SCIENTIFIC REPORT

Analyzing the impacts of GLDC innovations on the food and nutrition security in DryDev sites.

Jan 2019

I. Introduction

Producing more food for a growing population in the coming decades, while at the same time combating poverty and hunger, is a huge challenge facing African agriculture (Garrity, Akinnifesi et al. 2010). Biotic and abiotic stress intensify this challenge. The stress due to climate change is the most serious. Climate stress include a higher frequency of extreme weather effects such as drought and floods (Diamandé 2008). West Africa has seen substantial increases in rainfall variability during the latter half of the 20th century, leading to prolonged droughts in the 1970s and 1980s, and greater flood (Creech, Akoh et al. 2014). Between 1900 and 2005, the Sahel region experienced considerable drying, however, since the 1980s, it appears that the annual rainfall quantity has increased over time, but the higher rainfall variation over space and time make the predictions less robust (Keller 2009). Overlying this increased variability are expected longer-term changes, such as higher temperature and lower rainfall (or in some cases higher) (Balk, Montgomery et al. 2009). According to the latest Intergovernmental Panel on Climate Change report, the climate consequences of a 2°C warmer world are far greater than for a rise of 1.5°C, and Suh-sahara Africa is expected to record above the average warm (O. Hoegh-Guldberg 2018). Tubiello, Rosenzweig et al. (2008) argued that moderate warming (up to 2°C) in the first part of this century may benefit crop and pasture yields in the temperate regions while reducing crop yields in the semi-arid and tropical regions. The agriculture sector is expected to be the most affected by climate risks because of its higher dependence to rainfall and it is a large fraction of the economy, moreover, it relies on relatively basic technologies (Pearce, Cline et al. 1996).

The severity of the climate change impacts (biotic and abiotic stress) combined to land fragmentation, cropping of marginal lands and disappearance of the fallow land result in a strong pressure on soil and give favor to soil degradation projected in low crop production (Adger, Dessai et al. 2009). Meanwhile, the population is growing faster, the crop production is declining reflecting a cereal gap that creates food shortage. This situation makes way for permanent food shortage which intensifies the vulnerability of farm households and jeopardize rural household livelihoods.

To address the challenge related to biotic and abiotic stress, households are implementing a package of adapting strategies either from their own knowledge and tradition or adopted from development institutions, or from both (Ado, Leshan et al. 2018). According to Smit and Pilifosova (2001) adaptation refers to changes in processes, practices, and structures to moderate potential changes or to benefit from opportunities associated with climate shocks. Crops association and diversification, integrated crops-livestock and agroforestry have been perceived as key effective and efficient agricultural practices for mitigating biotic and abiotic stress and improve farmers' livelihood (Belsky 1993). Increasing numbers of studies review the different measures adopted by farm households in sub-Sahara Africa to mitigate biotic and abiotic stress; these strategies include mainly agroforestry, crops diversification and association, use of fertilizers, use of improved seed varieties adapted to the new climate request and irrigation technologies (Mertz, Mbow et al. 2009, Kato, Ringler et al. 2011). (Charles, Munishi et al. 2013, Lasco, Delfino et al. 2014) report that agroforestry practices improve household food security because of the multiple socio-economic and environmental benefits of trees, which are cash crops that demand relatively low levels of labor. According to ICRAF (1993), Agroforestry refers to land use systems in which perennial trees are deliberately introduced or left in association in a same production unit (farm) with crops and / or animals (or pastures) and in which there are significant ecological and economic interactions between the trees component and other non-woody components. This is certainly why the World Agroforestry Centre (ICRAF) is supporting national governments in Africa, Asia and Latin America in developing the tools, knowledge and capacities needed to successfully expand the scale of sustainable agricultural solutions with regard to agroforestry. Grain Legumes and Dryland Cereals Agri-food Systems (GLDC), a CGIAR research program is seeking to increase productivity, profitability, resilience and marketability of critical and nutritious grain legume and cereal. While promoting innovations for improving the yield of grain legumes and cereal as an important component of the agricultural system, there is a need to determine the contribution of the products in household food consumption one of the four dimensions of food security including food availability, accessibility, utilization and stability (van Dijk, 2012). Many farmers are also diversifying (from mono-cropping to) and associating crops (association of cereal and leguminous) in the same unit to reduce risk adverse due to biotic (pest and parasite attack) or abiotic (drought, storm, high temperature, flood, erosion, fertility declining) while some farmers are using fertilizers, improved seed varieties (resistant to water stress, short cycle duration) to cope with abiotic stress due to prolonged drought, shortage of rainy season and soil fertility declining, or using pesticide to anticipate or control stress from pest and parasites attacks. However, the design of effective strategies shapes to how farmers perceive the risks to which they are exposed as well as their level of adaptive capacity. Furthermore, the adoption of specific strategies is heavily dependent on their being low-cost and their perceived usefulness. This study attempts at analyzing farmers knowledge of climate change and managed natural resources practices impact on households' food and nutrition status. Specifically, the study intends at:

- To examine farmers' knowledge of climate change;
- To analyze farmers' agriculture practices and factor determining the adoption;
- To determine the influence of agriculture practices on households' livelihood;
- To assess households' food security and nutrition as well as factor determinants.

II. Methodology

2.1 Sampling Technique and Data Collection

The research used a mixed-method approach, combining qualitative and quantitative data. The approach focused on understanding the farmers' knowledge of abiotic and biotic stresses and their management options for adaptation and food security resilience. Research participants were selected using a multi-stage sampling approach. Firstly, in each of the three countries of DryDev program in the Sahel (Burkina Faso, Mali and Niger), one site under the supervision of SNV in Burkina Faso, AMEDD in Mali and Karkara in Niger were jointly chosen by all categories of actors. These sites are Zogoré in Burkina Faso, Yorosso in Mali and Droum in Niger (Figure1). At the second stage, eight villages were purposely selected from each district with the help of DryDev facilitators in the field, based on village' accessibility, GLDC project intervention, and culture diversity (based mainly on ethnicity diversity). Two villages where any project had intervened before has considered as control. A total of twenty-four (24) villages were surveyed in the three countries. The farm household was identified as the third unit of analysis, and in each country one hundred (100) households were identified to be surveyed.

At the fourth, stage, a reconnaissance visit was made to one selected village in each country to verify the accuracy of the random selection criteria. During these visits, a group interview and four individual interviews were held. The collected information served as a basis to amend the questionnaire accordingly. At the final step, one hundred (100) households from each district were randomly selected for surveying. Within these selected households, both the husband and the wife were interviewed separately using a questionnaire. The total sample of 600 respondents representing 200 respondents per country.

The survey was scheduled from 23 November to 3 December 2018. The data collection tools included semi-structured questionnaires and interview guide, and resource mapping complemented by field observations. The questionnaire covered topics including household socio-demographic and economic characteristics (i.e. Ethnic group; the number, gender and schooling levels of household members; the age, level of schooling and profession of the household head; their years of farming experience; their receipt of aid from an institution; and the household's sources of income [agriculture, livestock, forestry, trader, wage labor, aid, credit or other sources]), farm characteristics (i.e. farm size, type and number of animals, soil fertility appreciation, type and production volume for each crop), households' dietary diversity during a week (7 days), and farmers' perception of climate change. The farmers were also asked about the management strategies they currently employ to address biotic and abiotic stress (crop combination, combination of the crops with other farming components like livestock and trees or off-farm activities). All interviews were conducted in the local language of the country. The data from group interview were recorded using field notes, and the data from the individual interview were recorded using Open Data Kit (ODK).

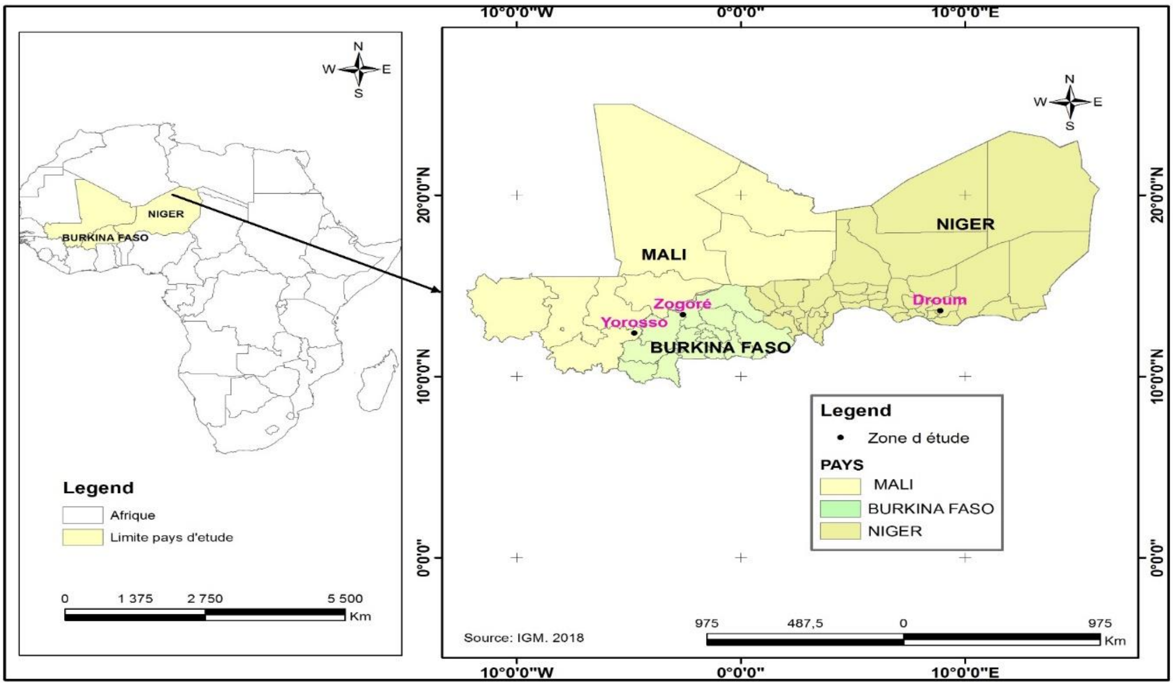

Figure 1: Description of the study area

2.2 Data analysis

The qualitative and quantitative data were managed in Rhomix version 1.4 and analyzed using the Rhomix. Descriptive statistics were used to summarize the data distribution into means, averages, frequencies, and percentage (%), and these results were reported as charts, graphs, and tables. Statistical (inferential) analyses were undertaken using Co-variance, Correlation matrix, and Non-linear regression to identify linkages, associations, and the influence of farmer characteristics and different land-use activities on the dependent variables.

2.3 Empirical Method

For a more explicit understanding of our research, we followed an analytical method for adaptation to abiotic and biotic stress. In this framework, we envisaged that dependent variables by mediating factors and farmers' endowments. Firstly, the study focused on farmers' socio-economic characteristics, and food security assessment using comparative approach and explored farmers' adaptation options for abiotic and biotic stress. The research also intends to assess the factors determining strategy adoption and respondent dietary. Following previous studies (Smit and Pilifosova 2003, Bryan, Ringler et al. 2013, Di Falco and Veronesi 2013), the research proposed the following analytical framework.

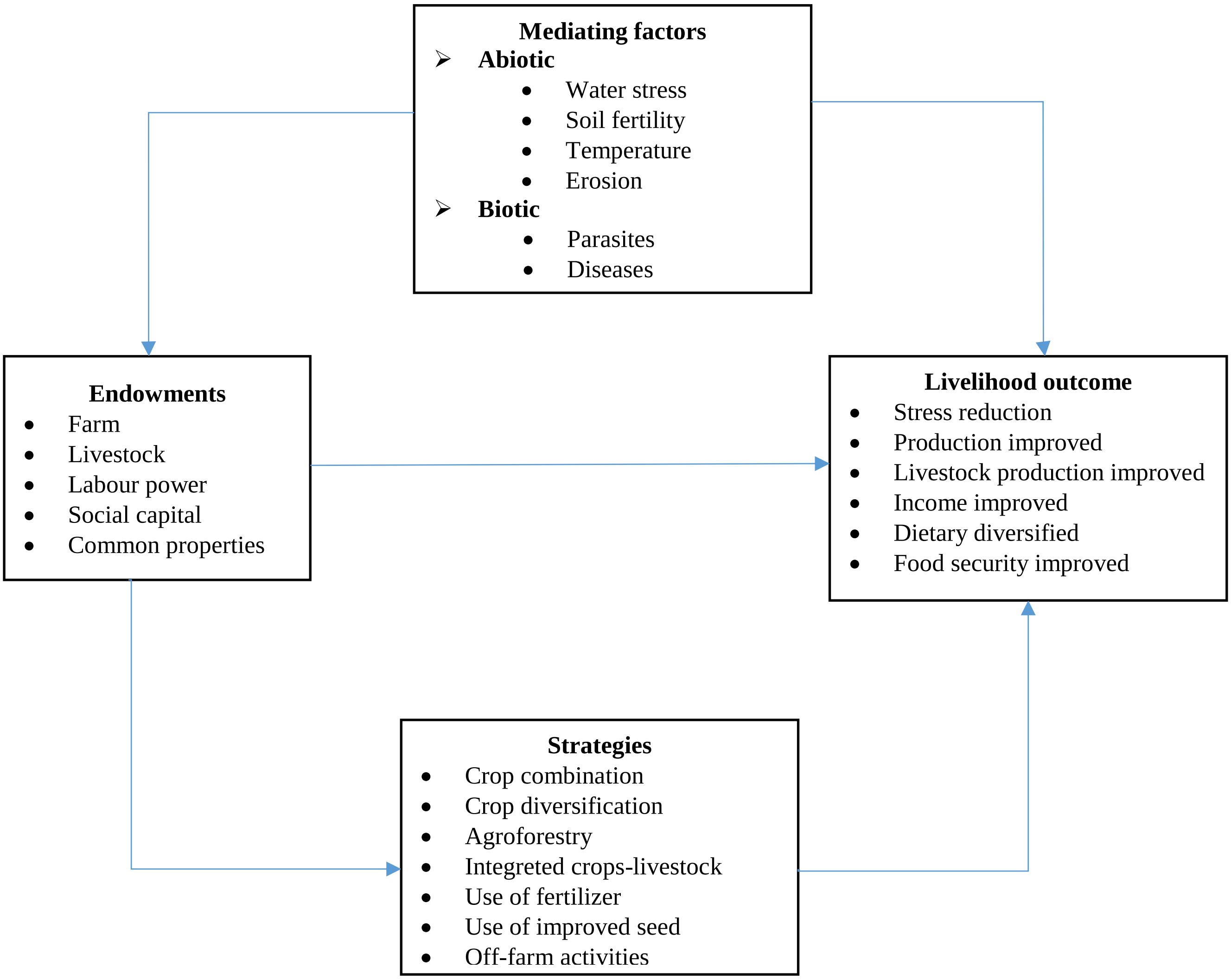

Figure 2: Analytical frameworks for strategy adoption assessment

A logistic regression (enter method), was performed to assess the most determinant variables affecting farmers' choice of strategy. Following the previous studies (Hassan and Nhemachena 2008, Abid, Scheffran et al. 2015, Manda 2016), we assumed that farmers adopt certain strategy if they are expecting a positive farm benefit (production increase, risk reduction, orcertain strategiesncome) from this strategy. This benefit is also called the utility and usually noted by U. Let denote U_1 the utility for adoption, U_0 for non-adoption and Y^* the difference of this utility ($Y^* = U_1 - U_0$). The farmer will adopt strategy if the difference of utility (Y^*) is greater than zero ($Y^*>0$). However, Y^* is an unobserved variable, all that we observe is *why*, a binary indicator that equal one if the farmer adopts a specific strategy and zero otherwise.

Thus, to model the decision to adopt a strategy, we consider the latent variable Y^*_{ij} which is equal to the expected benefit from the adoption of a specific strategy. i is depicting a farm household that has adopted a specific strategy, and j is depicting the different strategies (j=1, 2, 3, 4, 5).

The considered endogenous variables are the different strategies adopted by farmers. We denoted X_{ij} as the vector of exogenous factors influencing the farmers' decision to adopt specific measures which are the farmers' characteristics (i.e. household size, age, education level, ethnic group, social status, member of associations, education rates, production system, and income) and their farms' physical characteristics (soil fertility, food production and livestock ratio). We denote β_j as the vector of binary regression coefficient and ε_{ij} as the intercept. Thus, the equation for strategy adoption is:

$$Y^*_{ij} = \beta_0 + \sum \beta_0 X_{ij} + \varepsilon_{ij} \ \ (Eq_1)$$

$$Y_{ij} = \begin{cases} 1 \ if \ Y^*_{ij} > 0 \\ 0 \ if \ Y^*_{ij} \leq 0 \end{cases} \ \ (Eq_2)$$

Y^*_{ij} is directly an unobserved latent variable. All we observe is Y_{ij} , a binary variable that equals one if a specific measure is adopted and zero otherwise. A farm household (i) will adopt measure j ($Y_{ij} = 1$) if the expected benefit is greater than zero ($Y^*_{ij} > 0$). If the expected benefit is equal to or less than zero ($Y^*_{ij} \leq 0$), the measure will not be adopted ($Y_{ij} = 0$).

2.4 Overview of GLDC

The Grain Legumes and Dryland Cereals (Figure 1) is a CGIAR Research Program which intends to increase the productivity, profitability, resilience and marketability of critical and nutritious grain legume (chickpea, cowpea, pigeonpea, groundnut, lentil, soybean) and cereal (sorghum, pearl millet, finger millet) crops grown within the semi-arid and sub-humid dryland agro-ecologies of sub-Saharan Africa and South Asia. These agro-ecologies are where poverty, malnutrition, climate change and soil degradation are among the most acute globally. By 2022-2030, as a consequence of this research, 8.9-21.7 million farm households will have adopted improved varieties, helping 4.4-11.8 million people to exit poverty and 12.7-24.8 million people meet daily nutritional requirements, with 50% of beneficiaries being women. The CRP is logically structured on five Flagship Programs. Informed by purposeful monitoring and evaluation, research planning is driven by the analyzed needs of these agri-food systems (FP1: Priority Setting and Impact Acceleration). Through strategic partnerships, sector intelligence will identify and leverage value chain interventions that support dryland cereals and grain legume markets (FP2: Transforming Agri-food Systems). These analyses and innovation system engagements can inform and direct the cultivar requirements from crop improvement programs, seed and input supply systems (FP4: Variety and Hybrid Development) and the farming systems practices (FP3: Integrated Farm and Household Management) that lead to resilience and sustainable intensification outcomes. Modern breeding approaches will both underpin and increase the efficiency and effectiveness of crop improvement innovations that meet market demands (FP5: Pre-breeding and Trait Discovery).

The main objective of FP3 to which we are directly associated is to capacitate stakeholders such that they can improve the productivity, profitability and sustainability of smallholder farming systems using on-farm and in-household innovations to ensure household nutritional security and enhanced income generation through integrated crop, tree and livestock production systems. Its specific objectives are:

- To design, test and scale improved crop-tree-livestock management options and their interactions to optimize productivity and enhance resource use-efficiency;
- To increase the productivity and agro-biodiversity in farming systems and strengthen household livelihoods through improved nutrition and dietary diversity;

▪ To increase the climate resilience of farming systems through integrated soil, crop, water and nutrient management approaches;

▪ To manage and conserve the natural resource base and close nutrient cycles to avoid soil fertility losses; and

▪ To use (with FP1 and FP2) Innovation Platform (IP) approaches to identify opportunities for value chain enhancement.

