

**EFFECT OF CLIMATE CHANGE ON SMALL-HOLDER FARMERS'
LIVELIHOODS IN MANAFWADISTRICT, UGANDA**

OLUPOT JUSTIN

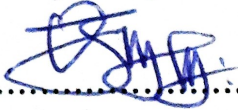
BU/GS18/MCC/34

**A RESEARCH THESIS SUBMITTED TO THE SCHOOL OF
POSTGRADUATE RESEARCH AND INNOVATIONS IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD
OF THE DEGREE OF MASTER OF CLIMATE CHANGE
AND DISASTERMANAGEMENT OF
BUSITEMAUNIVERSITY**

October, 2025

DECLARATION

I, **Olupot Justin**, declare that this dissertation is my original work, except where due acknowledgement has been made. I declare that this work has never been submitted to this university or any other institution for funding or fulfillment for any award.


.....

Olupot Justin

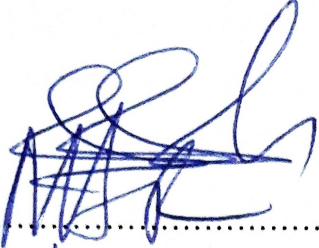
BU/GS18/MCC/34

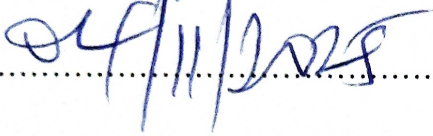
Date: **4/11/2025**

APPROVAL

This research dissertation is submitted as a partial fulfillment for the award of Masters of Science in Climate Change and Disaster Management of Busitema University, with my approval as the academic supervisor.

Dr. Masaba Sowedi

Signature:

Date:

DEDICATION

I dedicate this work to my family and all friends whose tireless efforts gave a firm background to my academic path up to this level and particularly my family members (Wife: Gloria Olupot, Children: Eliora Olupot, Elijah Olupot and Ellion Olupot) who withstood the thick and thin because of my decision to pursue further studies.

ACKNOWLEDGEMENT

In writing this dissertation, I drew a lot of inspiration from my fellow students, who often put me right whenever I was stuck; to them I express my heartfelt appreciation. I owe many thanks to several persons who were particularly helpful to me; among them are my supervisor whose supervision and guidance afforded me a smile. I also express my gratitude to the authorities of Busitema University, particularly Faculty of Natural Resources and Environmental Sciences, for availing me the necessary facilities and to the lecturers in the department whose knowledge and skills enabled me to achieve my goal as a Masters student.

TABLE OF CONTENTS

DECLARATION	2
APPROVAL	3
DEDICATION	4
ACKNOWLEDGEMENT	5
TABLE OF CONTENTS.....	6
LIST OF FIGURES	10
LIST OF TABLES	11
LIST OF ACRONYMS	13
ABSTRACT.....	14
CHAPTER ONE: INTRODUCTION.....	16
1.1 Background	16
1.2 Problem statement	17
1.3 Purpose of the study	17
1.4 Specific Objectives.....	17
1.5 Research questions	17
1.6 Scope of the study	18
1.7 Significance/ Justification of the study	18
1.8 The conceptual Framework.....	18

<i>Figure 1.1: Conceptual Framework the sustainable livelihood framework (adapted from DFID, 2000)</i>	19
--	----

CHAPTER TWO: LITERATURE REVIEW	19
--------------------------------------	----

2.1 Smallholder farmers' perception and understanding of climate change	20
2.2 Small-holder farmers' livelihoods amidst climate change	22
2.3 Climate change adaptation strategies by smallholder farmers	24
2.4 Theoretical Perspectives on Climate Change and Livelihoods	27
2.5 Identified Gaps in the Literature	27
2.6 Summary and Critical Reflection.....	28
3.0 Introduction	29
3.1 Research design.....	29
3.2 Study Area Description	29
3.2.1 Location.....	29
3.2.2 Rainfall	29
3.2.3 Soils.....	30
3.2.4 Vegetation	30
3.2.5 Drainage	30
3.2.6 Relief	31
3.2.7 Demography	31

Figure 3:1. Administrative units of Manafwa (source, Manafwa District statistical Abstract 2019-2020) 32

