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Rainfall Variability Coping Strategies for Improved Food Security: A Case Study of Baringo South, Baringo County, Kenya

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Abstract :
Climate variability impacts food production and hence food security. The Arid and Semi-Arid Lands (ASALs) experience water stress and drought events arising from climate variability. The focus of this study was to find out strategies used by small-scale farmers to cope with rainfall variability for improved food security in Baringo South Sub-County, Kenya. Baringo South is within ASAL region hence a suitable site for the study. A case study research design was adopted for the study, where 136 questionnaires were administered to household heads, to establish farmers' coping strategies corresponding to rainfall variability regimes. Descriptive statistics were used in the analysis of data and the results presented in the form of pie charts and tables. The study found out that; both seasonal rainfall and maize yield indicated a fluctuating pattern. It was also concluded that there was a strong positive relationship between seasonal rainfall amount and maize yield that was significant at 5% levels of significance. The study found that 90.5% of the small scale farmers in Baringo South sub-County coped with rainfall variability. The Findings of the study are significant to the County government of Baringo and Kenyan Governments in coming up with appropriate interventions for coping with rainfall variability for improved maize production and policy development, to cushion the local communities against the effects of climate change.

Keywords: *Climate variability, drought, desertification, water-stress, food security*

1. Introduction

Climate change is a major challenge to global food production. The extreme events resulting from climate change such as drought, desertification and heat waves, decrease amount of available water in the atmosphere, ground and surface water sources. According to studies conducted by McCann (2005); Ammani et al. (2012) and Tekwa & Bwade (2012), on maize water requirement for consumptive use for germination, growth, and development, rain-water was found to be approximately 200 mm to 500 mm in the tropical highlands and lowlands respectively. The daily maize crop water requirements range from 4.35 mm/day during the long rainfall season to 3.10mm/day during the short rainfall season, Tekwa & Bwade (2012).

According to Mwaura& Okoboi (2013), seasonal rainfall variability was a key parameter in determining maize crop yield, thus rainfall was considered as the main source of water for both rain-fed agriculture and irrigation, scarcity of which negatively impacted crop production. Water factor in climate variability drives the physiological and phenological progression of the maize plant and was found to be central to plant growth, development and yield formation. Soil water budgets influenced crop water budgets which in turn affected carbon dioxide fixation rates, photosynthetic transport and carbon dioxide sink-source relationships, Ketiem et al. (2013). According to Maranga (1993), crop water utilization is low in the ASALs due to water stress. Msafiri (2014) also indicated that crop production was challenged in the ASALs due to rainfall variability. The approximate global population affected by water-stress due to rainfall variability was projected to increase from 300 million in 1993 to 3 billion people by 2025 (Lewandrowski et al., 1993).

Climate variability affects crop production hence food security. Food insecurity is a major global challenge (Herrero et al., 2010). Food demand was projected to increase by two to threefold by 2050 due to rapid global population increase, however; deaths from famine and malnutrition were witnessed to be increasing globally especially in Sub-Saharan Africa (FAO, 2008). Each year, approximately 500 million people suffer from malnutrition and famine, whereby this vulnerable population was often found in developing Countries (Shiferaw, 2011). During the 2011 drought, 50,000 people died globally; with food supplies costing US $1.3 billion (Shiferaw, 2011). The global economic value of maize crop loss was projected to reach US $ 100-200 million annually by 2050 (Herrero et al., 2010). Despite the augmentation in demand; global maize yield from both irrigation farming and rain-fed agriculture was found to increase at a rate of 1.3% to 1.4% per year, though demand superseded the supply of the produce (Akanbi et al., 2004).

Edmeades et al. (1992) indicated that 15% reduction in crop production was due to rainfall variability in the lowland tropics and sub-tropics, accounting for16 million tons of grain loss. According to Cakir (2004), East and North-Eastern Africa, experienced recurrent periodic droughts leading to aridity, famine and malnutrition, which created the need to develop drought resistant crop seeds for such poor conditions. The global demand for maize products such as maize flour, cooking oil, glucose, starch, sweeteners, fodder, poultry feeds, biofuel, fibre, resins, bioactive derivatives, and ethanol created more demand for maize (Elander et al., 1993).

