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Climatic Shock Characterization and Their Effects on Livestock Production in Rural Malawi

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Abstract: Livestock husbandry is seriously affected by drought and other climatic extremes in Malawi. Farmers also use livestock as insurance against idiosyncratic and covariate shocks. This study analyzed the impact of drought on indigenous livestock production in rural Malawi and identified the extent to which livestock are used for shock impact mitigation. Data were collected from 300 randomly selected farmers and analysis was done with descriptive statistics and Tobit regression. Results show that farmers that were affected by climate change related shocks have significantly lower land, farm revenue and credit ($p<0.10$). About 38.67% of the farmers were affected by drought in the past 5 years. Number of goat and pigs owned by farmers that were affected by climate shocks were significantly lower ($p<0.05$) than those not affected. Goat and pig production significantly decreased with drought ($p<0.01$) while land owned significantly increased chicken and pig production ($p<0.01$). Selling of livestock was used by households to cope with drought, pests and diseases and sickness. However, reduction in meals constitutes the widely adopted means of coping against shocks. The study, among others, recommended marginal reforms that are targeted at inhabitants of drought prone rural areas in Malawi because of their present extreme vulnerability.

Key words: Climatic shocks, livestock, impact mitigation, drought, Malawi

INTRODUCTION

Climate change is one the major limiting factors of agricultural production in Malawi. Between 1997 and 2003, the country experienced series of droughts that affected >21 million people. Available data show that there were 18 major floods between 1967 and 2003 with the Southern part of the country being more vulnerable. Climate change is a serious problem because majority of the 6.3 million people that are living below poverty line in Malawi are in rural areas where >90% relies on rain-fed subsistence agriculture (ActionAid, 2006). Rural dwellers are already vulnerable because of low income profiles and lack of requisite skills for securing employment in the formal sector. However, climate change further suppresses them to serious vulnerability thereby mesmerizing their indigenous farming system knowledge and accumulated experiences.

As an economy where agriculture accounts for close to 85% of the labour force close to 40% of Gross Domestic Product (GDP) >80% of foreign exchange earnings >65% of industrial raw materials and >64% of rural incomes (Daudi), prospects of economic growth and development in Malawi is bleak without due consideration of agricultural growth and its development potentials. Although, the Malawian crop sub-sector exhibits more significance in terms of output and labour force engagements, livestock husbandry secures additional income, food and nutrition for some rural households. Available statistics have shown that there are about 1.2 million farm families that are into livestock husbandry in Malawi. Subsistence livestock farming which is an efficient way of transforming crop residues into food or cash constitutes about 85% (DAHLD, 2006). Specifically due to their ability to withstand environmental stress indigenous production of local breeds of livestock is prevalent in rural areas. This also sometimes serves as insurance against crop failure in the event of drought and any other idiosyncratic and covariate shocks (Freeman *et al*., 2008).

In terms of number, available statistics show that chickens, goats and pigeons/doves are with the highest population in Malawi (DAHLD, 2011). Banda (2008) noted that in the 1980s and 1990s population of cattle declined that of goats and pigs increased while that of chicken was static. Also in terms of utility derived per unit price, Malawians have indicated highest preferences for chicken, goat meats and pigs in that order (Munthali, no date). Beef had been ranked fourth due to its scarcity and high price. Therefore, without any prejudice or bias, revolutionary reforms in the Malawian livestock sub-sector should give paramount consideration for chickens, goats and pigs (Banda, 2008). Although, domestic production of livestock had been projected to fall short of demand by 2017 (Banda, 2008), tactical efforts from the Malawian government is required in order to propel production frontier into a level where consumer demand shortages will be substantially minimized. Specifically, several livestock production mitigating factors have been identified in literature (Banda, 2008; DAHLD, 2006). It is also important to note that many of these problems have been aggravated by drought and other climatic extremes. Too much rainfall and increase in temperature have been linked to higher incidences of animal diseases.

As climate changes, certain parasitic disease-causing organisms that have been in existence may have their geographical range expanded and become more prevalent (Epstein and Mills, 2005). Because of lack of insurance, farmers and pastoralists generally bear the consequences of their livestock death. This has often subjected households to poverty vulnerability, diseases, communal conflicts and break of social cohesion and orders (ActionAid, 2002).

