© 2019 IJSRSET | Volume 6 | Issue 1 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology
DOI : https://doi.org/10.32628/IJSRSET1841143

Indigenous Smallholder Farming Strategies in South-Western Burkina Faso in Climate Variability Context

Thiombiano Boundia Alexandre*, Ouédraogo Dénis
Institut du Développement Rural (IDR), Université Polytechnique de Bobo-Dioulasso (UPB), 01 BP 1091 Bobo-Dioulasso 01, Burkina Faso.

ABSTRACT

Existing production systems in West Africa are unable to maintaining a good enough nutrient cycling at farm level. Climate change is expected to increase food production issues in agro ecosystems. Adaptation of smallholders to climate change requires rethinking and adjusting their existing production systems in order to improve their nutrient balance and to ensure an efficient provision of food demand. To that end, better understanding indigenous strategies is still needed. The present study was conducted in South-western Burkina Faso. Three communities of the province were chosen through a cluster analysis using NDVI index, land use map, soil degradation information, and population density. Using soil map, six villages were randomly selected and 360 farms were surveyed. The findings show that farmers overwhelmingly (99%) perceive rainfall variability in the studied zone. Farmers used in average 22.69 ± 3.11 kg ha $^{-1}$ of mineral fertilizer. A total of 28.06 % and 23.6% of interviewed farmers were using farm yard manure and compost from crop residues, respectively. Stone bunds were implemented by around 35% of farmers. The study also showed that most farmers rely on non-scientific methods for determining sowing period. The study demonstrates the need for rethinking the policy intervention strategies to ensure a better uptake of proven practices in sustainable nutrient management, and to build capacities of smallholder farmers in agro-meteorology to guide the decision making.

Keywords: Climate variability, farming strategies, Smallholder agro-ecosystem, Burkina Faso.

I. INTRODUCTION

Populations in Sub-Saharan Africa largely rely on farming for their livelihood [1]. In countries like Burkina Faso, 80% of the population draw their living means from farming [2]. As much as 25% of the population were undernourished in 2011-2013 [3] and up to 43.9% of households in the country were poor in 2010 [4].

Farm production depends on the performance of the nutrient cycle threatened by climate change. Climate change is expected to negatively affect farming activities and aggravate crop production deficiencies, food insecurity, and thereby threaten livelihoods of populations [5-7].Staple crops in Sub-Saharan Africa (maize, millet and sorghum) will decrease by up to 25.5-27% under climate change during 21st century[8, 9].

Given the strong reliance of farming on rainfed agriculture, there is the need of better understanding smallholder farmers' strategies to face rainfall variability in order to guide decision making. The objectives of the current study are to (i) analyse the perception of climate variability by smallholder farms and (ii) identity main soil nutrient management strategies to face climate variability in South western Burkina Faso.

II. METHODS AND MATERIAL

The study was carried out in Ioba province located in South-Western region of Burkina Faso. The region represents 6% of the country's territory [10]. The Ioba province belongs to the South-Sudanian climatic zone. The rainfall is uni-modal and lasts for about 5-6 months starting from the end of April to October. The dry season starts from November to March-April and is characterized by harmatthan causing air borne diseases like meningitis. Wettest months are August and September while the hottest months are March and April. The Mouhoun River is the only permanent water body. Some dams exist offering the province opportunities for gardening and dry season irrigated cropping. Average rainfall varies between 900 mm and 960 mm [11]. The vegetation type is savannah. The only protected forest of the province is the Bontioli forest reserve which plays an important role in terms of biodiversity preservation and carbon sink.

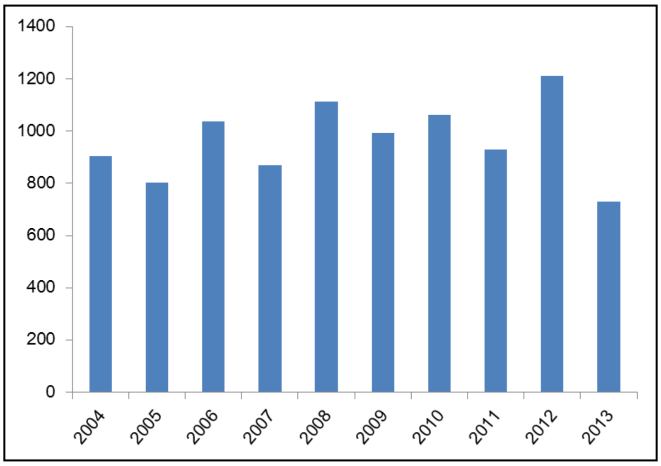

Figure 1. Annual rainfall for the decade 2004-2013

The main soil types are:

- Leached ferruginous tropical soils: Generally shallow, these soils cover 54% of the Ioba province [12];
- Hydromorphic soils: characterized by low organic matter content and very low phosphorus content. They represent 37% of the Ioba province lands [13];
- Lithosols: represents 5% of lands in Ioba province [13];
- Brown eutrophic tropical soils: They have low content in N, P and K [13].

Six villages were randomly selected: Pontieba and Loffing in Dano community, Babora and Dibogh in Koper community, and Kolinka and Bekotenga in Ouessa community. Random sampling was performed within Stata software. Sixty farms were randomly sampled per village. For each village, we used the list of households, as exhaustive as possible. In total, 360 of the 1,232 households were sampled (29% of total households). The data was collected during January-February 2013 using a semi-structured questionnaire which gathered socio-demographic data, geographical data, and information on farms' livelihood.

Climate variability perception, method for choosing sowing periods and soil fertility management strategies in use by farmers were analysed using descriptive statistics of data collected during the surveys.

III. RESULTS AND DISCUSSION

A. Climate variability perception and indigenous methods for choosing sowing periods

Farmers overwhelmingly (99%) perceive rainfall variability in the studied zone. According to 72% of interviewed famers, this variability is causing significant changes in crop calendar in the region for major crops. The main foods crops (Table 1) affected are sorghum according to 64.40% of farmers, corn (61.90%) and millet (38.90%). These crops play a key socio-economic role in the study zone. Indeed, sorghum is mostly used for making local alcohol sold as one of the main source of income for women. This alcohol is as well widely used during social events. Maize and millet are the main staple crops used for food consumption in households. Therefore, rainfall variability effects on these crops may potentially have significant negative impact on household livelihoods if sound strategies are not found and implemented to counter the rainfall variability in the region.

Table 1 : Major crops affected by calendar change under climate variability

Crop	Percent of farmers
Sorghum	64.40
Corn	61.90
Millet	38.90
Groundnuts	24.30
Rice	11.30
Coton	10.50
Beans	10.00
Voandzou	2.10
Yam	1.30
Soya	0.40

One of the main challenges for farmers in such situation is determining appropriate sowing period offering less vulnerability to the observed rainfall variability. In the region, farmers still rely on non-scientific methods for choosing sowing period. Around 36% of interviewed farmers declared to be basing their choice on the perceived amount of rainfall at the beginning of the season. They have no access to measured meteorological data. They only decide to start sowing when they feel the soil is moist enough for allowing seed to sprout based on their knowledge of their soils' moisture retention capacity. Because they have no other means of determining the appropriate sowing period, up to 22 % of farmers usually have May as fixed sowing period (Table 2). However, 19.60% of farmers rely on interpreting nature signs such birds' songs and behaviours, the flowering of trees, or activities of some insects. A significant percentage of farmers (10%) based their decision on past experience while 7.50% of farmers prefer early sowing with the risk of spending a lot of seeds against the hope that enough seedling. A share of 5.30 % of farmers follows other farmers for determining sowing period.

Table 2 : Farmers' methods for choosing crop sowing dates

Method	Percent of farmers
Amount of rainfall	35.70
Fixed period May	22.10
Signs from nature	19.60
Passed experience	10.20
Earlier sowing	7.50
Change in meteorological condition *(clouds, wind direction and temperatures)*	7.10
Follow other farmers	5.30

B. Soil nutrient management strategies

Different soils nutrient management practices are implemented by smallholders. Table 3 shows average amount of mineral fertilizer used per unit of cropped land. Farmers used in average 22.69 ± 3.11 kg ha $^{-1}$ of mineral fertilizer. Cotton producers had highest nutrient use intensity. These farmers benefit from fertilizer credit from cotton companies facilitating their access to mineral fertilizer. Most cotton producers usually divert fertilizer provided by cotton companies (through a credit system) for cropping cotton to cultivate food crops [14]. The poorest users were non-farm activities-based farmers who usually invest more in non-farm activities than in farm activities.