In Sub-Saharan African, the program is executed in 3 countries namely Burkina Faso, Mali and Niger.

Figure 3: Logo of GLDC

III. RESULTS AND DISCUSSIONS

This section presents the results and discussions of focus group discussion and individual interview.

2.5 Synthesis of focus group discussion

Agroforestry, the inclusion of woody perennials within farming systems, sustain and diversifies the socioeconomic and environmental benefits of farmers practicing subsistence agriculture in the context of climate variability (Zomer, Trabucco et al. 2009). However, very little research is known about the benefits of agroforestry in the Sahel. This chapter aims at analyzing the socio-economic and environmental benefits of forest species frequently used on farms.

3.1.1. Inventory of plant species and their importance

Due to the persistence of food insecurity and poverty mainly caused by multiple socio-economic and climatic hazards, farmers are increasingly resorting to agroforestry. This farming practice is perceived by numerous studies as an effective solution facilitating adaptation to the various hazards that threaten the livelihoods of rural families. Figure 2 summarizes the results of a focus group discussion of ten most popular trees in the farms and their economic and environmental importance. The score represents the mark over ten (/10) given by the farmers according to the socio-economic and environmental importance of the species and their popularity. Therefore, the higher the grade, the higher the forest species are significant.

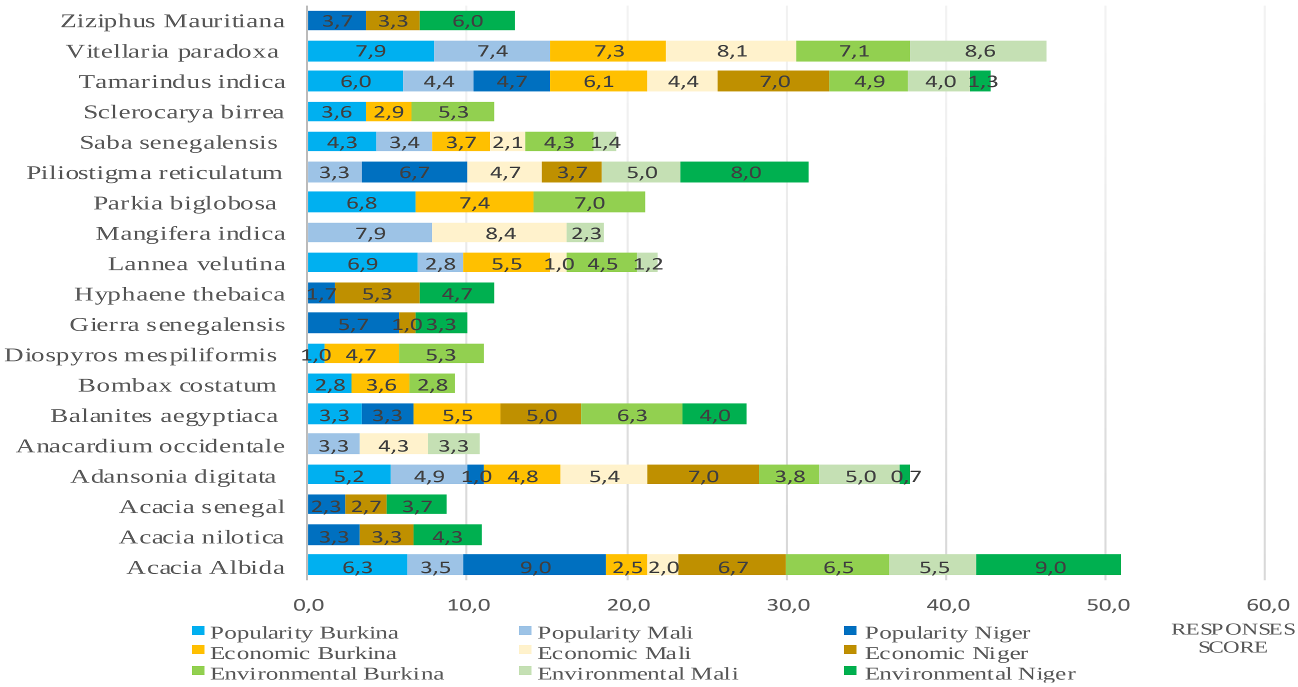

Figure 4:Inventory of forest species and their importance

In general, the result indicates that the most popular trees in the farm are respectively *Acacia albida*, *Vitellaria paradoxa*, *Tamarindus indica*, *Adansonia digitata*, *Pilostigma reticulatum and balanitesaegyptiaca* according to the country. Specifically, in Burkina the forest cover is respectively dominated by *Vitellaria paradoxa* (8.1), *Lannea velutina* (6.9) and *Acacia albida* (6.3) while it is dominated in Mali by *Mangifera indica* (7.9), *Vitellaria paradoxa* (7.4) and *parkia biglobosa* (6.8). In Niger, the vegetation cover is dominated respectively by *Acacia albida* (9.0), *Piliostigmareticulatum* (6.7) and *Guierra senegalensis* (5.7).

Forest species through the use of their different parts provide economic and socio-economic support for households. This is why Garba (2000) stated that farm trees are a refuge in which nature more or less generous, guaranteed a minimum of economic security. Regarding trees economic importance, species such as *Vitellaria paradoxa*, *Tamarindus indica*, *Adansonia digitata*, *balanites aegyptiaca* and *Pilostigma reticulatum* are perceived by farmers as the most treasured. In Burkina, *Vitellaria paradoxa* (7.3), *Lannea microcarpa* and *Balanites aegyptiaca* (5.5) are perceived as the most economically profitable tree species. In Mali, farmers perceived species, including *Mangifera indica* (8 .4), *Vitellaria paradoxa* (8.1) and *Adansonia digitata* (5.4) as the most important while in Niger the economic perception of forest species is dominated by *Adansonia digitata* (7.0), *Tamarindus indica* (7.0) and *Acacia albida* (6.7).

Loubelo (2012) supports our results by reporting that for commercial use, the exploitation of some non-wood forest products have opened up new perspectives, suggesting the possibility of part-time or full-time jobs, for men as well as for women in rural communities, or even in urban centers. (FAO 2003) reports that more than 150 non-timber forest products are traded in the various markets of Central Africa. Tabuna (1999) estimated Central Africa's non-timber forest products exports at 3,475 tons / year and the turnover generated by this volume is estimated at 96424251 dollar US. According to Garba (2000), the kilo of tamarind fruit is sold at 2000 FCFA on the Nigerien market.

The study also focused on determining the farmers' perception of the environmental importance of tree species present in the farms. The results reveal that *Vitellaria paradoxa*, *Acacia albida*, *Piliostigma reticulatum*, *Balanites aegyptiaca*, *Parkia biglobosa* and *Sclerocarya birrea* are of paramount importance to the environment due to their significant contribution to the improvement of soil fertility and bio-physical characteristics, protection against erosion (from water and wind) and high temperature. Farmers from Burkina rank in order of environmental importance the following species: *Vitellaria paradoxa* (7.1), *Parkia biglobosa* (7.0) and *Acacia albida* (6.5) while in Mali the order is respectively *Vitellaria paradoxa* (8.6) *Acacia albida* (5.5), and *Piliostigma reticulatum* (5.0). In Niger, *Acacia albida* (9.0), *Piliostigma reticulatum* (8.0) and *Ziziphus Mauritiana* (6.0) were respectively perceived as the best eco-environmental species. Regarding environmental side, several studies have proven the importance of trees in the field. Ado (2010) reports that the extensive root system of *Gierra senegalensis* helps reduce soil erosion during the rainy season, and thereby plays an important role in the crop production system. Boffa (1999) also reported that Faidherbia albida was highly valued for soil fertility improvement, buffering erosion, shadow.

3.1.2. Varied use of forest species

According to Saadou (1998), 468 forest species in Niger are exploited by man in the varied fields such as food, construction, medicine, crafts, culture. Applying the objective, different organs of the plant are utilized. Table 2.1 indicates the use of forest species and the organs concerned.

Tableau 1: Exploitation of forest species

Trees species	Food	Fodder	Construction	social use	Lumber	Energy wood	Medicine (Human)	Medicine (Veterinary)
Acacia albida		Fr. L.S	B	K	B.T	B.T	Fr. L.K.R	L
Acacia nilotica	Fr	Fr. L	B. T	Fr.L	B. T	L. B. T	L. Fr. R	Fr

Acacia senegal	Fr	L. Fr		Fr	B	B. T	L. K	
Adansonia digitata	Fr. L.S	L	B	L.K		B.T	Fr.L.R. K.S	Fr.L.K.S
Anacardium occidentale	Fr.	L	T	B	B.T	B.T	S	S
Balanites aegyptiaca	Fr. L.Fl.S	Fr. L.Fl.S	T		B.T	B.T	L.R.K.S	L
Bombax costatum	L. Fl	L. Fl		K	B	B.T	K	K
Diospyros mespiliformis	Fr	Fr. L	B. T	L .T	B. T	T	L. Fr. R.K.S	Fr
Gierra senegalensis		L			B. T	B.T	Fr. R. K	
Hyphaene thebaica	Fr. Fl. R. S	L	T	L. R	B. T	L	K	
Lannea velutina	Fr	Fr. L		Fr.K.S	T	T	Fr. L.R. K	L.K
Mangifera indica	Fr		B	B	B	B.T	L.K	K
Parkia biglobosa	Fr.L.S	Fr.L	B.T	B	B. T	B.T	Fr.K	Fr.S
Piliostigma reticulatum	S	Fr.L. S	B. T	K	B. T	B.T	L.R.K	L.K
Saba senegalensis	Fr		T	L			L.B	
Sclerocarya birrea	Fr.S	Fr. L	T	Fr.S	T	T	L.K.T	L.K
Tamarindus indica	Fr. L. Fl.S	L	B. T	Fr.L.K.S	B	B.T	Fr. L. K.S	Fr.R.S.K
Vitellaria paradoxa	Fr.S	L.T	B. T	Fr.T.S	B.T	B.T	Fr.L.R.K.S	L.K.S
Ziziphus Mauritiana	Fr.S	L			B	B. T	L. K. R	R

Fr = Fruit; L = Leave; R = Root; K = Bark; Fl = Flower; B = Branche; T = stem; S = Seed

For certain species such as *Adansonia digitata*, *Balanites aegyptiaca*, *Tamarindus indica*, *Vitellaria paradoxa*, *Diospyros Mespiliformis* almost all organs are used. However, flowers and plant roots are rarely used with the exception of a few species such as *Balanites aegyptiaca*, *Tamarindus indica*, *Bombax costatum* and *Hyphaene thebaica*. The most commonly plants organs used are respectively leaves (use value = 20.56%), fruit (16.94%), young branches

(16.53%) and stems (16.53%). The leaves are generally used for food and traditional pharmacopoeia. The study shows that 33.33% of the use of the leaves is allocated to fodder and 27.45% to the traditional human pharmacopoeia while 9.80% of use is assigned to human food as a dietary supplement. The results reveal also that the leaves of *Adansonia digitata, Balanites aegyptiaca, Tamarindus indica* and *Acacia nilotica* are the most utilized.

Regarding tree fruits, they are mainly used in food (human and animal) and pharmacopoeia (human and animal). The study shows that 57.14 and 33.33% of the use of fruits are respectively assigned to food and traditional pharmacopoeia. The fruits of *Acacia nilotica, Lannea velutina, Parkia biglobosa, Tamarindus indica, Vitellaria paradoxa* are the most utilized.

The branches and stems are mainly used as energy wood, lumber and construction. 34.15, 36.58 and 21.95% of the use of the branches are respectively allocated to energy wood, lumber and construction while 41.46, 29.26 and 26.83% of the use of the stems are respectively allocated to the energy wood, lumber and in construction. Almost the branches and stems of all the inventoried species are used.

With specific regard to barks, 85.71% of their use is predestined to the traditional pharmacopoeia (social ritual, human and animal medicine) while 55.56 and 44.44% of the tree seed utilization are respectively intended for the traditional pharmacopoeia (ritual, human medicine and animal) and food (human and animal). Nevertheless, it should be noted that no plant species has been identified as having a poison effect.

Various studies explore the use of different organ of trees in varying domain, including food, fodder, construction, medicine, social rites and other purpose. According to Saadou and Garba (1997) at least 40% of species occur in food (50.2% of species), pharmacopoeia (46.5%) and human nutrition (44.8%). Furthermore, Garba (2000) found that fruits (35%) and seeds (31%) are the most utilized for food, and leaves (90%) are used for fodder while leaves (76%), stem / bark (64%), roots and fruits (25%) are the most used in traditional pharmacopoeia.

3.1.3. Extinction and management of tree species

The study also focuses on the farmers’ perception of tree species extinction. The results from group interview are reported in Figure 3.2. The negative sign indicates the decrease while the positive depicts the increase of a specific tree species.

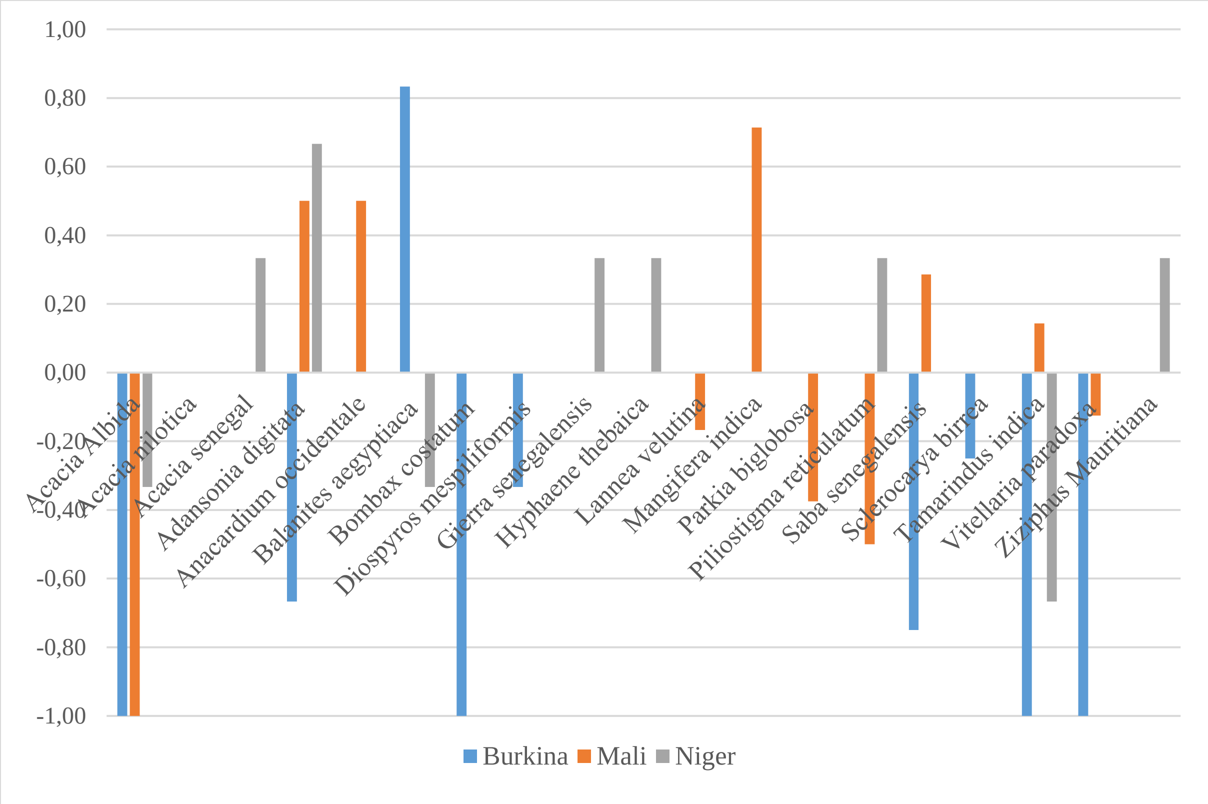

Figure 5: Tree species extinction

In general, the study records a decrease of tree species, particularly *Acacia albida, Bombax costatum, Diospyros mespiliformis, Lannea velutina, Parkia biglobosa, Sclerocarya birrea* and *Vitellaria paradoxa* while an increase of *Acacia senegal, Adonsonia digitate* (except in Burkina), *anacardium occidentale, Gierra senegalensis, Hyphanene thebaica,* and *Manguifera indica*. Some species such as *Adansonia digitate, Piliostigma reticulatum, Saba senegalensis* and *Tamarindus indica* evolve into a sawtooth according to the study area. *Acacia nilotica* shows a constant evolution. However, *Acacia albida, Bombax costatum, Tamarindus indica* and *Vitellaria paradoxa* indicate a considerable decrease. Our results are supported by Wezel and Lykke (2006) who reports that many species have decreased in numbers compared to the past, some species that existed 20 or 30 years ago have disappeared at various locations of Sahel. Gonzalez, Tucker et al. (2012) also detected significant 1954–2002 tree density declines in the western Sahel of 18 ± 14% and 17 ± 13% and a significant 1960–2000 species richness declines of 21 ± 11% across the Sahel.

The decrease of forest species might be due to overexploitation of different organs of these species combined to climate and environmental stress (temperature, drought) in the study areas (suggestion of regression to identify the linkage association between different organ exploitation and trees extinction). The decline of tree species affects negatively rural household livelihood such as crop production, nutrition, fodder, firewood, medicine, construction, and income. To sustain the trees use, farmers are implementing tree management strategies. The main strategies include plantation, pruning and natural regeneration. Table 2 indicates the different tree management strategies according to tree species.

Tableau 2: Farm tree management

Tree species	Burkina	Mali	Niger
Acacia Albida	2	1.2	1.2
Acacia nilotica			
Acacia senegal			2
Adansonia digitata	2.3	1.2.3	
Anacardium occidentale		1.2.3	
Balanites aegyptiaca	1.2		2
Bombax costatum	2		
Diospyros mespiliformis	2		
Gierra senegalensis			2
Hyphaene thebaica			2.3
Lannea velutina	1.2	1.2	
Mangifera indica		1.2.3	
Parkia biglobosa		1.2.3	
Piliostigma reticulatum		1.2	1.2.3
Saba senegalensis	2	1.2	
Sclerocarya birrea	2		
Tamarindus indica	2	1.2.3	1
Vitellaria paradoxa	1.2	1.2.3	
Ziziphus Mauritiana			2

1= Pruning ; 2= Natural regeneration; 3= Plantation

The study results reveal that farmers are more implementing natural regeneration (53%) while very few are planting directly the trees (18%). This is supported by Faye, Weber et al. (2011) who found that very few of farmers plant trees. This is might be due to the availability and accessibility of plant species as well as the knowledge gap for tree plantation implementation.

Mali have the highest score of trees plantation (67%) compare to Burkina (11%) and Niger (22%) where farmers have more preference to natural regeneration. This might be due to the fact that in Niger and Burkina, many projects (Scap, Drydev ...) promoted the farm managed natural regeneration (RNA) strategy which is relatively less cost strategy and does not require much exertion (Key and Runsten 1999). The pruning is also practiced in combination with natural regeneration.

