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# ANALYSIS OF PRODUCERS' ADAPTATION STRATEGIES TO THE CHALLENGES OF CLIMATE CHANGE IN FLOOD CONTROL PRODUCTION SYSTEMS IN YÉLIMANÉ, KAYES REGION

**Fatoumata BA[1]*, Soli KONE[2], Samba SOUMARE[2], Jens Bernt AUNE[3], Urbain DEMBELE[1], Siaka D. TRAORE[1] and Kalifa TRAORE[1]**

[1]Institute of Rural Economy (IER), Production Systems and Natural Resources Management Team (ESPGRN), Mopti, Mali

[2]Independent Researcher

[2]Independent Researcher

[3]University of Life Sciences, NorAgric – PO Box 5003, N-1432 Ås, Norway

[1]Institute of Rural Economy (IER), Production Systems and Management of Natural Resources Program, Sotuba, Mali,

[1]Institute of Rural Economy (IER), Production Systems and Management of Natural Resources Program, Sotuba, Mali,

[1]Institute of Rural Economy (IER), Scientific Direction, Bamako, Mali

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## ABSTRACT

Our study aims to contribute to improving the state of knowledge of the adaptation strategies of producers in flood recession production systems in Yélimané. The methodology is based on the collection of data at the level of the commune, where a general assembly made it possible to choose the villages, to define and validate criteria for classifying households into wealthy, moderately wealthy and poor on the basis of the level of equipment and the differentiation of flood recession production systems. A questionnaire was administered to heads of households, resource persons and a focus group interview guide with FOs and other actors involved in the field of Agriculture. In terms of results, 330 households were surveyed, including 110 per category. 65% are men and 35% women. 91% are married and 70% are illiterate. The average household size is 34.2, 27.5 and 17.4 people; they have an average area of 14.3, 4.8 and 5.2 ha respectively for types A, B and C. Poorly equipped, they practice flood recession and rainfed crops. The data shows that almost all households (96%) have actually observed climate change and the consequences are felt in the drop in yields and income. Also, households are limited to the types and diversity of crops they can grow. Among them, 59% of households have adopted strategies to reduce these negative effects and make ad hoc and technical adjustments in anticipation for all seasons.

**Keywords:** Strategies, Producers, Climate Change, Flood Recession Systems.

## 1. INTRODUCTION

Human activities have produced in a short time an enormous amount of greenhouse gases (GHGs) since the industrial revolution of the 19th century (Diallo 2012) and practically all the socio-economic activities we carry out (agriculture, livestock, transport, cooking, etc.) produce GHGs. Climate change (CC) is defined as a change in the state of the climate that can be detected by changes in the average or variability of its properties, and that persists for an

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extended period of time, usually decades or longer (Quito, October 2016). These are changes in climate, which are attributed directly or indirectly to human activity, that alter the composition of the global atmosphere and are in addition to the natural climate variability observed over comparable time periods (UNFCCC, 1994).

According to the Intergovernmental Panel on Climate Change (IPCC) cited by Duffau et al., (2011), agriculture is one of the sectors most threatened by climate change. More than three-quarters of the poor in developing countries live in rural areas and the livelihood of most of them depends on agriculture (Duddau et al., 2011), which is the main activity of the populations of the Sahel in general, and the Malian Western Sahel, especially in the circles of Nioro, Nara and Yélimané (Niakaté, 2020). The Yélimané area is facing, like several other areas in the Western Sahel, more biophysical shocks that increase the vulnerability of populations to food insecurity and their livelihoods (Niakaté, 2020).

According to surveys conducted in Benin with similar trends in Mali and Senegal (Gnanglè et al., 2012) and (Keita et al., 2019) for rural communities, climate change is at the root of the length of dry seasons, poor rainfall distribution and shortening of the rainy season. To address all these increasingly difficult conditions for agriculture and livestock, different technologies and proven strategies (micro dose, irrigation and drainage, use of varieties adapted to the local environment, land erosion control) in improving livelihoods and food security have been applied to help reverse trends of resource degradation and food insecurity and in the same way. time, consolidate farmers' incomes (Aïchi et al., 2003).

Populations have also opted to develop a plurality of adaptive responses. The notion of adaptation is a concept that derives its essence from the theory of evolution (Smit and Wandel, 2006; Sossou, 2015), it is the adjustment of natural or human systems in response to present or future climatic stimuli and their effects. In human systems, it aims to mitigate adverse effects or exploit advantageous opportunities. In natural systems, human intervention can facilitate adaptation to climate change and its expected effects. Based on socio-anthropological knowledge, rural communities have developed endogenous strategies to cope with climatic hazards (Noray and Coulon, 2000).