Table 3 : Mineral fertilizer use intensity (kg/ha)

n	$\overline{X}$	σ_X	$S.e_{\overline{X}}$	95% CI	
				Lower bound	Upper bound
328	22.69	1.58	28.58	19.58	25.79

Note: *n: number of households;* $\overline{X}$ *: Mean value of variable X;* σ_X*: Standard deviation of the mean,* $S.e_{\overline{X}}$ *: Standard error of the mean; CI: Confidence interval.*

Few farmers used organic fertilizer from crop residues composting and farm yard manure. Indeed, only 23.6% of farmers were composting crop residues and 28.06 % of famers were using farm yard manure for fertilizing crop lands. Stone bunds were implemented by around 35% of farmes as presented in table 4.

Table 4 : soil and water conservation practices (percentage of total sample)

Composting crop residues	23.6
Using farmyard manure	28.06
Implementing stone bunds	34.93

These results confirm that sustainable nutrient management practices remain limited [15-20]. The poor soil nutrient management results in nutrient mining in smallholder farms and thereby undermines crop productivity [21] and threatening farming sustainability [22].

IV.CONCLUSION

The findings of our study showed that though smallholder farmers well perceive climate variability, their adaptive response remains weak. Mineral fertilizer use is still low and the adoption of conservation agriculture practices (e.g. use of organic fertilizer, water harvesting and soil conservation measures) is limited to few farmers. Though Sustainable nutrient is been promoted by policy interventions for a quite long time the success is limited. In this context smallholder farmers are highly vulnerable to climate variability and change. The study demonstrates the need for rethinking the intervention strategies to ensure a better uptake of proven practices in sustainable nutrient management. There is a need as well to set up and plan capacity building of smallholder farmers in agro-meteorology to guide the decision making.

V. REFERENCES

[1] Shiferaw, B., K. Tesfaye, M. Kassie, T. Abate, B.M. Prasanna, and A. Menkir, Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. *Weather and Climate Extremes,* 2014. **3**(0): p. 67-79 DOI: http://dx.doi.org/10.1016/j.wace.2014.04.004.

[2] SPCPSA, Politique nationale de sécurité alimentaire et nutritionnelle. 2013, SPCPSA: Ouagadougou, Burkina Faso. p. 58.

[3] FAO, Revue des Politiques Agricoles et Alimentaires Au Burkina Faso, in Suivi Des Politiques Agricoles et Alimentaires en Afrique (SPAAA). 2013, Food and Agroculture Organization (FAO): Rome, Italie. p. 225.

[4] INSD, Analyse de quelques résultats des données de la phase principale de l'enquête intégrale sur les conditions de vie des ménages, EICVM 2009 2010, Institut National de la Statistique et de la Démographie: Ouagadougou. p. 13.

[5] Jalloh, A., G.C. Nelson, T.S. Thomas, R. Zougmoré, and H. Roy-Macauley, West African Agriculture and Climate Change. A Comprehensive Analysis. 1st edition ed, ed. A. Jalloh, G.C. Nelson, T.S. Thomas, R. Zougmoré, and H. Roy-Macauley. 2013, Washington, DC: International Food Policy Research Institute.

[6] Olsson, L., M. Opondo, P. Tschakert, A. Agrawal, S.H. Eriksen, S. Ma, L.N. Perch, and S.A. Zakieldeen, Livelihoods and poverty, in Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L.

Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White, Editors. 2014, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p. 793-832.

[7] Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso, Food security and food production systems, in Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White, Editors. 2014, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p. 485-533.

[8] Blanc, E., The Impact of Climate Change on Crop Yields in Sub-Saharan Africa *American Journal of Climate Change,* 2012. **1**: p. 1-13

[9] Sultan, B., P. Roudier, P. Quirion, A. Alhassane, B. Muller, M. Dingkuhn, P. Ciais, M. Guimberteau, S. Traore, and C. Baron, Assessing climate change impacts on sorghum and millet yields in the Sudanian and Sahelian savannas of West Africa. *Environmental Research Letters,* 2013. **8**: p. 9.