The objective this section is to understand farm tree species exploitation and dynamism in the study areas in order to better guide the management and development of these species for sustainable use. The study results reveal the socio-economic and environmental importance of different farm tree species as well as their contribution to improving household livelihood through the exploitation of different organs of trees. The most organ used include leaves, fruit, young branches and stems. These organs are mainly used for food, fodder, wood fire and medicine. However, forest species used in food are simply a dietary supplement but not a source of food for households. Farm trees exploitation also improves household income through the sale of edible forest products. The study also attempts at identifying key species endangered which are multi-purpose species used in many ways by the local population, underlines that the management of woody vegetation plays a crucial role. These species include *Acacia albida, Bombax costatum, Diospyros mespiliformis, Lannea velutina, Parkia biglobosa, Sclerocarya birrea* and *Vitellaria paradoxa*. Promoting natural regeneration shall benefit from sufficient tree production and development.

2.6 Households' socio-economic characteristics

2.7 Respondents' knowledge of climate change

3.3.1 Respondents' perception of climate risks

Perception is the key factor determining strategy implementation. How farmers perceive the risk they are exposed determine the coping strategy to implement to moderate the impact associated with the perceiving risk. This section reviews farmers' perception of the most relevant environmental risks. The results of this assessment are reported in Figure 5.

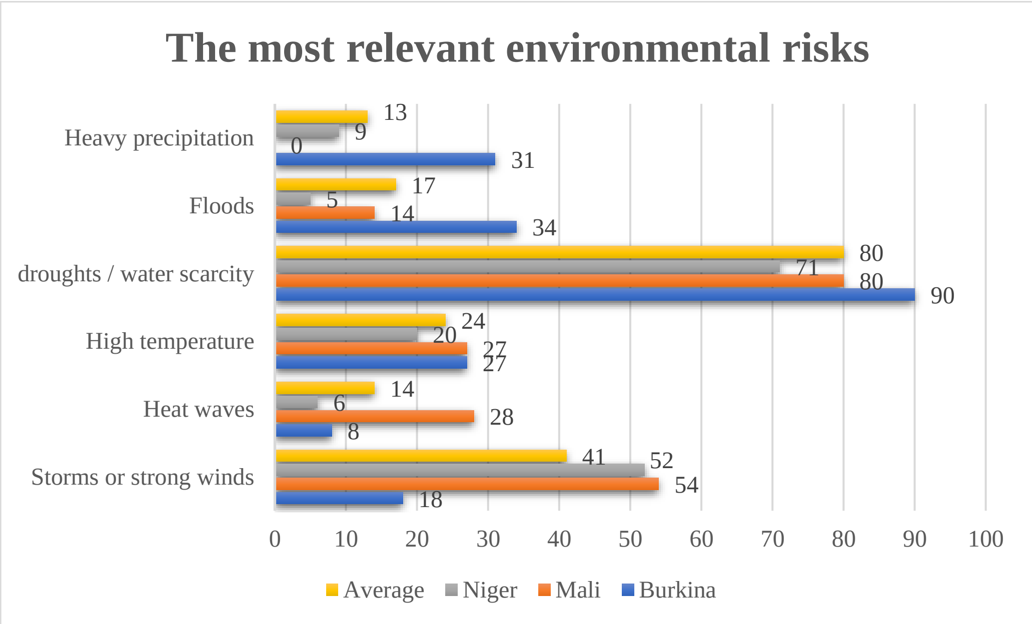

Figure 6: The most relevant environmental risks

Figure indicates farmers' perception of the most relevant environmental risks in the study area. The results reveal that drought (80%), storms or strong wind (41%), and high temperature (24%) are respectively the most relevant environmental risks that farmers are exposed. The spatial analysis of environmental risk perception shows a significant difference between the countries. In Burkina Faso, farmers perceived respectively drought (90%), flood (34%) and heavy precipitation (31%) as the most environmental risks while in Mali, drought (80%), heat wave (28%) and high temperature were perceived as the most environmental risks. In Niger, the farmers perceived respectively drought (71%), storms or strong winds (52%) and high temperature (20%) as the most environmental. Burkina Faso, records the highest score of risks perception except risks related to storms or strong wind and heat waves.

3.3.2 Respondents' perception of climate change impacts

The research examined how the respondents perceived climate change impacts on their livelihood, and particularly on crop production and revenue. Respondents were asked to indicate to what extent climate change affected their livelihood. The frequencies of responses are reported in Figure 6 and Table 3.

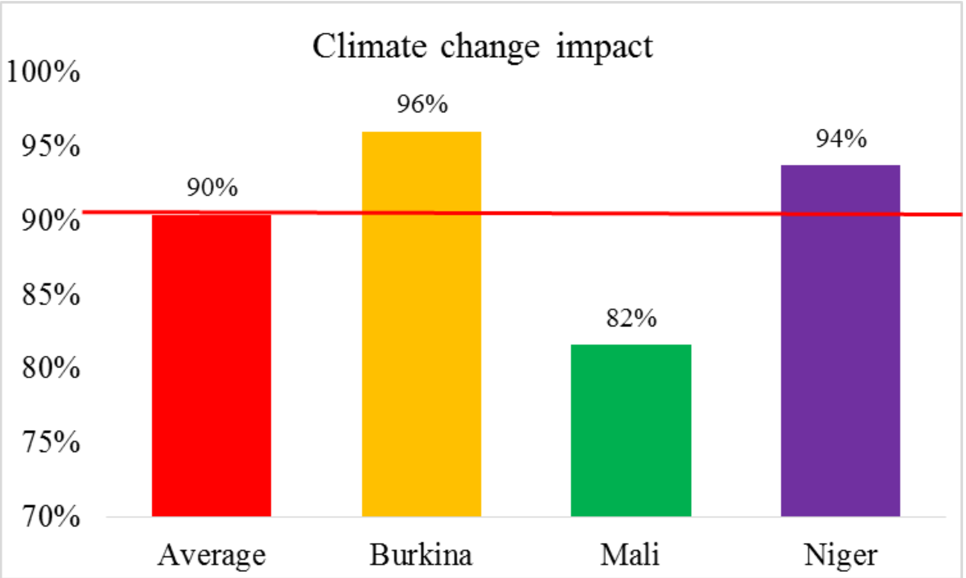

Figure 7: Climate change impacts

Tableau 3: Levels of Climate change impacts

Levels of impact	Burkina	Mali	Niger	Female	Male	Total
Positive		1.0%a		0.7%a		0.3%
None		11.4%b	6.3%b	9.2%a	2.9%b	5.9%
Low	0.5%a	10.9%b	36.6%c	19.3%a	13.2%b	16.2%
Bad	8.5%a	32.8%b	35.6%b	23.7%a	27.7%a	25.7%
Severe	67.5%a	36.8%b	21.0%c	36.9%a	46.0%b	41.6%
Very severe	23.5%a	7.0%b	0.5%c	10.2%a	10.3%a	10.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The respondents have different perceptions of climate change impacts. 90% of respondents reported negative impacts of climate change on their livelihood. Burkina Faso record the highest score (96%) of climate change impact. Likewise, Niger is above the average (94%). This might be due to the high rainfall variability on agriculture production. Ben Mohamed et al. (2002) estimated that by 2025, cereal production in Niger will decrease by 13% as a consequence of climate change. Nyuor et al. (2016) also reported also that climate (i.e. rainfall and temperature) variability significantly impacted household net revenue and cereal production.

The severity of climate change impacts differs across the country and farmers. The majority (42%) of respondents reported a severe level of negative impact. Most of the respondents reported negative impacts of climate change because of high climate variability, specifically rainfall variability, which is a feature of the study area. The findings of Seo and Mendelsohn (2007a, b) and Ringler et al. (2010) support our discussion by arguing that any significant change in climate variables (specifically temperature and rainfall) in combination with other socio-environmental changes (population density increased, vegetation decrease, droughts, and increased food demand) will negatively affect household livelihoods.

Surprisingly, very few of the respondents (1%) reported positive impacts of climate change on their livelihood. Additionally, few of the respondents (11%) perceived any impacts from climate change on their crop livelihood. Regarding the spatial perception of climate change impact, a majority of farmers from Burkina Faso (68%) and Mali (37%) perceived severe level of negative climate impact while the majority of farmers from Niger (37%) perceived low level of negative climate impact. This is may be due to the high dependency of farmers on the agriculture sector and or low capacity to withstand the changing climate impact.

The study seeks to determine the effect of respondents' socioeconomic characteristics on the levels of climate change. A linear regression model was used to assess the effect of selected variables on climate change impacts. Table 4 presents a summary of the results.

Tableau 4: Factors affecting the severity of climate change impacts

Modal	**B**	**Tolerance**	**VIF**
Beneficiary	-.222*	.810	1.235
Demographic	.163*	.892	1.122
Distance to market	-.163*	.859	1.164
Garden ownership	-.156***	.718	1.392

Gender	.067	.726	1.378
Farm size	-.008	.725	1.380
Fertilizer use	-.299***	.798	1.252
Livestock size	.069	.762	1.312
Improved seeds	.205*	.904	1.107
Extension service	-.142	.843	1.186
Modal characteristics	**R^2**	**Adjusted R^2**	
	.307	.220	

The results of the model test show that the associated *p* value for the overall model is equal to 0.000, the R-square value is 0.307, the percentages of tolerance are greater than 70 and all the VIP are below 2. These values indicate a good model fit for mixed data. We can therefore conclude that all the selected variables are a good fit and can significantly predict the factors affecting the farmers' level of climate change impact.

The results interpretation is based on regression coefficients. A positive sign implies that the higher value of the variables increases the probability of highly impacted by climate change, whereas a negative sign depicts a decrease in the probability of climate change impact.

The results from Table reveal that development project support (beneficiary), demography, distance to the market, garden ownership, fertilizers and improved seeds varieties use significantly affect the farmers' level of climate change impact.

The test reveals that demography has a positive and significant effect on the respondents' level of climate change impact. The number of household member increases the likelihood of affected by climate change by 16.3%.

Project support (beneficiary) negatively and significantly affects climate change impacts. The results of the regression analysis show that the support provided by projects decreases the likelihood of households to be affected by 22.2%. Households that are beneficiaries of project support are less likely to be affected by climate change impacts.

The study results reveal that the probability of being highly affected by climate change impact increases with a decrease of the distance. Table reveals that the distance from the household to market has a significant and negative association with climate change impacts. An increase in the distance of one km decreases the probability of households being severely affected by 16.3%.

Garden ownership is assumed to be an important factor in climate change impact buffering. The study reveals that garden ownership decrease the likelihood of households being affected by climate change impacts by 15.6%.

Table shows a significant and negative association between fertilizers use and level of climate change impact. Farmers who use fertilizers are 30% less likely to be severely affected by climate change impacts. This leads us to realize the importance of soil fertility in moderating the negative impact of mood alteration. Thus, the higher the soil fertility the lesser the probability to be severely affected by climate change negative impacts.

The use of new technology is also expected to reduce the exposure to climate change negative impacts. It was hypothesized that farmers who are using improved seed varieties will be less affected by climate change negative impacts because of the resistance of these varieties of different stress. However, the study results reveal that the use of improved seed varieties has a significant and positive effect on the severity of climate change negative impact. Farmers who adopt improved seed varieties technology are 18% more likely to be severely affected by the climate change negative impact. This might be because they do not actually use improved seeds. However, if they are actually using or intended to use improved seeds, they miss the cultural techniques or do not use the appropriate fertilizers to allow the seeds to well express their potential.

3.3.3 Respondents’ perception of the most affected crops of climate change

To understand how climate change affects the farmers’ livelihood, the study examines the impacts of climate change on crops and the growth stage at which the crops are affected. The results are reported in Figure 7.

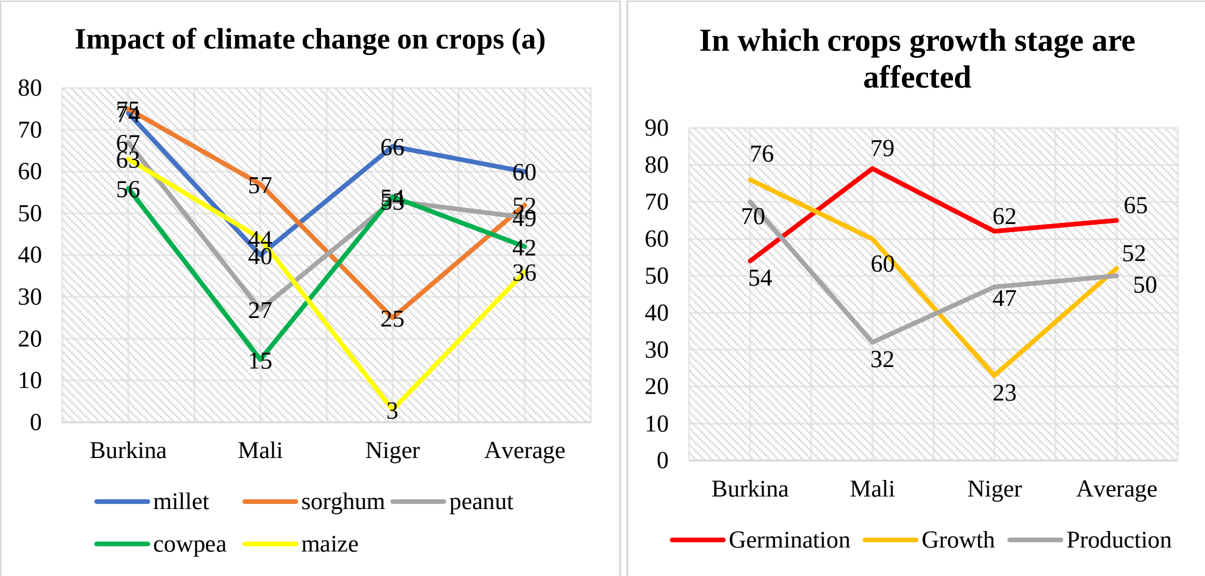

Figure 8: Climate change impacts on crops

Results of Figure show that in general cereal crops are the most affected by climate change negative impact, particularly millet (60%) and sorghum (52%) which are the main food crops in the study area. Maize crop indicates the lowest level of impact because it is cultivated by a few farmers, albeit it is mainly cropped in lowland (fertile and humid area) with a possibility of irrigation. Leguminous crops, particularly, peanut and cowpea indicate also a low level of sensitivity to climate change impact. However, depending of the country, the crops have not the same level of exposure to climate change negative impacts. In Burkina Faso, all the crops depict the highest level of sensitivity while in Niger, millet and peanut and cowpea indicate the lowest level of climate change impact sensitivity. Meanwhile, maize and sorghum record the lowest sensitivity in Mali. The difference between the countries might be due to the countries' ecosystem quality, climate variability and or farmers' capacity to cope with the climate change negative impact. Further analysis of climate change impact on crops reveal that the latter are mainly affected at germination, growth stage (65%) with a bit different regarding countries. Likewise, in Mali (79%) and Niger (62%) crops are generally affected at germination growth stage whereas it is at growth stage in Burkina Faso. In Mali and Niger crop might be affected by water stress mainly due to the repetitive long dry spell during crop germination growth stage. In fact, after the first rain and sowing, these countries experience repetitive dry spells leading to the loss of seedlings and or sowing not yet germinated. Often these crop losses result also from a combination of drought and parasitic attacks.

To reduce the negative impacts from a changing climate and to sustain rural household livelihoods, there is a need to strengthen the capacity of extension services to help farmers to implement appropriate strategies to respond to new climate demand and facilitate farmers' access to fertilizers and improved seed varieties resilient to biotic and abiotic stress.

3.3.4 Farmers' source of climate information

Availability and accessibility of information on climate change are assumed to be key determinants of the extent of farmer awareness, understanding and knowledge of climate change impacts (Ajayi 2014). This research therefore explored the different ways that farmers received information about climate change. The results are reported in Figure 8.

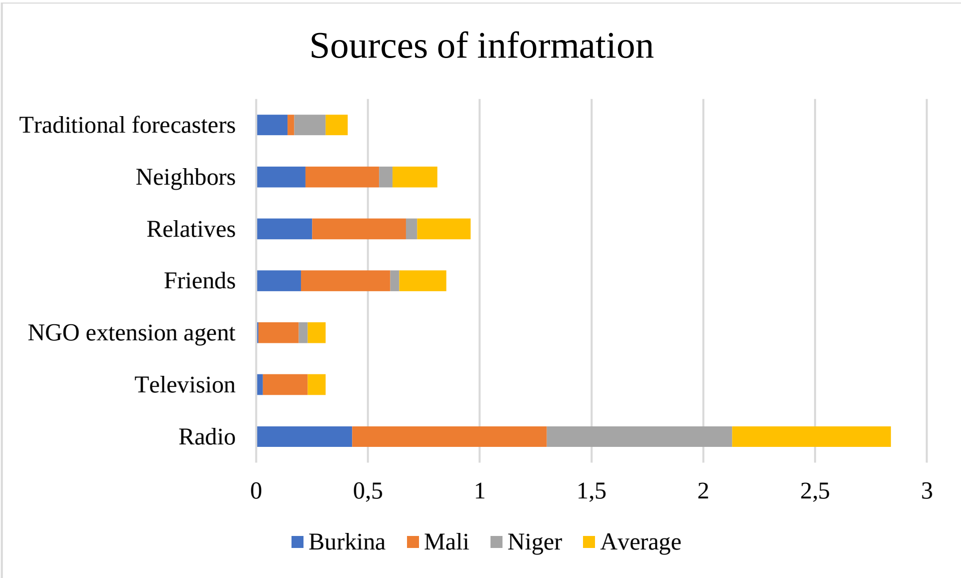

Figure 9:Sources of climate information

Figure reveals that the respondents received information about climate change mainly from the local radio station (71%). Other sources such as relatives (24%), friends (21%), Neighbors (21%), Traditional forecasters (10%) are also exploited. Televisions (8%), and extension services (8%) were far less important. The study underlined the absence of some sources of information such as newspapers and the internet. These results are in line with those obtained by Umar et al. (2013, 2016), who reported that in Katsina State of Nigeria, farmers mainly received information from relatives and friends. Similarly, Umar et al. (2013) reported that relatives were the main source of farmers' information (55%), followed by farmer cooperatives (35%), radio stations (25%) and extension services (20.83%). The study results indicate the lowest limited access to television and extension service in Burkina Faso and Niger likewise in Mali very few farmers explore traditional knowledge. Women rely more on their personal relationship, including friends and neighbors for the access to climate information.

The absence of some information sources such as newspapers and the internet in the study area might be due to the higher incidence of poverty and illiteracy, with majority of household heads having no formal education. The farmers preferred radio because the information is broadcast in the local language. The implication of these results is that information about climate change and associated impacts is very influential to the extent of community adaptation and local radio should be used as the main channel to broadcast adaptation messages in local languages.

3.3.5 Climate services used and needed

The study examines the different climate services used and needed by farmers. The results are reported in Figure 9.

