

Research Article

Analysis of Rainfall Variability Adaptation Strategies Employed by Wheat Farmers in Narok County, Kenya

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ABSTRACT

The purpose of this study was to analyze the adaptation strategies employed by wheat farmers as a result of seasonal rainfall variability in Narok County, Kenya. This was done by analyzing strengths against weaknesses on one hand and opportunities against threats on the other. Wheat yields can be limited either by drought and excess of water. Rainfall has a huge impact on nitrogen response by the crop too. A purposive sampling design was used to select wheat farming households in the four sub-counties in Narok County. Proportionate sampling was used to determine the sample size of farmers to be selected in each sub-County. Random sampling technique was used to pick the wheat farmers selected in each sub-County. In this study the targeted sample size was 200 respondents. A structured questionnaire was administered to the sampled population to collect data on adaptive strategies employed by farmers in the region. A SWOT analysis was used to analyze adaptation strategies by wheat farmers. The results are expected to help farmers and policy makers come up with adaptation strategies that are sustainable with the varying rainfall trends.

Keywords: SWOT Analysis, Rainfall Variability, Wheat Farming, Adaptation Strategies.

1. INTRODUCTION

A. Introduction

Adaptations are adjustments taken by the people and organizations so as respond to change in climate change geared towards reducing damages. Variability of climatic factors influences agriculture by aggravating the frequency and distribution of adverse weather conditions (13). Due to the fact that farmers adapt to their local climate in terms of what they grow, the definition of extreme weather conditions therefore depends on farmer's geographical location (16). Variability in climate plays an important role in determining the crop yields in Kenya as well as the other parts of the world (27). According to (18) wheat farmers have been forced to adapt to variability and changes in the climate. Some of trends witnessed in recent years include planting of early maturing varieties especially during short rain season.

According to (17), in order to plan and design better adaption strategies, there is need to evaluate current and feature variability of rainfall characteristics. There is high annual variability of rainfall in the semi-arid tropics which affect agriculture. More often than not, successful agricultural production depends on farmer's ability to make right decisions which at times depends on multiple variables. In such a case, rainfall variability affects farmer's decisions (10).

According to (5), due to extreme conditions weather conditions and more heat waves, wheat production in Australia is likely to become more volatile in coming days. With this, there will be a huge impact worldwide due to the fact that wheat is an important staple food globally with Australia being the world's largest exporter of wheat. As a result of reduction in wheat yields, the authorities are initiating adaptation measures to help farmers cope with the impacts of rainfall variability. Wheat yields can be limited either by drought and excess of water. Further, winter rainfall has a huge impact on nitrogen response by the crop (4).

Climate variability acts as an important stress factor for rural areas in a majority of third world countries where households have been adjusting to environmental shocks (30). Climate is a key determinant of crop yields under rain-fed conditions in Kenya. Climate variability has had adverse effect on maize production as well as food security (26). According to (19), the dry lands of Kenya including Laikipia and Narok County. As a result of reduction in wheat yields, the authorities are initiating adaptation measures to help farmers cope with the impacts of rainfall variability. es are most vulnerable to climate variability phenomenon. The future crop farming techniques and food production systems depends on adaptation strategies in place. Adoption of agricultural technologies by farmers is influenced by a number of variables, these include both farmer and farm attributes, technology characteristics and institutional factors. It is on this premise that drought tolerant varieties (DTV) of wheat were developed for production in Arid and Semi-Arid Lands (25).

The definition of extreme weather conditions depends on farmer's geographical location (16). In all factors of climate, day to day and inter-annual variability in rainfall are most important for rain-fed production. Daily variation of precipitation related with weather has big impact on agriculture. The combined impacts of climate variability and change coupled with low adaptation capacity will increase vulnerability and local food insecurity in poor developing countries that depend on rain-fed production (8). Various probable adaptation choices available for marginal change of existing agricultural systems are dependent on variations of existing climate risk management strategies (11).

Though there is evidence that farmers are varying their agriculture practices while responding to shocks resulting from climate variability and change, the rates of adaptation of new agronomic practices is still low while at the same time small scale. Further, most of these farmers are not able to adapt to new crops, water, soil management and agro forestry due to a number of hindrances (31). This research sought to assess the suitability and sustainability of adaptation measures by wheat farmers in Narok County in response to seasonal rainfall variability.

