Impacts of Climate Variability and Climate Change on Agricultural Productivity of Smallholder Farmers in Southwest Nigeria

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Abstract— This study was undertaken to assess the impacts of climate change on agricultural productivity and farmers' adaptation strategies in Egbeda local government area, Oyo State, southwest Nigeria. The study sourced primary data from a total of 411 households who are mainly farmers and it also used different methods and approaches including Social Analysis System (SAS^2), multi-stage sampling techniques, structured questionnaires, focused group discussion and key informant/in-depth interview. The secondary data was obtained from credible publications and institutions including the Nigerian Meteorological Agency (NiMet). The primary data obtained was triangulated with the secondary data to arrive at the findings of this study which covered a period of 30 years from 1985 to 2015. The findings from this study showed that crop yield had drastically decreased due to erratic rainfall, increase in sunshine hours, increase in temperature and pest infestation. This calls for urgent actions to be taken by all relevant stakeholders in the agriculture sector be it the farmers themselves, government, private sector, non-governmental organizations and other non-state actors to adequately address the adverse impacts of climate change.

Index Terms— Climate variability, climate change, rainfall, adaptation, climate change impacts, temperature

1 INTRODUCTION

The increase in the concentration of Greenhouse Gases (GHG) in the atmosphere have resulted in the current global warming observed through the increase in temperature, unpredictable rainfall patterns, flash floods among other climate variables in recent time [1],[2],[3]. Although the whole world experience this changes differently, the impacts are differentiated among continents, sectors, people and ecosystem. While some regions of the world may have the adaptive capacity to cope with the pounding impacts of climate change, the African continent remains vulnerable to the devastating impacts of climate variability and climate change [4],[5],[6],[7]. One of the major sectors in Africa that is most vulnerable to the impacts of climate change is the agriculture sector which also employs the largest labour force in the continent providing food and creating jobs for millions of its people [8],[9]. The incidences of erratic rainfall and increasing temperature had further complicated the already bad situation of poor crop yield experience by many smallholder farmers [10] who depend on this climate sensitive production sector for their livelihood [11],[12]. This has led to farmers trying out different strategies to mitigate and adapt to the adverse impacts of climate change especially in many developing countries including Africa [13],[14], [15],[16]. The experience and perceptions of these smallholder farmers on the changing climate patterns also corroborate the findings from the meteorological data that established these changes in our climate [17]. This study confirms other studies and reports [18],[19],[20] which showed that climate change has contributed to the growing food insecurity, poor crop yield, crop failure, reduced agricultural productivity, reduction in the Gross National Domestic Products (GDP) and host of other impacts of climate change in Africa and in Nigeria. Though opinions might vary and studies may differ on the magnitude of the impacts of climate change in Africa and Nigeria, one thing that is sure is the fact that the cost of inaction today will far outweigh the cost of action tomorrow and the time to act is now to safeguard lives, ensure food security and better livelihoods in addressing the impacts of climate change.

2 MATERIAL AND METHODS

This study adopted combination of methods that are both quantitatively and qualitatively as well as the use of other tools such as the second generation of Social Analysis System (SAS^2). The study focused on three categories of smallholder farmers namely, those whose occupation are only farming, those combining farming with livestock rearing and those who combine farming with trading. A total of 411 household heads was surveyed for the primary data using designed questionnaires, SAS^2 tools, Focused Group Discussions and Key Informant/In-depth Interviews while the secondary data was sourced from credible publications as well as agencies. The data obtained from primary and secondary sources was triangulated using other analytical tools and interpretation using the SAS^2 tool, Statistical Package for Social Sciences (SPSS) and MS excel. In the analysis of data, descriptive statistics was also used. Analysed data was presented in graphs, charts, and other pictorial format. A social engagement, participatory and collaborative tool of Social Analysis System (SAS^2) in combination with other approaches of stakeholder input of knowledge generation for a challenging problem through joint sharing of knowledge [21] and a comprehensive joint solution finding methods [22] was used in this Transdisciplinary (TD) research study. In addressing societal challenges of climate change and its im-

pacts, these methods become very useful to bridge the research gap between society and science in the co-production of knowledge and solutions.