3.3 Study population	32
3.4 Sample size.....	32
3.5 Sampling Procedure	33
3.6 Data Types and Sources	33
3.7 Data Collection Methods and Tools.....	34
3.8 Data Analysis	34
3.9 Operational Definition of Variables.....	34
3.11 Ethical considerations	37
3.10 Limitations and delimitations of the study	37
CHAPTER FOUR: DISCUSSION OF RESULTS	38
4.1 Socio-economic demographic characteristics of the respondents.....	38
4.2. Smallholder farmers’ perception and understanding of local climate change	39
4.3 Effects of Climate Change on smallholder farmers’ livelihoods	51
4.4 Adaptation strategies employed by respondents	57
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS	65
5.0 Introduction	65
5.1 Conclusion.....	65

5.2 Recommendations	67
References	69
APPENDICES	78
APPENDIX I: INTERVIEW SCHEDULE FOR KEY INFORMANTS	78
APPENDIX 2: GUIDING QUESTIONS FOR FOCUS GROUP DISCUSSIONSWITH SELECTED FARMERS.....	81

LIST OF FIGURES

Figure 1.1: Conceptual Framework the sustainable livelihood framework (adapted from DFID, 2000).....	17
Figure 3:1. Administrative units of Manafwa (source, Manafwa District statistical Abstract 2019-2020).....	27
Figure 4:1. A Farmer practicing second ploughing using oxen before planting.....	32
Figure 4:2. Pie chart showing the percentage of respondents who had witnessed climate change.....	32
Figure 4:3. Perception of respondents on the major climatic changes noticed.....	35
Figure 4:4. Perception of respondents on changes in temperature.....	37
Figure 4:5. Perception of the respondents on drought notices in the study area.....	39
Figure 4:6. Perception of respondents on the effects of climate change on livelihood.....	44
Figure 4:7. Effects of climate change on water for crop production.....	44
Figure 4:8. Perception of respondents on diseases induced by changes in climate.....	45
Figure 4:9. Perception of respondents on the impacts of climate change on crop yields.....	47
Figure 4:10. Percentage of respondents practicing adaptation strategies.....	50
Figure 4:11. Contour ploughing and terracing as adaptation strategy used by some of the farmers in the study area.....	51
Figure 4:12. A section of farmers land planted with trees as an adaptation strategy.....	52
Figure 4:13. A farmer using family labour to drain water logged garden before planting in Lwanjusi Sub-county.....	54
Figure 4:14. Percentage of respondents who own sources of water for irrigation.....	56
Figure 4:15. River Nangilima which has always acted as a source for irrigation water.....	56

Figure 1.16.Irrigation of cabbage in Kato sub-county, which has enabled farmers to produce throughout the year	57
--	----

LIST OF TABLES

Table 4.1: Perception of respondents on the causes of climate change.....	34
---	----

Table 4:2. Relationship between demographic factors and the possibility to notice a change in climate.....	36
Table 4:3. Perceptions of the respondents on the major weather changes noticed.....	37
Table 4:4. Relationship between times spent in the area and the possibility to notice climate changes.....	38
Table 4:5. Perception of the respondents about changes in rainfall received.....	39
Table 4:6. Perception of respondents about the change in flooding events.....	39
Table 4:7. Relationship between drought notices and demographic factors.....	41
Table 4:8. Months of excess temperatures.....	41
Table 4:9. Months of the year in which excess rainfall is noticed in the study area.....	42
Table 4:10. Months of the year in which excess rainstorms are noticed in the study area.....	42
Table 4:11. Months of the year in which excess windstorms are noticed.....	43
Table 4:12. Months of the year in which severe sandstorms are noticed in the study area.....	43
Table 4:13. Months of the year in which excess droughts are noticed in the study area.....	44
Table 4:14. Months of the year in which excess droughts are noticed in the study area.....	44
Table 4:15. Relationship between climate changes noticed and water for production.....	46
Table 4:16. Relationship between flooding events and increase in crop diseases.....	47
Table 4:17. Climatic changes noticed in the study area and their significance to the crop growing season.....	48
Table 4:18. Effect of climate change on farm markets.....	49