In Mali, in the Inner Niger Delta (DIN), fishermen in parallel with their fishing activity cultivate on previously flood-prone soils. A high number of villagers or nomads return to the cities. They stay there permanently or before the right fishing season. Among the Fulani herders, we see more and more often transhumants who do not own the herds with which they live. Many herders-owners were forced to sell what was left of their drought-decimated flocks because they could not ensure their survival. These communities do not always consider climate disruption in terms of threat but rather of social disorder following socially accepted and non-respected rules (Sinan, 2016).

## 2. MATERIALS AND METHODS

### 2.1. Presentation of the study area

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The study area is the flood recession zone of the Yélimané cercle, a territorial collectivity of Mali located in the Kayes region. It comprises twelve communes including one urban commune (Toya) and eleven rural communes. The circle is located in the north-east of the Kayes region between 14° and 16° North latitude and 10° and 12° West Longitude, it covers an area of 5700 km². It is bordered to the northwest by the Islamic Republic of Mauritania, to the southwest by the circle of Kayes, to the south by the circle of Bafoulabé, to the east by the circle of Nioro of the Sahel. It extends from North to South for 100 km and from East to West for 77.5 km.

### 2.2. Sampling of farm households

The sampling method used was random sampling in several stages, i.e. commune, village and farm households.

- **Commune level**

The study focused on six municipalities of intervention of the ACC project, among the 12 communes of the circle of Yélimané. To facilitate the aggregation of data, classification criteria have been defined at the level of the commune capital to validate the general criteria for classifying households into haves (A), moderately haves (B) and poor (C).

- **Village level**

The choice of villages was made at the commune level on the basis of the following criteria: the size of the village, the existence of basic socio-economic infrastructure, the practice of declining system cultures, socio-cultural and economic diversity. A sample of 11 villages out of the 18 villages of intervention of the ACC project was selected, representing a sampling rate of 61%.

- **Household level**

The choice of households in the villages was made according to a typology and in reference

studies by CE (2012) and Penda et al. (2020). This classification was based on the level of equipment and took into account the differentiation of production systems especially on flood recession crops. Thus, 10 households of each type were chosen.

### 2.3. Tools and data collection

The data collection tools used are those of participatory diagnosis, in particular questionnaires for farm households and resource persons and focus group interview guides for agricultural organizations and other actors involved in the field of agriculture. The main data collected relate to the analysis of producers' adaptation strategies while characterizing agricultural holdings, compiling generation of income accounts and analyzing the economic profitability of technologies by type of farm.

### 2.4. Data processing and analysis

The data were coded and entered into Excel software and exported and analyzed under Statistical Package for Social Sciences (SPSS).

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## 3. RESULTS

### 3.1. Characterization of agricultural holdings

#### 3.1.1. Socio-demographic characteristics of households

In terms of results, 330 households were surveyed, of which 110 per category and 65% were men and 35% women. Households are mainly Sarakoles (82.42%). They are all indigenous and Muslim. In relation to age groups, the analysis of the data shows that 21% of respondents are young, 52% are adults and 27% are old. Analysis of the data indicates that the majority of respondents are men (65%) versus (35%) women. The results show that the majority of respondents are married (92%). Analysis of the data indicates that 71% of those surveyed are illiterate.

**Table 1: General characteristics by household type**

| Characteristic | A | | B | | C | | Together | |
|---|---|---|---|---|---|---|---|---|
| | (n) | (%) | (n) | (%) | (n) | (%) | (n) | (%) |
| **Age range of actors** | | | | | | | | |
| Young (<40 years) | 26 | 24 | 19 | 17 | 25 | 23 | 70 | 21 |
| adult (40-60 years) | 47 | 43 | 62 | 56 | 63 | 57 | 172 | 52 |
| Old (> 60 years) | 37 | 34 | 29 | 26 | 22 | 20 | 88 | 27 |
| **Gender of actors** | | | | | | | | |
| Man | 76 | 69 | 69 | 63 | 68 | 62 | 213 | 65 |
| Wife | 34 | 31 | 41 | 37 | 42 | 38 | 117 | 35 |
| **Marital status** | | | | | | | | |
| Bachelor | 12 | 11 | 1 | 1 | 2 | 2 | 15 | 5 |
| Married | 94 | 85 | 107 | 97 | 101 | 92 | 302 | 92 |
| widow/widower | 4 | 4 | 2 | 2 | 7 | 6 | 13 | 4 |
| **Level of education** | | | | | | | | |
| Illiterate | 71 | 65 | 77 | 70 | 87 | 79 | 235 | 71 |
| Primary | 18 | 16 | 5 | 5 | 10 | 9 | 33 | 10 |
| Secondary | 3 | 3 | 7 | 6 | 3 | 3 | 13 | 4 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Alphabetisation | 4 | 4 | 7 | 6 | 1 | 1 | 12 | 4 |
| koranic school | 14 | 13 | 14 | 13 | 9 | 8 | 37 | 11 |

