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Research Application Summary

Analysis of strategies used in mitigating dry spells occurrences on rainfed agriculture in Homa Bay County, Kenya

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Abstract

Dry spells have been on the increase in both spatial and temporal scales in the last few decades exacerbating rainfall variability. Homa Bay County which is located in the Western part of Kenya in the Lake Victoria Basin is a sub humid region characterized by frequent dry spells resulting in poor crop yields. This paper evaluates the mitigation strategies to dry spells occurrences for sustainable rainfed agriculture in Homa Bay County. The study used a sample size of 384 households. Primary data were gathered through use of questionnaires, interview guides, Focus Group Discussions and observation while secondary data were obtained from publications, journals, newspapers and internet. Data analyses were done using statistical package for social scientists (SPSS) version 20. Results indicated that majority of the respondents (68.8%) practiced post-harvest storage; 59.8% grew drought tolerant crops; 46.8% practiced crop diversification; 30.8% practiced water harvesting; 30% practiced soil conservation techniques while 33.9% of the respondents were engaged in supplemental irrigation of the food crops as mitigation towards dry spells. Chi–square tests showed significant variations at $P<0.05$ among mitigation strategies applied on crop production. The findings further reveal that dry spells have continuously reduced agricultural production in Homa Bay County. These results obtained will inform the people of Homa Bay County on the strategic interventions needed to encounter dry spells occurrence for sustainable rainfed agriculture**.**

Key words: Climate smart agriculture, climate variability, Homa Bay, Kenya, supplemental irrigation, post-harvestpost-harvest strategies

Résumé

Les épisodes de sécheresse ont augmenté à la fois dans les échelles spatiales et temporelles au cours des dernières décennies, exacerbant la variabilité des précipitations. Le comté de Homa Bay, qui est situé dans la partie ouest du Kenya dans le bassin du lac Victoria, est une région subhumide caractérisée par des périodes de sécheresse fréquentes entraînant de faibles rendements. Cet article évalue les stratégies d'atténuation des épisodes de sécheresse pour une agriculture pluviale durable dans le comté de Homa Bay. L'étude a utilisé un échantillon de 384 ménages. Les données primaires ont été recueillies au moyen de questionnaires, de guides d'entrevue, de discussions de

groupe et d'observations, tandis que les données secondaires ont été obtenues à partir de publications, revues, journaux et Internet. Les analyses de données ont été effectuées à l'aide du progiciel statistique pour les spécialistes des sciences sociales (SPSS), version 20. Les résultats ont indiqué que la majorité des répondants (68,8%) pratiquaient le stockage après récolte; 59,8% ont cultivé des cultures résistantes à la sécheresse; 46,8% ont pratiqué la diversification des cultures; 30,8% pratiquaient la récupération de l'eau; 30% ont pratiqué des techniques de conservation des sols tandis que 33,9% des répondants ont été engagés dans l'irrigation supplémentaire des cultures vivrières pour atténuer les périodes de sécheresse. Les tests du chi carré ont montré des variations significatives à P <0,05 parmi les stratégies d'atténuation appliquées à la production agricole. Les résultats révèlent en outre que les périodes de sécheresse ont continuellement réduit la production agricole dans le comté de Homa Bay. Ces résultats obtenus informeront les habitants du comté de Homa Bay sur les interventions stratégiques nécessaires pour faire face à des épisodes de sécheresse pour une agriculture durable basée sur la pluie.

Mots clés: agriculture intelligente face au climat, variabilité climatique, Homa Bay, Kenya, irrigation supplémentaire, stratégies post-récolte après récolte

Introduction

Dry spells are a major triggering factor of drought phenomena with devastating climatic hazards in many areas of the earth. Studies indicate that large parts of the world rely on rainfed agriculture for their food security. Dry spells increase the risk of drought occurrence and make the affected regions more vulnerable to food insecurity (Downing, 1996). The growing population and trend towards more resources for food production (Fischer, 2012), will continue to increase in the coming decades. Over the last decades as a consequence of climate change, dry spells have been increasing in spatial and temporal scales leading to rainfall variability that has become a concern in the rainfed agricultural regions of the world (Mugalavai and Kipkorir, 2015).