Table 4:19. Effect of climate change on crop quality.....	49
Table 4:20. Effect of climate change on soil fertility.....	50
Table 4:21. Effect of climate change on crops.....	51
Table 4:22. Adaptation strategies practiced by respondents in the study area.....	52
Table 4:23. Relationship between adaptation to climate change and demographic factors.....	53
Table 4:24. Alternative adaption strategies adopted by respondents.....	54
Table 4:25. Challenges faced by farmers during the implementation of adaptation strategies..	54
Table 4:26. Percentage of respondents who had access to extension services.....	56
Table 4:27. Factors influencing access to agricultural extension services.....	56

LIST OF ACRONYMS

FGD : Focus Group Discussions

KIIs : Key Informant Interviews

CC : Climate Change

S.H.F : Small Holder Farmers

NEMA : National Environmental Management Authority

UNMA : Uganda National Meteorological Authority

FAO : Food and Agricultural Organization

UBOS : Uganda National Bureau of Standards

UNHS : Uganda National Household Survey

ABSTRACT

The aim of the study was to assess the effects of climate change on smallholder farmers in Manafwa District of Uganda. Specifically, the study assessed the community awareness and knowledge about climate change; the indicators, causes, effects, adaptation and mitigation measures employed and the challenges encountered by small holder farmers in response to climate

change impacts. A survey of 398 households, two FGDs and six key informant interviews were conducted. Survey data was analyzed with help of Stata version 16 whereas qualitative data was analyzed by way of manual coding. Climate-related hazards such as floods, landslides, prolonged droughts, too much rains, hailstorm presence, wind storm presence and temperature extremes were identified as major indicators of changing climate conditions. The study revealed that climate change affects smallholder farmers in a number of ways, including; destruction of crops, reduced soil fertility, increased crop pest and disease incidences, among others. Farmers adopted various adaptation practices and measures, including mulching, terracing, and diversifying crop types to improve resilience to climate impacts. The major issues hindering climate change adaptation were; the high cost of the available climate change adaptation mechanisms coupled with the high poverty levels among the small holder farmers.

The study recommends increasing farmer education and awareness through, sensitization, community training programs, design and implementation of development programs that provide alternative livelihood sources for the small holder farmers were recommended to effectively manage and reduce climate change impacts.

Key words: Climate change, livelihoods, adaptation, small holder farmers

References

- Abid, M., Scheffran, J., Schneider, U. A., & Elahi, E. (2019). Farmer perceptions of climate change, observed trends and adaptation of agriculture in Pakistan. *Environmental Management*, 63, 110–123.
- Alston, J. M., & Pardey, P. G. (2014). Agriculture in the global economy. *Journal of Economic Perspectives*, 28(1), 121–146.
- Altieri, M. A., Funes-Monzote, F. R., & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: Contributions to food sovereignty. *Agronomy for Sustainable Development*, 32(1), 1–13. <https://doi.org/10.1007/s13593-011-0065-6>

- Altieri, M. A., & Nicholls, C. I. (2017). The adaptation and mitigation potential of traditional agriculture in a changing climate. *Climatic Change*, 140, 33–45.
- Antwi-Aggyei et al. (2014). *Livelihood adaptations to climate variability: insights from farming households in Ghana*.
- Anwar, F., Mohsin, M., & Arshad, S. (2023). A Statistical Survey on the Socioeconomic and Demographic Livelihood of Brick Kiln Workers: A Case Study of Bahawalpur District, Punjab, Pakistan. *Proceedings of the Pakistan Academy of Sciences: A. Physical and Computational Sciences*, 60(4), 55–67.
- Anwar, M. R., Liu, D. L., Macadam, I., & Kelly, G. (2013). Adapting agriculture to climate change: a review. *Theoretical and Applied Climatology*, 113, 225–245.
- Arbuckle Jr, J. G., Morton, L. W., & Hobbs, J. (2015). Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, climate change beliefs, and perceived risk. *Environment and Behavior*, 47(2), 205–234.
- Baffour-Ata, F., Awugyi, M., Ofori, N. S., Hayfron, E. N., Amekudzi, C. E., Ghansah, A., & Akorli, R. (2023). Determinants of yam farmers’ adaptation practices to climate variability in the Ejura Sekyedumase municipality, Ghana. *Heliyon*, 9(3).
- Bamutaze, Y., Thiemann, S., & Förch, G. G. (2014). Integrated Watershed Management for Urban Water Security Integrated Watershed Management-a Tool for Urban Water Security Workshop Results from Mbale, Uganda. *Proceedings of the Integrated Watershed Management for Urban Water Security Integrated Watershed Management-a Tool for Urban Water Security Workshop Results from Mbale, Mbale, Uganda*, 10–16.
- Basher, R. (2006). Global early warning systems for natural hazards: systematic and people-centred. *Philosophical Transactions of the Royal Society a: Mathematical, Physical and Engineering Sciences*, 364(1845), 2167–2182.
- Batte, C., Nuwasiima, S., Semulimi, A. W., Apio, P. O., Mutebi, R. K., Mwesigwa, M. M.,

