Figure 7a-c). This correlation is negative and showed that the increase in rainfall leads to a decrease in rice production. There is no data for the Gobo site. For temperature, although rice production in Mayo-Danay of increases with temperature, the correlations are not significant ($P>0.05$) for the two seasons (Figure 7d-e). Their coefficient of determination were 0.170 and 0.308 respectively for the dry and rainy seasons

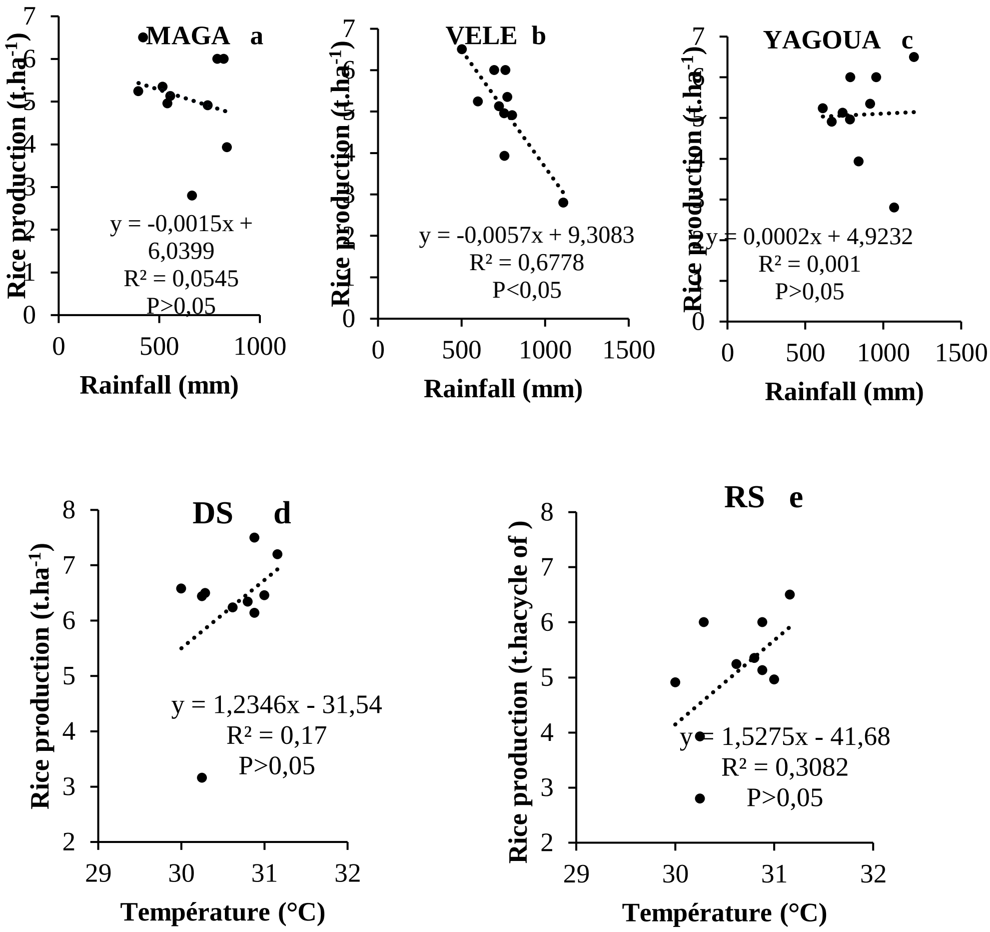


Figure 7. Linear regressions between rice production, rainfall in Maga (a), Vele (b) and Yagoua (C) during rainy season, and temperature in dry (d) and rainy (e) seasons in Mayo-Danay.