[10] INSD, Monographie de la région du Sud-Ouest, INSD, Editor. 2009, INSD: Ougadougou, Burkina Faso. p. 152.

[11] MAHRH and GTZ, Mission d'appui à l'identification des interventions du Programme de Developement de l'Agriculture de la coopération germano-burkinabè dans la région administrative du Sud-Ouest. 2004: Ouagadougougou. p. 35.

[12] Pallo, F.J.P. and L. Thiombiano, Les sols ferrugineux tropicaux lessivés à concrétions du Burkina Faso : Caractéristiques et contraintes pour l'utilisation agricole. *Soltrop,* 1989. **89**: p. 307-327.

[13] Kissou, R., L. Thiombiano, A.K. Nébié, A. Semde, and K.J. Yago. La Base mondiale de données sur les sols: avantages et faiblesses pour la connaissance et l'utilisation des milieux édaphiques au Burkina Faso. in *Quatorzième Réunion du Sous-Comité ouest et centre africain de corrélation des sols pour la mise en valeur des terres*. 2000. 9 au 13 octobre 2000, Abomey, République du Bénin: FAO, Rome.

[14] PAFASP and CAPES, Analyse des possibilités de diversification des sources de revenus en zones cotonnières du Burkina Faso. 2011, CAPES: Ouagadougou. p. 98.

[15] Place, F., C.B. Barrett, H.A. Freeman, J.J. Ramisch, and B. Vanlauwe, Prospects for integrated soil fertility management using organic and inorganic inputs: evidence from smallholder African agricultural systems. *Food Policy,* 2003. **28**(4): p. 365-378 DOI: 10.1016/j.foodpol.2003.08.009.

[16] Bationo, A., A. Hartemink, O. Lungu, M. Naimi, P. Okoth, E. Smaling, and L. Thiombiano, African Soils: Their Productivity and Profitability of Fertilizer Use., in African Ferilizer Summit, A. Bationo, H. A., L. O., N. M., P. Okoth, E. Smaling, and L. Thiombiano, Editors. 2006: 9-13 June 2006, Abuja, Nigeria. p. 25.

[17] Chianu, J.N., J.N. Chianu, and F. Mairura, Mineral fertilizers in the farming systems of sub-Saharan Africa. A review. *Agronomy for Sustainable Development,* 2012. **32**(2): p. 545-566 DOI: 10.1007/s13593-011-0050-0.

[18] Chianu, J.N., J.N. Chianu, and F. Mairura, Organic Fertilizers in Sub-Saharan Farming Systems, in *Organic Fertilisation, Soil Quality and Human Health*, E. Lichtfouse, Editor. 2012,

Springer Netherlands. p. 31-65 DOI: 10.1007/978-94-007-4113-3_3.

[19] Anley, Y., A. Bogale, and A. Haile-Gabriel, Adoption decision and use intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo District, Western Ethiopia. *Land Degradation & Development,* 2007. **18**(3): p. 289-302 DOI: 10.1002/ldr.775.

[20] Kabore-Sawadogo, S., K. Ouattara, M. Balima, I. Ouédraogo, S. Traoré, M. Savadogo, and J. Gowing, Burkina faso: A cradle of Farm-Scale technologies, in *Water Harvesting in Sub-Saharan Africa*, W. Critchley and J. Gowing, Editors. 2013, Routledge: London (UK) and New York (USA). p. 51-69 DOI: 10.4324/9780203109984.

[21] Giller, K.E., E.C. Rowe, N. de Ridder, and H. van Keulen, Resource use dynamics and interactions in the tropics: Scaling up in space and time. *Agricultural Systems,* 2006. **88**(1): p. 8-27 DOI: 10.1016/j.agsy.2005.06.016.

[22] Cobo, J.G., G. Dercon, and G. Cadisch, Nutrient balances in African land use systems across different spatial scales: A review of approaches, challenges and progress. *Agriculture, Ecosystems & Environment,* 2010. **136**(1–2): p. 1-15 DOI: http://dx.doi.org/10.1016/j.agee.2009.11.006.