Reports predict that sub-Sahara Africa (SSA) would be among the regions in the world that will experience severe impacts of climate change. It is suggested that due to climate variability such as rainfall deficit there will be severe implications in crop yields (29). If there is an improvement in the agricultural sector, rural incomes and the purchasing power of the majority of the people would improve. This would in turn lead to reduction in poverty and hunger (15). There is therefore a need for adaptation measures to ensure that high wheat yields are achieved despite the intra annual variability of rainfall.

Varying recommendations have been made to farmers in relation to adaptation to climate variability. For instance, (22) recommends that farmers change the seed variety and planting dates. Wheat farmers should use high quality seeds in terms of germination, growth rate, drought resistance and grain size (7). Small changes in variability of the rainfall within the season might limit the number of wheat growing opportunities and therefore reducing the crop growing rate which in turn affects the farm's profits. Therefore, the farmer's adaptation to this seasonality needs to be assessed at the farm's level (36).

Adaptation assessments show that shifting of planting dates as well as hybrid seed selection could have an impact of reducing the negative effect of climate variability and change in wheat yields (20). According to (3), there is little

empirical proof on crop production resulting from variation in climate characteristics. There is limited information on the effects of rainfall variation on wheat yields yet such information is necessary in evaluating mitigation measures on wheat farming. Though various adaptive strategies may have been employed by wheat farmers in Kenya, research on opportunities together with strengths against weaknesses and threats was needed.

Materials and Methods

The study area was Narok County in Kenya. The County is the leading wheat producing counties accounting for 45 percent of national wheat production (23). Decrease of wheat yields in Narok County is a threat to the country's GDP and food security. Narok County lies in the Southern part of the Rift Valley in Kenya. The County is situated between 0°30'S and 2°0'S latitudes, and between 34°46'E and 36°15' East longitudes. The main wheat growing seasons starts with the onset of long rains in the March – May season.

B. Data Collection

Data on adaptive strategies used by wheat farmers in the study area to cope with the impact of rainfall variability was obtained by administering questionnaires with the help of research assistants who were recruited from the selected sub -counties.

RESULTS AND DISCUSSIONS

C. Adaptation Strategies to cope with effects of Rainfall Variability

The results of the study shows that alteration of the planting dates as an adaptation strategy used by wheat farmers in Narok county

The second adaptation strategy employed by wheat farmers in Narok County was change of seed variety. In this research, thirty two respondents (42.1%) adapted by changing seed variety. According to (21), change of seed variety is an important measure taken by farmers. Farmers who are frequently faced by drought may change to early maturing varieties or disease resistant seed varieties.

Mixed cropping was another adaptation strategy employed by farmers in the study area. Approximately forty two (41.8%) percent of the farmers said that they had resorted to it due poor wheat yields and returns. According to (34), while adapting by mixed cropping forms an important element, information that can guide farmers on how best they can manage diversification in specific geographical farming systems is limited.

Farmers in the survey also said that they adapted by supplementing wheat farming with livestock rearing. The farmers said they reared animals like cattle, sheep, goats and poultry so as to supplement earnings from wheat yields. In agriculture, diversification may occur with farmers planting different crop varieties and rearing animals. Diversification may also occur with farmers engaging in non-agricultural activities such as taking jobs elsewhere. Both agricultural and non-agricultural activities may help farmers to adapt to climate variability by smoothing income fluctuations (33).

According to this research, approximately fifteen percent (15%) farmers in Narok County adapted to wheat yields fluctuations by substituting wheat with other crops. Some of farmers surveyed said they had reduced the area on which they had previously grown wheat by growing other crops. According to (12), with shorter growing seasons, farmers are usually forced to shift to crops which mature earlier. Changing cropping practices, which were implemented by farm households at farm level, could be short term or long term depending on the nature of the problem or risk (1)