3 DISCUSSIONS AND RESULTS

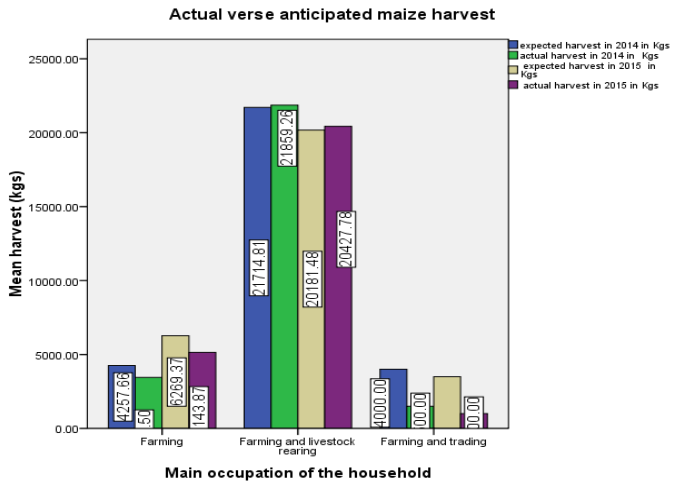

Fig.1.The actual and expected maize harvest in 2014 and 2015
Source: Field survey, 2017.

The result obtained from the analysis as computed (Fig. 1) showed that the actual harvested maize falls short of expected harvest in 2014 for those whose main occupation is only farming and those who combined farming with trading but different for those who combined farming and livestock rearing in which their actual harvest was slightly above their expected harvest. In the year 2015 from the study, a similar trend (Fig. 1) with that of the year 2014 was obtained for this three categories of farmers. This variance may be due to various factors such as extra sources of income, application of organic manure from the livestock or additional resources from the livestock to be able to purchase and apply inorganic fertilizer for those combining farming with livestock rearing.

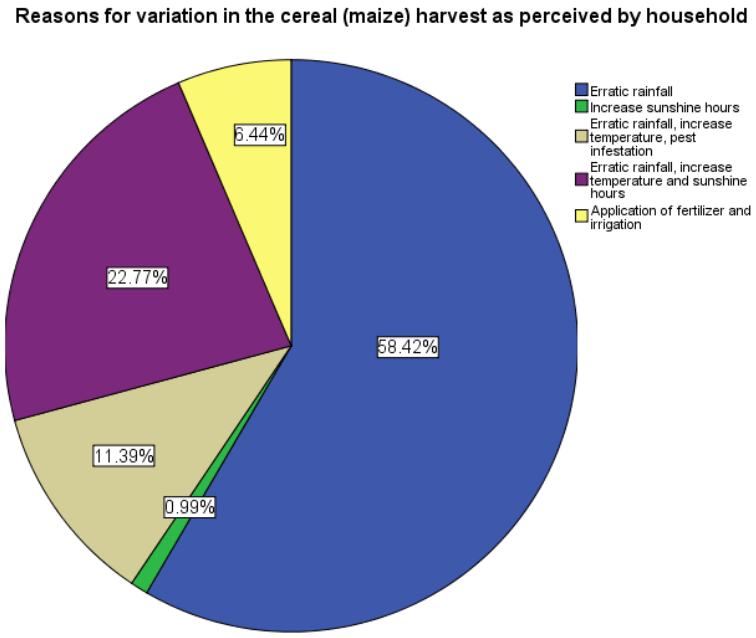

Fig. 2. Reasons for variation in the harvested maize perceived by farmers
Sources: Field survey, 2017

On the reasons that led the variations in the quantities of harvested maize (Fig. 2), majority of the farmers (58%) attributed it to erratic rainfall, 23% said it was a combination of erratic rainfall, increase in temperature and sunshine hours. Others 11% attributed the variation in yield to erratic rainfall and increase in temperature and pest infestation, while 6% and 1% said it was due to application of fertilizer with irrigation practices and increase in sunshine hours respectively.