**Source:** Personal survey data (2020-2021).

### 3.2.1 Household livelihoods

Agriculture is the main activity for 80% of farmers who also practice livestock with 62% of households. 78% of households own their land (from inheritance). The production system in the area is based on flood recession production and according to 65% of producers sorghum remains the main crop. They have an average area of 14.3, 4.8 and 5.2 ha respectively for types A, B and C.

Migration and pastoral activities are the main sources of income. Migrant remittances support residents in acquiring food, non-food items and other essential expenses. The main constraints of agricultural production are climate change, poor equipment, access to credit and inputs.

The surveys also covered data relating to decision-making and management of agricultural production. We note from the analysis that men and women each decide on the management of their agricultural production in all categories; as well as for the marketing of agricultural products and the use of income. In almost all households, the decision to cultivate, adopt technology, acquire inputs and allocate cropland rests with men.

With regard to access to and use of agricultural inputs, supply chains in the area consist of subsidies granted as part of intensification activities by the local agricultural service, the Research Institution and projects (IER, ACIDEF, PADDY), private traders, sometimes through cooperatives or producers' organizations. Seuls 18% of households use fertilizers, 42% improved seeds, 32% plant protection products. The main difficulties faced by producers in accessing inputs are financial and geographical accessibility.

Compared to the marketing of agricultural products,the results show that 40% of households sell part of their production. Product sales are rarely grouped individually. However, for 91% of households, women and young people have difficulties in accessing the market, including limited access to means of production (land, products) and financial resources, limited access to means of transport and isolation, especially in wintering and distance from markets and insecurity on the roads and some social burdens. We remember that there is a great enthusiasm of producers towards groups (association, cooperative) to face the adversities of time. This is driven by partners who only support legally designed community-based organizations that adopt rules of good governance.

## 3.2. Analysis of adaptation strategies in flood recession areas in Yélimané.

### 3.2.1. Peasant perception and adaptation strategies of producers

- **Climate variability, observed changes and consequences**

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**Table 2: Climate variability, observed changes and consequences**

| **Types of households** | **A** | **B** | **C** | **Total** | **%** |
|---|---|---|---|---|---|
| **Changes observed** | | | | | |
| Insufficient rainfall and reduced yields | 48 | 48 | 53 | 149 | 45,2% |
| Rising temperatures and strong winds | 11 | 9 | 14 | 34 | 10,3% |
| Flooding | 7 | 4 | 6 | 17 | 5,2% |
| Silting up of ponds and shallows and degradation of banks | 7 | 6 | 6 | 19 | 5,8% |
| Deforestation and land degradation and vegetation cover | 31 | 37 | 26 | 94 | 28,5% |
| Village conflict/Access to land/animal wandering | 5 | 1 | 1 | 7 | 2,1% |
| Diseases, bird attacks and predators | 1 | 5 | 4 | 10 | 3,0% |
| **Total** | **110** | **110** | **110** | **330** | **100%** |
| **Consequences of observed** changes | | | | | |
| Lower yields and incomes | 103 | 105 | 106 | 314 | 95% |
| Availability or lack of forage in pastures | 4 | 1 | 1 | 6 | 2% |
| Business diversification (revenue streams) | 3 | 3 | 1 | 7 | 2% |
| Disruption of the agricultural calendar | 0 | 1 | 2 | 3 | 1% |
| **Total** | **110** | **110** | **110** | **330** | **100%** |

**Source:** Personal survey data (2020-2021).

Table 2 shows thatalmost all households (96%) and groups did notice climate variability and its consequences. These are: insufficient rainfall with decreases in crop yields; rising temperatures and strong winds; silting up of ponds and shallows and degradation of banks; deforestation and degradation of land and vegetation cover; floods; diseases and attacks by birds and predators to which are added village conflicts related to access to land and the wandering of animals.

Some testimonies to illustrate the answers from the focus groups: (i) *During the years 1970-1973, because of famine, rats gnawed tree trunks in forests to feed, which caused deforestation of the entire area.* (ii) *To combat locust pests, people have used products that have contributed to deforestation.* (iii) *Every year I grow at least three varieties of cereals (millet, sorghum and*

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*maize), in recent years, due to lack of rain and predators (locusts, birds), I am limited to two crops or one*.

