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Research Article

PROPOSALS FOR APPROPRIATE ADAPTATION OF SORGHUM AND MAIZE CROPPING APPROACHES TO ADDRESS CLIMATE VARIABILITY AND PEDOLOGICAL CONSTRAINTS

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Abstract

Addressing climate variability in Sub-Saharan Africa and particularly in Burkina Faso is a big challenge. This article aimed at proposing cropping approaches for sorghum and maize to address climate variability and pedological constraints in Plateau Central region. The study was conducted on a sample of two hundred forty (240) maize and sorghum farmers were randomly selected. Data of socio-economic characterization of the farmers, their opinions on climate events, the commonly used adaptation methods and their recommendations were collected and process using the descriptive statistics. Concerning the process of building the resilient agriculture, the Clim Prospect method was also used. The results showed that only the combination of different methods can efficiently address the issues related to climatic variability and soil constraints. Therefore, three options of adaptation measures to climate variabilities taking to account farmer's financial capacity were proposed. These approaches are the optimum, medium and minimum options. The decision-making to building the resilience of rain-fed agriculture must be based on recurrent diagnosis of the impacts and vulnerability for each case of a risk occurring. The investigations showed that crops production should shift from rainfed to irrigation. For reaching a percentage of population cereals need ≥ 120, support for maize and sorghum producers in the construction of water harvesting structures for supplementary irrigation, access to fertilizers, subsidies for production equipment, subsidies for agricultural inputs, the use of adapted seeds varieties and capacity building are essential.

Keywords: Climate variability, Option of adaptation measures, Rainfed sorghum and Maize agriculture, Plateau Central, Burkina Faso.

INTRODUCTION

Climate variability and pedological constraints have heavy limitations on rainfed cereals productivity. Its results in to recurrent cereals deficits. With the development of the Sahelian countries and related multidimensional challenges, having consistent resilience systems for securing crops production to climate variability is essential for meeting cereals need of the population. Several adaptation methods have been suggested for achieving this goal. For (Labiyi *et al.,* 2018), the economic efficiency of maize production is mainly influenced by mineral fertilization, agro-forestery using leguminous plants, crops association and rotation and other sociodemographic factors. Indeed, the practice of crops association and rotation could enhance the net margin by 0.32% per hectare. However, the miss use of mineral fertilizers, organic manure and the adaptation strategy by some of producers, are limitation factors of sorghum productivity, (Salami Osseni, 2015). For Assogba *et al.* (2017) adaptation methods such us mineral fertilization (in 1960), leguminous based agroforestry (in 1980), herbaceous legumes base technology for maintaining soil fertility (in 1990), composting (in 1992) and the use of manure (in 1998) were gradually introduced as alternatives for addressing rural farmers' vulnerability. These technologies were introduced in research station in Burkina Faso since 1960 (Landais and Lhoste, 1990). To address the constraints of crops production, farmers developed adaptation strategies and the most common ones are: use of improved crops varieties, rain water harvesting and soil conservation technologies, use of organic manure, adaptation of seedling dates (Ouedraogo *et al.,* 2010 ; Sanou *et al.,* 2018). For Tidjani and Akponikpe, (2012), these proven adaptation approaches have some limitations due to the lack of baseline situation and also, the poor adaptation of the technologies to local context either cultural and climate characteristics of the country. To address this shortcoming, this article has been designed. Its objective is to formulate appropriate adaptation measures for the resilience of sorghum and maize crops to climatic variability and soil constraints.

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MATERIALS AND METHODS

Materials

Two hundred forty (240) farmers including hundred twenty-two (122) maize farmers and hundred eighteen (118) sorghum farmers have been investigated using digital survey sheets. The process allowed to directly compile data in Excel sheets. According to the group of data, descriptive statistic using or Factors Analysis of Multiple Components (FAMC) using the software SPAD 55_2 was performed.

Data

Primary and secondary data as well as quantitative data were collected through field investigation: interviews, direct observation on the field by pedological survey. Data on adaptation approaches developed by farmers were collected using the participatory method. It included the experience of the investigated famers on climate variability, practices developed in sorghum and maize farming systems, and the financial investment for the cropping campaign 2021–2022 for farm operations. Recommendation for policy makers in Burkina Faso were includes as well.