The dry sub-humid and semi-arid regions in Sub-Saharan Africa (SSA) continue to face water scarcity, i.e., insufficient amounts of water to meet population demands for food and development whilst maintaining eco-systems life supporting processes (FAO, 2001). As water demand increases for non-agricultural uses, it is unlikely that future food requirements can be met by sole reliance on irrigated crop production. Currently more than 90% of agricultural land in SSA is under rainfed production (Rosengrant *et al.,* 2002). The challenge remains on how to improve rainfed agriculture by simultaneously improving rural livelihoods and water productivity (Rockstrom *et al.,* 2003). Kenya Vision 2030 (GoK, 2007) identified agriculture as the key sector to deliver a 10 per cent annual economic growth. The Government considers that critical factors in achieving this target is the transformation of smallholders subsistence into a more vibrant sector through green economy strategies that are geared to reduce the severe impacts of climatic factors to half and reduce the number of poor and food insecure. The strategies employed in the study region are not well known. This study was therefore carried out to find the mitigation strategies for dry spells occurrence as mechanisms to ensure sustainable rainfed agriculture in Homa Bay County of Kenya.

Materials and methods

Study area. The study was carried out in Homa Bay County which is located in the Western part of Kenya in the former Nyanza province with an area of 3,154.7 km^2. It is bounded by latitude 0° 15' South and 0°52' South and longitudes 34° East and 35°" East. It has an altitude of 1146 m above the mean sea level.

Research design and sampling procedure. Evaluation research design was used to examine the mitigation strategies for dry spell occurrence to enhance sustainable rainfed agriculture for food security in Homa Bay County. Additionally, the study utilized both qualitative and quantitative approaches. A size of 384 households were interviewed using questionnaires.

Analysis of criteria of mitigation strategies in relation to food security (1950 -2017) in Homa Bay County. The use of the chi-square (x^2) necessitates preparation of cross tabulation of the variables which then generate significance test results (Nachmias, 2001). Pearson Chi square (x^2) test was done to measure the association between the mitigation strategies (on-farm and off farm) of the small scale farmers with regard to food security in Homa Bay County. A test at 0.05% significance level was used to measure the variability in the mitigation strategies in relation to food security. All the quantitative data were analyzed using the Statistical Package for Social Scientists (SPSS) version 20.

The study took a multistage sampling approach where 50% sampling units were studied following the approach by Mugenda and Mugenda (2003). According to Awange *et al.* (2007), the most affected sub counties by dry spells and droughts were the peripheral ones neighbouring Lake Victoria, in comparison to the wards that were located far away from the lake shores. These sub counties include Karachuonyo, Mbita, Homa Bay Town and Rangwe. The wards under these sub counties (Table 1) were purposively sampled given their proximity to the lake shore that defines the rainfall variability in the areas. The proportion of wards where the study was conducted were computed from the four sub counties based on 30 % sampling units as proposed by Mugenda and Mugenda (2003).

Table 1. Proportion of wards sampled

S/N	Sub counties (Wards)	Total number of wards	30% Sample of wards
1	Karachuonyo (Kibiri and Kanyaluo)	7	2
2	Mbita (Kanyamwa and Kolongi)	7	2
3	Homa Bay Town (Arujo)	4	1
4	Rangwe (Kagan)	4	1
Total		22	6

Source: Researcher, 2017

In-depth interviews were conducted using interview guides with two representatives from each organization including Ministry of Agriculture, Kenya Meteorological Department, Non-Government Organizations and County disaster management committee totaling to eight (8). These key informants were identified through a combination of simple random sampling, purposive and quota sampling techniques.

Results and Discussions

Mitigation strategies for rainfed agriculture in Homa Bay County. The study sought to examine the mitigation strategies to dry spells occurrences on rainfed agriculture in the study area. Based on the on-farm adaptation strategies to cope with the climate change and variability, small scale farmers and other governmental and non-governmental stakeholders in Homa Bay have come up with various on-farm strategies to mitigate the effects of dry spells (FAO, 2010). The study did not evaluate all the mitigation strategies for climate change and variability but focused on the ones identified by the relevant stakeholders in Homa Bay County. The strategies that informed the study and formed the basis of evaluation were crop based strategies such as soil conservation, water harvesting, growing of drought tolerant crops, supplemental irrigation and post-harvest storage strategies.