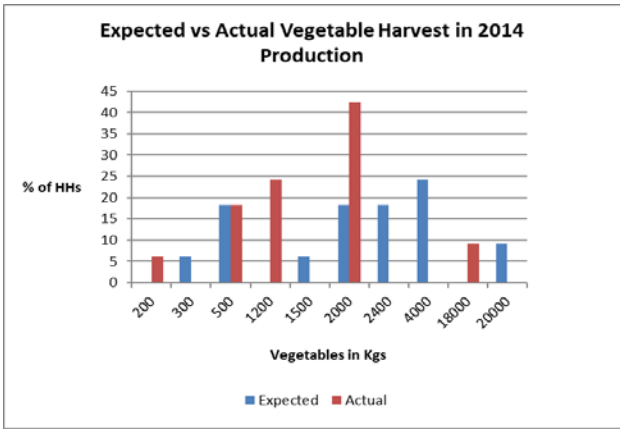

Fig. 3. Expected and actual vegetable harvest in 2014
Sources: Field survey, 2017

A good number of smallholder farmers in the study areas are also

engage in vegetable farming. In the year 2014, on the average, the expected harvest from vegetable fall far short from the actual harvest as shown in Fig. 2. In some cases, the quantities the farmers harvest was very insignificant or zero harvest compared to what they expected to harvest from a given portion of land.

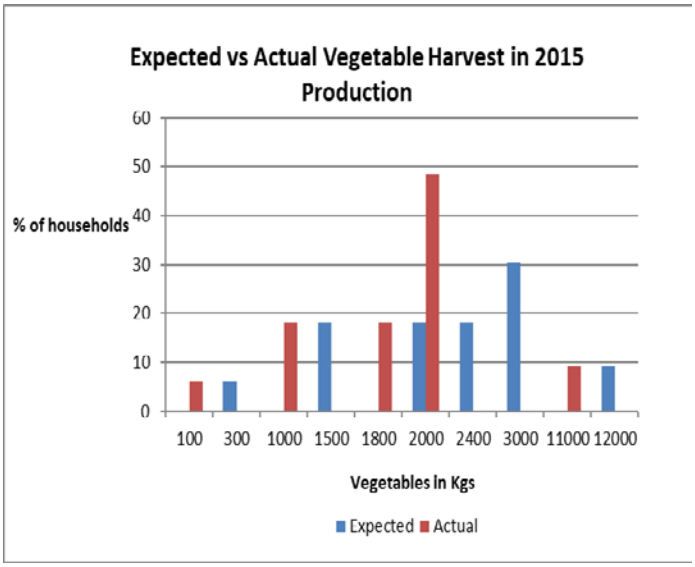

Fig. 4. Expected and actual vegetable harvest in 2015
Sources: Field survey, 2017

In the year 2015, the story of what the farmers harvested compared to what they expected to harvest on average was dismally almost none like in the year 2014 as shown in Fig.4. The actual harvest fell far short of the expected yield and the reason for all these according to the farmers is as shown in Fig. 5.

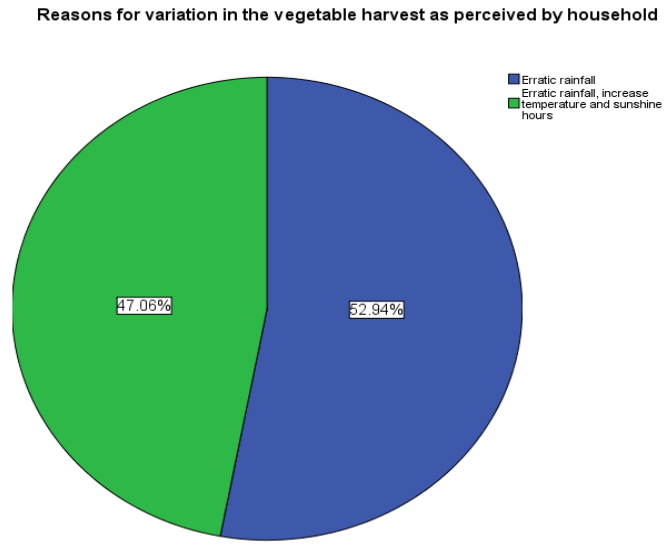

Fig. 5. Reasons for variation in the harvested maize perceived by farmers
Sources: Field survey, 2017

More than half (53%) of the farmers believed the reason for the variation in the quantities of harvested vegetable in 2015 (Fig.5) is as a result of erratic rainfall while the remaining 47% attributed it to a combination of factors such as erratic rainfall with increase in temperature and sunshine hours.