Method

Expert method

According to the literature sources, Climate variability impact evaluation requires at least thirty to fifthly years' experiences for selection of the person to be interview. However, due to the magnitude of the climate on rain-fed cropping systems, the low memory capacity of producers and also to address to the equality law in the population, the age criteria used for producers in this study was least 25 years with at least 10 years of experience in cereal farming.

Clim Prospect Method

The Clim Prospec method, the methodology for baseline situation building for climate variability resilience was used, (Gahi *et al.,* 2015). It is a decision support tool for specific options of adaptation approaches in relation to the recorded impacts. The impacts, being recorded by periods, their chronology must be well diagnosed for decision-making on resilience. Each crop has its *preferendum.* The documented impacts of the commonly used adaptation methods in the Plateau Central region, physical and chemical soil parameters established by soil survey, farms landscape, textural and the structural constitution of soils as well as the characterized climatic variables were analyzed for proposition of adaptation options. Pre-sowing plowing and crop management through regular mechanical weeding are the preliminary farm operations that better prepare seedbed and reduce competition between crops and weeds for nutrients and oxygen in one hand, and contribute to an enhancement of good achievement of the effects of adaptation measures on crops in the other hand. These farm operations are essential options for adaptation measures that will be formulated.

The application of good quality and enough (5000 kg/ha) organic matter according to the recommendation in Burkina Faso. The organic matter is from animal waste or composting (plant biomass). According to (Blanchard *et al.,* 2017), among the several approaches of soil fertility management (tilling, mulching, rotation with legumes plants, organic amendments, etc.), application of organic manure remains most recommended option. Organic manure is applied by broad casting or by local application in the *zai* holes or in the half-moon devices.

Data processing

Socio-economic information on investigated farmers, farmers' perception on climate variability, commonly used adaptation methods and recommendations for policy makers in Burkina Faso were compiled and processed using descriptive statistics. Factor Analysis of Multiple Component (FAMC). The FAMC was used to describe the nets between the different adaptation approaches used for addressing soil constraints and climatic variability and their impacts on maize and sorghum yields. In total 15 variables, including 12 active and 3 illustrative selected from a baseline field survey were considered.

RESULTS

The results present the average costs of cropping operations and adaptation approaches commonly practiced in the Central Plateau region, recommendation for general and specific adaptation options for sorghum and maize crops, the Clim Prospect decision and producer recommendations resulting from surveys.

Implementation cost of the adaptation measures

The mean cost for the different technologies of adaptation were collected during our field investigation. They are summarized in table 1.

Table 1. Mean costs of adaptation measures during cropping 2021–2022 cropping season

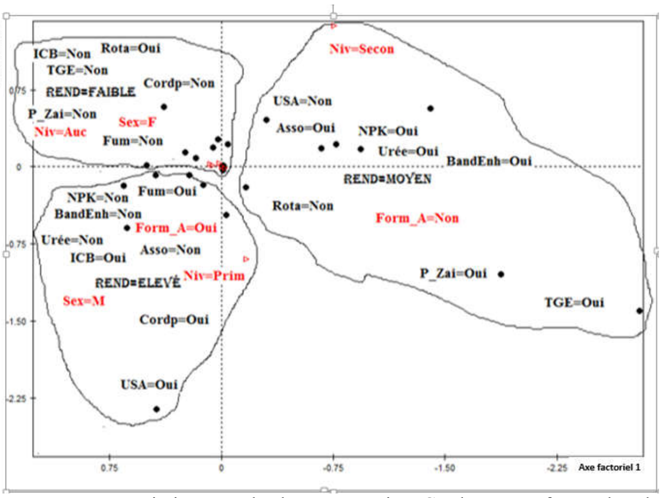
N°	Adaptation Measures	Cost per unit (FCFA/ha) from2021-2022 field investigation
1	Plowing	35,000
2	Regular mechanical weeding 2 weeding	25,000 /weeding
3	Crop rotation	0
4	Association of cultures	0
N°	Adaptation Measures	Cost per unit (FCFA/ha) from2021-2022 field investigation
5	*zaï* on bare (31250 *zai*/ha) (10 Man/Day) of work Duration: 5 years. To be refreshed every year	150, 000
6	Construction of grass strips (10 Man/Day)	150,000 /ha
7	Construction of stone bands (10 Man/Day)	Gathering: 150, 000 Transport (8m3 truck in 5 trips/day): 80,000/day 20 rubble trips 320,000 /ha
8	Construction of half-moons (530 half-moons/ha) (10 Man/Day) Duration: 5 years. To be refreshed every year	150,000
9	Application of organic manure	1 tonne = 20,000 FCFA 5 tons = 100,000 /ha or 2,5 tons = 50,000 /ha
10	Application of mineral fertilizers	NPK 50 kg = 18,000 Urea 50 kg = 16,000 Without the subsidy
11	Use of improved seeds adapted to drought (15 kg/ha)	1 kg maize = 600 1 kg sorghum = 800 Without the subsidy
12	Practice of supplementary irrigation (example: basin for collecting runoff water).	500,000 /basin
13	Crops insurance	According to the company of insurance
14	Following seasonal weather forecast	Any cost

