THE PERCEIVED IMPACT OF CLIMATE CHANGE ON SMALLHOLDER DAIRY PRODUCTION IN NORTHERN MALAWI

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ABSTRACT

The vulnerability of smallholder dairy farmers to climate change remains a major concern for many researchers. This paper analyses the perceived impact of changes in rainfall patterns on water availability, disease occurrences, pasture production, and in turn on milk production. Farmers' perception was obtained through a survey and analysed using a multi-nominal regression model. The results showed a statistically significant relationship between a fall in milk production and a decrease in water availability ($p < 0.05$), constant water availability ($p < 0.01$), and decrease in pasture production ($p < 0.05$). Constant milk production resulted from constant water availability ($p < 0.01$), and constant disease occurrences ($p < 0.05$). The model explained between 32% and 36% of the variation in milk production with the accuracy in classification of 60%. The results highlight the need for further analysis in the vulnerability and adaptation of smallholder dairy farmers to climate change.

Key Words: Climate change, dairy production, Malawi.

1. INTRODUCTION

It is well acknowledged that dairy farming both contributes to and is affected by climate change. Dairy production plays a part in greenhouse gases (GHGs) emissions, particularly methane, which contributes to climate change. While the livestock sector as a whole is responsible for 18 percent of total anthropogenic GHG emissions measured in carbon dioxide (CO_2) equivalent (FAO, 2006), global dairy production accounts for 4 percent of the total global anthropogenic GHG emissions (FAO, 2010). This figure includes emissions associated with milk production, processing and transportation, as well as the emissions from meat production from dairy-related culled and fattened animals. Thus, for sustainable dairy production, there is need to reducing GHGs emission from the dairy sector through improved feeding and manure management.

Dairy farming is vulnerable to climate change through increased temperatures and changes in rainfall patterns. These factors affect feed and water availability, animal health and breeds, and in turn milk production. Warmer and drier conditions increase the likelihood of heat stress in cattle. There is normally a decrease in milk production for cows under heat stress. Changes in rainfall patterns affects pasture growth patterns thereby affecting the quality and quantity of both feed grains and fodder produced outside dairy areas. Droughts lead to water shortage which in turn leads to a decrease in milk production (Siemes, 2008). There is also ample evidence that climate change has an impact on the increase or decrease in animal disease risk. Examples of diseases which are related to climate change include: avian influenza which spread over 4 continents since the beginning of the new millennium; bluetongue which spread across Europe; and the Rift Valley fever which spread in Africa as a result of severe floods (Bruckner, 2008). The other consequence of climate change as highlighted by Hoffmann (2010) is the increased risk that geographically restricted rare breed populations have due to climatic disturbances. Breeding goals may therefore have to be adjusted to account for higher temperatures, lower quality diets and greater disease challenges. Breeds that are well adapted to such conditions may become more widely used (Hoffmann, 2010).

African countries, therefore, needs to develop adaptation strategies through projections of climate change impacts on dairy farming, and impacts on feed, water and animal health and breeds. Through such projections, the countries can come up with ways through which dairy farmers can adapt their farming systems to cope with changes in climate change.

This paper analyses the perceived impact of changes in rainfall patterns on water availability, disease occurrences, pasture production, and in turn on milk production by smallholders farmers within Mzuzu Agricultural Development Division (Mzuzu ADD). Mzuzu ADD is one of the eight Agricultural Development Divisions in Malawi and comprises four districts. It has a cattle population of 193,834 of which 3,782 are dairy cattle (MZADD, 2010). The dairy population has been increasing overtime. For instance, the dairy herd increased from 3,328 in 2006/07 to 3,782 in 2009/10 (MZADD, 2007; 2010). The increase in dairy animals is in line with Government policy in dairy production whose goal is to ensure adequate supply and consumption of milk and milk products.

2. MATERIALS AND METHODS

In order to establish the perceived impact of changes in rainfall patterns on milk production by smallholder farmers within Mzuzu ADD, the study used data from a baseline survey of dairy farmers within the ADD. The survey was conducted in the three districts of Mzimba, Rumphi, and Nkhata-Bay. These districts are actively involved in dairy farming. Within the three sampled districts, 13 Extension Planning Areas (EPAs) were purposefully selected for the study. These EPAs were the ones that are also actively involved in dairy farming, hence their selection for the study. In each EPA, simple random sampling was used to select the most actively participating milk bulking groups (MBGs), dairy farming clubs, local institutions and individuals for the study. The sample that was selected in this study represented about 40 percent of approximately 700 households (DAHLD, 2005) participating in dairy farming in the ADD. Data was collected using household interviews. From the sample, only households that had dairy animals were selected for the study. Further, from the selected households, farmers who were present within their households were interviewed during the study. Field agricultural officers guided the research team to the appropriate households and respondents.