- **Strategies to reduce the negative effects of climate variability**

The results (Table 3) show that 59% of households have adopted strategies to reduce the negative effects of climate variability. These strategies focus on (i) the practice of income-generating activities (market gardening, fattening, poultry farming, small trade, arboriculture); (ii) the use of good agricultural practices (crop rotation and association, erosion control, stone cords); (iii) the use of animal feed (oilcake) and crop residues); (iv) the use of improved seeds and early or short-cycle varieties, and (v) the use of organic manure and crop residues for the fertilization of plots. Some stories to illustrate the responses from the focus groups: (i) *Unlike in the past, the exodus of boys is desired and even encouraged today by parents*". "*This is justified by the absence of young people and men in the villages*. (ii) *Millions can be used for the exodus, but not for the village because of unfavourable conditions (irregular rainfall, inadequacies of production factors).* This idea was confirmed by a young man returning from the exodus in gold panning zone who: *said would have gained more, if the gold mine area was not closed by the authorities* (exploitation is stopped at the beginning of wintering to allow young people to go and cultivate for the family).

**Table 3: Strategies to reduce the negative effects of climate variability**

| **Types of households** | **A** | **B** | **C** | **Total** | **%** |
|---|---|---|---|---|---|
| **Have you adopted strategies to reduce the negative effects of climate variability**? | | | | | |
| Yes | 68 | 65 | 63 | 196 | 59% |
| Not | 42 | 45 | 47 | 134 | 41% |
| **Total** | **110** | **110** | **110** | **330** | **100%** |
| % Yes | 62% | 59% | 57% | 59% | |
| **Techniques adopted** | | | | | |
| Practice of Income Generating Activities (market gardening, fattening, poultry farming, small business, arboriculture) | 29 | 45 | 61 | 135 | 41% |
| Crop rotation, crop association, erosion control, stone cords | 0 | 7 | 5 | 12 | 4% |
| Use of feed (purchase of oilcake) and crop residues | 9 | 0 | 5 | 14 | 4% |
| Use of improved seeds and early varieties | 69 | 58 | 35 | 162 | 49% |

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| | | | | | |
|---|---|---|---|---|---|
| Use of organic manure and crop residues | 3 | 0 | 4 | 7 | 2% |
| **Total** | **110** | **110** | **110** | **330** | **100%** |

**Source**: Personal survey data (2020-2021).

- **Rainy season forecasting**

The observation that emerges from the analysis of the results (Table 4) of the focus groups to anticipate the climate is the same as the responses of the households surveyed. Some quotes to illustrate the part: *Nowadays* the weather *threatens without rain or rains less (600 mm against 300 mm) or when the weather threatened, by observing we could define the quality and quantity of rain, but not now. That's why Sarakolé wants to go on an adventure and the income is used to buy grain.*

**Table 4: Rainy season forecasts**

| **Types of households** | A | B | C | Total | % |
|---|---|---|---|---|---|
| **Signs of rain** | | | | | |
| Temperature changes | 3 | 7 | 3 | 13 | 42% |
| The weather | 1 | 4 | | 5 | 16% |
| Wind direction | 1 | 3 | | 4 | 13% |
| Stars 7 lunar months | 2 | 1 | | 3 | 10% |
| The arrival of birds | 1 | 1 | | 2 | 6% |
| The position of the sun | | 1 | | 1 | 3% |
| The abundance of floods | | | 1 | 1 | 3% |
| The vegetative state of certain trees | | 1 | | 1 | 3% |
| Changes in the color of the sky | | 1 | | 1 | 3% |
| Total general | 4 | 8 | 1 | 13 | 42% |

**Source:** Author based on survey data (2020-2021)

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- ***Ad hoc andtechnical adjustments used in anticipation of a season***

*Table 5 shows that households in anticipation of seasonal changes use various forecasting techniques. In anticipation of a dry season, they mainly envisage the use of early seeds (54%) and sowing in the shallows (44%); In the normal wet season 55% do not envisage a change in techniques, 39% recommend the use of seeds of medium cycle varieties and cultivate all their fields. On the other hand, in the wet season with excess rainfall, they intend to develop flooded land (77%) and use early or late varieties (15%).*