Specifically inadequate availability of feeds had been further aggravated by persistent drought making animals to be fed with alternative crop residues. In absence of money to obtain the needed food supplements livestock deaths are inevitable. It is also important to remarkably note that households are normally compelled to sell livestock when there is food crisis. However, due to the fact that many households lack liquid cash and excess supply of livestock, prices are always lower than would ordinarily be (ActionAid, 2002). The implication is that households will generally realize little or no profit from sales of livestock because of persisting economic hardships.

This research has the objectives of determining the effect of climate-related shock (drought) (inter alia) on livestock production in Malawi. It also seeks to identify the roles that are played by livestock in mitigating the impacts of climatic changes. In trying to do this the livelihoods framework of Ellis (2000, 2003) was adopted. This framework provides the conceptual linkages for examining the roles of livestock in household livelihood strategies and identifying the links between vulnerability and livelihoods.

Freeman *et al*. (2008) noted that according to the framework, households are endowed with assets in the form of physical capital, natural capital, human capital (education, skills and health), financial capital and social capital. These assets are utilized to construct livelihoods which generate income and endow them with shock mitigating capability. Also, understanding of the critical risk chains gives us some insights into the ways of designing emergency risk management (Alwang *et al*., 2001). The remaining parts of the paper are divided into materials and methods, results and discussion and recommendations.

MATERIALS AND METHODS

Sampling procedures: The data were collected using multi-stage random sampling. At the first stage, two provinces were selected from the Lilongwe region. The selected provinces were the Central province (Lilongwe) and Northern province (Dowa). The second stage involved selection of two Enumeration Province Areas (EPAs) from each of the provinces. The selected EPAs were Chitekwer and Nyanja from Lilongwe and Madisi and Nachisaka from Dowa. The next stage was a listing of the villages under each of these epas from where samples were taken. Ten villages were randomly selected from Chitekwer (6) and Nyanja (4) and eleven from Madisi (4) and Nachisaka (7). The selection was done proportionately to the number of the villages. The last stage was selection of households. A total of 152 households were interviewed in Lilongwe and 148 from Dowa.

Estimated model: Factors explaining indigenous livestock production are modeled using Tobit Model because the data are censored with zero for those that did not keep livestock. The model is stated as:

$$Y_i = \eta + \beta_i \sum_{i=1}^{n} Z_i + e_i \tag{1}$$

Y_i is the number of livestock owned. Researchers were restricted to goats, chickens and pigs because these were the results where enough observations were available for meaningful analysis. The independent variable (Z_is) are gender (male = 1, 0 otherwise) age, province (Lilongwe = 1, 0 otherwise), years of education, household size, land size (ha), asset (MKW), farmers' revenue (MKW), nonfarm income (MKW), credit (MKW), pest management information (yes = 1, 0 otherwise), output market information (yes = 1, 0 otherwise) input market information (yes = 1, 0 otherwise), livestock husbandry information (yes = 1, 0 otherwise), irrigation information (yes = 1, 0 otherwise), health information (yes = 1, 0 otherwise), family planning information (yes = 1, 0 otherwise), soil water conservation information (yes = 1, 0 otherwise), market distance (km), drought (yes = 1, 0 otherwise). Also, η and β_i are the parameters to be estimated and e_i is the error term.

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers and access to information: Table 1 shows some descriptive statistics of the farmers that were affected by climatic shocks and those not affected. It reveals that farmers that were affected by climate change were a bit older with mean age of 43.89 years than those not affected with 42.79 years as the mean age. Also, the farmers that were affected climate shocks have lower average years of education (4.56) than those not affected (4.9). Climatic-shock-affected farmers also have average household size of 5.07 while those not affected have average household size of 5.48. Those farmers that were not affected by climatic shocks have significantly higher average male adult ($p<0.01$). Also, those that were not affected by climate shocks have significantly higher average land area ($p<0.10$), farm revenues ($p<0.05$) and credit ($p<0.10$).

Table 2 shows access to farm inputs and information by the farmers. It shows that climate shock affected farmers have higher access to improved maize varieties. Access to information on pest management, output markets input markets, livestock market, irrigation, health, family planning and soil conservation is higher among those not affected by climatic shocks.