Data collection was carried out from the 5th to 12th April 2009. A structured questionnaire with recall questions was used during data collection. The questionnaire was designed to capture information on socio-economic characteristics of the respondents and on six thematic areas of dairy farming namely: Animal breeds, feeding and feed availability, animal health and services, animal housing, farmer networks and climate change. On climate change, respondents were asked to indicate whether they had experienced any changes in the amount of rainfall over the past five years. A likert scale was used for the respondents to indicate whether the amount of rainfall had increased, decreased or remained constant. Apart from indicating their perceptions on change in rainfall pattern, respondents were also asked to mention the effects of those changes on dairy farming. In particular, respondents were asked to indicate the effects of changes in rainfall on the following attributes of dairy farming:

Pasture production, disease occurrence, parasite occurrence, water availability and milk production.

Data on perceived impact of changes in rainfall patterns was initially analysed using Statistical Package for Social Scientists (SPSS). Descriptive statistics such as percentages and frequencies were used for summarizing and presenting the results. Furthermore, a multi-nominal (logistic) regression model (Pallant, 2006) was used to analyse the statistical significance of these responses on milk production. Milk production was coded as a categorical dependent variable with the following values: 0 = decrease in milk production; 1 = constant milk production; and 2 = increase in milk production. Water availability, disease occurrences, and pasture production, were also coded as categorical independent variables with the following values: 0 = decrease; 1 = constant; and 3 = increase. SPSS was again used to run the logistic regression model.

3. RESULTS

A total of 284 farmers were interviewed during this study. Of the total, 150 (52.8%) were female and 134 (47.2%) were male. In terms of farmers' perception on rainfall patterns, the results revealed that majority (40%) of the respondents indicated that the amount of rainfall that the area had received over the past five years had increased (Figure 1). Some respondents (6%) had no idea on whether there had been any changes in the amount of rainfall over the past five years.

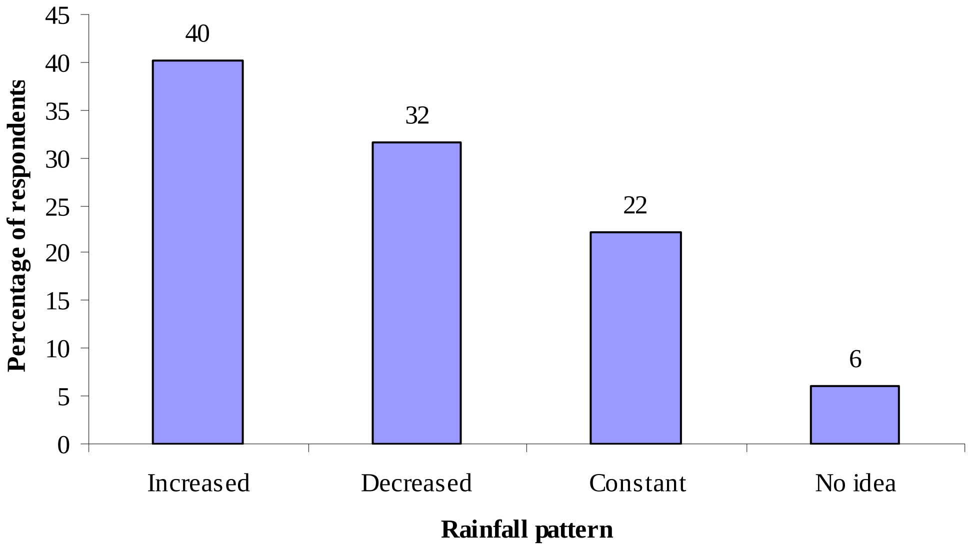

Figure 1: Perceptions of respondents on change in rainfall pattern over time

Table 1 presents results on the influence of changes in rainfall on dairy farming. The results showed that majority of the respondents who noted that there was an increase in amount of rainfall, felt that it led to an increase in pasture production, disease and parasite occurrence and water availability. However, 37.7% of the respondents had no idea on the resultant effect of the changes in rainfall on milk production. Among the respondents who indicated that there was a decrease in amount of rainfall, majority noted that it led to a decrease in pasture production, disease and parasite occurrence and milk production. However, majority of the respondents (54.4%) indicated that the decrease in rainfall had no effect on water availability.

The respondents who indicated that the rainfall pattern had remained constant, had mixed views on its effect on pasture production since 42.9% of farmers mentioned that pasture production had increased while an equal percentage noted that production had remained constant. Further, majority of the respondents mentioned that disease and parasite occurrence decreased while water availability remained constant. A high number of respondents (41.3%) had no idea on the overall effect of rainfall patterns on milk production.