D. Strength Weaknesses Opportunities Threats (SWOT) Analysis

In this study, SWOT analysis was used to analyze the trends of wheat production together with farmers' adaption in Narok County. A SWOT analysis matrix is a tool for planning which is used to assess strengths, weaknesses opportunities and threats in a project. In this research strengths, weakness, opportunities and threats to the adaption strategies were analyzed. Strengths put together with weaknesses are internal factors which can be influenced considerably while threats and opportunities are external and hence cannot be influenced (14). SWOT analysis forms the basis for examining internal strengths and weaknesses together with the external threats and opportunities from the environment (66)

Strengths versus weaknesses

In this research, actions taken by wheat farmers to cope with wheat yields fluctuations as a result of rainfall variability were taken as strengths while challenges emanating from human influence to these strategies were taken as weakness. The study therefore recommends that the strengths be used in order to overcome difficulties facing wheat farmers.

Narok County has large scale wheat farming activities (6). Large-scale farmers in Narok County, account for 75 percent (26). In the study this was strength because large scale farmers are able to adapt better to threats that face wheat farming. On weakness 69.7 % of the farmers said that they grew wheat on leased land with lease being renewed annually or after a few years. Where lease renewal was not guaranteed in the subsequent years, most farmers said that they had failed to invest in heavy farm machinery. The affected farmers said that they relied on hired farm machinery during planting, spraying of pesticides and harvesting which at times delayed farm operations and increased production cost in the long run. According to the farmers, delays during planting forced some to plant very early or too late leading to poor germination, they were also forced to spray against pests and diseases when it is too late leading to loses. Some farmers also said that they faced similar challenges during harvesting as they were forced to wait to hire combine harvesters.

Production was also being affected by rapid population growth. According (19) Narok County had a population of 850 900 people with 51 % being children of between 0-14 years. There was a high fertility rate in the area affected wheat production both positively and negatively. The high population implies that there was more supply of labour in wheat farms lowering the cost of production on one hand while on the other it led to fragmentation of land which affected economies of scale in wheat production. However, wheat farming is affected by a number of internal

weaknesses. Overpopulation and population growth places a tremendous amount of pressure on resources, which result in a chain reaction of problems as the nation grows (35).

The high levels of literacy of wheat farmers in the area meant that they were able to be more innovative and thus adapted better to rainfall variability with 71 % respondent attaining post primary education and 27.6% having tertiary education. This implies that the literate population was able to uptake better adoptive strategies against challenges facing wheat farming and hence the general increase in wheat yields over the years. Adaptation strategies were also boosted by wealth of experience accumulated by the long period farmers had grown wheat with 82.89% of farmers having grown wheat for more than six years. Highly literate farmers are expected to benefit by up taking weather forecasting information better leading to timely farming activities. However, in the survey, 21.7% percent of the farmer said they did not rely on weather forecasting information because it was not accurate and specific or it didn't reach them on time. Climate variability creates widespread risks for food production.

Availability of finances affects the farmer's ability to buy seeds and other farm implements before or during the growing season. According to the respondents the income from wheat farming activities is high meaning that they were able to adapt better with 25.1 % changing seed varieties while 24.3 % adopting mixed cropping. One of the weaknesses faced by wheat farmers in the study area was yield fluctuation (56.2%). Approximately twenty six percent (26.3 %) of the farmers said that they had changed to other agricultural activates due to high costs of agricultural inputs. Farmers also said that economic challenges hindered their ability to up take new farming methods with 26.3% saying that they could not access financial credit.

The results show that twenty five percent (25 %) of farmers reported having constantly changed to seed varieties that were either resistant to pest and diseases or early maturing. Some of the seed varieties grown in the area included; Njoro2, Kwale, Kenya wren, Eagle10, Robin, Duma and Mwamba. From the survey, 13.2 % of the farmers said that they had recycled what they had harvested in the previous seasons either due to high cost of certified seeds or due to poor dissemination of information on new seed varieties.

Opportunities versus Threats

The results show that, 80.3% of the farmers said that the greatest threat to wheat farming other than rainfall variability was pests and diseases with (48.7%) saying that this problem was made worse by the high cost of farm inputs. Presence of KARLO in the neighbouring Nakuru County is a great opportunity to wheat farmers. The research organization conducts research on how best to control pest and disease. High literacy of farmers in the study area made it easier for the farmers to uptake adaptation strategies against this problem.