According to FAO (2008), the hot deserts and the ASALs experienced hot climatic conditions with insufficient rainfall; leading to low crop yields. Mogaka et al. (2009) and Omolo et al. (2010) found out that variability of rainfall in Kenya exhibited a biannual occurrence trend succeeded by drought and famine. Baringo South Sub-County experienced a modified tropical climate of the lowlands and the highlands and high frequency of droughts leading to water-stress, degradation of farm-lands, ecosystem destruction and increased soil salinity. These conditions were not favourable to maize crop production (Ketiem et al., 2013). The small-scale maize farmers in Baringo-South resiliently cultivated maize for domestic consumption. Adoption of new farming methods and appropriate technology such as irrigation in production was recorded in some areas (Cakir, 2004).

A study conducted by Hahn et al. (2009) indicated that some farmers in the ASALs were already coping with rainfall variability in a number of ways: use of drought resistant seeds, drought tolerant seeds, genetically engineered seeds and practising irrigation. Investment in farm technology was also adopted by some farmers in ASALs (CIMMYT, 1994). According to McCann (2005), early maturing maize seeds can potentially improve crop yields in ASALs. The CIMMYT (1994) managed coping to rainfall variability through research on maize and wheat to improve food security in Central and South America. Braun et al. (1992) advocated for adoption of agronomic technology.

FAO (2008) advised adoption of irrigation farming, improving farming methods, effective water use and water harvesting as viable coping measures to improving food security. Studies conducted by MOA (1999), Kurukulasuriya et al. (2008), Shiferaw (2011) and National Irrigation Board (NIB) (2017) found out that effective agricultural policy formulation and implementation, accessibility and absorption of financial services marginally increased crop production.

2. Research Methodology

The case study research design was adopted where questionnaires were administered to 136 household heads to find out the coping strategies used by the small-scale farmers to cope with rainfall variability. The sample was selected using random sampling method. The analysis of the data was done using descriptive statistics and the results presented using pie charts and tables.

2.1. Study Area

Baringo South is Agro-climatic Zone V; a semi-arid zone with minimum temperatures of 10^0 Celsius in the highlands and maximum temperatures of 35^0 Celsius in the lowlands (MOA, 2001). Igneous and sedimentary rocks are predominant in the highlands to the lowlands respectively. The lowlands were characterised by stony soils with rock outcrop and lava rocks. Deep, reddish to brown friable, well drained and stratified soils were common (GOK, 2005). Baringo South Sub-County