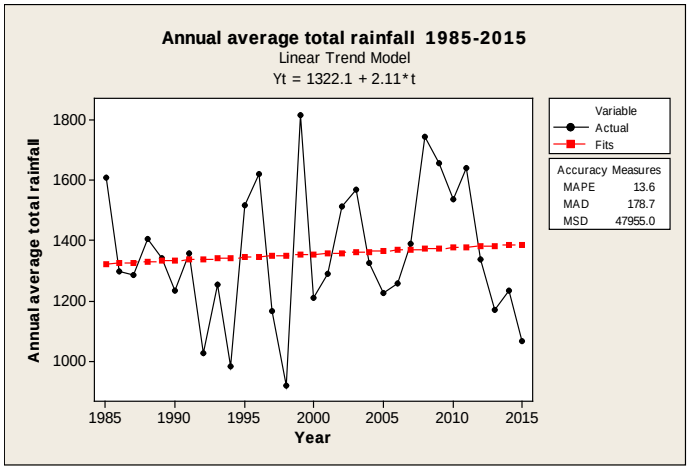

Fig. 6. The Average Rainfall for Oyo state (1985-2015)
Source: Ogallah, *et. al*. 2017

Fig. 6 showed a high level of variability which can also lead to erratic rainfall pattern as observed by smallholder farmers in the study areas. This meteorological information (Fig. 6) corroborated the findings from the farmers that the rainfall pattern has changed in recent time and this gives credence to the reasons in the variations in the quantity of harvested crop and crop yield in the region.

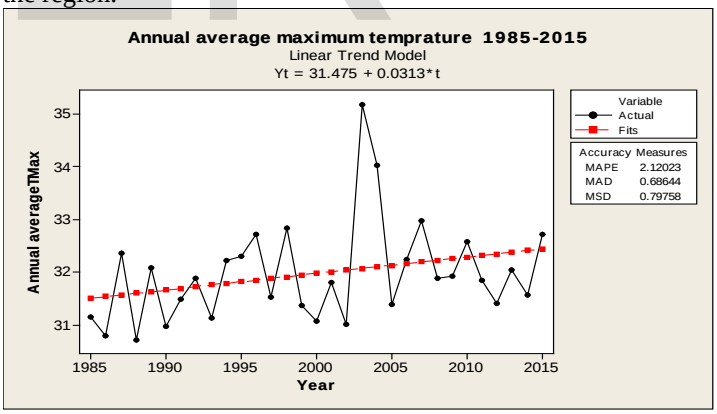

Fig. 7. The Average Maximum Temperature for Oyo State (1985-2015)
Source: Ogallah *et. al.* 2017

Given the increasing trend in the temperature pattern (Fig. 7) and the result from the study as shown in Fig. 2 and Fig. 5, it can be established therefore that increase in temperature has an adverse impact on agriculture produce of smallholder farmers in the region.