Wheat farmers in Narok County ought to use the opportunities available to them in order to counter the threats that they face. Several opportunities are available to the farmers which contribute in boosting wheat production in the area. These include the presence of a National Cereals and produce depot in Narok Town which offer a ready market. Wheat farmers in Kenya sell their produce to National Cereals and Produce Board (NCPB), or millers directly (24). The presence of NCPB in Narok Town means that farmers do not incur high cost of transportation.

About a third of cereals that is produced for human consumption go to waste globally which impact food security negatively (9). Approximately three percent (2.6 %) of farmers in the survey said they incurred heavy post-harvest losses as they were forced to sundry their wheat. The farmers said this was made worse if there was unexpected rainfall. However with technological advancement, there were some private companies which were offering modern mobile drying services which helped to reduce losses

A high percentage of farmers (75 %), said that the presence of agriculture officers helped in boosting production since they got necessary information on time. A majority of large and medium scale farmers in Narok were also members of Cereal growers association which advise the farmers. Continuous research by Kenya Agricultural and Livestock Research Organization (K.A.L.R.O) has led to development of new wheat varieties which are more resistant to pests and diseases.

From this study 42.1 % of the farmers said that they adapted by changing seed varieties while about forty two percent (42.1 %) said that they adapted by changing planting dates to conform to rainfall variability trends. Accurate timely weather information from Kenya Meteorological Station ought to be passed on to the farmers so as to make decisions that will increase wheat production. This information is necessary so that wheat growing activities take place at the right time. A significant percentage of farmers (21.7 %) felt that there is poor weather forecasting information which affects them in wheat farming. This was made worse by the fact that few farmers were able to access timely weather forecasts from the Kenya Meteorological Department. Farmers in Narok County said that certified seed were available in the agro vets within the county while the ministry of agriculture provided fertilizers at a subsidized price through the National Cereals and Produce Board. Use of weather forecast information is likely to lead to better decisions that may affect a large number of people (32).

Respondents said there were a number of threats to wheat farming activities. A large percentage felt that competition from other farming activities is the biggest threat at 71.1% and amount of rainfall (21.7 %). From the research, two percent (2 %) of the farmers said that their crop was attacked by animals from the herders. Peaceful coexistence should be enhanced to reduce these incidences. High cost of farm inputs (48.7%); Market prices (38.2 %) and access to credit were also cited by farmers as threats to wheat production. The government should give incentives to farmers to cushion them from these external threats.

From the study, 7.2 % of the farmers said that they did not easily access agricultural extension services from officers in the Ministry of Agriculture Livestock and Fisheries which meant that they did not get timely information. Variability in climate has been identified as the main challenge to farmers in Africa, a challenge still remain on accessing information on climate which is relevant to farming activities that would enable farmers to make critical decisions (38). On the other hand, most of the farmers (88.2%) said that they were able to adopt better to some of the challenges facing wheat farming such as disease and pest control.

2. CONCLUSIONS AND RECOMMENDATIONS

Respondents indicated that they had adapted to the variability in rainfall in different ways such as substituting wheat with other crops, adopting mixed cropping, change of planting dates, supplementing wheat farming with

livestock keeping and change of seed variety. Adaptation strategies might affect changing farming methods such as tillage practices, irrigation, planting date, earliness, crop protection methods, fertilizer control, and cultivar choice (37, 2).

There is need for policy makers to come up with adaptation mechanism that are sustainable with the changing rainfall regimes.