Source : Investigation, 2021

Base on the compilation of data from the activities of technical and financial partners, investigation carried out (Ouedraogo and Millogo, 2007) have determined the costs of the adaptation measures in the Region of Plateau Central. These production costs have increased. Cost evaluation for the three proposed options was based on the current prices.

Approaches to adapt to the effects of climate variability

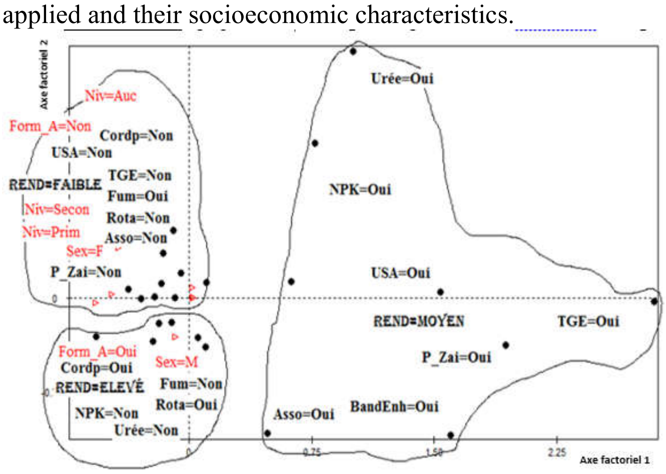
Three groups of farmers were identified using the AFCM. The group1 included farmers with lowers yields and group 2 and 3 respectively farmers with medium and high yields. Figure 1 shows the distribution of these three groups of maize producers according to the adaptation measures applied and their socioeconomic characteristics.



Asso = crops association; BandEnh = grass strips; Cordp = use of stone bunds; Form_A = training in agricultural technique; Fum = use of organic manure; ICB = complementary irrigation; NivSecon = level of secondary education; Rend = yield; Rota = crop rotation, Sex = gender; TGE: other water management techniques; USA= improved drought resistant seed varieties.
Source: data from field survey 2021

Figure 1. Distribution of groups of maize producers according to the adaptation measures

Figure 2 presents the distribution of the three groups of sorghum producers according to the adaptation measures applied and their socioeconomic characteristics.



Legend: = Asso = crops association; BandEnh = grass strips; Cordp = use of stone bunds; Form_A = training in agricultural technique; Fum = use of organic manure; ICB = complementary irrigation; NivSecon = level of secondary education; Rend = yield; Rota = crop rotation, Sex = gender; TGE: other water management techniques; USA= improved drought resistant seed varieties.
Source: data from field survey 2021

Figure 1. **Distribution of groups of sorghum producers according to the adaptation measures**

From the investigation carried out with the farmers of the group 3 who had better yields for the two crops, it comes out that que better option for addressing the effects of climate variability and pedological constraints is the combination of adaptation methods promoted by researchers and structures such us Projects and Programs. And, this combination is mainly based experience of the farmers on climatic variability, soil constraints and the use of adaptation approaches. This non-optional condition of the adaptation measures is associated with an indispensable condition of plowing operation before sowing, regular weeding of crops and application of organic manure. On this basis, what are the best options for combining the measures of adaptation to the effects of climate variability and soil constraints by crop?