- Twinamasiko, N., Siddharthan, T., Mukisa, J., & Mukunya, D. (2024). Coping strategies of school-going adolescents during the COVID-19 pandemic in the climate vulnerable Manafwa watershed, Uganda. *BMC Psychology*, 12(1), 312.
- Belay, A., Oludhe, C., Mirzabaev, A., Recha, J. W., Berhane, Z., Osano, P. M., Demissie, T., Olaka, L. A., & Solomon, D. (2022). Knowledge of climate change and adaptation by smallholder farmers: evidence from southern Ethiopia. *Heliyon*, 8(12).
- Below, T. B., Schmid, J. C., & Sieber, S. (2015). Farmers' knowledge and perception of climatic risks and options for climate change adaptation: a case study from two Tanzanian villages. *Regional Environmental Change*, 15, 1169–1180.
- Bhatta, G. D., & Aggarwal, P. K. (2016). Coping with weather adversity and adaptation to climatic variability: a cross-country study of smallholder farmers in South Asia. *Climate and Development*, 8(2), 145–157.
- Brown, O., Hammill, A., & McLeman, R. (2007). Climate change as the 'new' security threat: implications for Africa. *International Affairs*, 83(6), 1141–1154.
- Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints. *Environmental Science & Policy*, 12(4), 413–426.
- Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., & Herrero, M. (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. *Journal of Environmental Management*, 114, 26–35.
- Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., & Lobell, D. B. (2009). Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences*, 106(49), 20670–20674.

- Chambers & Conway. (1992). *An Analysis of the Effectiveness Farmer Field School (FFS) Approach in Sustainable Rural Livelihood (SRL): The Experience of Punjab-Pakistan*. Agricultural Sciences, Vol.6.
- Chikaire, J., & Nnadi, F. N. (2011). Indigenous Knowledge for Climate Change Mitigation and Adaptation in Agriculture in sub-Saharan Africa. *Report and Opinion*, 3(5), 32–40.
- Connolly-Boutin, L., & Smit, B. (2016). Climate change, food security, and livelihoods in sub-Saharan Africa. *Regional Environmental Change*, 16, 385–399.
- Cooper, P. J. M., Dimes, J., Rao, K. P. C., Shapiro, B., Shiferaw, B., & Twomlow, S. (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change? *Agriculture, Ecosystems & Environment*, 126(1–2), 24–35.
- Egeru, A., Barasa, B., Nampijja, J., Siya, A., Makooma, M. T., & Majaliwa, M. G. J. (2019). Past, present and future climate trends under varied representative concentration pathways for a sub-humid region in Uganda. *Climate*, 7(3), 35.
- F Dapilah, J Ostergaard Nielsen, Cecillie Friis, (2020). The role of social networks in building adaptive capacity and resilience to climate change. A case study from Northern Ghana.
- Fan, L., Lu, C., Yang, B., & Chen, Z. (2012). Long-term trends of precipitation in the North China Plain. *Journal of Geographical Sciences*, 22, 989–1001.
- Fonta, W., Edame, G., Anam, B. E., & Duru, E. J. C. (2011). *Climate change, food security and agricultural productivity in Africa: Issues and policy directions*.
- Fox, K. M., Nelson, S., Frankenberger, T. R., & Langworthy, M. (2018). Climate change adaptation in Ethiopia: developing a method to assess program options. In *Resilience* (pp. 253–265). Elsevier.
- Getachew, F., Bayabil, H. K., Hoogenboom, G., Teshome, F. T., & Zewdu, E. (2021). Irrigation and shifting planting date as climate change adaptation strategies for sorghum. *Agricultural*

Water Management, 255, 106988.

