Journal of
Climate Policy
(JCP)

Effect of Ambient Temperatures on Dairy Production in Africa. A Critical Literature Review

CARI Journals

Journal of Climate Policy

Vol.1, Issue No.1, pp 1 – 11, 2022

www.carijournals.org

Effect of Ambient Temperatures on Dairy Production in Africa. A Critical Literature Review

Dr. Josiah Mutembei

Kenyatta University, School of Environmental Science

Corresponding author's email: journals@carijournals.org

Abstract

Purpose: Dairy farming together with crop farming for decades has been a source of livelihood among the rural residents in Africa. The majority of people practice agriculture for capital creation and food security. The overall objective of this study was to examine influence of ambient temperatures on dairy production in Africa.

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: This study concluded that climate variability was evident in the area with variations in temperature and precipitation. Temperature and precipitation had rose from maximum averages across the years in the past 30 years. From the findings it is arguable that different places with Africa continue to be affected by climate variability. To the dairy productivity, exotic and indigenous dairy breeds are affected differently by climate variability. As per productivity, exotic breeds tend to be least affected unlike indigenous breeds. For instance, some common animal vegetative crops were highly hit and lowly heat by climate variability like Napier grass and natural grass respectively.

Unique Contribution to Theory, Policy and Practice: This study recommended that creation of awareness on matters pertaining to temperature and its effects on the dairy sector by the relevant country environmental ministry. This will build capacity about amplified challenges emerging from ambient temperatures to dairy farming. For instance, spread of diseases, delayed fodder growth and hampered animal feeding behavior.

Keywords: *Influence, Ambient Temperatures, Dairy Production, Africa*.

INTRODUCTION

Africa just like other continents, depend on dairy products for provision of protein supplements that is found in milk to compliment food security crisis (Khan et al., 2018). However, this trend of dependency on dairy products continue to deteriorate as the effects of climate change are being felt. In Botswana, average high temperatures are on the rise as the annual low rainfall temperatures continue to be experienced (Moreki and Tsopito, 2013). This significance of high temperatures and low rains deter dairy production. Fodder and other grown crops take long to mature and even result to stunted growth. For instance, in Swaziland a country in southern Africa, the manifestation of climate change impact has been noted. This is seen in hydrological disasters, changes in rainfall regime and extreme weather conditions. The periods that droughts have occurred and number of people affected (Vilane et al., 2015). These effects become severe to cattle as crop growth is hindered, the food that sustains both people and livestock (Manyatsia and Mhanzo, 2013)

Climate variability and change do affect dairy cattle in various ways. These include; low quality animal forage, decrease milk production level, spread of diseases, heat stress, animal breeding patterns and animal growth (Valtorta, 2012). Climate change has both indirect and direct impacts to dairy farming resulting from climate variability. Indirect effects affect animal performance and majorly emerge from nutritional alterations and the environment driven by climatic change. Animal pastures and forage crops are altered causing shortage of good feed supply to dairy animals a parameter that hinders the dairy animal production. Direct climate variability impacts cut across the animal morphology and the immediate climatic factors like ambient temperature, precipitation, radiations, wind speed and humidity. The surrounding environment of an animal determines its performance. For instance, heat from the immediate surroundings where the animal habits, determines its milk productivity. Heat stress has a negative impact on animal productivity like dairy cows (Johnson, 2012). Kenya is among the countries in the African continent projected to be hit most by climate change impacts that will both affect its agricultural productivity positively and negatively (IPCC, 2007). Climate change has two phases, the negative and the positive. However, the negative phase has more impact globally, therefore demanding for adaptation and mitigation strategies linger in it heavily. ‘Milk production in the country has been on a steady rise; however, demand outstrips production by 45 million liters’’ (MALF, 2014)

Sub-Saharan Africa already has been hit by the impact of climate change and variability (CCV) on livestock pastoralism systems and rain dependent agriculture (Ngeno et al., 2014). CCV is caused both by anthropogenic forces and natural variability. The degree of vulnerability of DBGs depends on the tropical location the exotic species' habits and its level of adaptive capacity. For instance, the Bos-Taurus genotype breeds are spread across different parts of Kenya as farmers have individual preferences on the breed they want to keep (Kasulo et al., 2012). Dairy cattle are reared in different ecological zones that vary in their productivity as per the environment; therefore, this makes them vulnerable to different CCV impacts. DBGs are vulnerable to disease incidences and heat load, poor feeding level, intensity of climate change (Valtorta, 2012). In

developing world and the majority of countries in the third world basically in Africa, climate related diseases that are triggered by variability affect animal productivity since they cause stress to animal health (Thornton and Gerber, 2010).