Adaptation measures to the effects of climate variabilities and pedological constraints for maize

Maize production is very sensitive to dry spells and poor soil fertility; mainly for nutrients deficiency such us nitrogen and potassium which are the main feature of the soil in the study areas. Other authors have predicted the serious consequences on meeting the cereal needs of populations in sub-Saharan Africa in the coming years. Yield and income loss assessment from sorghum and maize production showed in table 2, that to climatic variability negatively impact maize compared to sorghum. Maize farmers have addressed it by applying more organic manure to their corn farms. Therefore, to address the issue, the best measures (already practiced by group 3) to restore soils and improve maize yields in order to minimize income losses are presented in Table 3.

Analysis of table3 shows that approximately 35% of maize producers use stone bunds, 8% improved seed varieties, 1% practice additional irrigation through the use of runoff water collection basins and 86.06% apply organic manure. Even if the combination of these methods have given proven results in the cropping systems, the ratio of farmers who did not adopt it remained high except the application of organic manure. The low application of theses technics may be due to technical limitations and land ownership. The main constraints are: unavailability of aggregates for the construction of stone bunds, financial limitations for transportation of the aggregates use for the construction of runoff water collection on the field and devices for the additional irrigation. Based on these results, the options and measures of adaptation of maize in the framework of this investigation is summarized in table 4. The table 5 show the costs for the adaptation measures in maize cropping. The adaptation measures request heavy investment; therefore, it request supports form the State in à framework of a contract where farmers are committed to follow the technical itinerary of the different crops.

Adaptation measures to the effects of climate variability and pedological constraints in sorghum farming

In these past years, sorghum played a key role in meeting food security in the Region of Plateau Central in Burkina Faso. White sorghum account for 33% in percentage of population cereals need for the period of twenty years as outlined in the methodology of this investigation. As for maize, sorghum is also affected by climatic variabilities these years. Formerly considered as crop with low requirements, actually with soil degradation, sorghum production request the application of adaptation measures.

Table 2. Yield and income loss

Indicateurs calculés	Group 1	Group 2	Group 3	Total
total area in sorghum (ha)	0.77±0.58	0.90±0.64	0.85 ±0.88	2.50±1.059
Sorghum yield in normal rainfall during the cropping season (kg/ha)	892.64 ±699.6	608.91±447.70	740.95±724.72	1622.411 ±1166.34
Sorghum yield in deficient rainfall during the cropping season (kg/ha)	397.63±418.73	276.79±262.10	419.29±415.88	780.717 ±694.05
Sorghum yield in excess rainfall during the cropping season (kg/ha)	821.51 ±818.11	607.45 ±483.35	854.29±872.12	1468.674 ±1183.50
Sorghum yield loss (kg/ha)	495.01 ±426.78	332.12 ±326.26	321.66 ±462.60	841.693 ±636.00
Income loss(FCFA/ha)	74292.50 ±8186.9	68475.04 ±65640.95	76979.53 ±11723.69	131406.12 ±108507.6
Ratio of sorghum loss (%)	55.64 ±24.31	55.66 ±22.05	38.08 ±22.44	50.955 ±20.023

Source : field survey, 2021

Table 1. Adaptation measure in maize farming

Adaptation measures	Adaptors	Non-adaptors	Total
Use of stones-bunds	43 (35.2)	79 (64.8)	122 (100)
use of improved crops varieties	10 (8.2)	112 (91.8)	122 (100)
Additional irrigation using runoff water collection basins BCER	1 (0.8)	121 (99.2)	122 (100)
application of organic manure	99 (81.1)	23 (24.2)	122 (100)

Source: Investigation, 2021 population size (proportion in %)

Table 2. Proposition of adaption measures for maize production

N°	Soil textural constitution	Soil structure	Topography	*Adaption measures*
1	LA, LAS, LS	Poorly developed in element of medium and small size	Lightly undulated	<u>*0ptimum option*</u> mechanical or motorized plowing + application organic manure or well mineralized compost application 5000 kg/ha/year+ regular mechanical weeding + construction of stones-bunds or grass bunds or combination of the two + *zaï* or half-moon (on crusted soils, bare ground, non-flood zone) + application of NPK at 150 kg/ha and urea à 100 kg/ha+ device for runoff water harvesting
2	LAS, LS	Poorly developed in elements with very large, large and medium size.	almost flat	<u>*Medium option*</u> Mechanical plowing or motorized + application organic manure or well mineralized compost application at 2500 kg/ha/year+ regular mechanical weeding + application of NPK à 100 kg/ha and urea 50 kg/ha+ device for runoff water harvesting Possibilities of soil water conservation methods
3	LA, LAS, LS	Poorly developed element with very large, large, medium and small size	Almost flat or lightly undulated	<u>*Minimum option*</u> Mechanical plowing or motorized + application organic manure or well mineralized compost application at 2500 kg/ha/year+ regular mechanical weeding + application of NPK at 50 kg/ha and urea 20 kg/ha + device for runoff water harvesting Possibilities of soil water conservation methods

