ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 10, Issue 2, pp: (1-10), Month: April - June 2023, Available at: www.paperpublications.org

The effect of climate variability on milk production: Case of Milk Collection Centers in Kayonza District of Rwanda

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DOI: https://doi.org/10.5281/zenodo.7842567

Published Date: 18-April-2023

Abstract: **As the same at the world level, Rwanda faces to the climate variability problem perturbing different human activities including milk production. This work was done to assess the impact of climate variability on milk production in Kayonza District of Rwanda. The aim of this research was to assess the climate variability indicators in Kayonza District, to evaluate the milk production variability in 5 Milk Collection Centers (MCC), and to establish the relationship between climate variability and milk production. The survey was done on a sample of 248 respondents; Data related to rainfall and temperature collected from Meteo Rwanda, data on received milk were acquired at MCCs level, with field observation. Those data were analyzed using SPSS statistical Model. The findings were that farmers were facing the serous drought problem and there was correlation between supplied milk (dependent variables) and independent variables (temperature and rainfall). The value of -.6627 is the more value of high correlation (negative) while the value of 0.044 is the more low correlation (positive). Generally, there is not significant linear relationship between received milk at 5 different MCCs and considered climate variability factors (temperature and rainfall), but with only significant relationship between received milk and temperature at Mukarange MCC. The supplied milk variability was maybe due to MCCs mismanagement, cow management, milk value chain and milk regulation monitoring. Face to drought and irregularity of supplied milk, it will better that farmers adopt and strengthen different technics related to forage and fodder conservation facilitating animal feeding during drought , the local and central government will increase water supply infrastrures and MCCs monitoring for their sustainability. Different researches can assess the MCCs management and problems related to milk value chain.**

Keywords: **Climate variability, milk production, temperature and rainfall.**

1. INTRODUCTION

Globally, livestock is likely to face serious effects of climate change and variability including the risk of milk reduction (Mauger et al., 2015). Heat stress is major factor that reduces milk production in dairy cows (Bipasha, Chinmaya, Balakrishna and David , 2021). Climate change affects milk production because of the sensitivity of dairy cows to excessive temperature and humidity. Using climate data and country dairy industry data to estimate milk production losses for Holstein dairy cows in conterminous united states, and at the national level the loss is estimated to 1,9 percent with the prediction of 6.3 percent of loss in the end of twenty – first century (Mauger,Bauman , Nennich and Salathe, 2015) .In Central Europe,

ISSN 2350-1049

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with the current understanding of the effects of climate change, it is expected that fodder quality will be influenced positively and soil characteristics, which will simultaneously be affected by climate change (Gauly et al., 2013).

In Free State of South Africa, increasing temperature puts pressure on dairy cows, resulting in lowed production and revenue for farmers (Harmela, 2017). Climate change is global phenomena which poses a challenge to sectors of a country's economy; the dairy sector is no exception and producers are likely to suffer from it in South Africa (Abiodum,Ogundeji, Hemila, Weldemichael and Willen, 2021). Dairy production plays a vital role in the economy and wellbeing of the population but has become vulnerable due to the climate variability in Western Africa (Montcho, Padonou,Montacho, Mutua and Sinsin, 2022).

Concerning the regional level, the dairy – climate change dilemma in Kenya cannot be mistaken. Temperature had rose by 0.8 ^{0}C in the 30 year with anomalies rainfall across years indicating variability to dairy cattle. 89% of farmers respond on effect of climate variability to dairy cattle (Ngare,Koech,Manguriu,Gichuki and Karanja, 2016). The drought stress is the major challenge in Mvomero District of Tanzania and it has negatively affected grazing resources and pastoralists livelihoods in various ways (Magita and Sangeda, 2017).Changes in climatic patterns especially the increasing dry spell contributed to increased livestock diseases incidences, shortage of feed resources and overall reduction of milk production in the Kosirai in Kenya and Namayumba in Uganda (Kirui, 2014). According to (World Bank , 2015) , research indicate that rainfall patterns are becoming more irregularly and unpredictable with short rain seasons negatively affecting Rwanda agriculture (crop and livestock). It is evident that livestock production including milk is expected to decrease, and due to erratic rainfall in 2018 milk production losses are at 60% in times of drought.

2. MATERIAL AND METHODS

2.1. Description of the study areas

The study is be done in different Milk Collection Centers located in Kayonza, which is located in eastern province having Bugesera,Ngoma, Kirehe, Kayonza , Gatsibo, Rwamagana and Nyagatare Districts. According to the census of 2012, the population of Kayonza District was 344,157 people. This population is living in 12 administrative sectors (Gahini, Kabare, Kabarondo, Mukarange, Murama, Murundi, Mwili, Ndego, Nya mirama, Rukara, Ruramira and Rwinkwavu), 50 cells and 421 villages. The total area of the District is 1,937 km^2 and the density of 180/km^2.