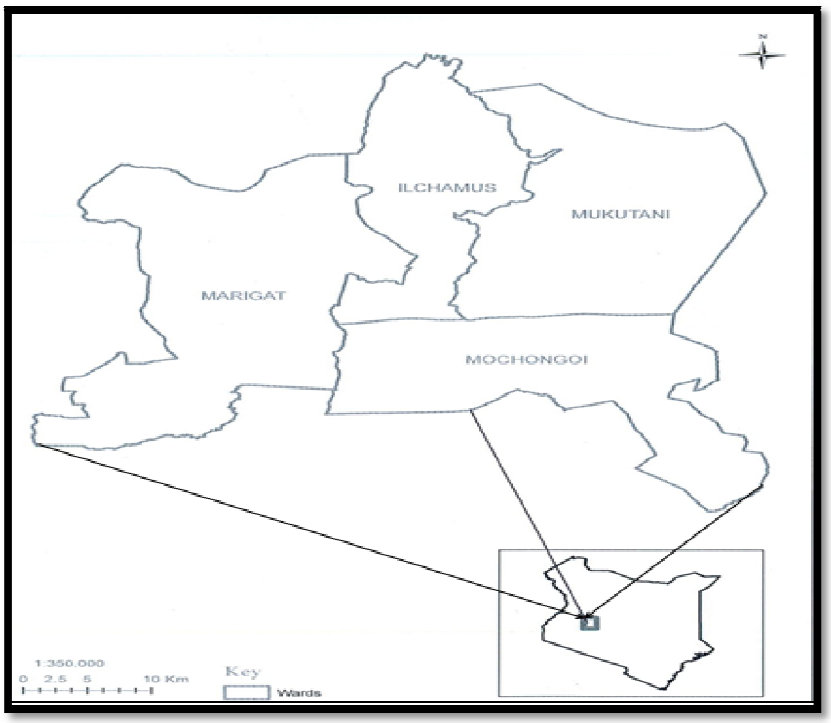

Figure 1: Map of Baringo South Sub-County Showing the Study Location.
Source: Nakuru County, Department of Planning (2017)

3. Results and Discussion

The results on Figure 2 indicate that majority (90.5%) of the small-scale farmers practiced rainfall coping strategies. The results of this study concur with the results of studies conducted in Nigeria and England by Ohajianyi (1996) and Seneviratne (2011) respectively, which indicated that there were increasing numbers of small-scale farmers coping with climate change.

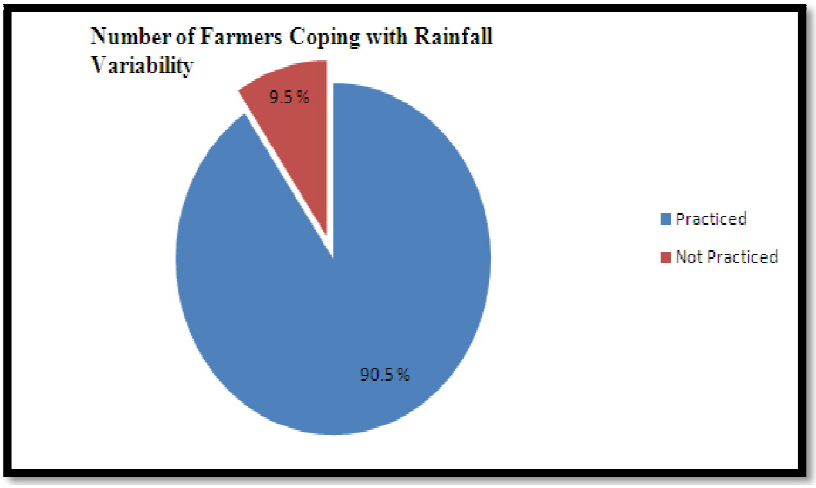

Figure 2: Number of Farmers Coping with Rainfall Variability

3.1. Agricultural Coping Strategies

Results on Table 1 show that majority of the small-scale farmers 54.5 % changed maize seeds/ varieties, while 33.6% diversified their crops, 31.1% planted early, 22.4% increased farm inputs and 20.9% practised irrigation respectively, as coping strategies. The results of this study concurred with the findings of studies conducted in Kenya by Ketiem et al. (2013), which indicated that use of adaptable and drought resistant maize varieties, early maturing maize varieties, planting early in water-stressed environments are commendable coping strategies which potentially increase maize crop production.

Agricultural Coping Strategies	Practiced	Not Practiced
Change of farming methods/ technology	36.6	63.4
Change of maize seeds/ varieties	54.5	45.5
Change from maize crop to other crops	33.6	66.4
Change from maize crop to livestock	9.7	90.3
Planting early	31.1	68.9
Planting late	13.4	86.6
Increasing farm inputs	22.4	77.6
Reducing farm inputs	1.5	98.5
Testing the soils	6.7	93.3
Increasing weed control	12.7	87.3
Reducing weed control	6.0	94.0
Not removing farm weeds	2.2	97.8
Practicing mixed cropping	6.0	94.0
Practicing irrigation	20.9	79.1
Practicing drought resistant agro-forestry	1.5	98.5
Changing land ownership systems	3.0	97.0
Integrated land and water use	4.5	95.5
Practicing mixed farming	9.7	90.3

Table 1: Small Scale Farmers Rainfall Variability Coping Strategies in Baringo South Sub-County

3.2. Usage of Farm Inputs

Results on Figure 3 show that majority of the farmers (94.0%) used farm inputs. The findings of this study were in agreement with findings of a study done in Cameroon by Fule (2013), which indicated that small-scale farming recorded a commendable trend in usage of farm inputs.