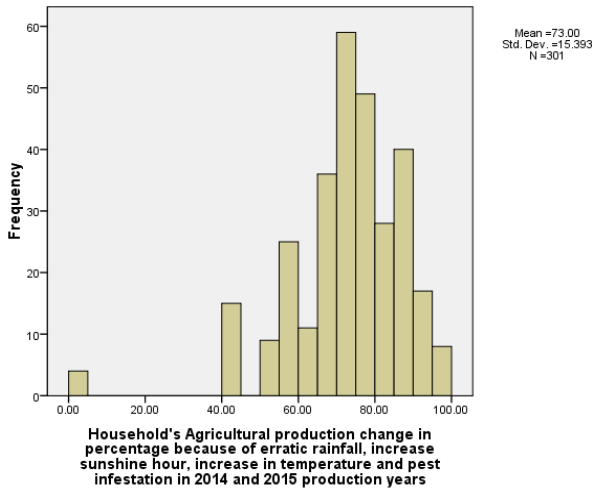

Fig.8.Average household agricultural production change due to erratic rainfall, increase sunshine hour, increase in temperature and pest infestation in 2014 and 2015
Sources: Field survey, 2017

Average household agricultural production change due to erratic rainfall, increase sunshine hour, increase in temperature and pest infestation in 2014 and 2015 production years was at 73%. Fig.8 depicts the spread as indicated by the different smallholder farmers in the study areas. This spelt a huge adverse implications and it comes with additional cost for the smallholder famers whose means of livelihood is tied to cultivation of maize and vegetables.

4 Conclusion

There is no doubt that in the business as usual scenario the impacts of climate change will continue into the near future unabated. As found from this study, the temperature has continued to increase and the rainfall pattern erratic in the past 30 years and the projection showed that this trend is likely to continue if urgent actions are not taken. The implication of this therefore is that smallholder farmers will bear most the brunt of these impacts which has already translated in decreased crop yield, crop failure, increase poverty level and general downward trend in agricultural productivity. Increase temperature and erratic rainfall patterns which are linked to climate change and variability are the major challenges responsible for the decline in agriculture produce in the study areas. The long term impacts can only be imagined than experienced as not only the farmers will suffer from the negative consequences of climate change and variability but also the government through decrease in the Gross Domestic Product for Nigeria. The study showed an average of 73 per cent in household agricultural production change due to erratic rainfall, increase sunshine hour, increase in temperature and pest infestation in 2014 and 2015 production years. This has huge implications on food security, securing livelihoods and the cost of adaptation to climate change in the agriculture sector. There is therefore need for further research to establish specific impacts and economic cost of climate change to agriculture and also on the smallholder farmers for effective adaptation strategy tailored toward specific location and target group of farmers. Designing appropriate adaptation interventions should take into account the inputs the smallholder farmers and other relevant actors in the agriculture supply chain.

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References

[1]. Ogallah, S.S., Wandiga, S.O., Olago, D., Oriaso, S. (2017) Smallholder farmers' perceptions on temperature trends and adaptation strategies to climate change in Egbeda District, Oyo State, Southwest Nigeria. *International Journal of Interdisciplinary Research and Innovations.* Vol. 5, Issue 4, pp: (1-6)

[2]. Ogallah, S.S., Wandiga, S.O., Olago, D., Oriaso, S. (2017) Farmers' perceptions of changes in rainfall pattern and adaptation to climate change in Southwest Nigeria, Egbeda Local Government Area. *International Journal of Interdisciplinary Research and Innovations.*Vol. 5, Issue 4, pp: (7-13)

[3]. John Houghton (2009) *Global warming: The complete briefing*. Cambridge University Press, Cambridge

[4]. Stern, Nicholas (2007) *The Economics of Climate Change: The Stern Review*. The Cambridge University Press, Cambridge, 692 pp.

[5]. NEST &Tegler, B. (Eds.) (2011b) *Climate Change Adaptation Strategy Technical Reports-Nigeria*, (CCASTR). Building Nigeria's Response to Climate Change (BNRCC)/Nigerian Environmental Study/Action Team (NEST), Ibadan, Nigeria,176 pp.

[6]. IPCC (2014) Summary for policymakers. In: *Climate Change 2014: Impacts, Adaptation &Vul*
Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., 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 (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

[7]. Steger Manfred (2017) *Globalization: Avery short introduction*. Oxford University Press, New York.

[8]. United Nations Environmental Programme (UNEP) (2014) *Africa's Adaptation Gap Report 2: Bridging the gap – mobilizing resources*. UNEP, Nairobi, 67 pp.