For centuries dairy farming and animal husbandry connected with agriculture have been an important integral part for human life in centuries. They provide food for ballooning human population globally and maintain the ecological balance. However, owing to the persisting climatic changes, animal health continues to be at risk. Some disease vectors flourish due to changing weather conditions and seasons affecting dairy livestock (Vink et al., 2016). For instance, NDDB in 2013, ranked India as the largest global milk producing country with annual milk production totaling to 132.4 million tones. With this rank and global recognition of India dairy industry, still climatic changes have no compromise to the dairy sector. A research carried by Chakravarty et al., 2012 suggests that, developing countries inclusive of India are highly vulnerable to climate variability. This is because of limited resource to adopt to climate change like technology, social understanding and finance. Therefore, in Kenya too it is important to find better solutions to formulate climate variability through well documented coping mitigating strategies. Globally, climate variability has exacerbated livestock production as ectoparasites continue to hamper animal livestock health (Khan et 19 al., 2013). Diseases like ticks' infections predisposing dairy animals to yellow fever, pneumonia and mastitis caused by their carried protozoa. This has been noted at the tropics and subtropics like East Africa, India, Pakistan and Bangladesh where climatic conditions are favorable to the growth of ticks (Nasehfar et al., 2015).

Statement of the Problem

Dairy farming together with crop farming for decades has been a source of livelihood among the rural residents in Africa. The majority of people practice agriculture for capital creation and food security. However, dairy farming levels continues to decline due to ambient temperatures effects (Moreki and Tsopito, 2013). Dairy production in Africa is vulnerable to climate variability effects, affecting both the farmers and cattle. Calil, 2012 adds that ambient temperatures is expected to hinder livestock production, hydrological balances and other agricultural systems. This calls for immediate research work to be done in the area on climate variability effects in dairy production. The destroying effects of global ambient temperatures are increasing and their effects are predicted to occur in developing countries such as Kenya because they purely depend on agricultural production that is livestock and crop growing (Musema 2018). Therefore, a response is needed towards dairy production decline that needs to curb the persistent farmers' drawback on livestock rearing. The implication of ambient temperatures towards animal health and production study has to be taken into account to help address this emerging issue among the dairy farmers. This study will therefore examine influence of ambient temperatures on dairy production.

Objective of the Study

The overall objective of this study was to examine influence of ambient temperatures on dairy production in Africa.

Significance of the Study

This research will be used as a term of reference to researchers and upcoming scholars in the area of ambient temperatures and dairy farming. It will therefore be an additional knowledge to this academic field. For the dairy farmers the research will assist them in understanding the effects of ambient temperatures on dairy cattle productivity. To the policy makers it will influence greatly on their decision making when addressing effect of climate change in dairy farming. This therefore underpins the need for this study that allowed for exploration of influence of ambient temperatures on dairy production.

LITERATURE REVIEW

Effect of Ambient Temperatures

On dairy cattle ambient temperature is the main environmental factor that greatly affects animal productivity ahead of solar radiations and humidity. Tropical regions majorly are characterized by high levels of ambient temperature, radiations and heat stress. This does limit animal growth and production among lactating cattle like the dairy animals (Scholta et al., 2013). Temperatures keep fluctuating at the tropics thus making dairy cattle vulnerable to adapt to ever rising and dropping temperatures which impact on their performance. However, the responses of animals to heat stress is determined by; production level and the level of exposure to a stressor and body size. Factors like age, sex, genetics physiological experience, also have influence on how an animal responds to a stressor (Nardone et al., 2016). The probable increase in the frequency of heat stress, droughts and floods will have adverse effects on productivity and the development of livestock discomfort indices should receive attention (Nardone et al., 2016). Dairy farming requires better production strategies in developing countries like Kenya and Sub-Saharan Africa to developed management level in the environment. Exotic breeds like DBGs are vulnerable to climate change that hinder their levels of milk production. Agriculture is a source of livelihood in Sub-Saharan countries, dairy products help small-scale farmers in capital creation and food security. Climate variability knowledge is essential to dairy farmers as this will help them improve their dairy farming productivity.