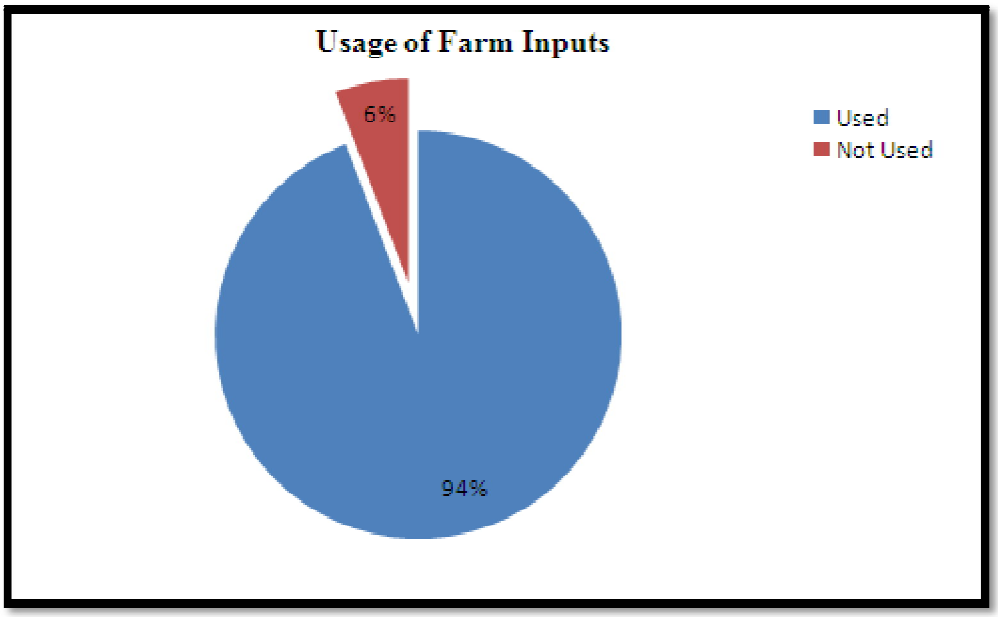

Figure 3: Usage of Farm Inputs.

3.3. Farm Inputs Used

Results on Table 2 show that majority (90.3%) of the small-scale farmers used fertilizer, while usage of other farm inputs by the small-scale farmers was as follows:(38.1%) pesticides, (37.3%) herbicides and (6.7%) fungicides. The results of this study were in agreement with findings of a study conducted in Cameroon by Fule (2013), which indicated that small-scale farming used farm inputs such as fertilisers and pest control chemicals which can potentially increase crop production.

Input Type	Used	Not Used
Fertiliser	90.3	9.7
Fungicides	6.7	93.3
Pesticides	38.1	61.9
Herbicides	37.3	62.7

Table 2: Farm Inputs Used in Baringo South Sub-County

3.4. Timing of Agricultural Activities

The findings on Table 3 show that majority, 73.9% of the small-scale farmers prepared land earlier, while 26.1% prepared land late, 49.2% of the small-scale farmers planted earlier while 50.8% of the small-scale farmers planted late, 36.6% of the small-scale farmers harvested earlier and 63.4% harvested late. The earlier preparation of land was done due to rainfall variability. The findings implied that climate change affected the farming activities. The results of this study were in agreement with findings of studies conducted in in Kenya and Mozambique by Hahn et al. (2009) and Oseni et al. (2011) respectively, which indicated that early land preparation and early planting in ASALs potentially increase crop production.