Crop production mitigation strategies for dry spells in Homa Bay County, Kenya. The study sought to evaluate the crop production mitigation strategies against dry spells. The results (Figure 1) indicate that post-harvest storage 68.8% (206) was practiced by the majority of the respondents, followed by growing of drought tolerant crops 59.8% (179), crop diversification 46.8% (140), Water harvesting 30.8% (92), soil conservation techniques 30% (90), and supplemental irrigation 33.9% (102), respectively. The results indicate that soil conservation was the least applied mitigation strategy towards management of dry spells in the study area by the respondents.

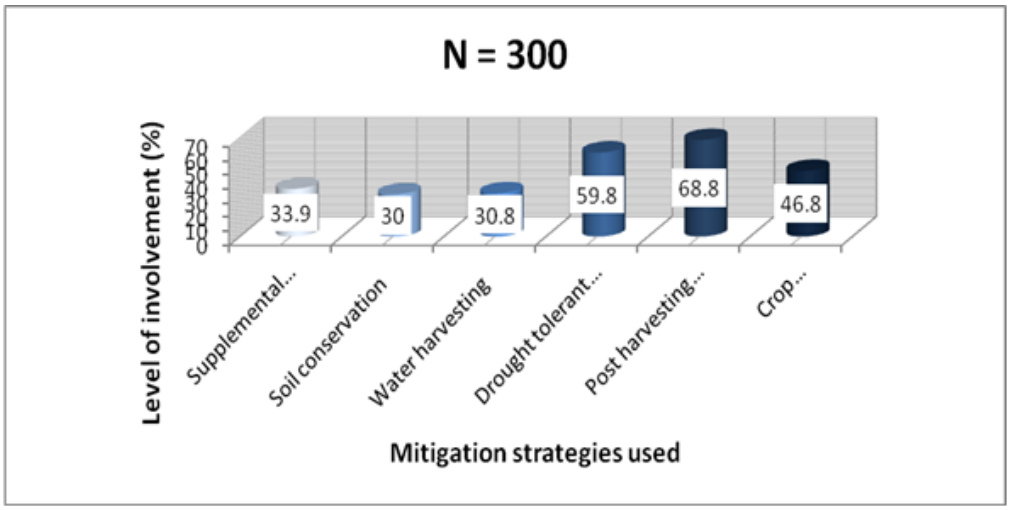

Figure 1. Mitigation strategies for crop production during dry spells period in Homa Bay County, Kenya. Source: Field data (2018)

Chi - Square value ($x^2_{5,0.05}$=67.85) showed that there was significant variations with a P-value of 0.000 at 0.05 error margin among mitigation strategies application on the rainfed agriculture but with limited or no improvement of food production in Homa Bay County. Dry spells pose a major threat to livelihoods hence food insecurity that makes the small scale farmers to adapt mitigation strategies to improve their production. Mitigation strategies seek to minimize the potential impacts of hazardous events like dry spells that may occur in agriculture (Rose, 2008).

From the FGDs and KIIs, it was noted that though the County residents were aware of the mitigation measures to employ during dry spells, these strategies however were not in full operation to improve food production. This was attributed to a number of factors that hinder the full implementation of the strategies. Some of the factors that constrain the full application of these strategies were financial constraints, insufficient technological knowhow and attitude change to current agricultural practices required to improve food production in the area. Ongeko *et al.* (2017) observed that inadequate resources to adapt to climate change limit the capacity of the Homa Bay County residents to increase food production.

Use of supplemental irrigation strategy in dry spell mitigation in Homa Bay County. The study sought to establish the level of use of supplemental irrigation in dry spells mitigation in Homa Bay County. The results in Figure 1 indicate that 33.9% (102) of the respondents used supplemental irrigation as a mitigation strategy during dry spells. It is therefore evident that a large number of small scale farmers do not practice the strategy or if practicing then this was not effective in improving food production in Homa Bay County.

The information gathered from KIIs and face to face interviews with the respondents revealed that a number of farmers practice small scale supplemental irrigation alongside Government's irrigation scheme like in the case of Kimira Oluch government funded project. However, the level of involvement in supplemental irrigation was low and unsustainable. Many small scale farmers still depend on rainfed agriculture even as the County borders Lake Victoria (Mati, 2005). This was reported in a study conducted by the Government of Kenya on climate risk on agriculture in Homa Bay County that asserted that over dependency on rainfed agriculture greatly affected rainfed crop production and livestock rearing in the County where only 13.3% of the land was under irrigation (GoK, 2013).