REFERENCES

1. Abdi, M. (2016) Climate change Impacts and Adaptation in the Agricultural Sector of Pakistan- Socioeconomic and Geographical Dimensions; Hamburg; Unpublished thesis
2. Abdi, M., Schilling, J., Scheffran, J., Zulfiqar, F.(2016) Climate change vulnerability, adaptation and risk perceptions at farm level in Punjab, Pakistan. *Sci. Total Environ.* 547, 447–46
3. Boubacar, I. (2010) The Effects of Drought on Crop Yield Variability in Sahel; Uninversity of Wisconsin - Stout
4. Carvalho, R. M., Serralheiro, J., Corte-Real J. and Valverde ,P. (2015).Implications of climate variability and future trends on wheat production and crop technology: adaptations in Southern regions of Portugal. *Water Utility Journal* 9: 13-18
5. CelciusPro (2010).Hedging Wheat Yields with Weather Derivatives Wheat Yields in NSW, Australia
6. CRECO (2012) Building a Culture of Peace in Kenya: Baseline Report on Conflict-Mapping and Profiles of 47 Counties in Kenya. Nairobi, Kenya
7. Ellis R.H. (1992) Seed and Seeding Vigor in Relation to Crop Growth and Yield, Plant Growth Regulation.Vol.11 no 3, Pp 249-255
8. FAO (2008) Climate Change, Water and Food Security Technical Background Document; From the Expert Consultation Held on 26th to 28th February 2008, FAO, Rome
9. F.A.O. (2013) Food wastage footprint; Full cost accounting: Final report, Rome
10. Helena, W., Sonja, V., Gernot, L., Max, O., Edidah, A., and Jat, M.L.(2014) Farmers, food and climate change: ensuring community-based adaptation is mainstreamed into agricultural programs, *Climate and Development*, 6:4, 318-328, DOI: 10.1080/17565529.2014.965654
11. Howden, S. M. and Meinke, H. (2003) Climate change: Challenges and Opportunities for Australian agriculture. In: Proceedings of the Conference on Climate Impacts on Australia's Natural Resources: Current and Future Challenges, Queensland, Australia, Canberra: Standing Committee on Natural Resource Management. Managing Climate Variability Program, pp. 53-55
12. Huho, J. K. W., Ngaira, J. K. W., Ogindo, H.O. and Masayi, N (2012) The Changing Rainfall Pattern and the Associated Impacts on Subsistence Agriculture in Laikipia East District, Kenya.*Journal of Geography and Regional Planning* Vol. 5(7), pp. 198-206, 4 April, 2012. <http://www.academicjournals.org/JGRP> DOI: 10.5897/JGRP12.018 ISSN 2070-1845
13. IPCC (2007) Contribution of Working Groups I, II and III to the Fourth Assessment Report of Intergovernmental Panel on Climate Change. Geneva, Switzerland. pp 104

14. Humphrey A. (2004) SWOT Analysis Method and Examples, With Free SWOT Template. <http://www.businessballs.com/swotanalysisfreetemplate.htm>
15. Irz, X., Lin L., Thirtle, C. and Wiggin, S. (2001) Agricultural Productivity Growth and Poverty Alleviation. *Development Policy Review* 19(4):449-466
16. Karanja M.A., Shisanya, C. and Makokha, G.(2014) Analysis of Rainfall Variability on Irish Potato Production in Ol-joro-orok Division, Nyandarua County, Kenya. *Agricultural Sciences*, 5, 834-838
17. Kassie, B. T., Rötter, R. P., Hengsdijk, H., Asseng, S.N., VanIttersum, S. M. K. Kahiluoto, H. and Van Keulen, H.(2013) Climate Change and Agriculture Research Paper; Climate Variability and Change in the Central Rift Valley of Ethiopia: Challenges for Rain-fed Crop Production; *Journal of Agricultural Science*, 152, 58 –74: Cambridge University Press 2013 doi:10.1017/S002185961200098
18. Kavikumar, K.S. (2010). Climate sensitivity of Indian Agriculture: Role of Technological Development and Information Diffusion, in *Lead Papers-National Symposium on Climate Change and Rain-fed Agriculture*, Indian Society of Dry land Agriculture, Central Research Institute for Dry land Agriculture, Hyderabad, pp.1-18.
19. KNBS, (2009) National population Census; Ministry of planning and vision 2030, Nairobi
20. Kumar, A. and Singh, A. (2014) Climate Change and its Impact on wheat Production and Mitigation Through Agro forestry Technology; *International Journal on Environmental Sciences*, vol. 5(issue 1)Pp 73-90
21. Lobell, D. and x Burke, D. (2010) *Climate Change and Food Security*, Chapter 8, Pages 133–153. Springer Science, Business Media
22. Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M. D., Falcon W.P. and Naylor, R.L (2008) Prioritizing Climate Adaptation Needs for Food Security in Kenya 2030 *science*, vol. 319,no 5863,pp 607-6104
23. Ministry of Agriculture Livestock and Fisheries (2015) *Economic Review of Agriculture (E.R.A.)*.Central Planning and Project Monitoring Unit, p.10.Nairobi, Kenya
24. Monroy, L., Mulinge W., Winter M., (2013).Analysis of Incentives and Disincentives for Wheat in Kenya. Technical notes series, MAFAP, FAO. Rome
25. Ndiema, A.C (2010) Factors Influencing Adoption of Drought Tolerant Wheat Varieties in The Arid and Semi-Arid Lands of Narok and Kajiado Districts-Rift Valley Province of Kenya; Unpublished thesis
26. Nyandiko, N, Omoyo, J.W. and Otenge, S. (2015).Effects of Climate Change Variability onMaize Yield in Arid and Semi-Arid lands of Lower Eastern, Kenya. *Agriculture Food and Security*
27. Nyangito, H., Ikiara, M., Ronge, E. (2002)Performance of Kenya’s Wheat Industry and Prospects For Regional Trade in Wheat Products. KIPPRA Discussion Paper No 17
28. Ojwang, ’ G.O., Agatsiva, J. and Situma, C. (2010) Analysis of Climate Change and Variability Risks in the Smallholder Sector: Case Studies of the Likipia and Narok Districts representing major agro-ecological zones in Kenya. *Environment and Natural Resources Management Working Paper*, FAO, Rome; Italy
29. Oyiga, B.C., Makib, H. and Weschkeil, C. (2011) Implications of Climate Change on Crop Yield and Food Accessibility in Sub-Saharan Africa. *Zentrum fur Enkwicklungforschung*. Center for Development Research, University of Bonn