- Gornall, J., Betts, R., Burke, E., Clark, R., Camp, J., Willett, K., & Wiltshire, A. (2010). Implications of climate change for agricultural productivity in the early twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 2973–2989.
- Harvey, C. A., Rakotobe, Z. L., Rao, N. S., Dave, R., Razafimahatratra, H., Rabarijohn, R. H., Rajaofara, H., & MacKinnon, J. L. (2014). Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 369(1639), 20130089.
- Hisali, E., Birungi, P., & Buyinza, F. (2011). Adaptation to climate change in Uganda: evidence from micro level data. *Global Environmental Change*, 21(4), 1245–1261.
- IPCC. (2021). *AR6 Climate Change: The physical Science Basis*.
- IPCC. (2014). *Impacts, adaptation, and vulnerability*.
- Khatri, B. B., & Pasa, R. B. (2023). People’s perception on climate change: The context of local and global discourse. *Asian Journal of Population Sciences*, 68–79.
- Kitoyi, A. (2023). *Factors affecting the adoption of improved ground nuts varieties by the farmers of Khabutoola sub county Manafwa district*.
- Mcguigan, C., Reynolds, R., & Wiedmer, D. (2002). London School of Economics Consultancy Project for The Overseas Development Institute POVERTY AND CLIMATE CHANGE: ASSESSING IMPACTS IN DEVELOPING COUNTRIES AND THE INITIATIVES OF THE INTERNATIONAL COMMUNITY. *London School of Economics Consultancy Project for the Overseas Development Institute*, 1–40.
- Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmers’ perceptions of climate change and agricultural adaptation strategies in rural Sahel. *Environmental Management*, 43, 804–816.

- Mhlanga, M. L. (2004). Adaptation to climate change: Technology needs in Lesotho. *Energy and Land Use Change and Forestry, Lesotho Meteorological Services, Ministry of Natural Resources, Maseru, Lesotho.*
- Minai, J. O. (2015). *Assessing the spatial variability of soils in Uganda*. Purdue University.
- Monarchi, D. E., & Puhr, G. I. (1992). A research typology for object-oriented analysis and design. *Communications of the ACM*, 35(9), 35–47.
- Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences*, 104(50), 19680–19685.
- Mugagga, F., Kakembo, V., & Buyinza, M. (2012). Land use changes on the slopes of Mount Elgon and the implications for the occurrence of landslides. *Catena*, 90, 39–46.
- Mutekwa, V. T. (2009). Climate change impacts and adaptation in the agricultural sector: The case of smallholder farmers in Zimbabwe. *Journal of Sustainable Development in Africa*, 11(2), 237–256.
- Mutua, K., & Goda, P. (2021). Multidimensional assessment of European agricultural sector adaptation to climate change. *Studies in Agricultural Economics*, 123(1), 8–22.
- Namugaya, J. (2017). Current Causes of Girls' Low Performance in Physical Sciences from Hard-to-reach Secondary Schools in Eastern Uganda. *International Journal of Secondary Education*, 5(1), 12. <https://doi.org/10.11648/j.ijsedu.20170501.12>
- Nath, P. K., & Behera, B. (2011). A critical review of impact of and adaptation to climate change in developed and developing economies. *Environment, Development and Sustainability*, 13(1), 141–162. <https://doi.org/10.1007/s10668-010-9253-9>
- NEMA. (2020). *Annual National Lead Agency Report*.
- Niang et.al. (2014). *Evaluation of onset and Cessation of Rainfall and Temperature on Maize in Akure, Ondo State, Nigeria*.

