$Q_{it} = \alpha + \beta P_{it} + \mu_{it};\ \mu_{it} = \rho_i \mu_{i,t-1} + \nu_{it}$

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TRANSFORMING SMALLHOLDER AGRICULTURE IN AFRICA: THE ROLE OF POLICY AND GOVERNANCE

Poster ID: Presentation Title:Climate factors as Determinants of Food Security in Semi-arid Kenya: A Longitudinal Analysis

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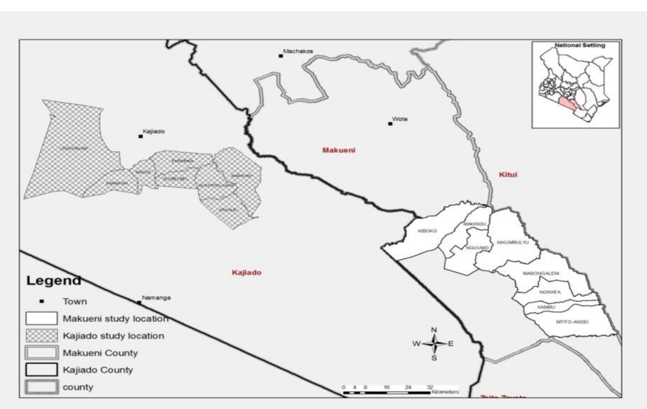
Introduction

- Agriculture is a key driver for pro-poor economic growth in Kenya and supports over 80% of rural households (Amwata *et al*., 2015).
- Challenges in the agriculture sector (RoK, 2010; 2012; Nyariki *et al*., 2005):
  - ✓ Limited national budgetary allocation: less than 1% of national budget
  - ✓ High vulnerability to climate change and variability
  - ✓ Use of traditional/outdated methods of production
  - ✓ Government preference for industrial sector with consistently high returns; thus jeopardising Kenya's long term goal of food self-sufficiency.
- GoK declares a state of food emergency almost yearly with arid and semi-arid lands (ASALs) as the worst affected: over 70% of the people live below the poverty line and depend on external food aid (Amwata *et al*., 2015).
- Governments and non-governments have devised innovative ways to enhance food production, access, availability and affordability: programmes, projects, policies, capacity strengthening and financing. Even with all these efforts, Kenya still remains food insecure.
- This study sought to investigate the interactions between climate factors, food security and household socio-economic parameters.

Materials and methods

Study area was Makueni and Kajiado Counties, Kenya (Figure 1)

Figure 1: Location of study sites in Kajiado and Makueni Counties



- Annual rainfall : 300 - 1300 mm
- Temperatures: 12ºC - 32ºC.
- Crops; maize, beans, and pigeon peas, millet and sorghum.

Model formulation:

- Total income per adult equivalent as dependent. Independent variables include livestock offtake/ha, % livestock offtake, maize and beef prices, human population, area under maize, annual rainfall, rain days, temperature, stocking rate and drought.

Model selection:

- Ordinary Least Squares (OLS), Generalised Least Squares (GLS) and Autoregressive (AR) model were tested - all give unbiased and consistent parameter estimates, and the criterion for discrimination was efficiency (Wooldridge, 2003).
- OLS assumes that independent and dependent variables have a uni-directional relationship and that the errors are uncorrelated. This can easily be violated for time series data.
- In AR model, dependent variable is lagged and used as an explanatory variable, thus poses a possibility of autocorrelation in the error term.
- GLS model uses a time-series auto-correlation technique and the Cochrane-Orcutt procedure (Equations 1& 2) (Baltagi, 2001).

Where

$$Q_{it} = \alpha + \beta P_{it} + \mu_{it};\ \mu_{it} = \rho_i \mu_{i,t-1} + \nu_{it} \ldots.1$$

$$\nu_{it} \sim N(0,\delta^2_{\nu});\ E(\mu^2_{it}) = \delta^2;\ E(\mu_{it}\mu_{jt}) = 0;\ E(\mu_{i,t-1}\nu_{jt}) = 0 \quad i \neq j \ldots.2$$

- To formulate a GLS model, a unit root test of stationarity of the variables was carried out (Gujarati, 2003). Taking an example with the deflated prices, the equation used was: where ΔP_t is the first-difference of the panel of prices, and the null hypothesis is set at $\delta = 0$. If there was a unit root problem in the data, δ would be equal to zero. The results were as follows

Kajiado County total annual rainfall (P_t):

$\Delta P_t = \alpha_1 + \delta P_{t-1} + \mu_t$

$\Delta P_{t-1} = 5.801 - 0.0837 P_{t-1}$

t = (0.837) (-7.942)

$r^2 = 0.700$; $d = 0.139$.... 4

Makueni County total annual rainfall (P_t):

$\Delta P_t = 5.801 - 0.0837 P_{t-1}$

t = (0.689) (-5.026)

$r^2 = 0.689$;

$d = 1.944$…………5

The error term was not autocorrelated for total annual rainfall in both counties—based on the Durbin-Watson (*d*) test—the stationarity of deflated prices was proved by the Dickey-Fuller (DF) test as seen from equations 4 and 5; at a significance level of 5%, the data did not exhibit random walk.