Activity	Earlier	Late
Land preparation	73.9	26.1
Planting	49.2	50.8
Harvesting	36.6	63.4

Table 3: Small Scale Farmers Timing for Agricultural Activities

3.5. Socio-economic Coping Strategies

The results on Table 4 found out that small-scale farmers in Baringo South adopted financial services and farm mechanization and were rated at 59.7% and 23.3% respectively. The low adoption of agricultural finance implied low access to the service which led to low mechanization. The results of this study were in agreement with findings of a study conducted in Uganda by Kurukulasuriya et al. (2008) which indicated that accessibility, adoption and effective use of financial services, technology and mechanization can potentially increase crop production.

Socio-Economic Coping Strategies	Practiced	Not Practiced
Adoption of financial services (Taking loans to improve farming methods)	59.7	40.3
Finding off-farm jobs	7.7	12.3
Using technology and mechanization	23.3	76.9
Increasing farm size	13.4	86.6
Reducing farm size	11.2	88.8
Leasing out your land	4.8	95.2
Changing cultural practices such as gender to farm	6.0	90.0
Buying maize produce insurance	4.8	95.2
Migrating from the area	4.8	95.2

Table 4: Small Scale Farmers Socio-Economic Coping Strategies

3.6. Access to Agricultural Extension Services

Results on Figure 4 show that majority of the small-scale farmers 77% received agricultural extension services and 23% of the small-scale farmers did not receive agricultural extension services. The high percentage of farmers accessing extension services implied efforts made to improve maize production by the extension officers. The findings of this study were in agreement with results of studies conducted in Kenya by MOA (2002) and MOA (2013) which indicated that there was increased effort in the provision of agricultural extension services in Baringo South.

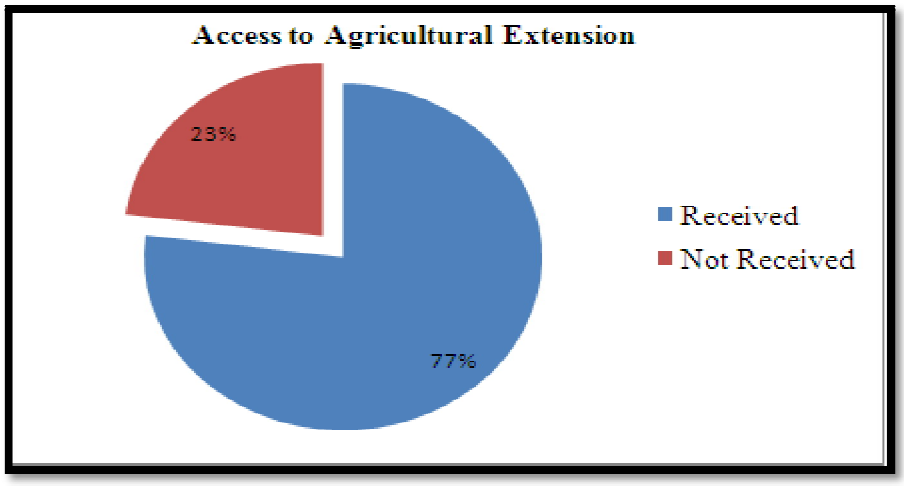

Figure 4: The Small-Scale Farmers Accessing Agricultural Extension Services

3.7. Extension Service Providers

The results on Table 5 show that majority, 69.4%, of the small-scale farmers received extension service from a government extension officer, while 0.7% from University/ College respectively. The findings of this study were in agreement with the findings of studies conducted in Kenya by MOA (2001) and Rees et al. (2000), which indicated that agricultural extension workers played a critical role in the provision of agricultural information and training of small-scale farmers.

Extension Service Provider	Received	Not Received
Government extension worker	69.4	30.6
Private extension worker	8.2	91.8
NGOs/ CBOs	31.3	68.7
Other farmers	9.9	90.1
University/ College	0.7	99.3

Table 5: Extension Service Providers

3.8. Agricultural Loan Access

Results on Figure 5 show that 73.9% of the small-scale farmers accessed loan and 26.1% of the small-scale farmers did not access loan. The high percentage of farmers who accessed agricultural loans implied that financial institutions played a big role in maize crop production in the study area. The findings of this study were in agreement with findings of a study conducted in Kenya by MOA (2013) which indicated that there was increase in access to agricultural finance. Access to agricultural finance was common however there was the need to ensure that all small-scale farmers access loan for farming of maize.