- Nyong, A., Adesina, F., & Osman Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, 12, 787–797.
- Okau, P. (2023). *Assessment of Flood Susceptibility in Mount Elgon Region of Uganda Under a Changing Climate and Risk Implication to Farmland Food Security*. University of Nairobi.
- Okoth, J. M., Otim, D., & Kamalha, E. (2024). Distribution of Floods Frequency of Manafwa River, Uganda. *East African Journal of Engineering*, 7(1), 1–20. <https://doi.org/10.37284/eaje.7.1.1670>
- Olmos, S. (2001). *Vulnerability and adaptation to climate change: concepts, issues, assessment methods*. Climate Change Knowledge Network (CCKN).
- Ongoma & Awange. (2019). Evaluation of precipitation simulations in CMIP6 models over Uganda. *International Journal of Climatology*.
- OPM. (2015). *Annual report*.
- Oyana, T. J., Kayendeke, E., Bamutaze, Y., & Kisanga, D. (2015). A field assessment of land use systems and soil properties at varied landscape positions in a fragile ecosystem of Mount Elgon, Uganda. *African Geographical Review*, 34(1), 83–103. <https://doi.org/10.1080/19376812.2014.929970>
- Pender, J., Nkonya, E., Jagger, P., Sserunkuuma, D., & Ssali, H. (2004). Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda. *Agricultural Economics*, 31(2-3), 181–195.
- Ricart, S., Castelletti, A., & Gandolfi, C. (2022). On farmers’ perceptions of climate change and its nexus with climate data and adaptive capacity. A comprehensive review. *Environmental Research Letters*, 17(8), 83002.
- Ríos-González, A., Jansen, K., & Sánchez-Pérez, H. J. (2013). Pesticide risk perceptions and the differences between farmers and extensionists: Towards a knowledge-in-context model.

- Environmental Research*, 124, 43–53.
- Sakho-Jimbira, S., & Hathie, I. (2020). The future of agriculture in Sub-Saharan Africa. *Policy Brief*, 2(3), 18.
- Saunders, M. N. K., & Townsend, K. (2018). Choosing participants. *The Sage Handbook of Qualitative Business and Management Research Methods*, 480–494.
- Sebuliba, E., Majaliwa, J. G. M., Isubikalu, P., Turyahabwe, N., Eilu, G., & Ekwamu, A. (2021). Characteristics of shade trees used under Arabica coffee agroforestry systems in Mount Elgon Region, Eastern Uganda. *Agroforestry Systems*, 1–13.
- Sebuliba, E., Mwanjalolo, M., Turyahabwe, N., Eilu, G., & Ekwamu, A. (2022). Effect of Inorganic Fertilizer Application on Green House Gas Emissions and Microbial Activity under Coffee Agroforestry in Eastern Uganda. *African Journal of Rural Development*, 7(3), 275–296. <https://doi.org/10.1002/essoar.10512959.1>
- Scoones. (2015). The politics of Sustainability and development.
- Shepherd, B. (2016). *Uganda*.
- Smit & Wandel. (2006). Adaptation, adaptive capacity and vulnerability. 282-292.
- Singh, S. (2020). Farmers’ perception of climate change and adaptation decisions: A micro-level evidence from Bundelkhand Region, India. *Ecological Indicators*, 116, 106475.
- Slater, R., Peskett, L., Ludi, E., & Brown, D. (2007). Climate change, agricultural policy and poverty reduction—how much do we know. *Natural Resource Perspectives*, 109(7), 1–6.
- Soubry, B., Sherren, K., & Thornton, T. F. (2020). Are we taking farmers seriously? A review of the literature on farmer perceptions and climate change, 2007–2018. *Journal of Rural Studies*, 74, 210–222.
- Tejada, J. J., & Punzalan, J. R. B. (2012). On the misuse of Slovin’s formula. *The Philippine*

Statistician, 61(1), 129–136.

- Thomas, K., Hardy, R. D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J. T., Rockman, M., Warner, B. P., & Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. *Wiley Interdisciplinary Reviews: Climate Change*, 10(2), e565.
- Thornton, P. K., Ericksen, P. J., Herrero, M., & Challinor, A. J. (2014). Climate variability and vulnerability to climate change: A review. *Global Change Biology*, 20(11), 3313–3328. <https://doi.org/10.1111/gcb.12581>
- Thornton, P. K., & Herrero, M. (2014). Climate change adaptation in mixed crop–livestock systems in developing countries. *Global Food Security*, 3(2), 99–107.
- Twongyirwe et al. (2019). Perceived effects of drought on security in South-Western Uganda: Coping responses and determinants.
- TO, E.-B. A., & EBA, C. C. A. (2010). *National Guidelines*.
- Wolf, J., & Moser, S. C. (2011). Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. *Wiley Interdisciplinary Reviews: Climate Change*, 2(4), 547–569.