**Table 5: Ad hoc adjustments and techniques used in anticipation of a season**

| **Types of households** | **A** | **B** | **C** | **Total** | **%** |
|---|---|---|---|---|---|
| **One-time adjustment (Yes/No)** | | | | | |
| **Total** | **110** | **110** | **110** | **330** | **100%** |
| % Yes | 35% | 35% | 37% | 36% | |
| **Techniques used in preparation for a dry season** | | | | | |
| Use of early seeds | 18 | 20 | 24 | 62 | 54% |
| Culture in the lowlands | 18 | 17 | 15 | 50 | 44% |
| Introduction of potato in decline | | | 1 | 1 | 1% |
| Use of organic manure | | | 1 | 1 | 1% |
| **Total** | **36** | **37** | **41** | **114** | **100%** |
| **Techniques used in anticipation of a normal wet season** | | | | | |
| No change | 15 | 7 | 13 | 35 | 54,69% |
| Use of mid-cycle varieties | 10 | 8 | 7 | 25 | 39,06% |
| Cultivation of all fields | | | 3 | 3 | 4,69% |
| Use of improved varieties | 1 | | | 1 | 1,56% |
| **Total** | **26** | **15** | **23** | **64** | **100%** |
| **Techniques used in anticipation of a wet season with excess rain** | | | | | |
| Cultivation of flooded land | 18 | 12 | 113 | 143 | 77% |
| Use of early and late varieties | 4 | 11 | 13 | 28 | 15% |
| Use of seeds of local varieties | 3 | 3 | 6 | 12 | 6% |

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| | | | | | |
|---|---|---|---|---|---|
| Increase in area | 0 | 1 | 2 | 3 | 2% |
| **Total** | **25** | **27** | **134** | **186** | **100%** |

**Source:** Author based on survey data (2020-2021).

### 3.2.2. Strategies of technical structures for management and support

*Policy strategies and technical guidance and support services make it possible to identify priority activities to be undertaken to address the urgent and immediate needs and concerns of producers to meet the challenges of climate change. To face the challenges of CCs, the ACC project intervened in the Yélimané area in response to the decrease in the yield of agricultural speculation, through the development of technological packages. These technological packages for adaptation to climate change are based on the combination of improved seeds, organic manure, mineral fertilizers and phytosanitary products* ***and*** *meet the expectations of farmers, even if farmers often experience difficulties in relation to the non-availability of these elements (organic manure, fertilizers, equipment) in quantity and at the right time. They integrate peasant practices well* ***and*** *promote an increase in production and producers' incomes. For example, surveys have been carried out on data relating to* ***the*** *analysis of the economic profitability of agricultural holdings by type. The analyses show that all farms are profitable, their revenues cover their expenses, generate profits and contribute to local wealth. Of these, the cost analysis focused on two, one on the cultivation of pure maize and one on the cultivation of sorghum.*

**Table 6: Costs of peasant maize production practice by types C and the technological package of improved maize production.**

| Indicators | C BUT | TMAIS |
|---|---|---|
| Materials and equipment | 16 010 | 30 141 |
| Inputs | 34 000 | 44 000 |
| Manpower | 152 787 | 139 752 |
| Cost of Production | 202 797 | 213 893 |
| Profit (VP-CV-CF) | 337 203 | 416 107 |
| Variable cost margin (MCV=VP-CV) | 353 213 | 446 249 |
| CVD rate (CVMT=CVD/VP) | 65% | 71% |
| Break-even point (SR=CF/TMCV) | 24 476 | 42 552 |
| Added Value (VP-IC) | 506 000 | 586 000 |

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| | | |
|---|---|---|
| Production value | 540 000 | 630 000 |
| Surface | 2,0 | 1,0 |
| **Indicators** | **C BUT** | **TMAIS** |
| Cost of Production per hectare | 101 398 | 213 893 |
| Profit per hectare | 168 602 | 416 107 |
| Production value per hectare | 270 000 | 630 000 |
| Value added per hectare | 253 000 | 586 0 |

**Source:** Personal survey data (2020-2021).

**Table 7: Costs of peasant practice of sorghum production by type A, B and C farms and the technological package of improved sorghum production.**

| **Indicators** | **A SORGHUM** | **B SORGHUM** | **C SORGHUM** | **TSORGHO** |
|---|---|---|---|---|
| Materials and equipment | 69 545 | 22 974 | 11 207 | 30 141 |
| Inputs | 87 000 | 26 400 | 16 800 | 25 500 |
| Manpower | 541 676 | 138 538 | 74 521 | 82 201 |
| Cost of Production | 698 221 | 187 912 | 102 527 | 137 842 |
| Profit | 726 779 | 252 088 | 107 473 | 212 158 |
| Variable cost margin | 796 325 | 275 062 | 118 679 | 242 299 |
| CVD rate | 56% | 63% | 57% | 69% |
| Break-even point | 124 450 | 36 750 | 19 830 | 43 539 |
| Value added | 1 338 000 | 413 600 | 193 200 | 324 500 |
| Production value | 1 425 000 | 440 000 | 210 000 | 350 000 |
| Surface | 6,0 | 2,2 | 1,4 | 1,0 |
| **Indicators** | **A SORGHUM** | **B SORGHUM** | **C SORGHUM** | **TSORGHO** |
| Cost of Production per hectare | 116 370 | 85 415 | 73 234 | 137 842 |
| Profit per hectare | 121 130 | 114 585 | 76 766 | 212 158 |