The low percentage of arable land that is under irrigation poses a greater risk to food security in the study area. From the FGDs, the participants' attributed this to insufficient funds to acquire equipment due to the high poverty levels in the County, low presence of agricultural extension staff at ward levels and over dependency on rainfed agriculture. The participants indicated that major crops that form part of the 13% irrigated land are kales, tomatoes, onions and water lemon. Culturally in the County, these are not regarded as contributors to food security given that they are not staple food (GoK, 2013).

Use of crop diversification strategy in dry spells mitigation in Homa Bay County. The analysis of crop diversification in Homa Bay County indicated that 46.8% of the household respondents (Figure 1) employed this strategy in attempt to improve crop production during dry spells occurrence in Homa Bay County. From the FGD's conducted in Kanyamwa and Kologi, numerous crops have

different characteristics in rate of maturity and level of tolerance to dry spells and other environmental challenges like diseases. Some of the crops listed were maize, sorghum, millet, beans and sweet potatoes. Although crop diversification is practiced in many regions of Africa, there has not been a significant improvement in food production sufficient to sustain the high and rising demand for food by the increasing population (Meseret, 2009).

Despite the use of crop diversification as a measure of increasing food productivity, the food insecurity rate in Homa Bay County stood at 50% (GoK, 2014). Information gathered from KII such as the Ministry of Agriculture revealed that there was over reliance on certain crops grown in the County and this promoted food insecurity in the event of a dry spell. This is also echoed by Asinjo (2014) in a study on coping and adaptation strategies of small scale farmers in Lake Victoria Basin which found out that over 80% of the County residents preferrred planting maize and beans. However, other crops which could be more resistant and tolerant to the prevailing extreme conditions especially during prolonged dry spells were avoided.

Use of soil conservation strategy in mitigating dry spells in Homa Bay County. The respondents were asked whether soil conservation was practiced and if it had helped reduce the impact of dry spells to rainfed agriculture. The results (Figure 1) show that only 30% of the respondents agreed that the strategy was effectively practiced to improve crop productivity. There was a high percentage of respondents who did not indicate that soil conservation measures employed could remedy dry spells impact on crop production in Homa Bay County.

From the FGDs conducted in Kagan ward, it was established that soil conservation was usually more labour-intensive and this made it mostly used by youths and male headed households. Even then, only 28% of youth and male headed households out of the 74% of the labour force employed soil conservation agriculture in Homa Bay County (GoK, 2014). The majority of the household respondents (70%) indicated that the strategy was ineffective in mitigating the impact of dry spells in Homa Bay County. This may have been attributed to the fact that 80% of the labour force were small scale farmers who used largely rainfed agriculture. Planting of Napier grass, mulching, planting of cover crops like sweet potatoes were the main soil conservation strategies employed by the small scale farmers. Minimum tillage is also practiced as a moisture conservation measure that employs the use of the cover crops in many parts of Kenya that majorly depend on rainfall for agriculture (Huho and Kosonei, 2014). The study revealed that appropriate soil conservation strategies aimed at improving soil fertility need to be implemented within the overall strategy to increase farm production and consequently increase food security to avoid hunger and starvation in Homa Bay County.

Use of post-harvest storage strategy in mitigating dry spells in Homa Bay County. The results in Figure 1 show that 68.8% of the household respondents used post-harvest storage as a mitigation strategy that helped to reduce the impact of dry spell in the study area. Compared to the other strategies reviewed earlier, a higher percentage of respondents practiced it to store the little produce after a growing season to mitigate future dry spells. The effectiveness of the strategy is attributed to the frequent dry spells in the County hence forcing the farmers to preserve the produce in their traditional storage facilities.

One of the causes of food insecurity in many parts of the world is lack of or insufficient storage

facilities for the harvested crops. Ellis (2000) observed that the extent of post-harvest loses in Kenya was wide, varied and caused an average of 10 – 15% loss. Major causes of post-harvest losses in Kenya are heavy rains, poor harvest management and insects. These factors affect the amount of on-farm food and consquently lead to food insecurity in many households (Mbithi, 2000).