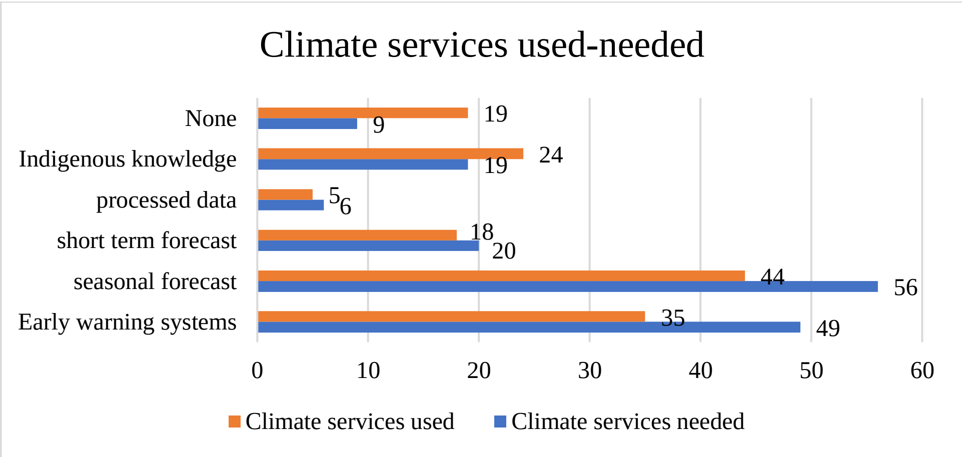

Figure 10: Climate services used-needed

The results of this study reveal that farmers are using a combination of climate services and the main types of climate information used by farmers include the seasonal forecast (44%), early warning (35%), short term forecast (20%) which are combined with their own local knowledge (19%). However, when farmers were asked about the different climate services needed, the majority (56%) responded seasonal forecast. 49, 20 and 19% of respondents also respectively desired early warning, short term forecast and indigenous knowledge. The reasons for choosing these types of services are various and dependable from farmers to farmers. Majority (49%) of respondents uses climate services for planning sowing activity during rainy season specially in Mali (56%) and Niger (50%). Moreover, climate services are used to take decision of certain strategies implementation such as the use and selection of improved seed varieties (35%), the use of compost (33%) and crop diversification (21%).

2.8 Agriculture strategies for abiotic and biotic stress

To anticipate climate change adaptation, households must first acknowledge that the climate is changing and perceive that this change poses risks to their well-being that warrant a response, whether it be proactive or reactive (Bryan et al. 2013). To address the adverse effects of climate change negative impact, the farmers have adopted various adaptation strategies based on both indigenous knowledge and strategies diffused by development institutes. Figure 10 shows the percentage of the most frequently adopted strategies in the study area.

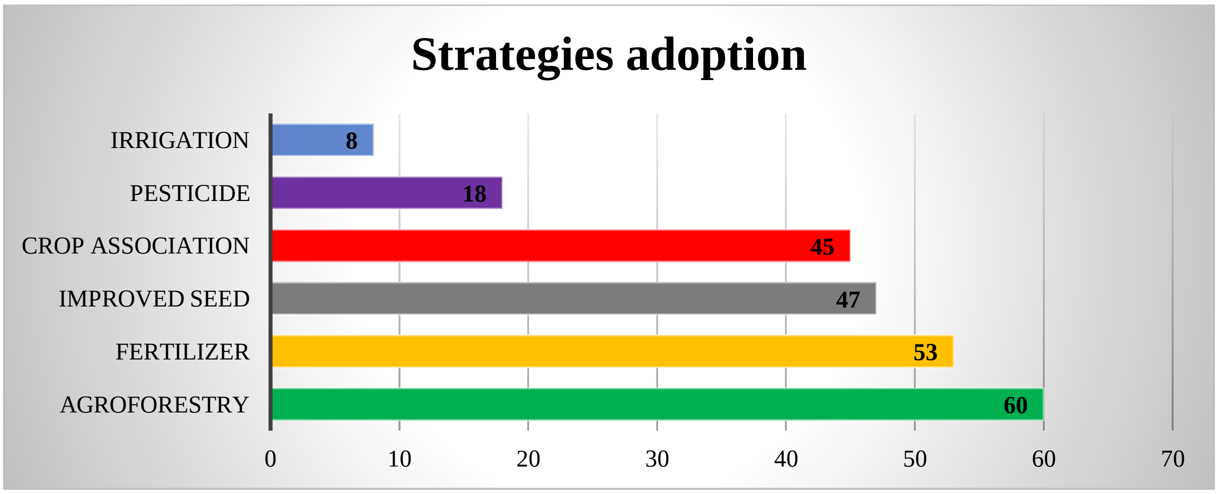

Figure 11: Strategies adoption

To address biotic and abiotic stress, farmers deploy a range of technical strategies which includes agroforestry (60%), use of fertilizer (53%), use of improved seed varieties (47%), crops association (45%), pest and parasite control (18%) and irrigation (8%). The strategy employed for biotic stress management includes mainly the use of pesticide. The abiotic stress management involves soil fertility management and risks adverse reduction which include agroforestry, use of fertilizer, use of improved seed varieties, crop association and diversification, and irrigation. A brief description of how these practices are deployed is provided in the below section.

3.4.1 Agroforestry

According to ICRAF (2017), Agroforestry is the practice and science of the interface and interactions between agriculture and forestry, involving farmers, livestock, trees and forests at multiple scales. Agroforestry involves a wide range of trees that are protected, regenerated, planted or managed in agricultural landscapes as they interact with annual crops, livestock, wildlife and humans. Agroforestry is adopted by 60% of the respondents and trees are respectively used for human food (64%), soil property improvement (57%), fuel wood (32%), animals' food (24%) and timber (21%). In Burkina Faso and Mali, the majority of respondents (respectively 81 and 69%) grows trees for food consumption while in Niger the majority (59%) grows trees for improving soil properties. Leaves and roots are the most part of trees exploited by the majority of respondents (53%). Fruits (43%) and nuts or seeds (24%) are also exploited for different domestic use. Despite this, very few of the farmers (18%) planted trees as a means of mitigating climate risks. This might be due to the limited availability of suitable trees for planting and their high cost when they are accessible. Adoption of most of the strategies is heavily dependent on their being low-cost and their perceived usefulness. Majority of the farmers (53%) preserve trees from natural regeneration through what is known as Farmers' managed Natural Regeneration (FMNR). The most dominant species preserved or planted are: Faidherbia albida, Vitellaria paradoxa, Tamarindus indica, Adansonia digitata, Piliostigma reticulatum and Balanites aegyptiaca.

3.4.2 Fertilizers use

Farmers have shown more preference for urea (41%), NPK (30%) and DAP (13%) which applied to millet, maize, cotton, groundnut and sorghum. Regarding to spatial preference, Majority of farmers from Mali (68%) and Niger (34%) show more preference for urea whereas in Burkina Faso NPK is the most adopted by the majority (45%). The results indicate that Mali records the highest rate of fertilizers adoption (70%) while Niger has the lowest score (39%). About half of the respondents (52%) in Burkina adopts mineral fertilizers.

3.4.3 Improved seed varieties use

The results of the survey revealed that on average 47% of the respondent are using improved seed varieties with Niger recording the highest percentage of adoption (53%) while Mali records the lowest percentage (42%). The inferential analysis reveals a significant difference of the adoption of improved seed varieties between Niger and the two other countries. The most improved seed varieties used by farmers include those of millet (53%), cowpea (51%), sorghum (46%) and groundnut (43%). About 39% of improved seed varieties are purchased from farmers specialized in producing improved seeds because of the trust in them. However, others few sources are also explored to access to improved seed varieties which include others (21%), subsidy from NGO/Project (14%), donation from NGO/Project (13%), and extension (8%) while government source records the lowest percentage of 1%.

The low rate of improved seed adoption might be due to farmers' unawareness of the performance of improved seed varieties and or a lack of access to fertilizer. Many of the farmers reported that there are not using improved seed varieties because its huge requirement of fertilizer. Likewise, some of the respondents stated that the unavailability of improved seed varieties at the right moment (first rain) limited its adoption, they usually received improved seed varieties very late (especially from government) when their crops reached a certain stage of growth. Notwithstanding, there is evidence that during crops' development growth stage, improved seed varieties require fertilizer, and at this period, majority of farmers have limited access (economic access or unavailability) to fertilizer because of low economic capacity or even the fertilizer availability. Furthermore, the adoption of improved seed varieties requires a good knowledge of its potential. However, the hypothesis of farmers' awareness of improved seed potential is doubtful because most of the seeds that are presented to the farmers do not present any descriptive leaflet of the seeds. Therefore, improving the farmers' level of awareness of the improved seed's potential may also boost its' adoption. Comminatory radio available at villages may serve as baseline to do so.

3.4.4 Crop association and diversification

This technique was considered important to help reduce the risk of harvest losses due to prolonged dry periods or pests and diseases. Despite, under half (45%) of the respondents adopt this strategy. The results show a significant difference this strategy adoption (p=0.000) between the countries. 88% of Farmers from Niger implements this strategy while only 7% of farmers from Mali associate crops in the same production unit. In Burkina Faso nearly 40% adopts this strategy. Mali who records the lowest rate of adoption has the lowest number of years' experience in crops association practices (4.5 year). When respondents were asked about the reason of crops association, the responses are insufficient of land (38%), don't know (19%), to improve crop productivity (17%), to reduce risk adverse (11%), crop diversification (7%), tradition (4%), soil fertility improvement (4%). The main crop associations according to the farmers are respectively millet-cowpea (25%), sorghum-cowpea (22%), and millet-groundnut (22%). The legumes are sowed between the cereal lines (41%) or the seeds of the two crops in the same sowing pit. However, most of the farmers (70%) cultivate either the cereals or legumes in pure and rotate them: a year of cereal is followed by a year of legume. Nonetheless, the reasons of crops association and how farmers perceive the impact of this agriculture practice are dependable. The study examines these two parameters (reasons and perception) and the results are summarized in figure 11.

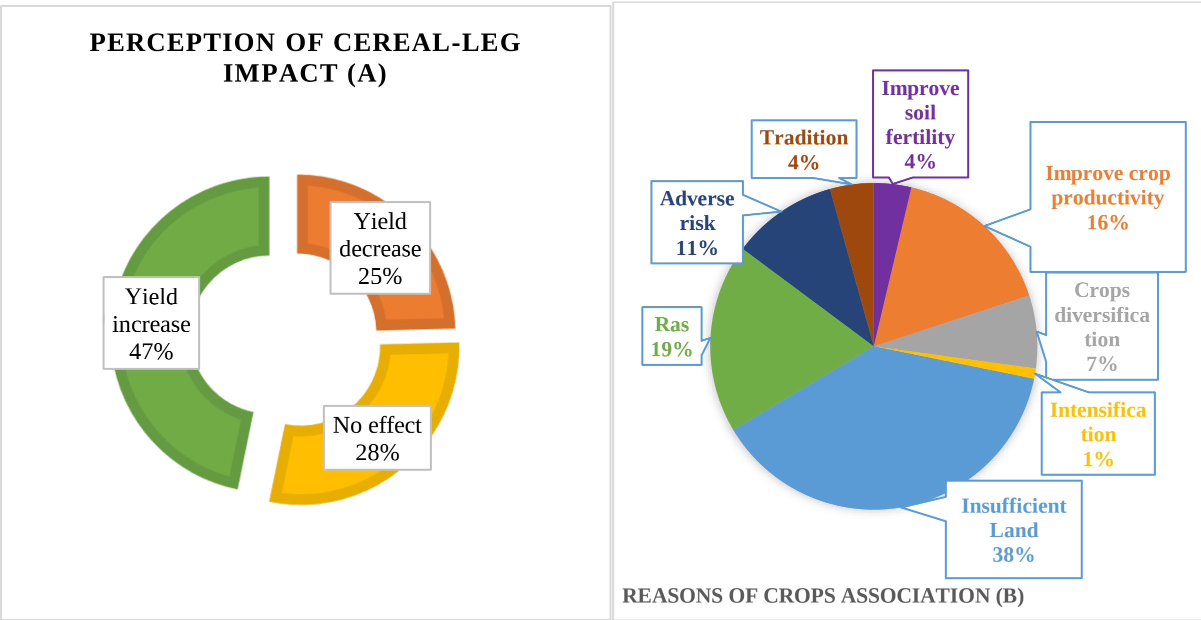

Figure 12: Perception of cereal-leguminous association

Regarding the farmers' perception of cereal-leguminous association, 47% of respondents perceive an increase of crop yield, 29% notes any effect on crop yield, and 24% think that the association decrease crops yield. The study reveals that the majority of farmers (38%) are associating crops because of land insufficiency. However, some farmers (7%) are associating crops to diversify their production while 11% of them are conducting this practice to reduce risk adverse. About 16% of farmers are associating crops to improve the crop productivity and very few (4%) to improve soil fertility. The main implication of this finding, the level of farmers' awareness of the impact of crops association need to be improve.

3.4.5 Pest and parasites control

Pests and diseases which require control were reported to be those of cotton, cowpea, and maize. Further, 20 and 8% of farmers are respectively, using chemical products and traditional treatment (ash, leaves…) to prevent from post-harvest pest and parasite attacks.

3.4.6 Irrigation

Irrigation is very little developed in the study area. It's more practiced in Mali (15%) and almost not used in Burkina Faso (3%). The irrigation method remains carrying water.

3.4.7 Factors determining strategies adoption

Logistic regression was run to determine the effect of farmers' socioeconomic characteristics on the decision to adopt specific strategy. The results of the logistic regression show that the choice of independent variables correctly predicted respondents' adoption of adaptation measure condition ranged from 70 and 90% of the total observations. The Cox & Snell R Square ranged from 17% to 33%. These values suggest an acceptable model fit for cross-sectional data. Therefore, we can conclude that all the selected variables are of good fit to significantly predict the factors affecting the adoption of the different adaptation strategies. Table 5 summarizes the statistical outcomes of the logistic regression of the factors affecting strategy adoption.

Tableau 5: Factors affecting the adoption of strategies

Variables	Agroforestry	Crop association	Fertilizer	Improved seed	Irrigation	Pest control
Beneficiary	0.028	0.191***	-0.007	0.072	0.013	0.139***
Gender	0.356***	0.023	0.301***	0.154*	-0.216***	0.093*
Demographic	0.053	0.25***	-0.077	0.038	-0.144*	-0.016
Farm size	0.055	-0.225***	0.037	-0.061	0.088	0.211***
Garden ownership	-0.038	0.161***	-0.044	0.035	0.323***	0.009
Extension service	0.046	0.053	0.116*	0.199***	0.036	0.116***
HH education	0.042	0.12*		0.187***	0.047	0.03
Agriculture training	0.166**	0.179***	0.146***	0.234***	-0.052	-0.166***
Distance to market	-0.039	0.01	0.061	0.06	0.025	-0.104**
Crop productivity	0.147*	-0.022	0.22***	-0.11*	0.156*	0.18***
Livestock size	0.02	-0.072	0.132*	0.1	-0.004	

Interpretation of the results is based on the regression coefficient (β). For continuous variables, a positive coefficient implies an increase in the likelihood of strategy adoption for every unit increase in the predictor variable, whereas a negative coefficient depicts the opposite relationship.

Agroforestry is employed by farmers to improve soil quality, crops and livestock productivity, and food availability. The adoption of this strategy is significantly and positively associated with gender, training on agriculture technics (cereal-leguminous association), and crop production. Women are 36% less likely to apply agroforestry. Nonetheless, training on agriculture training increase the likelihood of agroforestry adoption by 17%. The results reveal also that crop production increase the likelihood of agroforestry adoption. The adoption of agroforestry increases the crop production by about 15%. This is because of the multiple benefit of trees on crop development which are soil property improvement, decreasing of temperature intensity.

Crop association and diversification is expected to reduce risk related to yield decrease and or crop loss. The study results reveal that project intervention (beneficiary), demography, farm size, garden ownership, and access to agriculture training significantly influence the adoption of crops association. Farmers who beneficiary development project intervention are 19% more likely to adopt crop association strategy. Likewise, demography increases the likelihood of crop association adoption. The larger the household the greater the chance to associate crop in the same unit. One person increase in the household increases the likelihood of the adoption by 25%. However, the results show that farmers with small farming land are more likely to adopt this strategy of crop association and diversification, one hectare increase of land size decreases the likelihood of crop association by 23%. Garden ownership increases also the likelihood of crop association. This is in relation to their land size. In general, garden owners hold a small farm and the main reason for crops association that farmers stated is the insufficiency of cropping land. Education and access to agriculture training are capacity building which is expected to improve farmers' capacity to implement efficiency agriculture practices. The results show that education and access to agriculture training increase the adoption of crops association respectively by 12 and 18%.

Zhong et al. (2010) reported that organic manure plus balanced fertilization with N, P and K has a significant positive effect on soil microbial biomass, diversity and activity and thus enhances crop growth and production. The study results reveal that the use of mineral fertilizers is significantly influenced by gender, access to extension services and agriculture training, crop production and livestock size. Women are 30% less likely to use fertilizes to improve crop production. Extension services and agriculture training as a bridge for capacity building are assumed to facilitate the adoption of new technologies. The results reveal that access to extension services and agriculture training positively influence the use of mineral fertilizers. This might be due by the fact that extension services facilitate the access to mineral fertilizer. The results show that farmers with high crop production and greater livestock size are respectively 22 and 13% more likely to use mineral fertilizers. This is because crop production and livestock are liquid asset that can be easily converted or exchanged to mineral fertilizer.

The regression analysis test reveals that agriculture training access, education, access to extension services, crop production and gender have a positive and significant association with the adoption of improved seed varieties. Farmer with higher education level is 17% more likely to adopt improve seed varieties. Likewise, having access to agriculture training and extension service, increase the likelihood of the adoption of improved seed varieties respectively by 23 and 20%. Surprisingly, crop production indicates a significant and negative association with improved seed varieties. The use of improved seed varieties decreases the crop production by 11%. This might be because they do not actually use improved seeds. However, if they are actually using or intended to use improved seeds, they miss the cultural techniques or do not use the appropriate fertilizers to allow the seeds to well express their potential. This result supports the one obtained at 3.3.2 section.

Irrigation strategy is very little implemented in the study area to cope with water stress. Notwithstanding, the regression results reveal that garden ownership and crop production influence significantly and positively irrigation implementation. The farmers owning garden is the most likely to use irrigation strategy.

Pest and disease control is also implemented by very few farmers (18%) to cope with biotic stress. However, the results reveal that project support, gender, farm size, access to extension services and agriculture training, distance to the market, crop production and livestock size have a significant association with the use of pesticides.

3.4.8 The impacts of different strategies on crop yield

The different strategies implemented by famers may play an important role in moderating the level of climate change impact and improving crops production. Linear regression was performed to identify the influence of different strategies on crops production and level of climate change impact. Results from the test are summarized in Table 6.

Tableau 6forIcropnce of strategies on crops production and climate change impacts

Strategies	Production	Level of impact
Agroforestry	0.195***	0.220***
Fertilizer	0.216***	-0.017
Pest control	0.157***	-0.072
Irrigation	-0.047	-0.175***
Cereal-legume	0.063	-0.059
Improved seeds	0.049	0.021
R2	0.19	0.09

Adjusted R	0.18	0.07
Model Sig	.000	.000

The regression results reveal that crops production is positively and significantly influenced by agroforestry practice, the use of mineral fertilizer, and pest control. Mineral fertilizer use indicates the highest influence on crop production. Farmers who use mineral fertilizers are more likely to increase their production. One kilogram increase of fertilizer increases the crop production by 22 kilograms. Likewise, farmers who use agroforestry practice and pest control are more likely to increase their production respectively by 20 and 16%.

The different strategies implemented are expected to reduce the farmers' level of exposure to climate change negative impact. The study results reveal that agroforestry practice and irrigation are the strategies which have significant effect on climate change impact. Agroforestry depicts the highest effect on climate change impact. Farmers who are severely impacted are more likely to resort to agroforestry. The study results show that agroforestry enable farmers to moderate the level of climate change negative impact by 22%. Similarly, irrigation practice also decreases the level of climate change by 18%.