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| | | | | |
|---|---|---|---|---|
| Production value per hectare | 237 500 | 200 000 | 150 000 | 350 000 |
| Value added per hectare | 223 000 | 188 000 | 138 000 | 324 500 |

**Source:** Personal survey data (2020-2021).

## 4. DISCUSSION

### 4.1. Characterization of agricultural holdings

#### 4.1.1. Socio-demographic characteristics of households

The analysis of the characterization made it possible to distinguish three (03) types (A, B and C) of farms, 15 of which are rich (type A), 26% of medium rich (type B) and 59% of poor (type C). Studies conducted by EC (2012) show that in the Yélimané area, 14% are rich farms (type A), 27% are medium-rich farms (type B) and 59% are poor or very poor (type C). Also, Penda (2020) found a similar trend, 15% of farms are type A, 25% type B and 60% type C. Analysis of data on all categories shows that 21% of respondents are young, 52% are adults and 27% are old. This means that projects in their interventions must take into account the workforce of young people. The majority of respondents are men (65%), indicating that young people and women (35%) participate in and benefit from agricultural activities. However, the difficulties are related to women's and youth's access to land, which does not allow them to express themselves on research issues and climate change. Both men and women work in traditional agriculture, which employs 86% of the population (Duffau et al., 2011). This situation is comparable to that of Asia and sub-Saharan Africa where 80% of food production is based on a family farming model of which, in 45% to 80% of cases, women assume the burden (EICA, 2018). They are therefore the first to be affected when a drought or rains occur that ruin crops. When food and water run out, they must redouble their efforts to meet the needs of the household. A study on access to storage credit in Niger, Le Magadoux et al. (2013) show that, although there are no formal restrictions on women's participation, they are often excluded because they often do not take part in the decision-making process and also have limited access to land and production inputs. According to the same authors, this is a sign that awareness and participation in warrantage are stronger for men.

Our results show that the illiteracy rate of heads of household is very high (71%), which is explained by the lack of interest they have in the schooling of girls and even young boys. These are socio-cultural barriers (early marriage of girls, migration of boys) that limit the access of these groups to education. This leads to food and structural insecurity. This illiteracy situation is also accentuated by the absence of literacy centres in many of the localities surveyed. This also limits access to information on production technology techniques and packages. Studies by the World Food Programme show that the higher the level of education, the more people can adopt agricultural innovations (Sossou, 2015). Also, Madulu (2011) shows that educational attainment is positively associated with producers' participation in credit activities. This assertion was highlighted by Le Magadoux et al. (2013) which shows that the illiteracy rate or low level of education is an obstacle to the use of warrantage. This means that more educated farmers were more likely to be proficient in credit concepts and information. Studies by William and Kaserwa (2015) in Tanzania confirm this, since it was found that the majority of respondents (77%) had at least completed their primary education. In analysing this situation, it is important to implement

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literacy programmes that mobilize and involve as many beneficiaries as possible. To this end, it is necessary to build new infrastructure, rehabilitate existing centres and initiate information and awareness-raising campaigns aimed at target groups (men, women, traditional authorities) on the benefits of literacy for their socio-economic development**.**

The results of our study show an average size of 34.2 persons (13.4 men and 19.7 women) for type A holdings, 27.5 persons (12.1 men and 15.8 women) for type B holdings and 17.4 persons (7.6 men and 9.4 women) for type C holdings. These large sizes could be explained by the socio-cultural realities of the area and the extended nature of the families. Also, the size of the household increases with the age of the head of the holding until it reaches a maximum age (60-65 years) before starting to shrink afterwards. The opposite phenomenon occurs with the education level of chiefs where, the higher the level of education, the smaller the size of the household because populations can use measures to control births.