Nature of shocks exposure and livestock production: Table 3 shows the distribution of shocks that were experienced by the farmers. It shows that 38.67% of the farmers were affected by drought in the past 5 years. Also, adverse weather was reported by 3% of the respondents. Floods affected about 5% of the respondents. The farmers that reported pests and diseases and sickness were 24.67 and 17.33%, respectively. Only 2% of the farmers did not report any shock. Table 4 shows average livestock heads among the farmers that were affected by climate change and those not affected.

It shows that chickens, goats and pigs have highest means with 6.698, 2.65 and 1.386, respectively among all respondents. The table shows that except for duck and sheep, farmers that were not affected by climatic shocks have higher mean head of all the livestock. Also, means values for goats heads, pig heads, guinea fowl and dove are statistically significant ($p<0.10$).

Table 5 shows the estimated parameters for the production of selected livestock using Tobit regression analysis. It reveals that the models produced good fit for the data as evidenced by statistical significance ($p<0.01$) of the Likelihood Ratio (LR) statistics and statistical significance of the computed sigma values ($p<0.01$). Out of the included variables, age is statistically significant ($p<0.10$) in the estimated models for goats and chickens. Increase in the farmers' age increases the number of goats while it decreases chicken production. This is expected because in some instances, goats are kept by aged people as a store of wealth and for fulfillment of some traditional rites.

Chicken, especially the local breeds are largely kept by old people on a very small scale. However, the demands of raising exotic breeds go beyond what aged people can easily cope with. Therefore, younger and energetic people are at the forefront of raising bird which may primarily be for eggs or meat. The parameters of province for goats and chickens are statistically significant ($p<0.01$) and shows that farmers that were resident in Lilongwe have higher goat and chicken heads. This may have resulted from higher involvement in livestock husbandry as alternative income generating enterprises in situation of drought and adverse climate. The parameter of household size is statistically significant for chicken model ($p<0.10$). This shows that as household size increases, the number of chicken increases. This is expected because involvement of household members can ease chicken production because of the requirements of feeding, watering, house cleaning, etc.

Table 1: Descriptive statistics of farmers' socio-economic characteristics

Socio-economic characteristics	Affected by climate shock		Affected by other shocks		All respondents	
	Mean	SD	Mean	SD	Mean	SD
Age	43.89	15.339	42.79	12.496	43.3	13.882
Education	4.56	3.746	4.9	3.641	4.74	3.688
Size	5.07	2.237	5.48	2.086	5.29	2.163
Adult male***	1.26	0.772	1.54	1.015	1.41	0.919
Adult female	1.38	0.791	1.49	0.727	1.44	0.758
Youth	1.69	1.54	1.68	1.301	1.68	1.415
Children	0.76	0.886	0.79	0.812	0.78	0.846
Land*	1.6357	0.91097	1.8584	1.24133	1.7545	1.10344
Asset	29223.49	79705.6	40641	78800.11	35312.83	79296.7
Farm revenue**	21545.9	33440.66	50195.74	169209.5	36825.82	126295.2
Non-farm Rev.	31822.57	95426.93	28362.19	54872.57	29977.03	76403.66
Credit*	1650.77	5219.39	5371.5	26077.99	3635.16	19436.04

*Statistically significant at 10%, **Statistically significant at 5%, ***Statistically significant at 1%

Table 2: Percentage distribution of farmers' access to farm inputs and information

Farm input/information	Climate shock affected	Other shock affected	All respondents
Pest management information	25	33	29
Output market information	46	61	54
Input market information	46	58	52
Livestock husbandry information	21	28	24
Irrigation information	21	41	32
Health information	51	64	58
Family planning information	44	60	52
Soil water conservation information	44	47	45

Table 3: Different shocks experienced by farmers

Nature of shocks	Frequency	Percentage	Cumulative percentage
Adverse weather	9	3.000	3.0000
Drought	116	38.67	41.670
Floods	15	5.000	46.670
Pests/Diseases	74	24.67	71.330
Sickness	52	17.33	88.670
Striga	10	3.330	92.000
Theft	15	5.000	97.000
Wild animals	3	1.000	98.000
None	6	2.000	100.00