2.9 Respondents food and nutrition security analysis

Food security is one of the major challenges the World has been fighting for long. The food security study provides an excellent platform for tracking the social system evolution, because it provides a framework for the analysis, measurement, and implementation of an effective adaptation mechanism to shocks and constraints in the short, medium, and long term (Amaza et al. 2006). Grain Legumes and Dryland Cereals Agri-food Systems (GLDC), a CGIAR research program is seeking to increase productivity, profitability, resilience and marketability of critical and nutritious grain legume and cereal. While promoting innovations for improving the yield of grain legumes and cereal as an important component of the agricultural system, there is a need to determine the contribution of the products in household food consumption one of the four dimensions of food security including food availability, accessibility, utilization and stability (van Dijk, 2012).

3.5.1 Period of food availability

The study analyzes the availability of food over the year. The results are reported in Figure

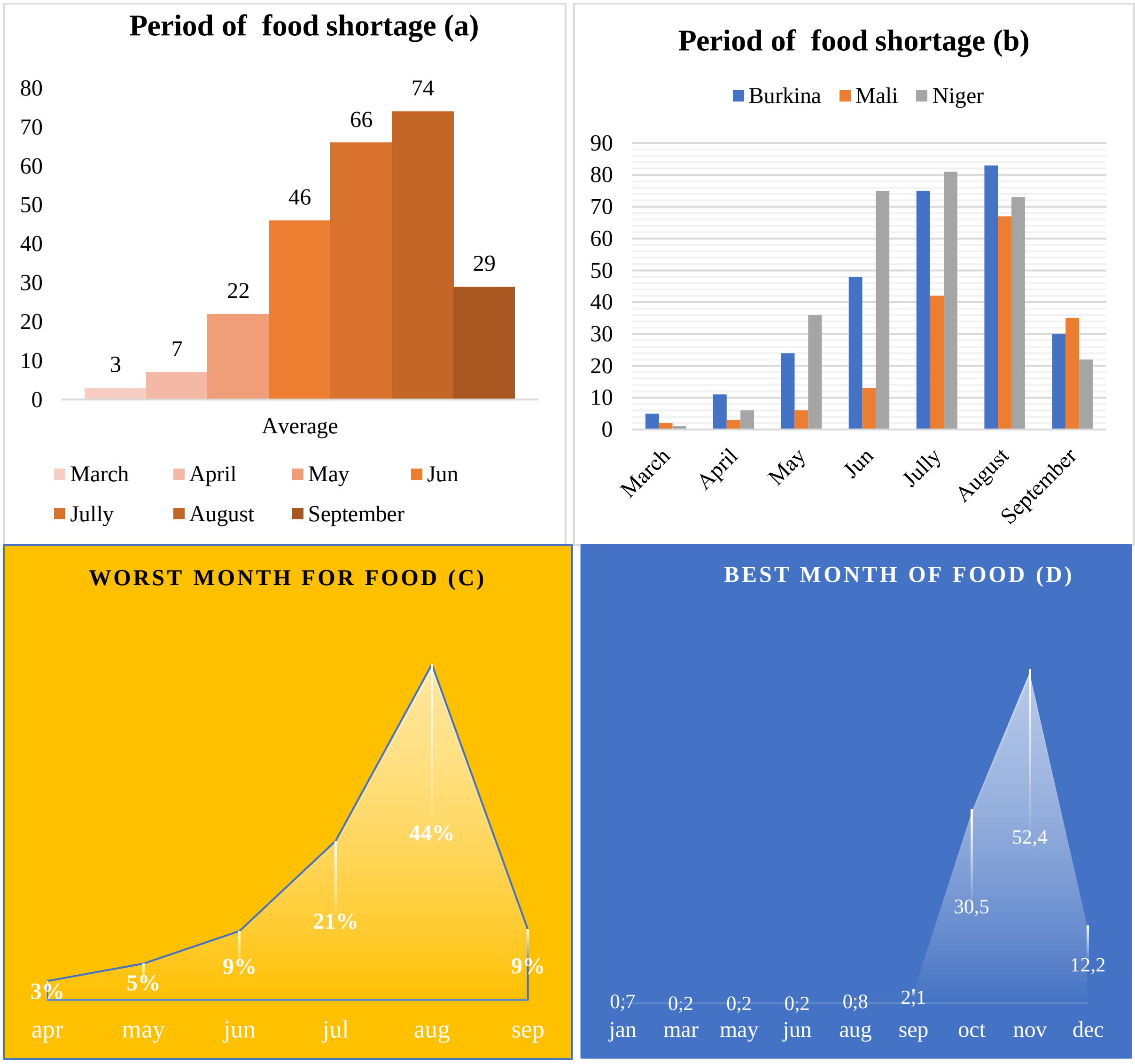

Figure 13: Periods of Food availability

Figure shows the frequencies of farmers responses when they were invited to indicate the tough of food shortage during the year. The study reveals that the precarious food months are respectively June (46%), July (66%) and August (74%). The spatial mapping of food shortage period shows that the majority of respondents from Burkina Faso (83%) and Mali (67%) choice August being a tough period of food shortage while in Niger most respondents (81%) indicate July. Therefore, the food shortage period can be considered from early June to end of August. This is because at this period, farmers sowed the remaining food they had, and the crops are not yet at its maturity. The harvest mainly started from September, that's why the percentage of responses significantly decreases at this month, but about 29% of respondents did not harvest. Figure indicates that the August (44%) is the worst month of food shortage while most of the respondents (52.4%) chooses November as the best month of food availability. According to gender, there is no significant difference between men and women regarding the period of food shortage and food availability, however, according to countries, the majority of respondents from Niger (44%) selected July as the worst month while in Burkina Faso and Mali respectively 45 and 61% chose August as the worst month. Similarly, regarding the best month of food availability, majority from Niger (65%) chose October as the best month of food availability, whereas it is November in Burkina Faso (64%) and Mali (65%). The difference between the countries might be understood if we admit that food availability is dependent to rainy season and the later does not occur at the same time in the different countries. The rainy season starts month later in Burkina Faso and Mali compare to Niger.

3.5.2 Dietary diversity scores

The study seeks at analyzing the respondents' dietary diversity scores. The scores from 0 to 3, with 0 = never eaten, 1 = monthly eaten, 2 = weekly eaten, and 3 daily eaten. The results are reported in Figure 13.

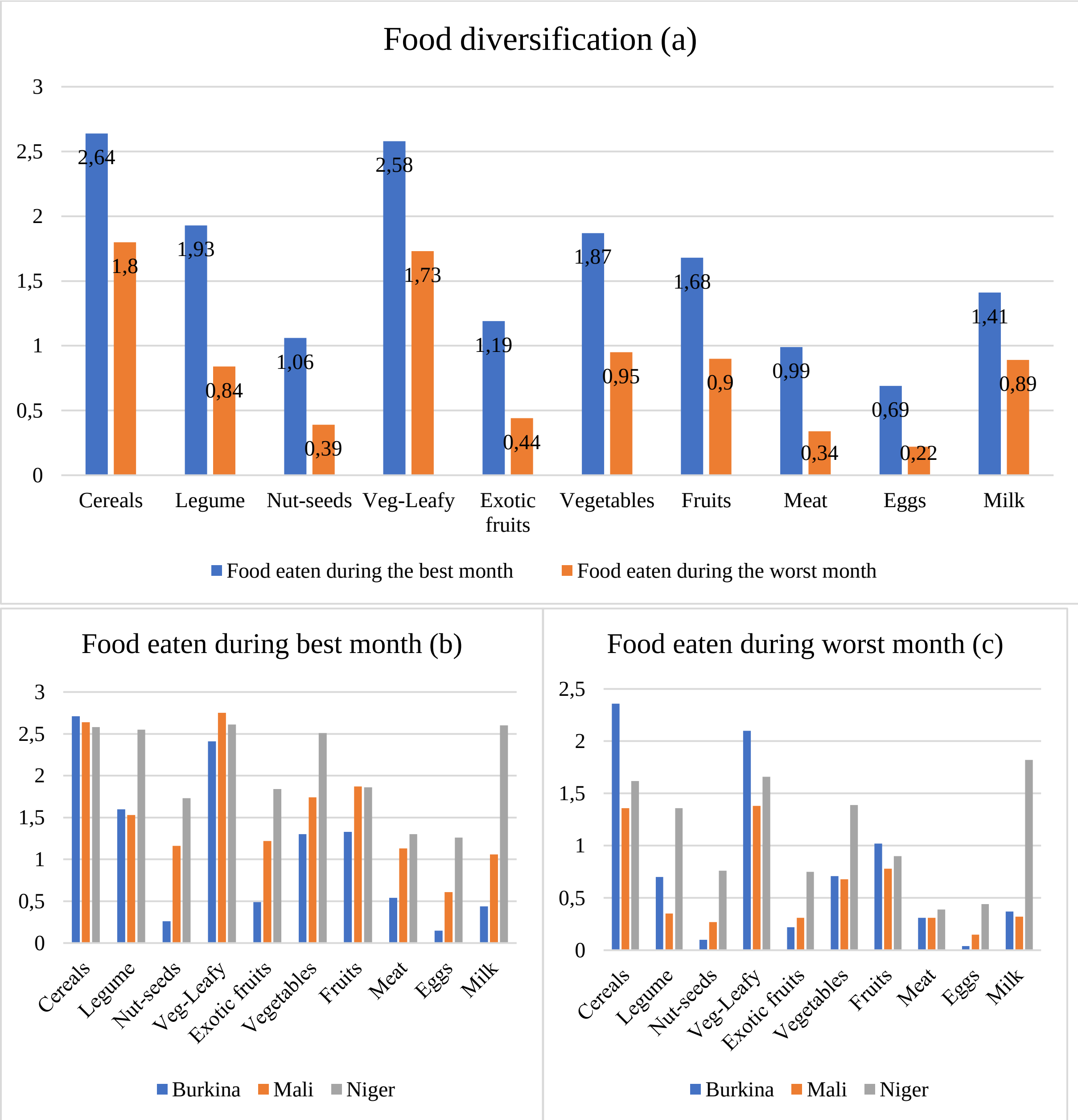

Figure 14: Dietary diversity

The study results show that respondents food consumption is mainly based on cereals including millet and sorghum. However, depending on the period and food availability farmers are diversifying their consumption. The frequency of different food group consumption differs also according to the country. Notwithstanding, the study results reveal that there is no significant difference between women and men in terms of dietary diversity. During the best period of food availability, the study shows that cereals (millet, sorghum, maize, rice) are consumed almost every day (2.64 over 3) with leafy vegetables (leaves of moringa, adonsonia, others) scoring 2.58 while legumes including beans, peas, lentils (1.93) and fruits (1.58) are eaten less than once a month. Tree leafy vegetable is also consumed, especially in Mali (scoring the highest score of 2.75) where the consumption is done almost daily. Animal food, including meat (0.99), eggs (0.69) and milk (1.41) is rarely consumed, less than (once a month) except Niger where milk (2.6) is consumed almost every day. Burkina Faso is where the consumption rate of fruit (1.33), vegetables (1.33) and animal products (meat, eggs, and milk) is the lowest compared to Mali (1.87 for fruits and 1.74 for vegetables) and Niger (1.86 for fruits and 2.51 for vegetables). During the worst period of food shortage, food consumption decreases for all the food groups in the three countries. This is unsurprisingly due to the food availability. However, legumes (1.36), tree leaves (1.66) and milk (1.82) consumption remains higher in Niger. Regarding trees leaves, there is evidence that when the main food is scarce, the population tends to increase the consumption of wild products (often not use during the period of food abundance) while milk is mostly associated with Fura (Nigeriens main food in rural area) justifying its high score in Niger. Further, many of the nutritionally valuable trees like Moringa have been promoted in Niger by development projects. In Burkina Faso during the worst period of food, some group of food, including, nut-seeds, exotic fruits, and eggs are not used. This might be due to the accessibility and or availability of these products during the worst period.

The main implication of these findings is that development projects targeting food insecure households may improve food availability during the worst period to help households to smooth nutritional transition worst period to best period through the promotion of trees with nutritional and market value whose production period coincides with the lean season.

3.5.3 Food sources

The study explores the different sources from which rural households are getting food according to the period. The results of this study are reported in Figure 14.

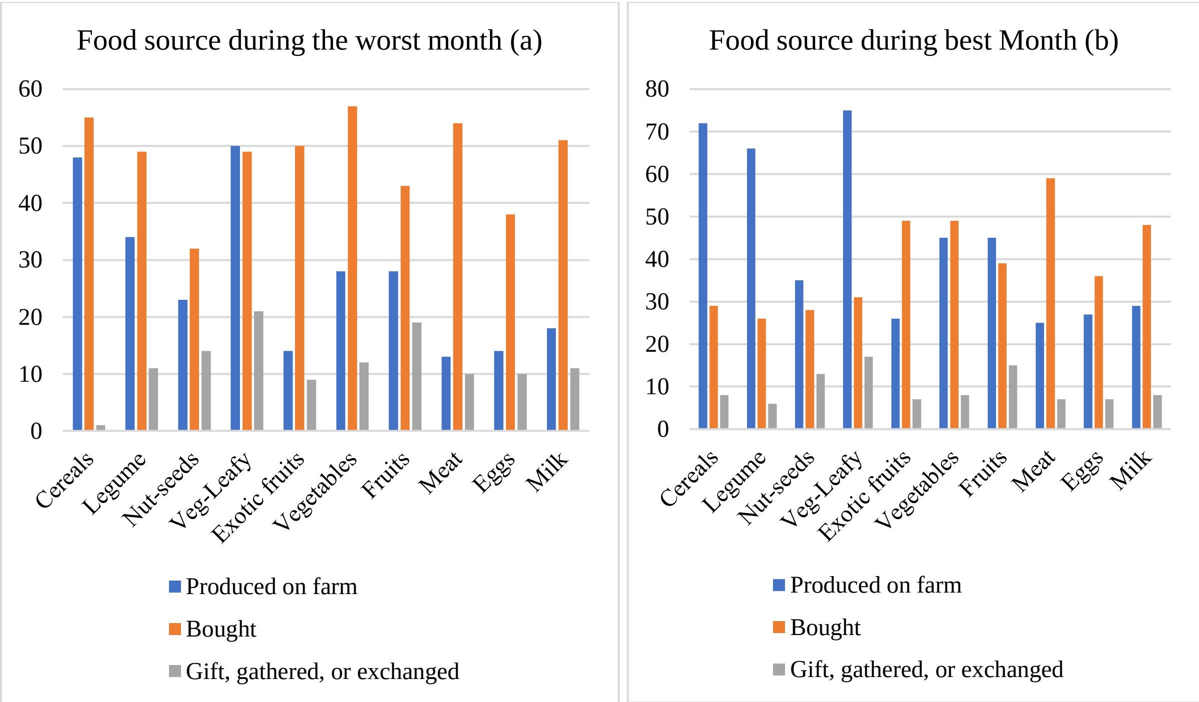

Figure 15: Food sources

The main sources of food are farm (produced on the farm), market (bought) and forest or social network (gift, gathered, or exchanged). A household mainly explore at the same period all the sources to assure food consumption (that's why the sum of the percentage is higher than 100). However, the main farmers' food source is dominated by the farm production. Nevertheless, the respondents' food sources depend according to the period. During the worst month, the majority of respondents are getting food from the market (example: 55% of respondents are getting cereal whereas 48% still use the cereal produced on the farm) except for the vegetable leafy group. This confirms our evidence at 3.5.3 by stating that when the main food is scarce, the population tends to increase the consumption of wild products. During the good period, most of the respondents rely on their own farm production regarding the main food while they still explore the market for food group, including [exotic fruits (49%), vegetables (49%), meat (59%), eggs (36%) and milk (48%)]. The study reveals that during the best period, respondents significantly reduce their accessibility to the market for all the groups of food.

3.5.4 Different crops production utilization

Respondents crop production use was also assessed using the six points Likert Scale None, little, under-half, half, most and all. The results of this assessment are reported in Figure 15

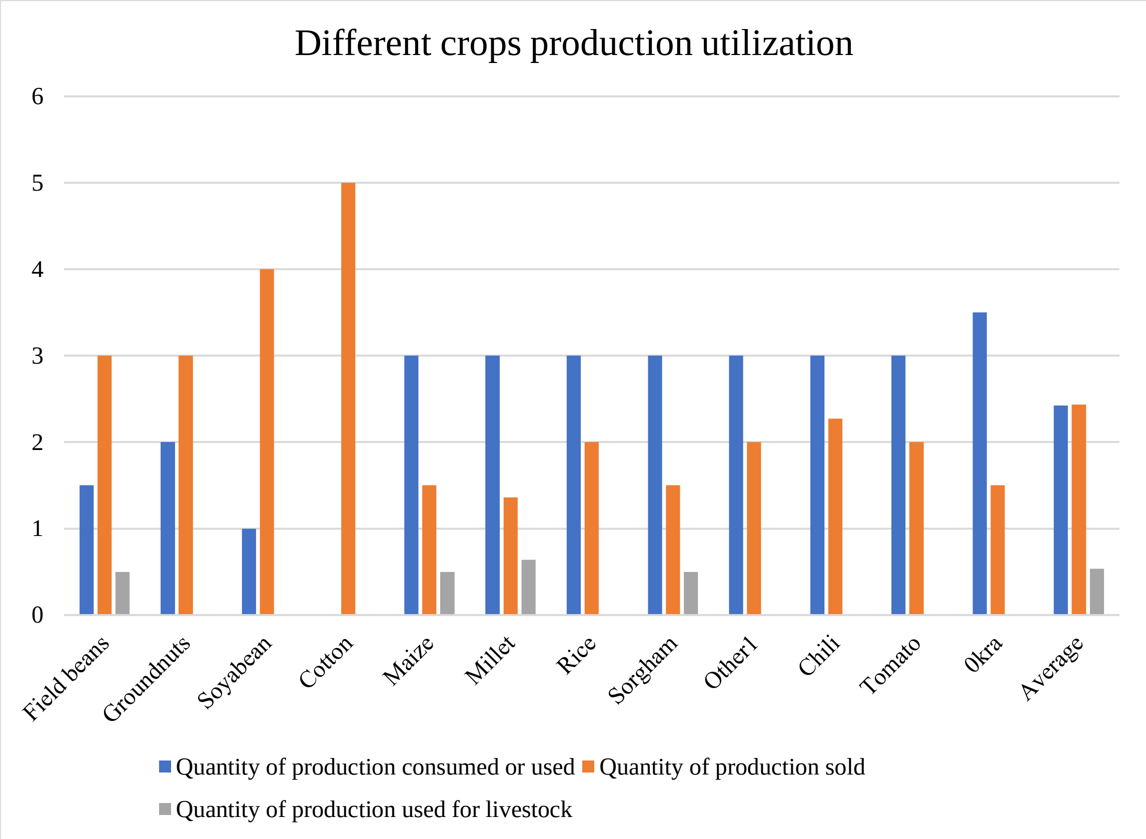

Figure Erreur ! Signet non défini.**: Different crops production utilization**

The results also revealed that farmers in the Sahel produce a large variety of crops including cereals (sorghum, millet, maize, and rice), legumes (cowpea, soybean, peanut) and other cash crop such as cotton, chili, tomato, etc. However, the quantity of cereals consumed (3/5) is higher than the quantity sold (1/5) while the quantity of legume sold (3.3/5) is higher than the quantity consumed (1.5/5).