### 4.1.2. Household livelihoods

Land is the main factor in livelihoods. Our results show that type A farms have on average 14.3 hectares of land or 58.8%, type B farms 4.8 hectares or 19.8% and type C farms 5.2 hectares or 21.4%. This means that 78.6% of the land belongs to type A and B farms. Studies by the European Commission (Household Economic Analysis report, 2012) also show that 75% of cropland is concentrated in the hands of type A and B farms. The method of acquisition by inheritance is the only way to guarantee land ownership that can avoid land conflicts. Analysis of the data shows that women have traditionally not owned or inherited land. The traditional distribution or structuring of activities in the villages directs women towards domestic tasks and all the more so since they also have difficulty accessing the "land" resource. As a result, they have only small plots of land on request from their husbands or heads of household (these are often infertile or sometimes difficult to work and abandoned by men) that they exploit for family rather than economic purposes. They sometimes access by loan, and become owners only in circumstances where the husband (the landowner) has died and has no heirs (male). They now have access to market gardening plots developed by partners such as the Yélimané Sustainable Development Support Program (PADDY). Rules for the management and exploitation of resources have traditionally been set by men, who do not sufficiently promote women's participation in decision-making at the household level. Women only manage the income they earn from their income-generating activities or the small plots of land they cultivate.

Our results show that type A farms own 82% of productive assets (ploughs), type B farms 59% and type C farms 34% or on average 70.5% for farms A and B. EC studies (2012) show that 85% of productive goods are concentrated in the hands of type A and B farms. Our results also show that type A farms have 49% of the livestock, type B farms 26% and type C farms 25%, i.e. on average 50% for farms A and B. EC studies (2012) show that 70% of livestock is concentrated in the hands of type A and B farms. While the poor category represents more than 59% of households in the area. Analysis of the concentration of capital goods shows that more than 75% of cultivated land is owned by affluent and middle-income households, which represent just over 38% of households. Agricultural equipment is very insufficiently used in activities in addition to lack of resources, it is also because of poor mastery of agricultural techniques. Analysis of the results on production and yield shows that the duration of food self-sufficiency does not cover

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the needs of the population, even in a normal year in the area (EC, 2012). Climate projection impact studies (CILSS, 2016) indicate a trend towards a reduction in agricultural yields, particularly millet and sorghum, of up to 50% by 2050, hence the need to use new techniques and production technology packages.

### 4.2. Analysis of adaptation strategies in flood recession areas in Yélimané.

- Analysis of adaptation strategies indicates that themain effects induced by CC are summarized as

fall in rainfall, rising temperatures, strong winds and falling agricultural productivity, disruption of the crop calendar. In response to such adverse effects of climate change, in response to the declining yield of agricultural speculation, technology packages for the production of sorghum and flood recession maize have been developed by the ACC project. They are a response to climate change. Their use has shown that the adaptation strategies used allow producers to cope with the vagaries of climate change and meet their basic needs. Indeed, the average yields of these technological packages of sorghum production are estimated at 1400Kg/ha against 900, 800 and 600kg/ha for the peasant practice of type A, B and C farms respectively. Those of maize represent 2100 Kg/ha against 900 kg/ha for the peasant practice of type C farming. However, their practice requires their financing in terms of inputs (improved seeds, fertilizers and labour).

- Economic profitability has been determined. From that economic analysis, it emerges that,

Technological packages for the production of flood recession maize and sorghum are more cost-effective than the systems practised by farmers. The revenues they generate cover expenses, generate profits and contribute to local wealth.

For flood sorghum production activities, the results show that the revenues cover expenses and generate estimated profits of 121,130, 114,585 and 76,766 CFA francs per hectare respectively for type A, B and C farms, contributing to local wealth and 212,158 CFA francs for technology. Regarding maize practiced by type C farms, the profits per hectare are estimated at 168,602FCFA for peasant practice and 416,107FCFA for the technological package.
They provide farmers with incomes estimated at 350,000 and 630,000 FCFA/ha respectively for sorghum and flood maize. For each FCA franc spent on the peasant practice of sorghum production, farms of types A, B and C earn respectively 1.04, 1.34 and 1.05 FCFA against 1.54 FCFA for the technological package of sorghum production. Also, for each CFA franc spent on the peasant practice of maize production, the farmer earns 1.66 francs against 1.95 francs if he uses maize production technology. This performance of the technological packages for the production of sorghum and flood maize will certainly allow producers (farmers) to cope with the vagaries of climate change and meet their basic needs (income generated).

## 5.CONCLUSION

At the end of this study, our concern was to understand the adaptation strategies of producers in the flood recession zone in Yélimané in the face of the challenges of climate change. To make the results of this study more objective, we used data collection tools and analytical methods. At the tool level, questionnaires and interview guides were used to obtain the data. On analysis, it appears from this study that the irregularity of rainfall caused by CC has accentuated negative

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consequences on agricultural activities. The households are limited to the types and diversity of crops they can practice. The time of the exodus of young people is becoming longer and longer, the number of exodars is more numerous, conflicts between herders and farmers are becoming frequent because of the decrease in pastoral areas. Thus**,** producers have developed strategies to adapt.