## DISCUSSIONS

### Farmer perception on climate change and its impact on rice production

Farmers' perception of the impact of climate variations on rice production in Mayo-Danay showed that rice farmers have a fairly clear perception of climate change through indicators such as delayed rains, early cessation of rains, strong wind, flood, drought, decrease in rainfall, and insolation. This is in agreement with the study of DOUMBIA and DEPIEU (2013), GNANGLE et al. (2012), DELILLE (2011) and BROU et al. (2005) on farmers' perceptions of climatic phenomena in several cropping systems. The delay in the rains is better perceived in this area compared to the early cessation of the rains in recent decades due to the delay in the onset of the rains. These farmer observations were also in agreement with the meteorological data of the study area which indicate that the rainfall is marked by a variability which tends to decrease in the municipalities of Gobo, Maga and Vele, and to increase in the municipality of Yagoua, and confirmed the results of DASSOU et al. (2015) on the characterization of the spatio-temporal variability of rainfall from 1960 to 2010 in the Sudano-Sahelian zone of Cameroon. Their results showed an overall downward trend over the past five decades. However, flood disturbance is well perceived in this area due to the recent floods of 2012 which destroyed large areas of agricultural and grazing land, and displaced many (KANA et al., 2013; SAMBO, 2018; ABOSSOLO et al., 2017).

As far as temperature is concerned, according to the farmers, “it is manifested by intense insolation whose average intensity varies from one season to another and from one year to another”. In addition, meteorological data on temperature suggest that this area was characterized by a variable annual average temperature which tends to rise.

**Farmer perception of the impact of climate change on rice production**

According to farmers, the most influential climatic parameters on rice production were temperature, rainfall, wind and relative humidity. Thus the impact of the variations of these on rice growing is manifested directly on the yield and through its variations such as increase or decrease in yields.

Temperature influences the rice production cycle much more during the period of assimilation of fertilizers, the periods of tillering and heading, because a low temperature induced by the cold inhibits the assimilation of fertilizers by the plant. These farmer observations agree with the study of CORNILLON (1977) on the tomato showing a reduction in the absorption of nitrogen, and more particularly of nitrate at low temperature. In the soil, unlike the hydroponic medium, a low root temperature has a strong effect on the mineral nutrition of the rice. Microbial activity is slowed down or even inhibited. Nitrate reductase in the roots was stopped; the plant will incorporate nitrogen directly in nitric form and not $NH_3$. This is further supported by the study of NEILSON et al. (1972), DE LUCIA (1987), who considered cold as a $CO_2$ inhibitor in the process of photosynthesis within the plant. However, the reduction in $CO_2$ absorption would be the consequence of a modification of the membrane permeability of the cytoplasm (MURATA et al., 1982, RAISON and WRIGHT, 1983) and of the lipid and protein composition (LEHNINGER, 1970), allowing the plant to maintain maximum membrane fluidity (CORNILLON, 1980).

Rainfall influences the rice production cycle much more during the sowing period, the tillering and flowering and caryopsis maturation periods. Indeed, during the rainy season, the delay in the rains directly influences the date of sowing, and consequently the production of rice. The lack of rainfall creates water stress in the plant, which slows down their growth. It is in the same perspective that DANCETTE (1974), Boyer and PHERSON (1975) and BEGG and TURNER (1976) demonstrated that in all cereals, the reproductive stage is potentially the most sensitive to water deficit and the consequences on yields are the most serious, because speaking of rice, a water deficit during panicle initiation decreases the number of spikelets per panicle. If stress occurs during anthesis, the result is flower sterility. Water stress during grain filling results in decreased grain weight. Excessive rainfall in turn causes drowning and destruction of plants, which limits the tillering of the plant and its process of photosynthesis, since rice is a heliophilous plant that requires sunlight to complete its development cycle normally.

Wind influences the rice production cycle during the fertilization period. This corroborates the results of Pliny in the 8th century, who suggests that "in a country, both greedy and sometimes disturbed by the wind, the mistral is a wind of life which pollinates our cultures, therefore a singular festival is closely associated with it". This influence of the wind on the rice production cycle also occurs during the caryopsis maturation period and confirms the results of DELBOS (1982), who noted the consequences of disturbance of the rains on the maturation of the plants as well as on the material in the country of Arles in the 20th century. Thus, light, the wind has a favorable effect, because it accelerates transpiration, and strong, it can uproot young plants or cause lodging and scalding at maturity.