Temperature Anomalies

Climate change extremes for the past four decades continue to amplify globally. Data collected by researchers from different weather stations and satellite, clearly indicate the changes in temperatures that continue to really affect the agricultural sector (UNFCCC & IPCC, 2007). However, it is worth to mentioning that 2011 was the warmest year ever to be recorded. Carbon dioxide is among the GHGs, which continue to increase as more emissions emanate from livestock

wastes like manure or forage remains that are poorly managed by their disposal. By 2000 dating back 1880, the effect has more than doubled as per IPCC. This results to unpredicted weather events as some areas across the globe experience high and low temperatures propelling more anomalies, a significant effect to dairy production and animal survival at the rangelands (Polley et al., 2013). Therefore, these changes resulting from climate change indicators like temperature does affect growth of forage and animal productivity (Moore and Ghairaman, 2013)

Effect of Climate Variability on Pasture Climate

Change is modelled through statistical analysis by models in temperatures and or precipitation rainfall trend across the globe (Dai, 2013). Anomalies in precipitation and temperature increase are likely to impact on C4 pasture species like Kikuyu grass, maize, paspalum and forage sorghum and other species of same to have increase competition at the expense C3 nutritious species like ryegrasses (Lawes et al., 2014) It is projected that there will be a shift in the length of summers, as they will be hotter and at some places and they will start early but finishing late. This predisposes an immediate effect to growth of pasture and change of milk productivity trend among different breeds of dairy cattle (Lambertz, 2014). Potentially this will lead to more heat stress over the summer where the peak of spring will be short. However, with short rotational pasture systems, some fodder crops will do well depending on the variety. Some varieties of fodder flourish with high atmospheric precipitation and some low depending on their species (Malcolm et al., 2014 & Zhu et al., 2014) Pasture growth demands better environmental conditions and balanced soil nutrients to increase its vegetative nature for harvesting (Orgill et al., 2014). This continues to deteriorate as global temperature keep changing in different parts of the world. From climatic models, some parts have to receive more rainfall than other (Gobiet et al., 2014). Therefore, climate variability is greatly affecting the adaptive nature of indigenous pasture species (Chapman et al., 2014).

Empirical Review

Otieno (2019), conducted a study on the effects of climate change on agricultural productivity in Kenya. The study adopted time-series data on all the variables under study. The study employed Ricardian Regression Model to analyze time-series data. A diagnostic research design was employed to carry out the study as it explored secondary sources of data which was analyzed using multivariate regression model and Augmented Dickey Fuller (ADF) was carried out to check the stationary of the data. The study found out that temperature and relative humidity significantly affect agricultural productivity. Relative humidity was found to be positively related to agricultural productivity; temperature has negative relationship. The study recommended that government should sensitize the farmers on the need to carry out smart agriculture to reduce losses as a result of climatic change. The study also found out that rainfall positively related to agricultural productivity. Therefore, the study concluded that indeed climate change affect agricultural

productivity in Kenya. The study however presented a methodological gap as it utilized diagnostic research design while our study will utilize desktop review approach.

Kiarie (2016), conducted a study that evaluated trends in rainfall and temperature between1983 and 2013, assessed how these trends of climate variability have affected farmers' perception in climate variability and also explored small-scale farmers' adaptation strategies. Results of the study established that small scale farmers in Kijabe experienced climate variability in the period 1983-2013. The results of this study established a positive relationship between temperature variation and adaptation by small scale farmers in Kijabe. Small scale farmers who detected an increase in temperature were more likely to adapt compared to those who have not detected any increase in temperature ($r= 0.015$, $p<0.020$). The study further showed that small scale farmers who detected an increase in rainfall were less likely to adapt compared to those farmers who detected a decreased in precipitation ($r= -0.014$, $p<0.001$). The study presented a conceptual gap as it focused on trends in rainfall and temperature between1983 and 2013 while our study will focus on influence of ambient temperatures on dairy production in Africa.

Nkonge (2022) conducted a study to evaluate the ability to adapt socially, physically, and economically to climate variability among the Ngaremara pastoralists in Isiolo County. The study used a cross-sectional research design. Systematic, simple, and purposive sampling methods were used to sample the population. Data presentation is in the form of tables, figures, and graphs. The expected output was that low socioeconomic development among Ngaremara pastoralists in Isiolo County increased vulnerability to climate variability. The study proves that there is reduced adaptive capacity and their traditional methods to cope with climate variability are futile. Their living standards are deficient because their livelihood sources solely rely on pastoralism, which has been affected by climate variability. Moreover, fluctuating rainfall of between 250mm and 400mm and an annual average temperature of 290C have exposed pastoralists to drought, floods, famine, and pastoral conflicts. Still, they are willing to adopt new coping strategies for climate variability. The impact of the study will enable informed decision-making by external agencies such as policy makers, NGOs, Isiolo County Government, and the community to improve the adaptive capacity to climate variability by developing coping strategies, creating information avenues such as Early Warning Signs, and enhance development by introducing various projects to diversify livelihoods. The study was done in Isiolo County presenting a geographical gap while our study will be done in Africa.