Legend: LA=Silt- clay, LAS= Silt- clay- sand, LS=Silt- sand

Table 5. **Costs for the adaptation measures in maize cropping**

N°	Options for adaption measures	Cost (FCFA)
1	Optimum option	Aop =442 000 (plowing + 2 weeding + 5 tons of organic manure + 150 kg NPK + 100 kg urea + 15 kg seed) Bop = 912 000 (Aop + stone bunds construction) Cop= 1 062 000 (Bop + grass bands) Dop= 1 212 000 (Cop + *zaï* or half-moon) Aopor Bop or Cop or Dop + 500 000 (at least for the construction of the device of run-off water collection)
2	Medium option	Amo =358 000 (plowing + 2 weedings+ 2,5 tons of manure + 100 kg NPK + 50 kg urea + 15 kg seed) Bmo =828 000 (Amo + stone bunds construction) Cmo =978 000 (Bmo + grass bands) Dmo =1 128 000 (Cmo + *zaï* or half-moon) Amo or Bmo or Cmo or Dmo+ 500 000 (at least for the construction of the device of runoff water collection)
3	Minimum option	Ami= 168 400 (plowing+ 2 weedings+ 2,5 tons of organic manure + 50 kg NPK + 20 kg urea + 15 kg seeds) Bmi= 638 400 (Ami + stone bunds construction) Cmi =788 000 (Bmi + grass bands) Dmi= 938 000 (C + *zaï* or half-moon) Ami or Bmi or Cmi or Dmi + 500 000 (at least for the construction of the device of runoff water collection)

Table 6. Adaptation measures for sorghum cropping

Adaptation measures	Adaptors	Non- adaptors	Total
Crops rotation	48 (40.7)	70 (59.3)	118 (100)
Crops association	55 (46.6)	63 (53.4)	118 (100)
Zaï	21 (17.8)	77 (82.2)	118 (100)
Other water management technique at the plot level	8 (6.8)	110 (93.2)	118 (100)
Grass-bunds	21 (17.8)	96 (81.4)	118 (100)
Stones-bunds	45 (38.1)	73 (61.9)	118 (100)

Source: Investigation, 2021 population size (proportion in %)

Results of the previous investigations reported that the best option to reduce the effects of climate on sorghum yields is the combination of adaptation measures as practiced by group 3. These measures c=include crop rotation (40,7%) and crops association (46,6%). Also, *zaï* (17,8%), and other practices of water management at the plots level (6,8 %), construction of barriers in grass and stones respectively (17,8%) and (38,1%). Even if the farmers are not able to correctly applied mineral fertilizers (NPK and Urea) because do their economical inaccessibility. Table 6 show the costs for the adaptation measures in maize cropping.

Even though the combination of these adaptation measures has been proven on farms, the proportion of non-adopters remains high. Therefore, the options for adaptation measures of sorghum in the context of this investigation in accordance with the methodology are presented in Table 7.

The costs of the adaptation measures in Table 1 were used to estimate the costs of the different options proposed in Table 8.

The establishment of a climate for casting service and attending to weather forecasts at the beginning of the season as well as agricultural insurance as supporting measures for these proposed options.

Resilience of rainfed sorghum and maize production

The model ClimProspect was used to build the methodology of the characterization ofrainfed sorghum and maize the resilience to dry spells. Based on the impacts of climate variability and soil constraints on production of sorghum and maize under rainfed conditions as well as the analysis of options for adaptation measures addressed, the resilience of rainfed sorghum and maize production will be built depending on the response to recurrent problems (Tapsoba-Mare *et al.,* 2021). Therefore, resilience will be targeted. The fdo family of impacts is the first group of impacts experienced when drought occurs.
The components of these vectors are ranked from zero- to five (eir1d0, i=1,…,5) on each of the components of vector (e) is rainfed agriculture. It has 5 components: food production, contribution of steeple crops to food security, to the national economy, financing and governance of food crops farming.

fd0 = (*decline in production, failing of agriculture in addressing food security, poor economic growth, substantial increase in the need for supporting agriculture and food sector from the budget, increase in the demand on the ministry in charge farming*). several fields are covered by the components fd0: food production, food security, economic growth, institutional management.

vr1d0 is the vulnerability configuration to address to avoid the fd0 group of impacts. vr1d0 = (*rain-fed agriculture, poor investments to secure the contribution of agriculture to food security in case of dry spells, No fluent economic mechanisms for securing the contribution of agriculture to endogenous investment capacities of the State, poor financing structure of drought risks management, poor inclusion of drought risks in the formulation of development policies*).