Acknowledgements:

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Results

Descriptive statistics:

- Low % livestock offtake, stocking rate, maize prices and beef prices were linked to extreme climate events: droughts (1983/84, 1991/1992 and 1995/96; 1999/2000, 2004/2005) and El Niño floods in 1997/1998.
- Income levels were highest during periods of high rainfall and lowest in periods of low rainfall or drought

Regression models:

GLS Model had the best fit for the data: had highest number of significant variables and was significant at P≤0.05, thus was selected for discussion in this study (Table 1).

Table 1: Regression results for GLS, AR and OLS Models

Variables	GLS Model		AR Model		OLS model	
	Kajiado	Makueni	Kajiado	Makueni	Kajiado	Makueni
Constant	0.3	0.9	-1.4	-2.5	-1.7	-2.9
Human population	-0.9	-0.8	-0.9	-	0.9	-
Drought year (Yes or No)	1.4	-1.7	-1.8*	-0.7	-1.3	-0.8
Lagged total annual rainfall	3.6**	-2.0**	0.9	-0.6	0.9	-0.5
Rain days/per year			0.7	1.4	0.4	1.6
Maize price per kg	3.1**	1.4	2.3**	1.3	1.9*	1.2
Beef prices per kg	0.8	2.2**	1.0	1.9**	-0.6	2.56*
Mean annual temperature	-3.7**	-	-1.7	-0.3	-2.0**	- 0.1
Area under maize	-	-	-	0.5	1.2	0.6
Maize production(metrics tons)	1.7	-	1.8*	-0.7	0.5	-0.7
Per cent livestock offtake	4.7**	5.0**	2.8**	-	4.5**	-
Livestock offtake/ha		-	-	4.6**	-	5.5**
Rainfall days per year	1.8*	1.9*	-	-	-	-
Stocking rate	-	4.4**	-	3.2**	-	3.3**
Lagged income /AE	-		0.9	0.6	-	-
Kajiado (R^2=0.8, F-value=8.5**; Durbin Watson (*d*)=2.098) and Makueni (R^2=0.8; F-value=10.9** Durbin Watson (*d*) = 2.0)			Kajiado (R^2 = 0.9, F=27.5 (p≤0.05), H-value = 38 and Makueni (R^2 = 0.970, F = 53.48 (P≤0.05), H-value = 36.4)		Kajiado: AdjustR^2=0.9, F= 40.1, Durbin Watson (*d*)=1.5 (P≤0.05); Makueni: R^2=0.9, F=60.8, Durbin Watson (*d*)=1.5 (P≤0.05)	

** Significant at p≤0.05, * Significant at p≤0.10

Kajiado:

- Lagged total annual rainfall, maize price per kg and % livestock offtake had a positive and significant influence (P≤0.05) on total income. With higher maize prices, less food was purchased. However, households that grew maize along the river valleys or practised irrigation had higher incomes due to higher maize producer prices.
- The mean annual temperature had a negative and significant (P≤0.05) influence on total income; thus an increase in temperature has a negative impact on livestock production, which is a key economic activity in the county.

Makueni:

- Stocking rate (SR), beef price per kg and % livestock offtake had a positive and significant influence (P≤0.05) on total income. The positive effect of SR on total income indicates a mismatch between livestock and the available forage (carrying capacity (CC) is lower than recommended). Thus, increasing SR increases livestock production and income levels. The reverse may be true if the CC is exceeded and forage is limited.
- Lagged rainfall had a negative and significant (P≤ 0.05) influence on total income. The negative effect may occur if the rains are too high to cause floods resulting in erosion and salinity, hence reducing crop production and pasture growth.

Conclusions

- Climate data are critical for forecasting and supporting the design of agriculture adaptation strategies.
- Climate factors are highly variable and strategies for adaptation are site specific.
- Creation of micro-climates through agroforestry of multipurpose trees and shrubs moderates temperatures and attracts rainfall.
- Livestock offtake remains central to ASAL household income; it accounted for 78.2% of county total income in Kajiado and 38.2% in Makueni Counties.
- Decentralised markets (KMC, milk processing plants and leather industries, extension services, access to credit, vet health care are fundamental to livestock improvement.

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