Kariuki (2017) conducted a study to establish the key areas of climate change addressed by the current Kenya's secondary school formal curriculum; to establish the extent to which implementation of the curriculum contributes to awareness of climate change among teachers and students and to evaluate effectiveness of curriculum developers in infusing climate change content into Kenya's secondary school curriculum. To achieve the set objectives, the study adopted a descriptive survey research design. Analysed data established that sampled subjects had an aggregate variation ratio of 0.44. A statistical test established that the chi-square value was greater

than the significant value, that is 0.567>0.495. A conclusion was made that climate change content in the sampled subjects was inadequate. On the relationship between implementation of curriculum and awareness among teachers, the chi-square value was greater than the significant value, 0.794>0.659, and therefore the relationship was not significant. However, for students a significant relationship was established with likelihood ratio being less than the significant value, 0.196>0.658. Finally, the study established that 63% and 13% of sampled curriculum developers rated the curriculum as poor or very poor respectively. This implied that infusion of climate change content into the curriculum was not been effective. The study presented a contextual gap as it focused on schools while our study will focus on dairy farmers.

Nyirandorima (2021), conducted a study on to evaluate the socio-economic factors that determine the effects of climate change on rice production and consequently how level of farmers‟ perceptions and awareness determined their choice of adaptations strategies. Specifically, the study analyzed climate trend of Bugarama from 1981-2017, assessed the extent of awareness among rice farmers about climate change, identify the climate-change adaptation strategies adopted by rice farmers, and determined the factors that influence the adoption of adaptation strategies in rice production, finally the study calculated the marginal cost for farmers‟ rice production. The study was conducted in Bugarama Wetland, Rwanda and stratified sampling technique was employed. The Bugarama area was stratified into administrative villages and farmers were non-randomly chosen regardless of their scale of farming where the rice agriculture production cooperative of 1600 farmers operating their agro-business with a sampling size calculated of 320 farmers; the Descriptive survey design was used in this study with quantitative and qualitative based on primary data; A stratified sampling technique was employed to systematically select farmers during data collection. The results deduced that the level of education ($p = 0.019$) extension access ($p=0.001$), market distance ($p=0.002$) and rice income ($p < 0.001$) had a high probability of influencing farmers‟ perceptions about climate change thus the need to adapt. Based on outcome model, results showed that extension access ($p < 0.001$), household size ($p= 0.098$), market distance ($p= 0.047$), rice income ($p =0.032$), farmers-to-farmers ($p < 0.001$) and effects of climate change on rice ($p=0.038$) had a greater probability of influencing farmer’s choice of adaptation method used to improve rice yields. The results showed that farmers a profit margin 0.296. To conclude, the study found that access to informational facilities, rice income, influenced farmers‟ perceptions while extension access, rice income, market distance, farmers-to-farmers contact and effects of climate change on rice yield strongly had a probability of determining farmers‟ choice of adaptation. The study presented a methodological gap as it used descriptive research design while our study will use desktop review approach.

METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to influence of ambient temperatures on dairy production in Africa. Three sorting stages were implemented on the subject under study in order to determine the viability of

the subject for research. This is the first stage that comprised the initial identification of all articles that were based on examining influence of ambient temperatures on dairy production in Africa. The search was done generally by searching the articles in the article title, abstract, keywords. A second search involved fully available publications on the subject on influence of ambient temperatures on dairy production in Africa. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to influence of ambient temperatures on dairy production in Africa which was split into top key words. After an in- depth search into the top key words (influence, ambient temperatures, dairy production, Africa), the researcher arrived at 5 articles that were suitable for analysis. This were findings from:

Otieno (2019), who conducted a study on the effects of climate change on agricultural productivity in Kenya. The study adopted time-series data on all the variables under study. The study employed Ricardian Regression Model to analyze time-series data. A diagnostic research design was employed to carry out the study as it explored secondary sources of data which was analyzed using multivariate regression model and Augmented Dickey Fuller (ADF) was carried out to check the stationary of the data. The study found out that temperature and relative humidity significantly affect agricultural productivity. Relative humidity was found to be positively related to agricultural productivity; temperature has negative relationship. The study recommended that government should sensitize the farmers on the need to carry out smart agriculture to reduce losses as a result of climatic change. The study also found out that rainfall positively related to agricultural productivity. Therefore, the study concluded that indeed climate change affect agricultural productivity in Kenya.