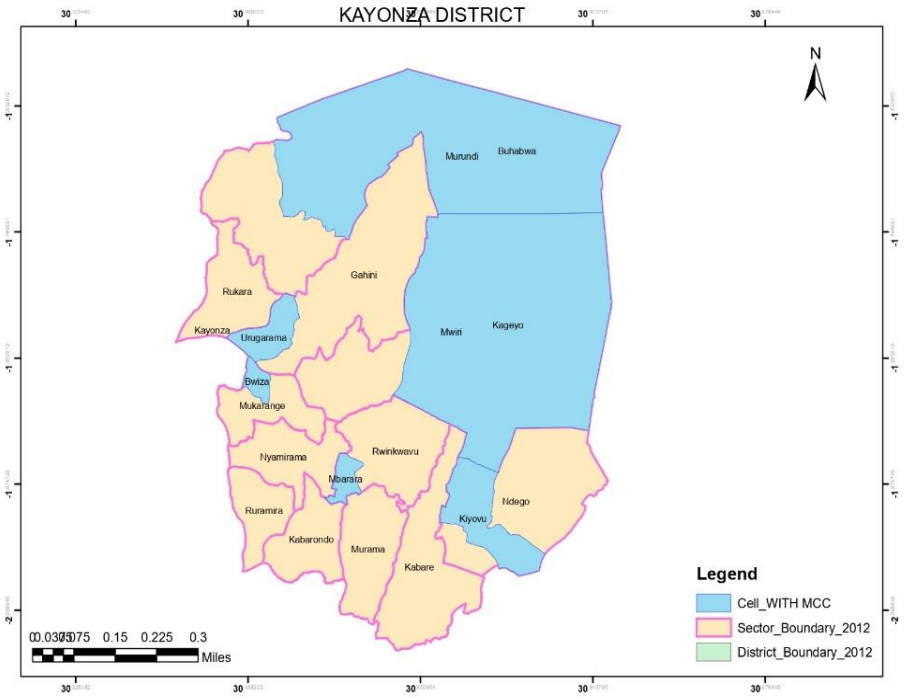

Figure 1: Study area (Sector & Cell).

Kayonza District is situated in the wet tropical climate area with an alternation of two wet season and two dry seasons. The recorded annual average temperature lies between 18 °c and 26 °c. The annual average pluviometer varies generally between 1000mm and 1200mm.

2.2. Data collection techniques and analysis

The study was done in different Milk Collection Centers located in Kayonza, which is located in eastern province of Rwanda. According to the census of 2012, the population of Kayonza District was 344,157 people. The total area of the District is 1,937 km^2 and the density of 180/km^2. Kayonza District is situated in the wet tropical climate area with an alternation of two wet season and two dry seasons. The recorded annual average temperature lies between 18 °c and 26 °c. The annual average pluviometer varies generally between 1000mm and 1200mm.

The study used quantitative and qualitative approaches, secondary data related to climate variability factors (temperature and rainfall) are collected from Mateo Rwanda. The monthly received milk production was collected from Milk Collection Centers.

During this study, the questionnaire (Likert scale model) was used and auto administered to the sample of the population to evaluate the effect of climate variability on milk production concerning the view of farmers. The observation was done and helping to understanding the incidence of climate variability on milk production.

The population is all farmers suppling milk to different MCCs located in Kayonza District Ngedo (65) , Gahini : MCC (55) , Mwili (100) , Mukarange (111), Murundi (320). The total is 651 farmers /suppliers of milk at MCC.

The sample size to use was formulated by Yamane (1967); its simple formula to calculate sample size is: $n = \frac{N}{1 + N(e)^2}$

Where; n is the sample size, N is the population size and e is the level of the standard error (5%). For the present case, $n = \frac{651}{1 + 651(0.05)^2}$ =248. Based to the above formula: $ni = \frac{Ni * n}{N}$,

The sample size was 25 in MCC ndego , 21 in MCC Gahini, 38 in MCC Mwiri, 42 in MCC Mukarange and 122 in MCC Murundi.

To organize data we used Microsoft Excel, those data were analyzed using SPSS,V.21. To evaluate the relationship between climate variability factors and the quantity of supplied milk at MCCs, we used statistical correlation model.

3. RESULTS AND DISCUSSION

3.1. Demographic Characteristics of respondents.

The big number of respondents (68.5%) were males, this indicate that men participate in milk production and supply more than women. Women responsibility in milk production and supply remain at low level in the area of study comparatively to male. This low participation of the women in milk values chain activities can lead to dairy sector mismanagement while the women active participation can contribute on the milk production increasing.