Table 4: Descriptive statistics of livestock heads among farmers

	Affected by climate shock		Affected by other shocks		All respondents	
Livestock	Mean	SD	Mean	SD	Mean	SD
Oxen	0.03	0.238	0.04	0.353	0.03	0.304
Breeding bull	0.00	0.000	0.01	0.079	0.00	0.058
Dairy cows	0.01	0.169	0.01	0.158	0.01	0.163
Other cows	0.02	0.188	0.10	0.665	0.06	0.503
Goats**	1.59	2.344	2.35	2.851	1.99	2.650
Pigs***	0.21	0.735	0.71	1.740	0.47	1.386
Rabbits	0.02	0.254	0.13	0.848	0.08	0.644
Chicken	4.44	5.204	5.38	7.764	4.94	6.698
Guinean fowls*	0.00	0.000	0.11	0.752	0.06	0.551
Doves*	0.11	1.194	0.91	5.583	0.54	4.171
Ducks	0.10	0.798	0.03	0.316	0.06	0.592
Sheep	0.02	0.254	0.01	0.158	0.02	0.208

*Statistically significant at 10%, **Statistically significant at 5%, ***Statistically significant at 1%

The results also show that land size parameters are statistically significant ($p<0.01$) for the chicken and pig models. These imply that if land area increases by 1 ha, the number of chicken and pigs with increase by 2.2 and 1.68 units, respectively. Land is a constraining factor in livestock production, especially poultry and piggery where avoidance of environmental pollution from odours from their droppings implies locating such farms in the outskirt of the village or town. Local breeds of goats are sometimes kept on free range, except for insecurity problem from human theft.

The parameters of asset value are with positive sign and statistically significant in all models ($p<0.10$). This shows that farmers wealthier farmers have higher number of livestock heads. This is expected because of the financial requirements for housing, feeding, medication and labour. Also, it is only in the model for goats that farm revenue parameter show statistical significance ($p<0.10$). This is expected because Banda (2008) and Rischkowsky and Steinbach (1997) noted that due to their relatively smaller size, number of goats kept by farmers have recently increased. Smith (2005) also noted that importance of goats in the Limpopo river basin is as a result of their ability to thrive in drier climate. Therefore, due their ruggedness, expected losses among goats will be lower than that in other livestock like chicken or cattle. Access to information on livestock husbandry significantly increases chicken production ($p<0.10$). This is expected because commercial raising of chickens requires adequate management knowledge in order to minimize losses from diseases. The irrigation information parameter is with negative sign and statistically significant ($p<0.10$) for pig model.

Table 5: Tobit regression of factors influencing livestock production in central Malawi

	Goats		Chickens		Pigs	
Variables	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Gender	-0.2632494	0.5953474	0.7607052	1.219188	-0.1190923	0.9431276
Age	0.0772427***	0.0181961	-0.0693482*	0.0373089	-0.001836	0.028469
Province	1.679168***	0.5331658	3.654345***	1.08625	-1.039002	0.8109252
Years of education	-0.004651	0.0698098	0.0350037	0.139722	-0.1158312	0.1019557
Household size	0.1125101	0.1209401	0.4525917*	0.2449742	-0.0122852	0.1831279
Land size	0.4501206	0.2999928	2.200657***	0.616513	1.67602***	0.4335502
Asset	8.89e-06***	2.89e-06	0.0000124**	6.11e-06	7.43e-06*	3.82e-06
Farmers' revenue	4.98e-06*	2.88e-06	-2.94e-06	6.10e-06	-5.06e-06	4.34e-06
Nonfarm income	1.77e-06	2.99e-06	3.25e-06	6.29e-06	5.53e-07	4.53e-06
Credit	-0.0000234	0.0000158	-0.0000652	0.0000401	-0.0000368	0.000035
Pest management information	0.5384249	0.6781484	1.38051	1.425721	1.296187	0.980451
Input market information	-0.5401679	0.7072169	-2.084927	1.46514	-1.064253	0.9831809
Livestock husbandry information	-0.083593	0.6842293	2.744292*	1.405583	1.548755	1.018026
Irrigation information	-0.1192082	0.6627889	-0.7363695	1.371479	-1.904438*	1.048577
Health information	0.7721961	0.606667	3.368646***	1.239282	0.982867	0.9067085
Family planning information	0.1391848	0.6235261	-2.892853**	1.284057	-0.9073857	0.9468109
Soil water conservation information	0.0795998	0.5853341	-1.233142	1.177225	0.0314267	0.8610618
Market distance	0.0769784	0.1094027	0.1232661	0.2145161	-0.1332221	0.1756038
Drought	-1.199744**	0.5205564	-0.7170721	1.050731	-2.59106***	0.8773797
Constant	-5.708406***	1.391866	-3.907825	2.754356	-5.775195***	2.049347
Sigma	3.588929***	0.2139698	7.711684***	0.3934252	3.860227***	0.4360964
LR Chi^2 (24)	73.83***		62.87***		56.31***	