According to farmers, humidity influences the rice production cycle much more during the heading period and the caryopsis maturation period. Heading or flowering is the development stage of rice most sensitive to drought. Indeed, the lack of moisture in the soil and in the environment of a plant is manifested in the plant by water stress, which causes it to decrease growth and productivity (KRAMER, 1983). This is because grain yield is dependent on the amount of water transpired, the efficiency of water use and the harvest index (LUDLOW and MUCHOW, 1988).

**Production itinerary and adaptative strategies to climate change**

In terms of farm structure, we note that rice farms vary greatly in size and are between 0.5 and 3 hectares. Majority of farmers own their plot and/or subscribe to SEMRY. In the production areas covered by SEMRY (Yagoua, Maga and Velé), the majority of farmers have a farming area of between 0.5 and 1 hectare. This is justified by the fact that "SEMRY gives only one stake (0.5 hectare) to a household". On the other hand, in the municipality of Gobo, farmers have other priorities apart from rice growing, because they grow much more cotton. The farming areas are prepared in protective or anti-erosion bunds to be able to retain enough water in the plot according to the stage of development of the plant and also to regulate the water level for good plant growth. While the most cultivated varieties in these sites are IR46 and NERICA, but the one that SEMRY recommends in its production area is the IR46 variety because of its ecological plasticity and its favorable productivity. The majority of farmers in our sites sow their rice seed on December for the dry season campaign and on May and/or June for the rainy season campaign. Speaking of fertilization, the majority of rice farmers use it but much more chemical fertilizers. A minority uses organic fertilizers (bat droppings), because according to them, it attracts destructive insects such as caterpillars.

Our results relating to the farmer strategies of adaptation to climate change in Mayo-Danay showed that, in the dry season, rice farmers adapt better to variations in climatic parameters compared to the rainy season and their adaptation strategies. The most practiced adaptations are the use of improved varieties, direct seeding, or transplanting, the construction of protective or anti-erosion bunds, and the use of boreholes. Thus, according to them, the supporting signs of their adaptation can be seen in performance. Because in the dry season, 80% of respondents testify that the average yield and 91.25% of them say that the low yield in the rainy season. These farmer observations were consistent with data from the SEMRY production area, which also shows low rice productivity in the rainy season compared to the dry season campaign.

## CONCLUSIONS

It was a question of analyzing the farmer perception of the impact of climate change on rice production in Mayo-Danay Division. It appears that the farmers of Mayo-Danay perceived climatic disturbances in irrigated and rainfed rice cultivation. Based on the answers of the respondents, nine types of climatic disturbances perceived by the farmers emerged. These are the delay of rains, the early cessation of rains, the violent wind, the flood, the drought, the decrease in rains, the increase in rains and insolation. Climate change affects rice production according to producers. Thus, rainfed rice farmers are the most vulnerable to variations in climatic parameters. This vulnerability manifests itself during the end of the rainy season through a low rice yield. Faced with these climatic disturbances, rice farmers have adopted several coping strategies. Two types of adaptation have been identified in our work. This involves the use of improved varieties and cultural practices such as the practice of direct seeding, transplanting or transplanting, the construction of protective or anti-erosion bunds and the use of boreholes. Despite these peasant adaptation measures, rainfed rice cultivation remains exposed to climate risk. Moreover, apart from the effects of variation in climatic parameters on rice production, the latter is also threatened by other production constraints which are linked to climate change or not, such as the variation in seasons, low soil fertility, diseases and pests, poor access to equipment, high input prices. These climatic variations expose the population of Mayo-Danay to major problems characterized by famine, poverty, unemployment, rural exodus, under-education and disease

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