The z0 configuration of resilience is the stat farming activities are carried out in order to avoid/ address the impact group fd0. Its characteristics are:

z0 = (irrigated agriculture*, accommodation between investments in agriculture and the challenge of meeting food security during dry spells, accommodation between the mechanisms of securization local funding of farming activities and State capability, Availability of robust funding structure to address dry spells risks, efficiency in taking into account drought risks in the formulation of development policies)*

The decision will be made by taking the operator az0 as standard. The operator to change the vr1d0 vulnerability configuration to the z0 resilience configuration is az0.

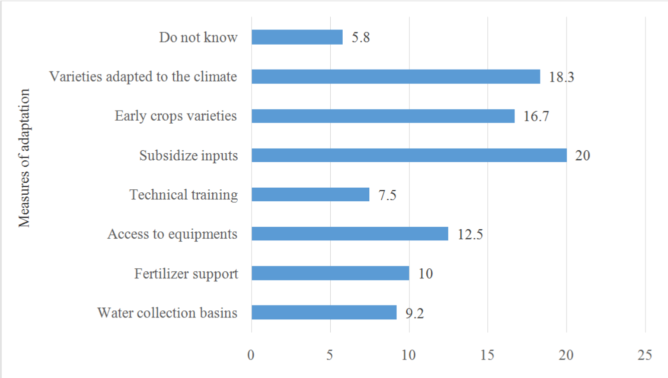
The components of the az0 = *(Design and implement a socio-economic program for the transition to irrigated agriculture, tools for improving the economic investments performance in order to secure the contribution of agriculture to food security, economic mechanisms for securing the contribution of agriculture to the state's local investment capacities, expanded partnership for the structuring financing process of the resilience, institutional mechanism for integrating the effects of climate risks into development policies)*

The farmers also sized their concerns through some recommendations.

Recommendations of farmers

To address challenges related to constraints of adoption of measures of climatic variability and soil constraints, producers have done recommendations on for the State, technical and financial partners. 6% of the farmers do not have clear idea of what they need in order to improve the productivity in their farms. For them, climate variability and pedological constraints cannot be addressed. The certainly belong to the group1: farmers who do not adopt any adaptation measure. However, 9.2% of farmers, requested the construction of runoff water collection device (BCER) for supplementary irrigation in case of dry spells and easy access to the access to the National Security Food Stock Management Company (SONAGESS), in the event of a cereal deficit. Also, 10% of the investigated farmers requested support for access to fertilizers (mineral and organic amendments) very important for improving sorghum and maize yields, support in accessing to farm equipment's (12.5%); capacity building in farm operation (7.5%), subsidies as a means of accessing to good quality inputs (20%), the use of varieties improved crops to address effects of the climate (18%) and the use of early varieties (16.7%); these results are outlined in figure 3. Limitations of these parameters are major constraints that threaten farmers 'capacity to respect and strongly adopt the adaptation measures promoted by the different stockholders.

The request of farmers to get support improved seed varieties (18.3% and 16.7%) deserves a particular attention. During the 2008 agricultural campaign, the State of Burkina Faso promoted these seeds through the 80% and 90% of subsidies respectively for men and women. Fourteen years after, approximately 18.3% of producers are asking this support. This ratio may come from producers in group 1 who have undoubtedly lost hope and have remained without an initiative for innovation and collaboration with the technical services in charge of agriculture, to adapt their agricultural production.