[9]. Stern, Nicholas (2007) *The Economics of Climate Change: The Stern Review*. Cambridge University Press, Cambridge, 692 pp.

[10]. Ogallah, S.S., Wandiga, S.O., Olago, D., Oriaso, S. (2017) Smallholder farmers' perceptions on temperature trends and adaptation strategies to climate change in Egbeda District, Oyo State, Southwest Nigeria. *International Journal of Interdisciplinary Research and Innovations.* Vol. 5, Issue 4, pp: (1-6)

[11]. IfejikaSperanza, Chinwe (2010) *Resilient adaptation to climate change in African agriculture*. DeutschesInstitutfürEntwicklungspolitik, Bonn, 311 pp.

[12]. Bello, O. B., Ganiyu, O. T., Wahab, M. K. A., Afolabi, M. S., Oluleye, F., Ig, S. A., Mahmud, J., Azeez, M. A., Abdulmaliq, S. Y. (2012) Evidence of climate change impacts on agriculture and food security in Nigeria. *International Journal of Agriculture and Forestry.* **2***(2): 49-55.*

[13]. Ogallah, S.S., Wandiga, S.O., Olago, D., Oriaso, S. (2017) Smallholder Farmers' Adaptation Strategies to Climate Change in Southwest Nigeria, Egbeda Local Government Area, Oyo State. *International Journal of Interdisciplinary Research and Innovations.* Vol. 5, Issue 4, pp: (14-19)

[14]. NEST and Woodley, E. (Eds.) (2011a) *Reports of Pilot Projects in Community-based Adaptation - Climate Change in Nigeria*. Building Nigeria's Response to Climate Change (BNRCC)/Nigerian Environmental Study/Action Team (NEST), Ibadan, Nigeria, 235pp

[15]. NEST &Tegler, B. (Eds.) (2011b) *Climate Change Adaptation Strategy Technical Reports-Nigeria,* (CCASTR). Building Nigeria's Response to Climate Change (BNRCC)/Nigerian Environmental Study/Action Team (NEST), Ibadan, Nigeria,176 pp.

[16]. NEST (2011d) *Reports of Research Projects on Impacts and Adaptation*. Building Nigeria's Response to Climate Change (BNRCC)/Nigerian Environmental Study/Action Team (NEST), Ibadan, Nigeria. 339 pp.

[17]. Ogallah, S.S., Wandiga, S.O., Olago, D., Oriaso, S. (2017) Farmers' perceptions of changes in rainfall pattern and adaptation to climate change in Southwest Nigeria, Egbeda Local Government Area. *International Journal of Interdisciplinary Research and Innovations.*Vol. 5, Issue 4, pp: (7-13)

[18]. Ozor, N. (Eds.) (2014) Climate Change, Agriculture and Higher Education: Multidisciplinary Issues and Perspectives. Grand Heritage Global Communications, Nsukka, 2-322 pp.

[19]. Alemu, A.A., Wandiga, S.O., Olago, D., Omondi, P., Oriaso, S. (2017) Household's adaptive capacity level to climate change impacts and food security in Northern Ethiopia, Kolla Temben District. *International Journal of Interdisciplinary Research and Innovations.*Vol. 5, Issue 3, pp: (9-13)

[20]. Ogallah, S.S., Wandiga, S.O., Olago, D., Oriaso, S. (2017) Smallholder Farmers' Adaptation Strategies to Climate Change in Southwest Nigeria, Egbeda Local Government Area, Oyo State. *International Journal of Interdisciplinary Research and Innovations.* Vol. 5, Issue 4, pp: (14-19)

[21]. Jacques, M.C, and Daniel, J.B. (2008) *A Collaborative Inquiry and Social Engagement*. SAGE Publications India Pvt. Ltd, New Delhi, India, 317 pp.

[22]. Openjuru, G,L., Namrata, J., Rajesh, T., and Budd, H., (2015) Despite knowledge democracy and community-based participatory action research: Voices from the global south and excluded north still missing. *Action Research Journal (ARJ).***13***(3): 219–229* [19].