Table 1: Effect of changes in the rainfall pattern on dairy farming

Rainfall pattern	Effect on dairy farming	Respondents (%)			
		Increased	Decreased	Constant	No idea
Increased	Pasture production	73.7	9.6	14.0	2.6
	Disease occurrence	37.7	22.8	26.3	13.2
	Parasite occurrence	35.1	21.9	30.7	12.3
	Water availability	70.2	5.3	21.9	2.6
	Milk production	30.7	19.3	12.3	37.7
Decreased	Pasture production	13.3	65.6	20.0	1.1
	Disease occurrence	23.3	36.7	26.7	13.3
	Parasite occurrence	20.0	43.3	30.0	6.7
	Water availability	10.0	35.6	54.4	0.0
	Milk production	16.7	34.4	18.9	30.0
Constant	Pasture production	42.9	12.7	42.9	1.6
	Disease occurrence	23.8	34.9	27	14.3
	Parasite occurrence	23.8	38.1	25.4	12.7
	Water availability	34.9	7.9	49.2	7.9
	Milk production	22.2	27.0	9.5	41.3

Results from the multi-nominal regression model are presented in Table 2. The results showed a statistically significant relationship between a fall in milk production and a decrease in water availability ($p < 0.05$), constant water availability ($p < 0.01$), and decrease in pasture production ($p < 0.05$). Constant milk production resulted from constant water availability ($p < 0.01$), and constant disease occurrences ($p < 0.05$).

Table 2: Parameter estimates and their significance

Change in Milk Production[1]	Variable	B	Std. Error	Wald	Sig.	Exp (B)	95% Confidence Interval for Exp (B)	
							Lower Bound	Upper Bound
Decrease	Intercept	-0.821	0.390	4.425	0.035			
	Water =0	1.657	0.709	5.465	0.019	5.244	1.307	21.043
	Water =1	1.842	0.622	8.768	0.003	6.309	1.864	21.351
	Disease =0	-0.676	0.531	1.620	0.203	0.508	0.179	1.441
	Disease = 1	-0.420	0.603	0.485	0.486	0.657	0.201	2.144
	Pasture = 0	1.427	0.617	5.352	0.021	4.167	1.244	13.964
	Pasture = 1	0.246	0.611	0.162	0.687	1.279	0.386	4.233
Constant	Intercept	-1.974	0.578	11.670	0.001			
	Water =0	-0.326	1.048	0.097	0.756	0.722	0.093	5.630
	Water = 1	2.095	0.674	9.660	0.002	8.123	2.168	30.432
	Disease = 0	0.387	0.688	0.316	0.574	1.472	0.383	5.666
	Disease = 1	1.437	0.710	4.092	0.043	4.207	1.046	16.926
	Pasture = 0	1.063	0.724	2.159	0.142	2.896	0.701	11.958
	Pasture = 1	-0.654	0.709	0.850	0.357	0.520	0.130	2.088

[1] The reference category is: Increase

Note: Results for Water = 2, Disease = 2, and Pasture =2 have not been presented because they are redundant.

The Cox and Snell R^2 and the Nagelkerke R^2 were 0.317 and 0.360 respectively; suggesting that between 32% and 36% of the variation in milk production was explained by the three variables. The percentage accuracy in classification was about 60%.

4. DISCUSSION

The perception of many farmers (40%) to indicate that there was an increase in the amount of rainfall over the past five years may probably be due to the good rainfall pattern the sampled area had experienced over the past five years. This perception may also have been induced by the general increase in agricultural production realized over the period. This implies that communities may not see climate change as an immediate problem. The reason for some farmers to have no idea on changes in the rainfall pattern may be that during the past five-year period there was no clear trend in the amount of rainfall that the area had received. Some variations in the rainfall pattern had been experienced in the area from one year to the other over the five-year period, hence some respondents could not figure out the actual trend of the rainfall pattern.

Respondents' failure to indicate indirect effect of the changes in rainfall on milk production shows that the relationship between the two variables (rainfall and milk production) was not clear to these farmers. The relationship between the two variables was unclear probably because the effect of the increase in rainfall which led to an increase in pasture production and water availability was offset by the increase in disease and parasite occurrence. Further, the decrease in rainfall may not have significantly affected water availability as the area under study has not experienced any severe water shortages.

Results from the multi-nominal regression model confirm that there is a positive relationship between milk production on one hand and water availability, and pasture production on the other. The relationship between milk production and disease occurrence remains unclear since it is only constant disease occurrence which is significantly related to constant milk production.

From these results, it can be concluded that farmers in the study area do not consider climate change as having any significant influence on dairy farming. The five-year period under consideration was probably too short for the communities to establish a clear relationship between rainfall pattern and dairy farming. Moreover, most of the farmers have been in dairy farming for less than five years. However, considering the possible negative effects of climate change on livestock production in general and dairy production in particular, it is fundamental to prepare for these effects on dairy production in the study area. Thus, there is need for further studies in the vulnerability and adaptation of smallholder dairy farmers to climate change in the area. The adaptation studies may consider the development and utilisation of improved breeds and alternative sources of feed to match the evolution in farming systems arising from climate change. In developing these technologies, it would be important to ensure that they suit local conditions in order to be beneficial and relevant to the dairy farming communities.

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