Source: investigation, 2021

Figure 3. Cereals farmer's recommendations for support

DISCUSSION

If the problems are within the capacity of any firm, the solutions appear easy and satisfactory. Thus, the problems of climatic variability and soil constraints seem to be beyond the capacity of producers, given its impact on farms. To this end, the adaptation measures introduced in recent years as solutions seem to have experienced limits in their smooth implementation. This chapter has analyzed the measures for adapting maize and sorghum crops to climatic variability and soil constraints. The results showed significant decrease in yields of maize and sorghum as effects of climatic variability and soil constraints. This finding confirms investigations conducted by (Konte and Soumaoro, 2022) who used the Ricardian approach to assess the impact of climate variability on Malian agriculture. The conclusion drown is that temperature and precipitation have direct, indirect and total effects on maize yield. To address the effects of extreme climate variability, they suggest that to decision-makers to promote the use of resilient agricultural techniques and raise farmers' awareness of the appropriate options for adaptation measures. These recommendations show that the construction of stone-bunds as land management practices, use of improved crop varieties, complementary irrigation using runoff water collection basins, and application of organic amendments are more convenient for improving maize yields. However, their adoption level remains low. Locally, several adaptation approaches are already being used by Sahelian farmers. Many studies have raised that the adoption of new resistant and short-cycle varieties guarantees household food security and income (Bertrand and Richard, 2012). Similarly, the main adaptation strategies are water and soil conservation techniques, the use of organic manure, supplemental irrigation and the use of adapted varieties (Kabore *et al.,* 2019; Da, 2008). Consequently, the results showed that the practice of crops rotation and association, the practice of *zaï*, the technique of water management, the development of grassy strips and stone bunds are appropriate to improve sorghum yields. These different adaptation measures have beneficial effects on farmers' incomes and productivity, even if they use low doses of NPK (26.90 kg/ha), urea (9.73 kg/ha) and organic manure (2,062.55 kg/ha) for financial reasons. The standards recommended for maize crops: NPK (150 kg /ha), urea (100 kg/ha) and organic manure (5000 kg/ha) and for sorghum: NPK (100 kg/ha), urea (50 kg/ha) and organic manure (5000 kg/ha). The quantity of fertilizers reduces when using the micro dosing fertilizer application. These results confirm those of (Salami Osseni, 2015; Konte and Soumaoro, 2022). Parameters such as the use of meteorological information at the beginning of the rainy season, registration to agricultural insurance had a proportion of 0% in the investigated population. However, (Dabire, 2017) showed the economic interest of availing rainfall forecasts information to farmers. Climate information facilitates the ability of small scale farmers to address variability and extreme events, (Sultan *et al.,* 2013; Zongo, 2016). Also, the use of agricultural insurance is a motivating element that can encourage farmers in this attitude of acceptance and non-preparedness for risk, (Eldin, 1989).

However, the adaptation approaches pointed out in this investigation are widely implemented in sorghum and maize production in the Region of Plateau Central. The adaptation method to address erratic rainfall by complementary irrigation is practically not applied one irrigation regardless of the water source have been found to be a convenient approach of adaptation to the pernicious effects of climate variability; followed by training and awareness raising. Farmers (Smadhi and Zella, 2012). For Zougmore *et al.* (2018), the correlation between profitability and increased household income, as well as improved productivity is significant, when the practices supplementary irrigation is included in the farming practices.
The support of policies is requested by the farmers for building runoff water collection devices for irrigation or any other mechanism for water harvesting at the field level, supports for access to fertilizers and farming material, the subsidy of good quality inputs, the use of varieties adapted to the effects of the climate, the use of early varieties and capacity building. These recommendations are online with (Aminou, 2021). Where parameters to be considered for improving crops productivity while taking in to account the specify of each region and the target groups (farmers, policies, technicians) are outlined.

Conclusion

Depending on the typology of the farmers, various adaption approaches are currently applied in sorghum and maize farming. The group of farmers who mostly combine these adaption approaches had always. Mostly the average yields for the sorghum or maize was optimum in the group of farmers who used to combine these adaptation measures. The diagnosis of impacts and vulnerability using ClimProspect is a decision-making tool for agricultural resilience funding. The three standards (optimum, average and minimum) of adaptation measures proposed to improve sorghum and maize yields will probably be a source of higher agricultural production costs. There is a need for specific support for a large adoption of these approaches by farmers. The backstopping efforts of farmers must remain constant, in order to avoid laxity in the implementation of technological packages. Farming activities is one of the oldest one. It provides food for humanity and, that is why it should be conducted in a context of overall innovation leading to an increasing productivity and not the opposite.

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