Kiarie (2016), who conducted a study that evaluated trends in rainfall and temperature between1983 and 2013, assessed how these trends of climate variability have affected farmers' perception in climate variability and also explored small-scale farmers' adaptation strategies. Results of the study established that small scale farmers in Kijabe experienced climate variability in the period 1983-2013. The results of this study established a positive relationship between temperature variation and adaptation by small scale farmers in Kijabe. Small scale farmers who detected an increase in temperature were more likely to adapt compared to those who have not detected any increase in temperature ($r= 0.015$, $p<0.020$). The study further showed that small scale farmers who detected an increase in rainfall were less likely to adapt compared to those farmers who detected a decreased in precipitation ($r= -0.014$, $p<0.001$).

Nkonge (2022), who conducted a study to evaluate the ability to adapt socially, physically, and economically to climate variability among the Ngaremara pastoralists in Isiolo County. The study used a cross-sectional research design. Systematic, simple, and purposive sampling methods were used to sample the population. Data presentation is in the form of tables, figures, and graphs. The expected output was that low socioeconomic development among Ngaremara pastoralists in Isiolo County increased vulnerability to climate variability. The study proves that there is reduced

adaptive capacity and their traditional methods to cope with climate variability are futile. Their living standards are deficient because their livelihood sources solely rely on pastoralism, which has been affected by climate variability. Moreover, fluctuating rainfall of between 250mm and 400mm and an annual average temperature of 290C have exposed pastoralists to drought, floods, famine, and pastoral conflicts. Still, they are willing to adopt new coping strategies for climate variability. The impact of the study will enable informed decision-making by external agencies such as policy makers, NGOs, Isiolo County Government, and the community to improve the adaptive capacity to climate variability by developing coping strategies, creating information avenues such as Early Warning Signs, and enhance development by introducing various projects to diversify livelihoods.

Kariuki (2017) who conducted a study to establish the key areas of climate change addressed by the current Kenya's secondary school formal curriculum; to establish the extent to which implementation of the curriculum contributes to awareness of climate change among teachers and students and to evaluate effectiveness of curriculum developers in infusing climate change content into Kenya's secondary school curriculum. To achieve the set objectives, the study adopted a descriptive survey research design. Analysed data established that sampled subjects had an aggregate variation ratio of 0.44. A statistical test established that the chi-square value was greater than the significant value, that is 0.567>0.495. A conclusion was made that climate change content in the sampled subjects was inadequate. On the relationship between implementation of curriculum and awareness among teachers, the chi-square value was greater than the significant value, 0.794>0.659, and therefore the relationship was not significant. However, for students a significant relationship was established with likelihood ratio being less than the significant value, 0.196>0.658. Finally, the study established that 63% and 13% of sampled curriculum developers rated the curriculum as poor or very poor respectively. This implied that infusion of climate change content into the curriculum was not been effective.

Nyirandorima (2021), who conducted a study on to evaluate the socio-economic factors that determine the effects of climate change on rice production and consequently how level of farmers‟ perceptions and awareness determined their choice of adaptations strategies. The results deduced that the level of education ($p = 0.019$) extension access ($p=0.001$), market distance ($p=0.002$) and rice income ($p < 0.001$) had a high probability of influencing farmers‟ perceptions about climate change thus the need to adapt. Based on outcome model, results showed that extension access ($p < 0.001$), household size ($p= 0.098$), market distance ($p= 0.047$), rice income ($p =0.032$), farmers-to-farmers ($p < 0.001$) and effects of climate change on rice ($p=0.038$) had a greater probability of influencing farmer's choice of adaptation method used to improve rice yields. The results showed that farmers a profit margin 0.296. To conclude, the study found that access to informational facilities, rice income, influenced farmers‟ perceptions while extension access, rice income, market distance, farmers-to-farmers contact and effects of climate change on rice yield strongly had a probability of determining farmers‟ choice of adaptation.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Conclusion

This study concluded that climate variability was evident in the area with variations in temperature and precipitation. Temperature and precipitation had rose from maximum averages across the years in the past 30 years. From the findings it is arguable that different places with Africa continue to be affected by climate variability. To the dairy productivity, exotic and indigenous dairy breeds are affected differently by climate variability. As per productivity, exotic breeds tend to be least affected unlike indigenous breeds. For instance, some common animal vegetative crops were highly hit and lowly heat by climate variability like Napier grass and natural grass respectively.