In addition, producers are supported by management structures with the support of Agricultural Research (Institute of Rural Economy) and projects (ACC) that develop strategies to cope with the adverse effects of climate change. Technical supervision services facilitate access to credit and the supply of inputs to producers through their organizations to which they belong, in return to repay at the end of the season according to the conditions of grant.

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**REFERENCE**

Adama Sinan: Resilience of cotton farmers to climate change in northern Côte d'Ivoire: the case of Napieleodougou producers. African Journal of Anthropology, Nyansa-Pô, n° 21 - 2016. Péléforo Gon Coulibaly University of Korhogo.

Aï chi H., Ba F., Gnakpenou D., Moulla F., Ranaivoarisoa H., Saley A Moussa and Torquebiau T. 2003: Dissemination of Integrated Soil Fertility Management Strategies in Zoundéweogo. Working Paper Series N°112-Burkina Faso. ICRA. P36-37.

Aurore Duffau, Damien Lagandré, Anne Chetaille, Ilan Rozenkopf, Guillaume Horréard, Bastien Oggeri: Index insurance and warrantage, what interest for small farmers? Analysis of experiences in East Africa and India. Coll. Études et travaux, online series n° 28, Éditions du Gret, www. gret.org, 2011, 44 p.

UNFCCC, 22 September 1992 and 28 December 1994: https://admin.ch "OPC" classified-compilation: United Nations Framework Convention on CC 1992-1994.

EC, 2012: European Commission (Household Economic Analysis report, 2012): Livelihood Zone N°8: Sorghum - Transhumant Livestock and Migration, Cercle de Yélimané, Kayes Region. March 2012.

CILSS, 2016: Fight against climate change. CILSS achievements, November 2016. Special Bulletin. Published by the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS).

Diallo Daouda, AEDD/Mali: Information for communal actors on Climate Change, February - March 2012.

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ISSN: 2456-8643

EICA, 2018: Séminaire International sur: Climate Change & Its Impact on Agriculture and Food Security: attended by 60 Participants from 38 countries representing Africa & Asia & Latin America and Eastern Europe. Held in Cairo-EGYPT, from 15-18 March 2018.

Gnanglè et al., 2012: P. Césaire GNANGLÈ, Jacob YABI, K. Romain GLÈLÈ and Nestor SOKPON: Climate change: Perceptions and adaptation strategies of farmers facing the management of shea parks in Central Benin, 2012.

Kéita et al, 2019: Peasant perception of climate change in the rural commune of Madiama, Mopti region of Mali. RASP, Vol 18 (1), 138-155.

Madulu, R. B. (2011). Improving access to credit for paddy farmers through warehouse receipt-based agricultural marketing system in Tanzania. In African Crop Science Conference (Vol. 10, pp. 37–39). Uganda. Retrieved from. Dans: http://www.cabi.org/cabdirect/FullTextPDF/2013/20133200276.pdf.

Niakaté, 2020: Mahamadou Niakaté. Agriculture and food on the margins of cities in Mali: the case of the Western Sahel: Yélimané circle. History. University of Lyon, 2020. French. NNT: 2020LYSE2025.

Noray Marie-Laure, COULON Gilles, ORANGE Didier « Delta. Living and working in the Inner Niger River Delta in Mali" Ed. IRD (France) and Donniya (Mali). 2000.

Quito, October 2016: IPCCC AR5, 2015: HABITAT III ISSUE PAPERS: Habitat III. United Nations Conference on Housing and Sustainable Urban Development: Climate Change and Risk Management-New York, 31 May 2015.

Le Magadoux, A., Mahamane, A., Déla Sida, F., & Van der Elstraeten, A. (2013). Input management and gender: Fair warrantage applied by the Cigaba union. Niger: FAO. Retrieved from: http://www.fao.org/documents/card/fr/c/b477b92a-bd58-5e0f-985c daa 04726cac2.

Smit, B., & Wandel. J, 2006: Adaptation, adaptive capacity and vulnerability. Global Environmental Change, 16(3) : 282-292.

Sossou Comlan Hervé, 2015: Financing agriculture in Benin: farm management and adaptation strategies. (Doctoral thesis in French). Belgium, University of Liège-Gembloux Agro-Bio Tech. 181 pages, 31 tables, 47 figures, 1 map.

William, J. G., & Kaserwa, N. (2015). Improving smallholder farmers access to finance through warehouse receipt system in Tanzania. International Journal of Economics and Financial Research, 1(3), 41–49. Retrieved from: http://www.academia.edu/download/38840442/014-IJEFR-41- 49-015.pdf