Farmers in Homa Bay County like in many other parts of Kenya and Africa experience post-harvest losses. The main storage facilities in Homa Bay County are Cribs (75%) and gunny bags (24%) while Silos are mainly used by the National Cereals and Produce Board (NCPB) in their depot in Magunga (GoK, 2013). This means that over 90% of farmers use traditional storage methods that may not appropriately store the farm outputs given the varying climatic changes in the County. The study established that due to the unpredictable weather patterns coupled with the rudimental way of storage in the County, many farmers lose harvested food crops to bad weather. This accounts for the large number of respondents who echoed the ineffectiveness of the strategy in Homa Bay County.

Use of storage facilities and technologies like hermetic bags, community grain and input storage facilities and promotion of agro processing are recommended (GoK, 2016). Due to the limited (1%) use of silos available, there is need for appropriate collaboration among stakeholders like the County Government, various NGOs and individual small scale farmers in the County to develop strategies to reduce the high losses and enhance food security. Effective storage of the farm produce can mitigate crop loss by stabilizing food supply at the household level from season to season (Thamaga *et al.,* 2009).

Use of water harvesting strategy in mitigating dry spells in Homa Bay County. The results in Figure 1 indicate that 30.8% of the household respondents use water harvesting strategy which has helped somewhat to reduce the impact of dry spells in the study area. However, a high percentage of respondents indicated that water harvesting did not lead to increased productivity and yield in Homa Bay County.

One of the critical components of food security is to ensure that sufficient water is available for agriculture throughout the year. Water is the greatest constraint in both crops and livestock production hence farmers need to adopt different mitigation strategies for water availability enhancement in order to cope up with the frequent prolonged dry spells (Mwang'ombe *et al.,* 2011). Food insecurity therefore results due to overreliance on rainfed agriculture in many parts of Kenya and specifically in Homa Bay County. Unless this dependence is addressed, through monumental shift from rainfed agriculture, challenges of attaining food security may continue and subject Homa Bay County to food insecurity given the inconsistent rain patterns and stresses (FAO, 2013).

The study found out from the FGDs that not many participants use water harvesting techniques to limit the impact of dry spells. A few do it on small scale to specific non staple food crops. This was largely due to insufficient funds for large scale construction of the ponds and for building dams since agricultural practices are small holder based. Water harvesting techniques used in Homa Bay County include construction of shallow wells, use of water pans and mostly use of domestic water tanks. Such strategies are not adopted by many farmers due to the fact that they tend to be capital intensive (GoK, 2016). Wasula *et al.* (2012) observed that irrigation is a recommended strategy for increasing agricultural production in the Arid and Semi-Arid Agricultural lands (ASALs) but its

implementation is limited since households are mostly impoverished.

Growing drought tolerant crops to mitigating dry spells in Homa Bay County. The results in Figure 1 show that 59.8% of the household respondents indicated that the strategy has helped reduced the impact of dry spells on rainfed agriculture in Homa Bay County. However, some respondents indicated that the contribution of drought tolerant crops towards promoting food security was still low. Icheria (2008) observed that planting of drought tolerant crops such as cassava can reduce the short fall of food that might be experienced in a year and season in a region of unpredictable rainfall.

These findings on the use of drought tolerant crops as a mitigation strategy for dry spells in Homa Bay County resonate with those of Awange *et al.* (2007) on the frequency and severity of drought in Lake Victoria region (Kenya) and its effect on food security. The study indicated that in response to the changing climatic conditions, the small holder farmers have resorted to growing considered drought tolerant crops like cassava and sweet potatoes. However, there is still over reliance on maize and rice as sources of staple food in the region.

The participants in FGD's stated that there is increase in maize crop cultivation compared to for drought tolerant crops. This is attributed to other environmental factors that affect the drought crops in the fields. According to Kiptot *et al.* (2006), there is a significant decline in growing of drought tolerant crops, specifically cassava, in the region due to moles and diseases.

Conclusion and recommendation

Rainfed agriculture has continuously become unpredicted and erratic. There is need therefore for appropriate capacity building in terms of training, awareness creation and financial assistance for farmers. This will enhance the level of uptake and implementation of the identified strategies for sustainable rainfed agriculture. There is need for appropriate mitigation measures to supplement the rainfed agriculture through contingency plans, which will substantially reduce the effect of dry spells.

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