Concerning age, 76.2% of respondents are in the interval of age between 36 and 60 years which correspond to active population, 17 % of respondents are below 36 years, 16.9 % of respondents have more 60 years. So the active population participate more in milk supply activities which build the advantage in milk industry improvement. Additionally it is this active population which is better positioned on the cow growing engagement imposing the hard work especially for the smallholders. The young population participates in milk production given that 16.9 % of respondent are in the range age not more than 35 years.

More of respondents (54.4%) are in householders with 3 to 6 members per family, 37.1% of respondents have the family with more 6 members, 6.9 % respondents with the 2 members per family and 1.6 % having the family with 1 member. The observation is that the more respondents have householders with 3 to 6 members; this can conduct to important family milk consumption contributing to the reduction of the milk supplied at the MCC level. However the range of 3 – 6 members can build the set of workers in different activities related to the milk production.

The more part of respondent 52.8% have primary level of education, 38.3 % without education level, 8.1% with secondary level and 0.8% with university level of education. Given that more of respondents have primary level of education; this builds the understanding potentiality to livestock skills, regulations, and guideline established by concerned institutions in order improve milk production.

3.2. Climate variability indicators in Kayonza District from 2011 to 2021:

Views of the farmers on Climate variability

The results shows that 80.64% of respondents strongly agree that they are facing the problem of drought, 18.95% were agreed that assertion, while 0.40% were neutral that farmers are facing serious problem of drought with the mean of 4.8024 and standard deviations of 0.409. That means confirms that the drought issue is popular and sensible to the more of farmers supplying milk to the different MCCs.

The respondents equal to 72.17% strongly agree, 27.82% agree with the persistency of drought at the end of long dry season perturbing the following rain season with the mean and standard deviation of 4.7218 and 0.449 respectively; While 75.40% of respondents strongly agreed , 17 % agreed , 3.22 % neutral and 0.80 % that the drought persists at the end of small dry season and affects the following rain season, the mean 4.6411 and standard deviation 0.7503 justify the position of respondent on this assessment. This is the serious indicator that the cultural season A and B are affected by drought leading to the forage, fodder and crop residues reduction.

The majority of respondents (50.40%) disagreed, 25.40% strongly disagreed, 16.93 were neutral, 2.41% agreed and 4.83% strongly agreed that drought occurs every year from May to September, with the mean of 2.1089 and standard deviation 0.9735 show the tendency of respondents to the statement with disagreement with large dispersion. It means that there are some years without drought according to respondent. It is the advantage to use this time to proceed to forage, fodder and crop residues conservation.

The number respondents corresponding to 78.62 % strongly agreed, 20.16 agreed, 0.40 % were neutral , 0.40% disagreed and 0.40 % strongly disagreed that drought affects the cows feeding; with mean of 4.7782 and 0.4879 standard deviation justifying the agreement tendency of respondent to the assessment. This drought affects cow feeding can lead to the milk reduction, and sometime to the loss of a number of cows.

The respondents equal to 70.56% agreed, 28.62% agreed and 0.80 % were neutral that drought impacts the farmer's capacity to care their animal as shown by the table 4.2; with the mean 4.6976 and standard deviation 0.4775 justify the agreement of respondent to the statement. The low capacity to care cattle concerns especially the low family revenue for feed and drugs supply.

Variation of annual average temperature and rainfall:

As shown in table 1, at Murundi MCC, it was noted the variation of temperature with the means of 21.4736 ^{o}C and standard deviation of 0.59227 ^{o}C. The rainfall mean and standard deviation are respectively 656.364 mm and 286.6392 mm.

Table 1: Variation of annual average temperature and rainfall

MCC		Minimum	Maximum	Mean	Std. Deviation
Murundi MCC	Average temperature(^{0}C)	20.59	22.54	21.4736	.59227
	Rainfall(mm)	256.0	991.0	656.364	286.6392
Gahini MCC	Average Temperature(^{0}C)	20.85	22.18	21.3718	.39097
	Rainfall(mm)	403	1174	847.36	228.018
NdegoMCC	Average Temperature(^{0}C)	20.95	22.60	21.8373	.47255
	Rainfall(mm)	153	922	681.64	233.890
MukarangeMCC	Average Temperature(^{0}C)	20.78	22.01	21.2964	.43121
	Rainfall(mm)	340	1175	811.45	212.838
Mwiri MCC	Average Temperature(^{0}C)	20.38	21.85	21.1536	.45107
	Rainfall(mm)	256	1043	749.18	216.776