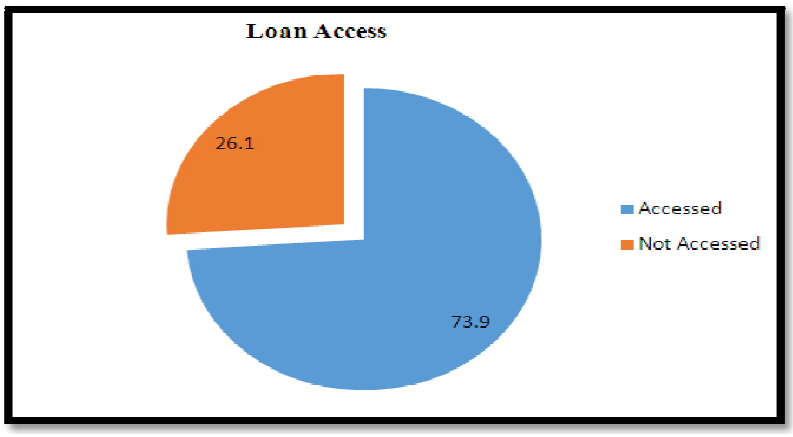

Figure 5: Small-Scale Farmers Access to Credit Facilities

3.9. Source of Agricultural Credit

Results of the findings on Table 6 show that majority of farmers, 44.8% accessed loan from Cooperatives (Sacco) while 8.8% from local money lenders. The high percentage of farmers accessing agricultural credit from Cooperatives (Sacco) implied that the Cooperatives played a major role in maize crop production in the study area. There is need to improve access to loan from other commercial institutions. The findings of this study were in agreement with findings of a study done by Rees et al. (2000) which indicated that agricultural finance and cost of agricultural finance impacts government programmes such as crop production and mitigation of climate change.

Source of Credit	Received	Not Received
Agricultural Finance Corporation	23.1	76.9
Commercial Banks	20.9	79.1
Cooperatives (Sacco)	44.8	55.2
Input stores	9.0	91.0
Micro-Finance Institutions	35.1	64.9
Local Money Lenders	8.2	91.8

Table 6: Small Scale Farmers Source of Credit

3.10. Technological Coping Strategies

3.10.1. Farm Equipment

The findings on Figure 6 show that majority of the small-scale farmers 96.3% used simple farm equipment. The high percentage of farmers using simple farm equipment implied that more effort is required in accessing farm machinery to improve maize production. The findings of this study were in agreement with results of studies conducted by Dixon et al. (2004) and Pressman (2011) which indicated that there was an increase in the use of simple farm equipment by small-scale farmers.