*Statistically significant at 10%, **Statistically significant at 5%, ***Statistically significant at 1%

Table 6: Frequency distribution of farmers' ex-post shock coping options

Coping options	Adverse weather	Drought	Floods	Pests/Diseases	Sickness	Striga	Theft	Wild animal	Total
Asking for	0	0	1	0	3	0	1	0	5
Borrowing	0	0	1	2	4	1	0	0	8
Collecting	0	0	1	0	0	0	0	0	1
Doing casual work	1	21	3	8	9	0	1	0	43
Eating cassava	0	19	0	14	7	2	1	0	43
Eating sweet potatoes	1	3	0	0	0	0	0	0	4
Eating vegetables	0	3	3	4	0	0	0	1	11
Growing early maturing crops	0	2	0	0	0	0	0	0	2
Migration	0	1	0	2	0	1	1	1	6
Reducing food intakes	4	46	3	15	14	3	4	0	89
Selling livestock	0	12	1	17	5	0	1	0	36
Using savings	3	5	2	10	6	3	5	1	35
Total	9	112	15	72	48	10	14	3	283

This shows that farmers with access to irrigation information have lower pig heads. Health information parameters is only statistically significant ($p<0.01$) for chicken model. This implies that households with access to health information have higher chicken heads. Banda (2008) reported hygiene as an important issue in livestock husbandry.

For chicken, access to health-related information can increase production because of direct contact and co-habitation with humans. Family planning parameters is with negative sign and statistically significant ($p<0.05$) in the chicken model. This shows that farmers with access to family planning information have significantly lower chicken heads. This can be explained from the need for more of family labour involvement in raising chicken. Therefore, when family planning is in place and household size reduces, labour inputs into chicken production will be reduced because children are often directly involved in its management. The drought parameter for all the models are with negative sign but on statistically significant ($p<0.05$) in goats and pigs. This implies that farmers that experienced drought have lower goat and pig heads. Reduction in livestock heads can reduce as a result of drought because of selling off of the animals in order to off-set family income requirements that are not met from crop enterprises.

Coping options against climatic and other idiosyncratic shocks: Table 6 shows that climatic shock in the form of drought was largely mitigated by reducing food intakes (46). This implies risk of malnutrition and exposure of households to higher risk of disease infection. Drought affected farmers were also involved in casual work (21), eating cassava (19) and selling livestock (12). The table also shows that in the event of livestock pest and diseases, farmers were also selling their livestock (17) and reducing their food intake (15). Fewer number of farmer were selling livestock because of sickness but it alarming to note that households were also reducing their food intakes due to illness. It should be emphasized that as a country where HIV and AIDS is having devastating effect among households, sickness posses a lot of challenges to access to food and nutrition in rural Malawi.

CONCLUSION

In order to boost production of livestock, the findings have identified such efforts as targeting of aged farmers for goat and younger ones for chicken, land reforms that ensures access to good pastureland for livestock husbandry, provision of vital information in livestock husbandry, especially for poultry and preparedness to forestall adverse impact of drought on livestock production. Intensive research efforts for developing livestock breeds with higher resistance to drought will go a long way is reducing fluctuations in livestock production and its expected demand shortages.

RECOMMENDATIONS

Livestock husbandry in rural Malawi provides some kind of insurance against climatic shocks. This research also investigated the impact of drought on production of some indigenous livestock. The findings have pointed to the following recommendations: Climate change affected farmers have lower assets, revenues and land when compared to those not affected. This shows that farmers that are often affected by drought and other climatic extremes in Malawi have been depleted of vital resources that can be used for shock mitigation. This necessitates government's intervention in providing some marginal reforms that are adequately targeted at drought-prone areas in Malawi.

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