3.5.5 Households' strategies food shortage

To cope with food shortage, the farmers diversify their food sources which mainly include the use of wild food (60%), head keeping, and small business (48%).

- **Wild food collection**

Wild food collection strategy intends to improve the households' food security status by providing substitutional food, thus sustain the consumption of the main food to facilitate the lean season transition. Figure 17 shows the period of wild food gathering, and its contribution to rural household nutrition.

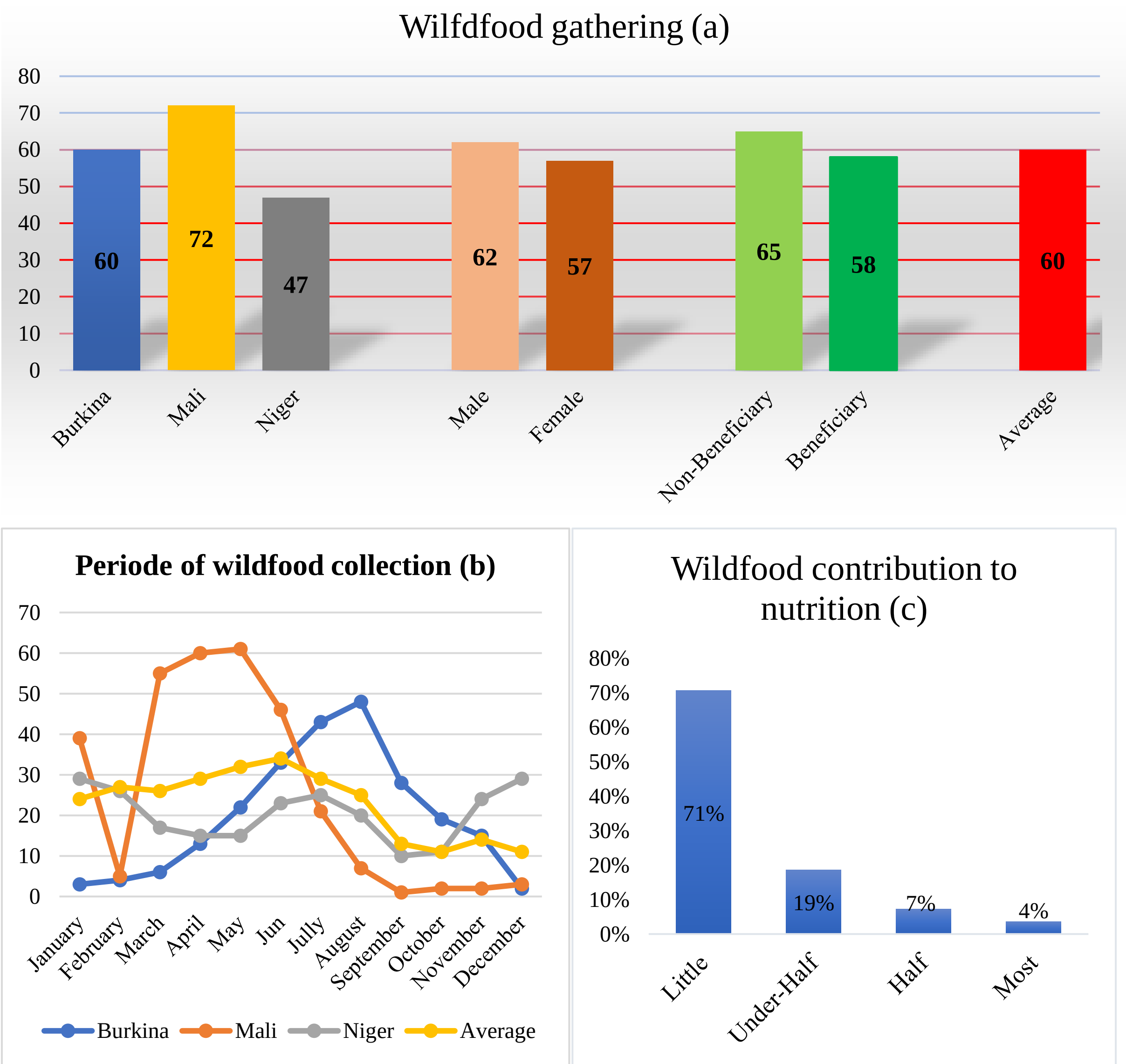

Figure 16: Wildfood collection and contribution to livelihood

Leafy vegetable (53%), fruits and nuts (43%) are the most food collected from trees growing in the parklands and other woodlands. The most important tree species cited by the respondents include *Faidherbia albida (51), Vitellaria paradoxa (46), Tamarindus indica (43), Adansonia digitate (38), Piliostigma reticulatum (31)* and *Balanites aegyptiaca (28).* Thirteen species out of 19 listed produce fruit or vegetable for human nutrition. This is also shown on the characteristic showing food as the most important product followed by fuelwood, timber animal food. *Mangifera indica* and *Anacardium occidentale* are the only exotic species noted par the respondents.

The study reveals that more men (62 %) are gathering wild food than women (57 %). Further, farmers who do not benefit from project support are more collected wild food (65%) comparable to those who benefit from projects support (58%). Wild food gathering also differs among countries. About 72%, 60% and 47% of the respondents are gathering wild food respectively in Mali, Burkina Faso and Niger. Dietary habits and availability of major foods have a significant influence on the wild food collection.

The study focusses on determining the period of wild food collection and it is shown that the period of wild food gathering extends from January to July, except in Niger. While the wild food collection increases in Burkina Faso and Mali, it decreases Niger. Respondents from Burkina Faso and Niger are more wild food during the lean season (May, June, July) while during the same period percentage of respondents from Mali collecting wild food decreases. During the best period of food availability (September to December), respondents mainly decrease the use of wild food except in Niger. This may be a strategy to anticipate food shortage stress during the lean season.

Respondents were asked to indicate their perception of the wild food contribution to their nutrition on a four-point Likert scale little, under-half, half and most. 71 and 19% of farmers indicate that wild food contributes respectively a little and under-half of their nutrition. Very few (4%) reports that most of their food come from the wild food collection.

- **Off-farm activities**

The study also focusses on the analysis of off-farm activities importance on farmers' livelihood. The results reported in Figure 17.

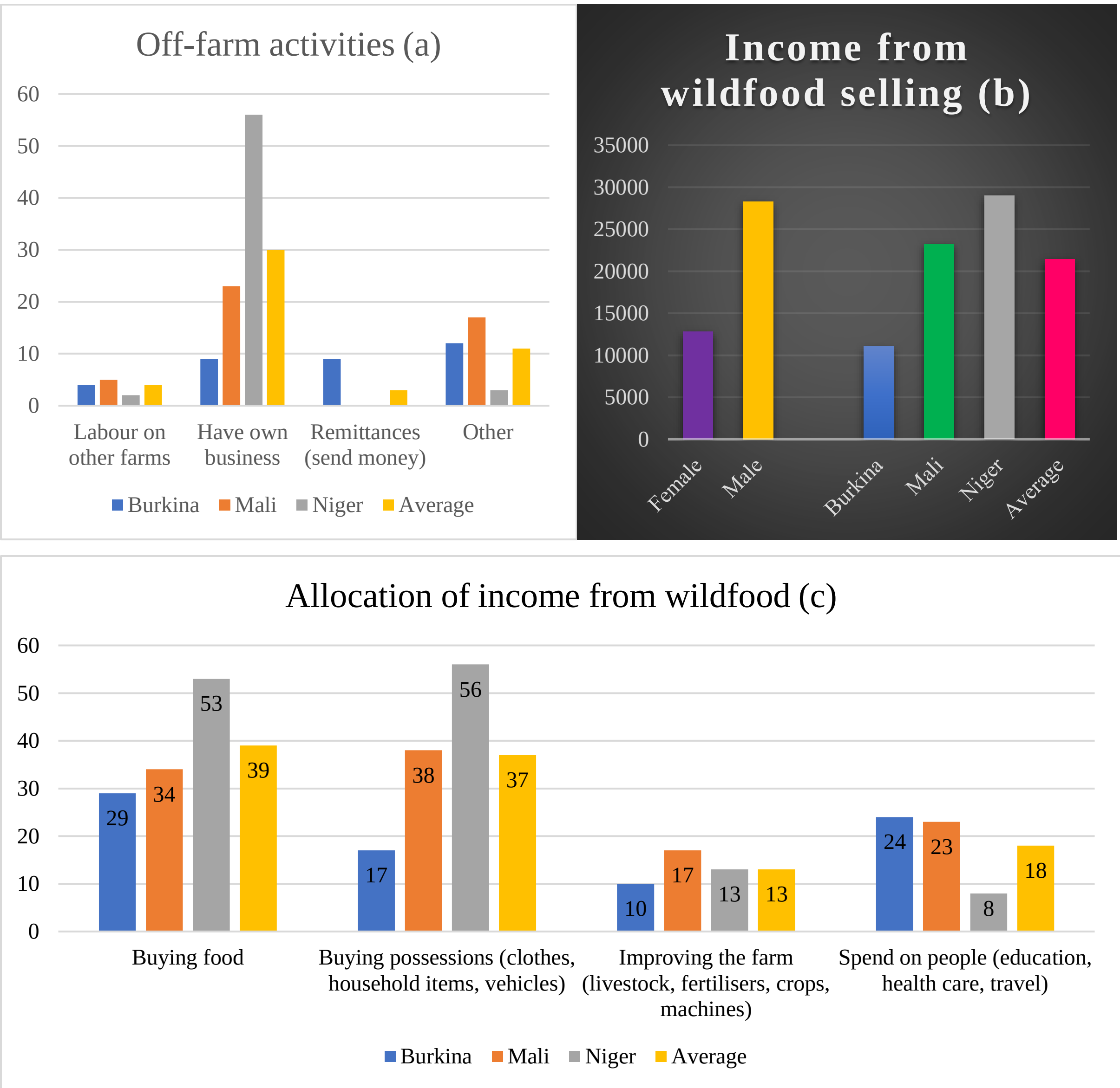

Figure 17: Off-farm contribution to food nutrition

The results show that farmers are getting their livelihood from other activities apart from farming. About 30% of the respondents engage in off-farm activities. This percentage is relatively low because of a low market opportunity and a low financial capital. However, the percentage of farmers engaging in off-farm activities depends on the country with Niger having the highest score of 56%. Furthermore, 59% of respondents carrying off-farm activities are men. The off-farm activities include mainly small trading (30%). The business that farmers are doing includes small trade, carpenter, traditional medicine; gold panning. Very few (4%) engages in wage labor (labor on another farm). Niger records the highest percentage (56%) of farmers engaging in off-farm activities while Burkina Faso has the lowest percentage (9%). From these activities, farmers are earning on average 21,456 XOF. Surprisingly, men (28,304 XOF) were gained more income from wild food trading than women (12,842 XOF). When farmers were asked to indicate the allocation of income from off-farm activities, 39% and 37%, respectively mention buying food and possessing buying (clothes, household item). Very few (13%) reports that they invest in farm (livestock and agriculture inputs) while some (18%) spend on household members health care, education and travel. The results show that more farmers from Niger are spending on food (53%) and possessing (56%) while very few (8%) are likely to spend on health care, education and travel. Similarly, in Mali, very few farmers are investing in farm (10%) and possessing (17%).

- **Livestock**

In addition to crops, farmers also keep livestock. Goats (X = 3.34) are the most important livestock kept in Niger while in chicken are the most important in Burkina (X = 6.20) Faso and Mali (X = 10.50). Cattle, donkey and sheep are the following most important.

Conclusion

The overall objective of the study is to analyze farmers' knowledge of climate change and farm managed natural resources practices impact on households' food and nutrition. The study revealed that farmers held differing perceptions of climate change impacts. The majority of them (42%) reported severe level of negative climate impacts on their livelihood and very few (1%) reported that climate change had a positive impact livelihood. Approximately 11% of respondents did not perceive any impacts from climate change. However, the linear regression analysis reveals that development project support (beneficiary), demography, distance to the market, garden ownership, fertilizers and improved seeds varieties use significantly affect the farmers' level of climate change impact. The study results also reveal that cereal crops, particularly millet (60%) and sorghum (52%) which are the main food crops in the study area, are the most affected by the climate change negative impact.

The study reveals that the majority of farmers (71%) received their information about climate change from community radio. In contrast, other sources such as television, farmers' associations/extension service, personnel relationship and local knowledge were hardly used to source climate change information. The main types of climate services desired by farmers include the seasonal forecast, short term forecast early warning which is combined with their own local knowledge. To address the different stresses, farmers deploy a range of technical strategies which includes agroforestry (60%), use of fertilizer (53%), use of improved seed varieties (47%), crops association (45%), pest and parasite control (18%) and irrigation (8%). The regression results reveal that project support, gender, demographic, arm size, garden ownership, access to extension service, household head education, agriculture training, distance to market, and crop productivity significantly influence farmers' decision to adopt specific strategy. Further, Agroforestry practice, use of mineral fertilizer and pest control are the most significant strategies affecting crop production.

Most of the respondents mentioned June (46%), July (66%) and August (74%) as months of food shortage with variability between countries. July is the worst month of food shortage in Niger (81%) while in Burkina Faso (83%) and Mali (67%) it was August. In contrast, the best period for food availability extends from September to December with October for Niger (65%) and November for Mali (65%) and Burkina Faso (64%) being the most favorable months. During the good period, cereals are consumed almost every day along scoring 2.68 over 3 with leafy vegetable scoring 2.58 while legumes (1.93) and fruits (1.58) are eaten less than once a month. Tree leafy vegetable is also consumed, especially in Mali (scoring the highest value of 2.75) where the consumption is done almost daily. Animal food, including meat (0.99), eggs (0.69) and milk (1.41) is seldom consumed, less than (once a month) except Niger where milk (2.6) is consumed almost every day. During the worst period of food availability, food consumption decreases for all types of food within the three countries. Legume (1.36), tree leaves (1.66) and milk (1.82) consumption remains higher in Niger. The results also revealed that farmers in the Sahel produce a large variety of crops including cereals (sorghum, millet, maize, and rice), legumes (cowpea, soybean, peanut) and other cash crop such as cotton, chili, tomato, etc. However, the quantity of cereals consumed (3/5) is higher than the quantity sold (1/5) while the quantity of legume sold (3.3/5) is higher than the quantity consumed (1.5/5).

The use of wild food (60%), and trading (48%) are the main strategies adopted by farmers to cope with the food shortage for human beings and the livestock. Leafy vegetable (53%), fruits and nuts (43%) are the most collected food stuffs from trees growing in the parklands and woodlands. The most important tree species cited by the respondents include Vitellaria paradoxa (46%), Tamarindus indica (43%), Adansonia digitata (38%), Balanites aegyptiaca (28%) for humans as well as Faidherbia albida (51%) and Piliostigma reticulatum (31%) for fodder. Surprisingly, men (28,304 XOF) were reported to generate more income from wild food trading than women (12,842 XOF). More men (62 %) were found to be engaged in the wild food collection than women (57 %) and about 72%, 60% and 47% of the respondents are active in the sector in Mali, Burkina Faso and Niger, respectively.

Based on the research findings, the development of institutions to improve farmers' access to information about climate change could help to increase their adaptive levels and food security status. Radio broadcasts about weather, climate change and its impacts would be well received. There is also a need to promote strategies for soil fertility management, land restoration and to improve the capacity of extension services to help farmers develop and adopt appropriate adaptation strategies including for crop pest mitigation. However, it is important that such extension services are adapted to the local context and based on local agro-ecological knowledge and techniques. Another important need is the implementation of more efficient irrigation techniques to help save water and more irrigated crops. This would inevitably lead to a more sustainable use of water resources and the improvement of households' adaptation through reducing climate change impacts (exposure and sensitivity), improving households' production and thus improving households' food and nutrition security.

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Annex 1 : Restitution INERA, Burkina Faso

Rapport de l'atelier de restitution des données de l'enquête du projet «*Grain Legumes and Dryland Cereals (GLDC)*» dans la commune rurale de Zogoré dans la province du Yatenga

Avril 2019

Introduction

Le jeudi 04 avril 2019 s'est tenue dans la salle de réunion de la mairie de la commune rurale de Zogore dans la province du Yatenga (Ouahigouya), l'atelier de restitution des résultats, d'échange et de validation de ces résultats pour la définition des activités du projet dénommé «*Grain Legumes and Dryland Cereals (GLDC*)» mise en œuvre dans trois pays : Burkina Faso (Zogoré), Mali (Yorosso) et Niger (Droum). Au Burkina Faso, il est mis en œuvre dans la commune rurale de Zogore situe à 28 km de Ouahigouya dans la province du Yatenga. Cet atelier a vu la participation de trente-huit personnes composées de l'équipe de l'INERA, du Dr Abdou Ado de l'ICRAF (présentateur), l'équipe de SNV, les enquêteurs et les autorités administratives (maire, préfet) et les producteurs des huit villages de la commune (Liste complète en annexe).

L'atelier avait comme ordre du jour :

1. *Amendement et adoption du programme de l'atelier (voir annexe) ;*
2. *Présentation des résultats des données de l'enquête, échange validation ;*
3. *Divers.*

Déroulement de l'atelier.

L'atelier a débuté à 9h 30mn. Le début des activités a été pointé par le mot de bienvenu du préfet de la commune. Ce dernier dans son intervention, a d'abord salue tous les participants en particulier l'équipe de l'ICRAF et de l'INERA et le l'animateur de SNV qu'il considérait comme des étrangers, mais e réalité ce ne sont pas des étrangers car ils étaient ici dans les mois de novembre pour les enquêtes. Il a ensuite remercie l'SNV car c'est grâce à cet institut que ce travail est venu ici à Zogoré. Enfin il a remercié les producteurs pour leur disponibilité, présence et l'intérêt qu'ils ont accordé à ce travail. Je vous exhorte à plus de participations, a-t-il souligné avant de passer la parole au présentateur.

1. *Amendement et adoption du programme de l'atelier (voir annexe). ;*

Avant l'amendement du programme, il y a un tour de table pour coller un nom à chaque visage. Le programme a été adopté sans modification majeur (Voir annexe). Pour des questions de langues, l'animateur de l'SNV s'est porté volontaire pour traduire les présentations en langue locale « mooré » pour les producteurs.

2. *Présentation des résultats des données de l'enquête ;*
    a. *Présentation du projet.*

Le projet dénommée GDLC « *Grain Legumes and Dryland Cereals* » s'inscrit dans le programme

Adaptation aux changements climatiques et sécurité alimentaire de l'ICRA. Le projet est mis en œuvre par consortium. Dans le contexte de changements climatique le projet fait entre agriculture et changement climatique. L'agriculture est l'élément clé pour tous les pays en développement. 40% des populations dans le monde pratique l'agriculture. Au Niger comme au Burkina Faso 85% sont des agropasteurs. C'est pourquoi d'ailleurs IPCC a considéré que les changements climatique est un danger pour l'agriculture. La hausse de la température, la variabilité pluviométrique, les vents affectent l'agriculture et menacent la sécurité alimentaire. La sécurité alimentaire existe lorsque toutes les personnes ont à tout moment un accès physique et économique à des aliments sains, nutritifs et en quantité suffisante, qui répondent à leurs besoins et à leurs préférences alimentaires pour une vie saine et active. Cette définition est basée sur la disponibilité, accessibilité, utilisation et la stabilité. Les impacts des changements climatiques peuvent déstabiliser tous les paramètres tels que l'augmentation des prix des denrées alimentaire, la destruction des récoltes.