30. Sara, L.M., Trearu, P. & Mertz, O. (2011) Rainfall Variability and Household Coping Strategy in Northern Tanzania: A Motivation for District Strategies. *Reg. Environ. Change* doi: 101007/s10101September 2011/vol.11 Issue 3 pp 471-481
31. Silvestri, S., Sabine, D., Patti, K.J. Wiebke, F.J. Maren, R., Lenatta M.J. Carles, Q.F. Herren M., Ndung'u A., Ndiwa, N.J. Mango J., Chessen L., and Rufino M.C. (2015) Household and Food Security: Lessons from Food Secure Households in East Africa. Nairobi, Kenya.
32. Tall, A., Mason, S.J., van Aslt, M., Suarez, P., Ait-Chellouche, Y., Diallo, A. D., Braman,
33. Thornton P.K., Lipper L., Baas S., Cattaneo A., Chesterman S, Cochrane K, de Young C, Ericksen, P., van Etten J., de Clerck F, Douthwaite B., DuVal A, Fadda C, Garnett., Gerbr P., Howden, M., Mann W, McCarthy N, Sessa R, Vermeulen, S., and Vervoort, J. (2012) How Does Climate Change Alter Agricultural Strategies to Support Food Security? Background Paper for the Conference "Food Security Futures: Research Priorities for the 21st Century", Dublin
34. Thornton, P.K., and Herrero, M. (2014) Climate Change Adaptation in Mixed Crop- livestock Systems in Developing Countries ; Research Program on Climate Change, Agriculture and Food Security (CCAFS), ILRI, Nairobi . Kenya
35. Thuku, G.K., Gachanja, P. and Obere, A. (2013) The Impact of Population Change on Economic Growth in Kenya. *International Journal of Economics and Management Sciences* Vol. 2, No. 6, pp. 43-60 managementjournals.org
36. Rodriguez, D., de Voil P., Power, B., Cox, H., Crimp, S. and Meinkel, H. (2011) The Intrinsic Plasticity of Farm Business and their Resilience to Change; *Aust. example field crop Res.* 124 (2) 157-170
37. Swe, L.M. M., Shrestha, R. P., Ebberts, T., Jourdain, D. (2014) Farmers' Perception and Adaptation to Climate-change Impacts in the Dry Zone of Myanmar ; *Clim. Dev.* 7, 437-453
38. UNEP (2008) Human Vulnerability and Food Insecurity: Rainfall and Economy in Sub-Saharan Africa. Available online at: <http://maps.grida.no/go/graphic/human-vulnerability-and-foodinsecurity-rainfall-and-economy-in-sub-saharan-africa>