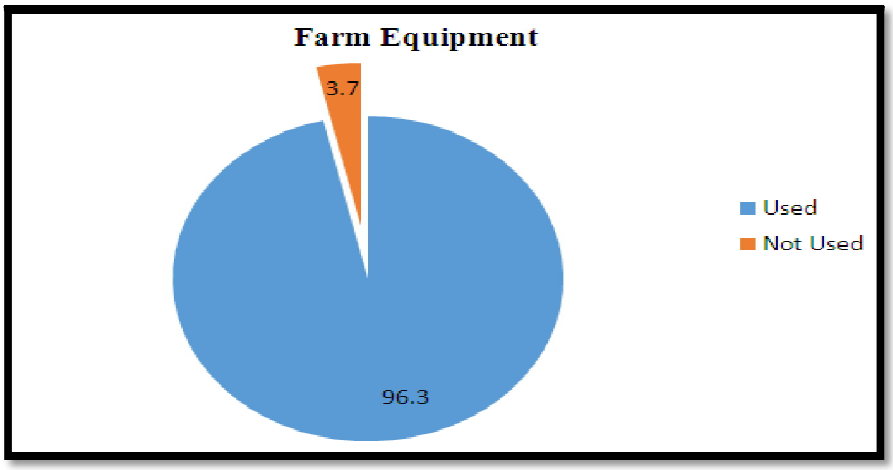

Figure 6: Farm Equipment Used by Small Scale Farmers

3.11. Source of Agricultural Information on Coping Strategies

Results on Table 7 show that majority, 61.9% of the small-scale farmers received information on coping strategies from radio, while 8.3% from neighbours. Radio was the most popular source of information on coping strategies indicating that 61.9% of the small-scale farmers used it. The findings of this study were in agreement with findings of studies conducted by Rees et al. (2000) and Sutherland (1999) which indicated that the media, family, neighbours and civic groups were key sources of information on crop production. There was the need to increase the effectiveness of the other sources of information to improve farming and increase maize yield.

Extension Service Provider	Received	Not Received
Radio	61.9	38.1
Television	18.7	81.3
Newspapers	17.2	82.8
Neighbours	8.3	91.7
Family	9.8	90.2
Internet	9.0.	91.0
Baraza	36.6	63.4

Table 7: Source of Information on Coping Strategies among Small Scale Farmers

3.12. Challenges to Coping with Rainfall Variability

Results on Table 8 show that 55.3% of farmers experienced inadequate funds, 48.6% experienced poor quality of seeds, 25.4% of the small-scale farmers experienced Lack of technology/ machines/ inputs, 19.9% experienced lack of information and 18.7% of farmers experienced shortage of labour. Majority of farmers experienced lack of money as the leading constraint to coping with rainfall variability. The results of this study were in agreement with findings of studies undertaken by FAO (2008) and Kurukulasuriya et al. (2008) which indicated that access to agricultural financial services was a major challenge to crop production. FAO (2008) indicated that poor quality seeds were a major challenge to maize production.

Constraint	Yes	No
Inadequate funds	55.3	44.7
Lack of information	19.6	80.4
Shortage of labour	18.7	81.3
Low level of technology/ Machines/ Inputs	25.4	74.6
Poor quality of seeds	48.6	51.4

Table 8: Constraints in Coping with Rainfall Variability among Small Scale Farmers

3.13. Extension Services

The study findings as shown on Table 9indicated that the small-scale farmers received various extension services which included: crop production services (58.9%), rainfall variability coping strategies (44.0%) and livestock production services (23.9%). The results of this study were in agreement with findings of a study conducted in Kenya by MOA (2010) which indicated that there was increased provision and access to agricultural information, training and mentorship in crop production in Baringo South, though more resources were required for the same.

Agricultural Extension Service	Received	Not Received
Crop production	58.9	41.1
Livestock production	23.9	76.1
Coping strategies to rainfall variability	44.0	56.0

Table 9: Services Received

4. Conclusions and Recommendations

4.1. Conclusions

After analysis of the findings of this study, it was concluded that seasonal rainfall and maize yield had a corresponding pattern in fluctuation over the years of study, effectively a rise in the amount of seasonal rainfall led to a rise in maize yield and vice versa. It was also concluded that there was a strong positive relationship between seasonal rainfall amount and maize yield that was significant at 5% levels of significance. Further, it was also concluded that majority of the small-scale farmers 90.5% in Baringo South Sub-County practiced rainfall variability coping strategies. The study also found that the most appropriate coping strategies included: changing maize seeds/ varieties, shifting from maize crop to other crops, early planting, increasing farm inputs and rainwater harvesting for irrigation.

4.2. Recommendation for Further Research

- This study was limited to coping strategies to rainfall variability employed by small-scale farmers in ASALs. It is recommended that a study be conducted on large scale farmers' adaptation strategies to climate change in ASALs for improving food production.

5. Acknowledgement

We wish to thank Mr. Makau S. Lawrence and Mr. Mureithi James; Baringo County Crops Officers for allowing the collection of secondary data of maize yield at the various County agriculture offices. We also thank Mr. Njau Peter (Mount Kenya University) for the review of the data, the management of NIB, Snake Farm and Kenya Agriculture and Livestock Research Organization (KALRO) Marigat for enabling access to rainfall data.

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