Les pays en voie de développement sont plus sensibles au changement climatique et cela est lie à leur niveau d'adaptation. Les effets des changements climatiques sur l'agriculture augmentent leur vulnérabilité. Il est dont très capital de s'adapter à ce fléau. S'adapter fait référence à des changements des comportements et des habitudes culturales. C'est dans ce contexte que l'ICRAF à travers ces projets met l'accent sur la promotion et le développement de l'agroforesterie, comme le projet GDLC

GDLC « *Grain Legumes and Dryland Cereals* » est un projet qui a pour objectif principal, augmenter la productivité, la rentabilité et la résilience. Ce projet est structurée en quatre programme et c'est la composante trois qui intervient à Zogoré : Intégré des fermes et des ménages. A la fin de de la présentation des questions ont été posées, parmi ces questions on peut retenir :

1. *Le projet accompagne-t-il des groupements ou des individus ?*
2. *Comment expliquez-vous l'agroforesterie ?*
3. *Quelles est la durée du projet ?, le projet est fini ou il vient de commencer ?*
4. *Quels sont les critères de choix de la zone de Zogoré ?*
5. *Pourquoi le choix de 8 villages sur 18 dont compte la commune ?*

A ces questions des réponses ont été données par l'équipe de l'INERA et par les présentateurs : Le projet accompagne aussi bien les groupements que les individus. L'agroforesterie est tout simplement l'association des cultures avec les arbres. Le projet a une durée de 3 ans et les activités ont déjà démarrées avec les enquêtes. Le critère de choix de Zogoré est des ordres, *(i)* la similitude avec les autres zones du projet, (ii) la facilité d'intervention dans la zone par la présence du partenaire SNV.

b. Présentation des résultats

Dans cette deuxième présentation les données méthodologiques ont été brièvement abordées car jugées moins important pour les producteurs que les résultats.

✓ Caractéristique des ménages

Les cultures principales exploitées par les ménages se classe comme suit : (i) *niébé, (ii) arachide, (iii) mil, (iv) sorgho.*

Les cultures maraichères principales se classe comme suit : (i) oignon, (ii) tomate, (iii) Gombo, (iii) Aubergine, (iv) concombre.

Pour ce qui est de l'arboriculture les espèces les plantées sont : (i) manguiers, (ii) orangers, (iii) citronniers, (iv) papayers, (v) goyaviers.

Dans le domaine de l'élevage, les espèces animales les plus élevées par ordre d'importance sont : (i) volaille, (ii) caprins, (iii) ovins, (iv) asins, (v) bovins
Sur cette présentation il y a peu de discussion. Les producteurs n'étaient pas d'accord que le niébé soit la principale spéculation, et que les ânes viennent avant les bœufs. Mais avec les explications du coordonnateur et de l'animateur de l'SNV, ils ont plutôt compris que principale n'est pas liée a la quantité mais au nombre.

✓ **Autres type activités génératrices de revenus**

Sur ce point un certain nombre d'activités qui était énuméré dans la fiche d'enquête a savoir petit business, rémittence, commercialisation des produits agricoles. Mais c'est autre qui dominait. Le présentateur a cherché à comprendre les activités que les producteurs mettent dans autre. Les activités citées par les producteurs sont les suivantes : maçonnerie, apiculture, cordonnerie, restauration, boucherie, forge, poterie, soudure, menuiserie.
A l'issu de ces résultats, il ressort que 98% de la population vit en dessous du seuil de pauvreté (moins de 2$/jour) et 2% au-dessus du seuil de pauvreté.

Autres activités effectuées par les producteurs

- *Maçonneries*
- *Apiculture*
- *Cordonnerie*
- *Couture*
- *Restauration*
- *Boucherie*
- *Soudure*

✓ Information sur les impacts des changements climatique sur les cultures.

98% des enquêtes disent que les changements climatiques ont un impact sévère sur les cultures. Les spéculations les plus touchées sont le sorgho et le mil. Les impacts sont échelonnés a diffèrent stade de développement de la plante : 54% à la germination, 76% à la montaison, 70% à la production. Les risques les plus importants sont les sécheresses et les poches de sècheresse (90%) et les inondations (34%). L'une des informations climatiques dont les producteurs ont besoins pour faire aux impacts est la prévision saisonnière (66%). Les informations qu'ils utilisent sont leurs connaissances indigènes (40%). Ils ont besoin de cette information pour mieux faire la sélection variétale (44%) et planifies leur date de semis dans le temps (40%).
Les sources d'information des producteurs sur les services climatiques sont principalement la radio communautaire (43%).

Les stratégies d'adaptation (les bonnes pratiques agricoles) selon les données de de l'enquêtes sont : agroforesterie (64%), usage des engrais chimiques (52%), variété améliorées (46%), association des cultures (40%), usage des pesticides (16 %). L'agroforesterie est la principale pratique parce que 81% des producteurs estiment qu'elle contribue à l'alimentation humaine, 67 % estiment qu'elle protège du sol, 37% estiment qu'elle fournit du bois d'énergie, 22% estiment qu'il fournit bois de charpente, 12% estime qu'elle contribue à l'alimentation des animaux. Les produits de l'agroforesterie les plus utilisés dans l'alimentation humaine sont les feuilles et les racines (51%), ensuite viennent les fruits (37%) et enfin les graines et les noix (19%).

Les sources d'approvisionnement des semences

Pour ce qui est de la source d'approvisionnement, majorité des producteurs font l'auto sélection c'est-à-dire qu'ils prélèvent leur semences de la production issue des semences améliorées octroyées par le service de l'agriculture. Les principales associations entre les cultures sont par ordres d'importance: sorgho niébé (39%) et mil niébé (28%). Les associations se font selon les modelés suivant : la légumineuse et la céréale dans le même poquet (88%), la légumineuse entre les lignes céréale (6%), la légumineuse et la céréale interposées (4,8 %). Ces association se font pour plusieurs causes dont les principales sont le manque de terre (38%), l'amélioration de la production (26%) et pour minimiser les risques climatiques (10%). La perception des producteurs sur les associations est qu'elle contribue à l'augmentation des rendements (43%) et parfois cela conduit à une diminution des rendements (15%). Pour ce qui est des rotations, il ressort que la majorité des producteurs gardent la même association, céréale-légumineuse (87), quelques producteurs changent la céréale (9%) et d'autre la légumineuse (3%)

Associations de culture

- *sorgho-mil*
- *mil-sesame*
- *oseille-sesame*
- *mil-niébé*
- *mil-arachide*
- *sorgho-arachide*
- *sorgho-sésame*

Les résultats des enquêtes des focus group

Les participants (producteurs et STD) n'étaient pas d'accord sur le classement des espèces dites populaire, celles dites sociales (qui entre dans les rites coutumiers) et celle qui protègent le plus l'environnement. Les questions de la fiche d'enquête administrées aux producteurs n'étaient pas trop précises. Les producteurs ont confondu le terme populaire et le terme important. Pour cela les espèces ont été reclassées par les producteurs avec l'appui du forestier de la commune.

- ***Classement des espèces populaire par les participants.***

1 *V paradoxa*
2 *Adansonia digitata*
3 *Tamarindus indica*
4 *Acacia macrostachya*
5 *Bombax costatum*
6 *Sclerocarya birrea*
7 *Lannea microcarpa*
8 *Balanites aegyptiaca*
9 *Saba senegalensis*
10 *Ziziphus mauritiana*

- ***Classement des espèces sociales (qui sont plus utilisées dans les rites coutumiers et la pharmacopée traditionnelle) par les participants.***

1 *Saba senegalensis*
2 *Ziziphus mauritiana*
3 *Tamarindus indica*
4 *Vitellaria paradoxa*
5 *Balanites aegyptiaca*
6 *Acacia nilotica*
7 *Ximenia americana*
8 *Acacia albida*
9 *Sclerocarya birrea*
10 *Lannea microcarpa*

Classement des espèces qui jouent un rôle important dans la protection de l'environnement par les participants.

1 *Acacia albida*
2 *Balanites aegyptiaca*
3 *Piliostigma toningii*
4 *Vitellaria paradoxa*
5 *Tamarindus indica*
6 *Acacia macrostachya*
7 *Sclerocarya birrea*
8 *Bombax costatum*
9 *Acacia nilotica*
10 *Adansonia digitata*

- **Les modes de régénération des espèces**

Le mode le plus utilisée pour la gestion des espèces est la régénération naturelle assistée (RNA) (83%).

- **Sécurité alimentaire**

Il ressort des enquêtes que 99% des ménages ne sont pas en sécurité alimentaire (moins de 2$/jr). Les mois pendant lesquels les ménages sont en pénurie d'aliment est la période de juin (75%) et aout (83%). Le mois le plus critique de la pénurie alimentaire est le mois d'aout. Les aliments consommés pendant ces périodes critiques sont les céréales, les feuilles des végétaux, et les fruits des arbres. Les arbres dont les feuilles sont consommées sont *Adansonia digitata*, *Cassia tora*, *Moringa oleifera*, les feuilles du niébé. La source d'approvisionnement de ces aliments est le marché.

Les feuilles consommées en période de soudure

- *feuilles de baobab*
- *feuilles de haricot*
- *feuilles d'oseille*
- *feuilles de Cassia tora (sogda en mooré)*
- *feuilles de moringa*

Le mois pendant lequel les producteurs ont quoi se nourrir est le mois de novembre. Les produits forestiers (ligneux et non ligneux) contribuent à hauteur de 29% pour l'alimentation humaine. Les différents usages et les parties utilisées des espèces ont été consignes dans un tableau qui a été amendée par les participants. Sur ce point on peut retenir que : *Acacia nilotica* n'est pas consomme mais est utilisés dans la médecine humaine et vétérinaire, la gomme de *Acacia seya* est utilisée dans la médecine vétérinaire, les cosse de néré sont utilisées dans la construction, l'écorce de *Piliostigma reticulatum* est aussi utilisée dans la construction.

3. Divers.

Sur ce point il n' y a pas eu de divers.

Conclusion

L'atelier s'est bien déroulé. Le premier adjoint au maire a remercié tous les participants pour leurs interventions qui ont été à la hauteur des attentes des responsables dudit atelier. Il a remercié aussi les présentateurs pour la qualité des présentations. Les échanges ont été fructueux sur les résultats qui vont sans doute aider les institutions et les partenaires financiers et techniques à la décision. Toutes les suggestions et critiques des participants seront prises en compte pour l'amélioration des résultats des enquêtes avant leur validation. Sur ce point il a souhaité bon retour aux participants dans leurs zones respectives avant de déclarer clos l'atelier à 15h30mn.

Liste de présence a l'atelier de Zogore (04/04/2019)				
Numéro	**Nom et Prénom**	**Village/ville**	**Fonction**	**Contact**
1	OUEDRAOGO Salif	Piiga SoNdin	Producteur	77 81 65 88
2	PORGO Mahamadi	Nango Foulsé	Producteur	60 30 05 30
3	TINTO Moumouni	Zogoré	Producteur	76 53 64 58
4	TALL Abdoulahi	Trobo	Producteur	76 03 36 18
5	TEGUERA Azèta	Teousgo	Producteur	65 74 79 48
6	SANA Aguiratou	Bouloumsi	Producteur	67 62 46 00
7	BAGAYA Harouna	Nango Yersé	Producteur	73 02 12 23
8	SAWADOGO Inoussa	Puga Soudin	Producteur	75 47 24 91
9	PORGO Abdoulaye	Nango Foulsé	Producteur	76 83 15 88
10	SAWADOGO Zakaria	Zogoré	CVD	73 67 66 02
11	OUEDRAOGO Ousmane	Zogoré	Président sous Bassin	75 21 13 74
12	BAGAYA Moussa	Nougo	Producteur	64 04 43 05
13	TRAORE Halidou	Nango Yarsé	Producteur	75 49 46 76
14	GUIRO Salifou	Nango Yarsé	Producteur	76 73 01 59
15	OUEDRAOGO Ousmane	Viré Sougdin	Producteur	76 18 65 49
16	OUEDRAOGO Adama	Viré Sougdin	Producteur	76 18 65 49
17	PORGO Ousseini	Nango Foulsé	Producteur	57 42 84 15
18	SORO Moumouni	Tinonsgo	Producteur	74 06 19 70
19	OUEDRAOGO T Souleymane	Pugo Toundin	Producteur	74 14 06 99
20	TALL Bibata	Torolo	Producteur	66 98 86 79
21	OUEDRAOGO Ousmane	Boulinsi	Producteur	77 08 08 62
22	SAWADOGO Gisèle	Zogoré	Chef CAT	71 81 60 03
23	TALL Mahamadou	FC Forobo	Forobo	76 80 27 12
24	OUEDRAOGO Adama	Zogoré	Préfet	70 22 60 76
25	SAWADOGO G. Maurice	Zogoré	1er Adjoint/Maire	72 38 17 87
26	OUEDRAOGO Tinga	Boulinssi	CVD	76 94 33 47
27	GUIRO Ousseini	Nango Yarsé	Producteur	77 37 95 04
28	OUEDRAOGO Daouda	Viré Sougdin	Producteur	75 74 53 92
29	BELEM Amadé	Ninga	Producteur	70 53 60 22
30	BELEM O Alhassane	Zogoré	Agriculture	70 56 36 07
31	OUEDDRAOGO Malick	Zogoré	Forestier	70 31 35 45
32	KABORE Issiaka	Ouaga	Agent de collecte/Ouaga	70 93 81 52
32	KANAZOE Mahamadi	Ouaga	Agent de collecte/Ouaga	70 4 2 30 06
33	SAMA Koudnonga	Ouaga	Agent de collecte/Ouaga	72 29 42 06
34	OUEDRAOGO SoumaÏla	Ouaga	Superviseur /collecte	76 59 62 37
35	BAZIE Paulin	Ouaga	Chercheur/INERA	70 01 41 47
36	SANOU Cyrille Victorien	Ouaga	Chauffeur/INERA	79 00 05 98
37	BADIAL Salfo	Ouahigouya	Animateur SNV	70 85 13 50
38	SANOU Josias	Ouaga	Chercheur/INERA	70 29 07 02

Annex 2 : Restitution IER, Mali

REPORT OF THE RESTITUTION WORKSHOP OF THE STUDY ON CLIMATE CHANGE ADAPTATION AND FOOD SECURITY: INFORMATION NEEDS TO INTEGRATE THE USE OF IMPROVED GLDC VARIETIES TO IMPROVE FARMING SYSTEM PERFORMANCE

Dr Kalifa TRAORE; Dr Ado Abdou; Mr Amadou Kanté

IER /ICRAF/AMEDD

1. General introduction

West Africa climates are unpredictable, especially at the interannual level (Sivakumar et al., 1992) and the high increase in rainfall variability also, drought and floods make farmers, in short term, very vulnerable in these resource limited zones. Most countries experienced climate change that work to their disadvantage, with temperature increases, longer droughts, and increasingly frequent, violent storms exacerbating stresses that have already been challenging their agricultural production systems (Fujisaka et al.2011). Despite of site-specific resilience, Hansen (2002) mentioned that many households remain poor and vulnerable to future climatic shocks in a context of growing population, shrinking land resources, lack of endowment and decision capacity. Deressa et al (2011) argued that the major factors responsible for the low productivity include reliance on traditional farming techniques, soil degradation caused by over-grazing and deforestation, poor complementary services such as extension, credit, marketing, infra-structure as well as climatic factors such as drought and flood.

Several strategies have been developed by farmers to adapt their productions systems to these constraints but these traditional systems alone are unlikely to be able to sustain crop productivity. ICRISAT (2010) reported that optimized management of intra and interspecific agrobiodiversity can reduce the vulnerability of farmers to climate change. The judicious cultivation of species and cultivars that differ in their cycle duration and sensitivity to specific stresses will buffer the effect of climate variability. Other buffering strategy is expected from intercropped fields or production systems that combine several crop species with different levels of stress tolerance. In strategies developed by farmers, cereal/legume intercropping which is mainly practiced in the parkland, is a very common practice among small-scale farmers in the semi-arid tropics, but will not suffice to cope with increasing climate variability and change. More aggressive diversification is required, as better matching of crop species to locations would increase economic returns and reduce environmental hazards. Furthermore, agroforestry, crops diversification and association, integrated crops-livestock, use of fertilizers, improved seed, adapted varieties and irrigation technologies were also mentioned as strategies by several authors (Boffa et al., 2000; Garrity et al. 2010; Gonzalez et al. 2012: Bayala et al.2003.; Bernard et al., 1995; Van Heerden et Stevens 2016, Yan et al. (2018) to adapt to climate constraints. Grain Legumes and Dryland Cereals Agri-food Systems (GLDC) program is aiming to mitigate these constraints by increasing productivity, profitability, resilience and marketability of critical and nutritious grain legume and cereal. Grain legumes and cereal are

an important component of the agricultural system, therefore, there is a need to determine their contribution in household food consumption which is one of the four pillars of food security.
The objectives of this study were: i) to examine farmers' knowledge of climate change; ii) to analyze farmers' agriculture practices and factor determining the adoption; iii) to determine the influence of agriculture practices on households' livelihood; iv) to assess households' food security and nutrition as well as factor determinants.

2. Steps of the project implementation

The main steps of the project were sites identification, data collection, reporting and restitution of the results to communities.
The present document is a reporting of the restitution of the results of the project to farmers, municipalities, extension services, technical agents, NGOs and administrative services.

3. The restitution session of the results of the project

The restitution workshop of the study on the "Climate Change adaptation and Food Security: information needs to integrate the use of improved GLDC varieties to improve farming system performance" project was held in the AMEDD NGO conference room in Yorosso district on Wednesday April 24th, 2019.

➢ **The participants were:**

The Central Sub-Prefect of Yorosso;

- The representatives of the municipalities of Kiffosso, Menamba and Koumbia communes;

- the head of the Production System and Natural Ressources Management Program of the National Research System (IER);

- the representative of ICRAF;

- the versatile advisors of the project;

- The head of office and agents of the AMEDD NGO in Yorosso district;

- technical services (agriculture, veterinary service, livestock nutrition, water and forests);

- representatives of the civil society of the study villages;

- entertainers of the rural radio of *Signè* and *Kanuya*

3.1. Objectives of the restitution session

The objectives of the workshop were to:

-present the preliminary report of the diagnosis made to the different actors of the study area;

- submit the results of the study to their assessments;

- take into account the various comments, observations and recommendations to be included in the future operational work plan.

3.2.Méthodologie

- A PowerPoint presentation was made on the outputs of the project;
- Questions and responses were performed on all the aspects of the project presented to the participants. In each question an exchange of experiences was done and the information clearly shared among the participants.

3.2.1. Progress of the workshop

After the welcome speech of the head of AMEDD NGO in Yorosso, floor was given to the deputy chief of the prefecture of Yorosso district, followed by the presentation of the participants.

After these commissioning activities, the facilitator spoke for the presentation of the preliminary diagnosis report.

3.2.2. Choice of study sites and sampling strategy

The study was conducted in yorosso for Mali, where 200 farmers were interviewed in 8 villages and 2 mores villages as control i.e not concerned and influenced by the project's activities. The survey was conducted from November 23th to December 03 th , 2018.