Recommendations

This study recommended that creation of awareness on matters pertaining to temperature and its effects on the dairy sector by the relevant country environmental ministry. This will build capacity about amplified challenges emerging from ambient temperatures to dairy farming. For instance, spread of diseases, delayed fodder growth and hampered animal feeding behavior.

REFERENCES

Afande, F. O., & Wachira, I. J. (2015). Constraints to Profitability of Smallholder Dairy Farmers in Nyeri South Sub-County, Kenya. Developing Country Studies, 5(7), 11-42.

Payo-Payo, A., & Lobo, J. M. (2016). The unpredictable characteristics of the localities where new Iberian species will be discovered. Diversity and Distributions, 22(1), 73-82

Baldos, U. L. C., & Hertel, T. W. (2014). Global food security in 2050: The role of agricultural productivity and climate change. Australian Journal of Agricultural and Resource Economics, 58(4), 554-570.

Chapman, D. F., Lee, J. M., & Waghorn, G. C. (2014). Interaction between plant physiology and pasture feeding value: a review. Crop and Pasture Science, 65(8), 721-734.

Chevalier, V., Courtin, F., Guis, H., Tran, A., & Vial, L. (2016). Climate Change and Vector-Borne Diseases. In Climate Change and Agriculture Worldwide (pp. 97- 108). Springer Netherlands

Funk, C., Shukla, S., Hoell, A., & Livneh, B. (2015). *Assessing the contributions of East African and west Pacific warming to the 2014 boreal spring East African drought*. Bulletin of the American Meteorological Society, 96(12), S77-S82.

Hennessy, D., Delaby, L., Dasselaar, A., & Shalloo, L. (2015). Possibilities and constraints for grazing in high output dairy systems. *Grassland Science in Europe*, 20, 15-21

Kaur, A., Sraw, P. K., & Kukal, S. S. (2017). Climatic Variability Impact on WheatBased Cropping Systems of South Asia: Adaptation and Mitigation. *In Quantification of Climate Variability, Adaptation and Mitigation for Agricultural Sustainability* (pp. 353-370). Springer International Publishing

Kusangaya, S., Warburton, M. L., Van Garderen, E. A., & Jewitt, G. P. (2014). Impacts of climate change on water resources in southern Africa: A review. *Physics and Chemistry of the Earth*, Parts A/B/C, 67, 47-54.

Lambertz, C., Sanker, C., & Gauly, M. (2014). Climatic effects on milk production traits and somatic cell score in lactating Holstein-Friesian cows in different housing systems. *Journal of Dairy Science*, 97(1), 319-329.

Lawes, R. A., Ward, P. R., & Ferris, D. (2014). Pasture cropping with C4 grasses in a barley–lupin rotation can increase production. *Crop and Pasture Science*, 65(10), 1002-1015.

McMahon, C., Edgar, H. W. J., Hanna, R. E. B., Ellison, S. E., Flanagan, A. M., McCoy, M., & Malone, F. E. (2016). Liver fluke control on sheep farms in Northern Ireland: A survey of changing management practices in relation to disease 67 prevalence and perceived triclabendazole resistance. *Veterinary Parasitology, 216, 72-83.*

Nasehfar, A., Bonyadian, M., Boroujeni, R. K., Esfahani, M. M., Kazemeini, H., & Shahraki, M. M. (2015). Prevalence of Coxiella Burnetii by Nested PCR in Bovine Bulk Milk Samples in Central Zone of Iran. *American Advances Journal of Biological Sciences, 1(1), 10-13*

Orgill, S. E., Condon, J. R., Conyers, M. K., Greene, R. S. B., Morris, S. G., & Murphy, B. W. (2014). Sensitivity of soil carbon to management and environmental factors within Australian perennial pasture systems. *Geothermal*, 214, 70-79.

Peck, R., Olsen, C., & Devore, J. (2015). Introduction to statistics and data analysis. Engage Learning. California

Silanikove, N., & Koluman, N. (2015). Impact of climate change on the dairy industry in temperate zones: Predications on the overall negative impact and on the positive role of dairy goats in adaptation to earth warming. *Small Ruminant Research*, 123(1), 27-34.