Conceptual Framework

This framework was discussed under four axes in table 1

Table 1: Components of the conceptual framework

Mediating factors	Endowments	Strategies	Livelihood outcome
➢ **Abiotic** • Water stress • Soil fertility • Temperature • Erosion ➢ **Biotic** • Parasites • Diseases	• Farm • Livestock • Labour power • Social capital • Common properties	• Crop combination • Crop diversification • Agroforestry • Integreted crops-livestock • Use of fertilizer • Use of improved seed Off-farm activities	• Stress reduction • Production improved • Livestock production improved • Income improved • Dietary diversified Food security improved

4. Presentation of the outputs of the project

4.1. Study area

The site surrounded in black represented the location of the study area in Mali.

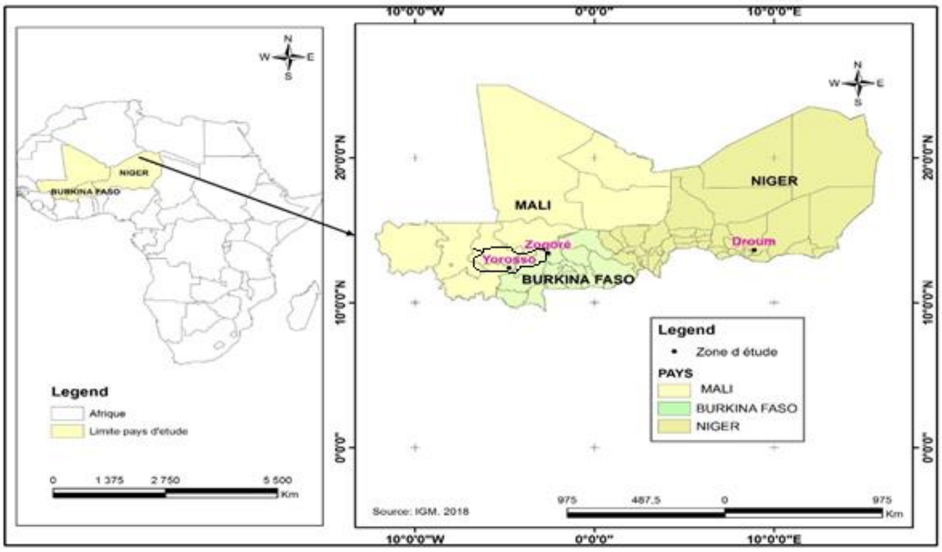

Figure 1: Location of the study area in Mali, 2018

4.1.Context and problems

In this section, the facilitator explained the big Challenge that is "How to produce more for a fast-growing population in the future decades t while fighting poverty and hunger" in the light of the current problems related to the negative effects of climate change in sahelian regions such as drought, flood, temperature rise; insect appearances or decreases, as well as the appearance or aggravation of diseases. These problems were coupled with inadequate cultivation practices and the disappearance or reduction of fallow length, as well as the high pressure on soil causing soil and environment degradation, resulting in low production of crops. Then, it was clearly explained to all participants that the global objective of the GLDC program was aiming to increase the productivity, profitability, resilience and marketability of critical and nutritious grain legume (chickpea, cowpea, pigeonpea, groundnut, lentil, soybean) and cereal (sorghum, pearl millet, finger millet) crops grown within the semi-arid and sub-humid dryland agro-ecologies of sub-Saharan Africa and South Asia.

4.2. Strategies used by producers in the project area

Among strategies mentioned by farmers to mitigate or adapt to the negative effects of climate change, the following ones were mentioned:

- ❖ Agroforestry
- ❖ Crop diversification
- ❖ Intercropping of cereals and grain legumes
- ❖ Use of fertilizers
- ❖ Use of adapted varieties to climate variability
- ❖ Use of irrigation in some specific areas.

The presentation of the results of the study allowed the facilitator to give detailed explanations of the following points which were usually graphs:

- ❖ Inventory of plant species and their importance;
- ❖ Extinction and management of tree species;
- ❖ Farm tree management ;
- ❖ Perception of climate risks ;
- ❖ Impacts of Climate Change ;
- ❖ Perception of the most affected crops of climate change;
- ❖ Source of climate information ;
- ❖ Needs and use of climate services;
- ❖ Agricultural strategies to fight against biotic and abiotic stresses;
- ❖ Intercropping and crop diversification ;
- ❖ Periods of Food availability and shortage;
- ❖ Dietary diversity;
- ❖ Food Sources ;
- ❖ Different crops production and utilization;
- ❖ Wild food collection ;
- ❖ Off-farm activities.

Finally, the facilitator made a conclusion in which it appears that:

- ❖ Farmers have a different perception of the impacts of climate change. In fact, it also appears that development project support (beneficiary), demographY, distance to the market, garden ownership, fertilizers and the use of improved seeds varieties use, affect farmers' level of climate change impact.
- ❖ Cereals and especially millet (60%) and sorghum (52%) which are the main crops in the study areas are the most affected by the negative impacts of climate change.

- The majority of farmers (71%) receive climate information through community radios. On the other hand, other sources such as television, farmers' associations, extension services, personal relations and local knowledge are little used as sources of climate information.
- To cope with stress, farmers are deploying several strategies that include agroforestry (60%), fertilizer use (53%), use of improved varieties (47%), and crop combinations (45%).), pest and parasite control (18%) and irrigation (8%).
- Regressions showed that project support, gender, demography, farm size, land ownership, access to extension services, household head's level of education, agricultural training received, distance to markets and crop yield, significantly influence farmers' decision to adopt a specific strategy. In addition, agroforestry, the use of mineral fertilizer and control of pests are the most affecting strategies on crop production.
- The month of August is the food shortage month (67%) and November the period of food availability (65%).
- The quantity of cereals consumed (3/5) is higher than that sold (1/5) while the quantity of legumes sold (3.3 / 5) is higher than the quantity consumed (1.5 / 5).
- The use of wild food (60%) and trading (48%) are the main strategies adopted by farmers to solve the food deficit for humans and animals. The leaves (53%), fruits and nuts (43%) are the main food harvested from trees. The main species mentioned were *Vitellaria paradoxa* (46%), *Tamarindus indica* (43%), *Adansonia digitata* (38%), *Balanites aegyptiaca* (28%) for humans and *Faidherbia albida* (51%) and *Piliostigma reticulatum* (31%) for fodder.
- Men generate 28304 FCFA from picking products while women make 12 842 FCFA. It appears that more men (62%) were engaged in collecting wild food than women (57%) on average.
- Promoting structures to improve farmers' understanding of climate change could improve their adaptive capacity. Improving the diffusion of emissions on climate, climate change and their impacts would be beneficial.
- There is also a need to promote soil fertility management and soil restauration strategies.
- There is also a need to strengthen the capacity of extension agents to that they train farmers on integrated pest management strategies.
- Another no less important strategy is the implementation of efficient irrigation systems that save water and irrigate more crops

After, the presentation, participants asked several interesting questions respond by the facilitator of IER and the representative of ICRAF. These questions were mentioned in table 2.

Table 2 : Questions and responds during the restitution session in Yorosso, Mali.

QUESTIONS	REPONSES
What are the study villages?	Menamba, Sièla, Dionkouna, Zangousso Lopégué, Kiffosso1, Kiffosso2, Makoungo
How do you explain the high percentage of men's involvement in wild food collection?	The study was more interested in the earnings of wild food because women usually use for the household food needs while men sell them.
Why did the study show that seedlings are more exposed to germination in Mali and Niger, while in Burkina it is at emergence?	It depends on the rainfall gradient; the beginning of the rainy season differs from one country to another so that the periods of threats of biotic and abiotic stresses are not the same.
In the presentation, we can see that trees are well maintained in Mali than in Burkina. What explains that?	We are talking about agroforestry and the three practices (pruning, natural regeneration and planting). If one realizes the importance of a tree that is on the way of extinction, the project will take steps for extension. Ex: *Acacia Albida*

- **Additions and clarifications**
  - The food shortage in Mali extends over the months of August and September but the crucial month is August.
  - That of Niger extends over the months of July, August and September but the crucial month is September.
  - Intercropping improve soil fertility especially legumes (peanut, cowpea) but we must have the technicality to do it.

- **Constraints**

  - The attack of aphids (insects) on crops in Makoungo for several years.
  - Lack of financial means to purchase improved seeds.

- **Recommandations**

  - Extension of Balazan (*Acacia albida*) and Néré (*Parkia biglobosa*) trees plantation;
  - Involvement of technical services in future actions on the ground

- **Next step ?**

  - This document will be developed with comments, additions and recommendations to put in place an operational work plan that could be proposed to other partners in the same domain or made an article and published for the whole world to have access.
  - Partners will be invited after the development of the operational work plan for presentation and taking into account of the observations and recommendations.

- **Acknowledgment**

  - The spokesman for the participants thanked the facilitators and urged them to come back for more.
  - The very satisfied facilitators thank the participants for their active and massive participation while promising to put back the observations, additions and recommendations, a big thank to the partnership with AMEDD which dates from a long time.
  - Central Sub-Prefect also thanked the participants as well as AMEDD and its partners for the success of all activities.

5. Conclusion

The active and massive participation of the various stakeholders in the study area through the exchanges have undoubtedly contributed to the success and achievement of the objectives of this workshop.

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Some pictures of the restitution













Annex 3 : Restitution INRAN, Niger

Restitution de l’enquête GLDC/ICRAF sur l’adaptation au changement climatique, l’Agroforesterie et la sécurité alimentaire dans la commune de Droum

Avril 2019

Introduction

DryDev est un programme régional coordonné par The World Agroforestry Centre (ICRAF) et est mis en œuvre par de nombreux partenaires nationaux au Mali, au Burkina Faso, au Niger, en Ethiopie et au Kenya. Ce programme quinquennal, est financé par la Direction Générale de la Coopération Internationale (DGIS) du Ministère des affaires étrangères des Pays-Bas. Son objectif reste le renforcement de la sécurité alimentaire et hydrique grâce à des actions de gestion du sol et de l'eau, de valorisation des produits agro-pastoraux, d'appui institutionnel et de renforcement des capacités des acteurs en matière de politiques agricoles. Pour ce faire, le programme met un accent particulier sur les capacités des paysans à innover pour la sécurité alimentaire et le développement rural. Il repose essentiellement sur des approches participatives ascendantes (Bottom Up et OXC). Le programme DryDev maintient comme axes majeurs la production des denrées agricoles pour satisfaire entre autres les besoins de tous les types de producteurs à travers la diversification, mais aussi au même titre la production animale avec comme objectif primordial l'intensification et l'intégration des systèmes de production agro-sylvo-pastoraux résilients et performants.

En effet, afin d'avoir des informations sur les céréales, les légumes la sécurité alimentaire, le changement climatique…, l'ICRAF a conduit une enquête du 30 novembre au 01 Décembre 2018 dans la commune de Droum.

Les résultats de cette enquête ont été restitués le 09 Avril 2019 à Droum.

I. Restitution de l'enquête GLDC/ICRAF

L'atelier de restitution de l'enquête s'est déroulé dans la salle de réunion de la Mairie de Droum et a enregistré la participation d'une quarantaine de participants (ref. annexe 1). Ces derniers sont entre autres les représentants de l'ICRAT au Niger, les représentants de l'ONG Karkara et DryDev, les agents enquêteurs ayant conduit l'enquête, le Maire de Droum, les conseillers, les membres de la PI, les délégués présidents grappes, les membres de Laboratoire d'innovation sociale, les délégués thématiques de la PI, les représentants des producteurs enquêtés, etc.

Ainsi, après la Fatiha d'ouverture, le Maire de Droum a souhaité la bienvenue à tous les participants. Puis les représentants de l'ICRAF au Niger ont présentés les résultats de l'enquête. L'enquête s'est déroulée en trois (3) parties : le changement climatique, les focus groupe sur l'agroforesterie et la sécurité alimentaire.

1.1.Résultats sur l'agriculture et l'élevage

L'enquête a montré que le mil, l'arachide, le niébé et le sorgho sont les principales cultures dans la commune de Droum. Pour le maraichage c'est principalement le chou, l'oignon, la laitue, la tomate et la patate douce. Pour l'arboriculture c'est le manguier et le dattier. Pour l'élevage, ce sont les volailles, les caprins, les ovins et les bovins qui sont les dominants.

Ainsi en dehors de l'agriculture et l'élevage, environ 60% des producteurs enquêtés pratiquent les Activités Génératrices de Revenu (AGR).

<u>Seuil de pauvreté :</u> environ 70% de la population n'arrivent pas à avoir deux (2) dollar/jour donc 1000f/jour.

1.2.Résultats sur le Changement Climatique

Les changements climatiques ont des impacts sur les populations de Droum, 37% sont peu impactés, 36% sont moyennement impactés, 21% sont sévèrement impacté sur l'agriculture et l'élevage et 6% sont très sévèrement impactes, ils ont tout perdu.

Les autres informations sur les changements climatiques sont les suivantes :

- **Impact sur les cultures :** le mil est le plus impacté puis le niébé et l'arachide ;
- **Au stade de germination**, les cultures sont plus impactées par le Changement climatique, aussi les criquets causent des véritables problèmes aux cultures à la levée et à la récolte ;
- **La sécheresse et les vents forts** sont les principaux risques environnementaux ;
- **Le système d'alerte précoce, la prévision saisonnière et les connaissances indigènes** sont les services climatiques les plus utilisés pour mieux planifier les semis, prise de décision sur le choix de spéculation et le choix des variétés (à cycle court ou long) ;
- **La radio et la prévision traditionnelle** sont les principales sources d'information.

Les stratégies adoptées pour réduire les impacts du Changement Climatique sont :

- L'association des cultures mil-niébé-sorgho principalement et mil-arachide aussi, l'association des cultures permet d'augmenter le rendement. La principale raison de cette association est l'insuffisance des terres de cultures ;
- Utilisation des produits forestiers comme les **feuilles**, les **racines** et les **fruits** ;
- Urée, DAP et NPK sont les engrais les plus utilisés dans la commune
- Utilisation des semences améliorée du mil, niébé et arachide. Ainsi, les résultats d'enquête révèlent une importante utilisation des semences améliorées par de producteurs. Ce qui particulièrement attiré l'attention des représentants d'ICRAF sur la provenancnce de ces semences en questionnant les participants.

A ce niveau, des éclaircissements ont été donnés par les participants sur la question : D'où proviennent les semences améliorées utilisées et quel pourcentage de la population de Droum utilisant les semences améliorés ?

Les réponses sont : les semences améliorées proviennent des ONG et des Multiplicateurs des semences et environ 10% de la population de Droum utilise les semences améliorées.

1.3.Résultats de Focus groupe sur l'agroforesterie

Les informations issues des focus groupe montrent que :

- ✓ les arbres les plus populaires à Droum sont *Faidherbia albida* et *Piliostigma reticulatum* ;
- ✓ les arbres ayant plus d'importance économique sont *Tamarindus indica*, *Adansonia digitata* et *Faidherbia albida*;
- ✓ Environ 54% des producteurs pratiquent la RNA dans leurs champs ;
- ✓ Extension/multiplication des arbres

A ce niveau des éclaircissements ont été donnés par sur la question à savoir si *Acacia nilotica, Faidherbia albida, Balanites eagyptiaca, Tamarindus indica* augmentent ou pas ?

Les réponses sont : les espèces comme *Acacia nilotica, Balanites eagyptiaca, Tamarindus indica* diminuent du jour au lendemain alors que *Faidherbia albida* connait une légère augmentation.

1.4.Résultats sur la Sécurité alimentaire

A Droum les pénuries alimentaires s'étendent de Juin à Septembre, le mois le plus critique c'est le mois **Août** et les aliments proviennent du marché. Le mois d'abondance des aliments céréales est **Octobre** et les aliments proviennent des champs.

Les aliments sauvages collectés sont les feuilles, les racines et les fruits et contribuent très peu à la sécurité alimentaire (dans l'amélioration de l'état nutritionnel des consommateurs) et la période de collecte des ces aliments sauvages va de Novembre à Janvier et de juillet à Août.

BN : Faire la promotion des cultures du maïs qui tend à disparaitre compte tenu des faibles précipitations et l'ensablement qui menace la Korama de Droum.

Conclusion

En définitive, les participants sont convaincus des résultats d'enquête et ont apporté des précisions sur l'utilisation des semences améliorées et l'extension/diminution de certaines espèces d'arbres.

<u>Annexe 1 :</u> Liste des particpants à l'atelier de restitution des résultats de l'enquête GLDC/ICRAF

N°	Nom et prénom	Fonction	Provenance	Contact
1	Saidou Sani Adji	Maire	Droum	90737795
2	Ousmane Ali Kaoura	Rep. chef canton	Droum	90740534
3	Bounia Amadou	Conseiller municipal	Droum	96111318
4	Maoudé Dan Sofoua	Conseiller municipal	Koudouma	98991941
5	Sakina Tidjani	Conseiller municipal	Droum	
6	Samaila Magagi	CDA	Droum	97317221
7	Laminou Adamou	S.C. Elevage	Droum	91766439
8	Hamidou Lawali	S.C. Environnement	Droum	97525338
9	Souleymane Ali Marka	CP/ ONG Karkara	Zinder	96526890
10	Hanarou Salissou	Facilitateur DryDev	Droum	97165420
11	Fatima Zara Mahamane	Stagiaire DryDev	Zinder	99543367
12	Salamatou Moutari Mamane	Enquêtrice	Zinder	96577573
13	Mariama Abdou	Enquêtrice	Zinder	

14	Mamane Bachir	Enquêteur	Zinder	
15	Youssouf Moha Mahamae	Enquêteur	Zinder	
16	Dayanou Sani	Enquêteur	Maradi	
17	Kabirou Ado	Enquêteur	Maradi	
18	Abdoul Kader Mamane Lawan	Enquêteur	Zinder	
19	Rachida Harouna	Stagiare Karkara		
20	Rachida Yahaya	Membre PI	Zinder	92397931
21	Issa Ibrahim	Président PI	Droum	91313051
22	Djazouli Inoussa	SG/PI	Gogo	91571525
23	Amadou Ibrah	SG/commission GIRE	Droum Kafi	97302621
24	Rabilou Kailou	Tresorier PI	Koudouma	96932826
25	Hassane Issia	Producteur enquêté	Banima	80602576
26	Achirou Ali	Producteur enquêté	Machaya	91316889
27	Halilou Ali	Président grappe/PI	Droum	80654511
28	Bachir Malam Sanda	Producteur enquêté	Maissagé	97170639
29	Bachir Malam Abdou	Président grappe/PI	Mazoza	90530717
30	Salissou Lassan	Président grappe/PI	Garaourawa	99542399
31	Laminou Moutari	Producteur enquêté	Daba Massaki	90819068
32	Abdoul Razak Moussa	Producteur enquêté	Koumtchi	91141321
33	Souley Saley	Producteur enquêté	Abdalla	89055145
34	Lawali Souley	Producteur enquêté	Abdalla	95393241
35	Kabirou Lawali	Producteur enquêté	Baourou	91071677
36	Ibrahim Illo	Laboratoire des jeunes	Droum	
37	Issaka Elh Sanoussi	Laboratoire des jeunes	Droum	

38	Saidou Malam Habou	Délégué PI	Zangon Tambari	92549929
39	Abassa Tougiani	Point Focal ICRAF	Maradi	
40	Ado Matsalabi	ICRAF	Niamey	