Source: Meteo Rwanda data analysis

Both average temperature and rainfall vary with different values of standard deviation which is more remarkable on rainfall. At Gahini MCC, we noted the mean and standard deviation respectively 21.3718 and .39097, concerning rainfall the mean was 847.36 and standard deviation was 228.018. Is noted at Ndego MCC, the variation of temperature with the mean of 21.3718 ºC and standard deviation of .47255 º C. The rainfall mean and standard deviation are respectively 681.64mm and 233.890 mm. At Mukarange MCC**,** is noted the variation of temperature with the mean of 21.2964 and standard deviation of .43121. Concerning the rainfall, the mean and standard deviation are respectively 811.45 mm and 212.838mm. At Mwiri MCC**,** the variation of temperature with the mean of 21.1536 ºC and standard deviation of 0.45107 ºC. The average temperature varies from ºC 20.38 to 21.85 ºC. Considering the rainfall, the mean and standard deviation are respectively 749.18 mm and 216.776 mm. The considered climate variability factors (temperature and rainfall), were submitted to the variation in different MCC located in Kayonza District; the low average minimum temperature was found at Mwiri MCC (22.38ºC) and the low rainfall at Ndego MCC (153 mm). The high average temperature was found at 22.60ºC at Ndego MCC and the high rainfall is 1175 mm at Mukarange MCC.

3.3. The milk production variability in different Milk Collection Centers (MCC) in Kayonza District.

3.3.1. Views of farmers on milk variability

Influence of feeding on milk production.

The respondents corresponding to 87.90 % strongly agreed, 9.67% agreed, 2.01% were neutral and 0.40 % disagree with sufficiency of forage in normal rainfall condition. The mean 4.8508 and standard deviation 0.3844 is supporting the position of respondents concerning the present statement. This is the best situation for cattle feeding without difficulties. The number corresponding to 64.9 % of respondents strongly agreed , 34.67% agreed and 0.40 % were neutral that during drought the forage quality decrease, the mean is 4.6452 and with standard of deviation 0.4878 explaining the strong agreement to the statement. This means that the forage quality is affected during the period of drought and it can lead to the milk production reduction. With the mean of 4.7863 and standard deviation 0.42049, 79.0 %) of respondents strongly agreed, 20.56% agreed and 0.40% were neutral with reduction of forage quantity during drought, this lack of forage quantity affects the milk production.

Age of animal influencing milk production

The number corresponding to 85.88% respondents strongly agreed, 27.82% disagree, 5.64% were neutral and 0.40% disagreed that the age of cow affects the quantity of milk produced with strong agreement; this is related to mean of 4.8145 and standard deviation of 0.51483. This indicates that the age of animal as a factor which can influences the milk production.

The middle age of animal is favorable for milk production, more of respondents equal 66.12% strongly agreed , 27.82% agreed , 5.64% were neutral and 0.40% disagreed that the cows produces more milk in middle age, with 4.5968 and 0.6584 mean and standard deviation respectively. This explains the necessity to reform animals (to replace old by the young) for more milk production.

Influence of animal management on milk production

With the mean 4.7863 and standard deviation of 0.44845, majority of respondents equal to 80.24 % strongly agreed ,18.14% agreed and 1.61% were neutral that animal hygiene contributes to milk production, this is explained by the diseases due to lack of hygiene practices in the farm, it is the case of mastitis disease which decrease the milk in quantity and quality.

Considering the mean 4.6411 and standard deviation 0.51323, the number of respondents 65.72% agreed, 32.66 % agreed and 1.61% were neutral that animal vaccination helps on milk production. This is explained by importance of vaccine in disease prevention and the negative impact of diseases on milk production.

With mean of 4.7056 and standard deviation of 0.50708, the respondents which equals to 72.98 % strongly agreed, 24.59% agreed and 2.41% were neutral that stress reduction participates on milk production; this indicates the necessity stress reduction to access to the top production, especially tress due to heat and inadequate cowshed. Adequate animal nutrition contributes to milk production; 59.67 % of respondents strongly agreed, 39.11 % agreed and 1.20% were neutral face to above statement with the mean of 4.5847 and standard deviation of 0.51779. This adequate feed in quality and quantity is a condition to produce milk.

Breed influence milk production

Concerning breed, local breed of cows don't produces more milk, given that 84.67% strongly disagreed, 12.09 agreed, 2.41% were neutral, 0.40% agreed and 0.40% strongly agreed that local bread of cows produces more milk, with mean of 1.1976 and standard deviation of 0.52976. Generally the local cows produce low quantity of milk. The big number of respondents equal to 87.09% strongly agreed, 10.08 % agreed, 0.40% were neutral and 2.41% strongly disagreed that exotic and cross breed produces more milk, with the mean is of 4.7944 and standard deviation of 0.68069. The exotic and cross breed have a high potentiality of milk production and farmers have to adopt the animal genetic improvement to increase the milk production.

Length of lactation on milk production

More of respondents did not accept that small length of lactation increases milk production, In fact 89.91% strongly disagree, 8.87% disagree , 0.80% were neutral and 0.40% strongly agreed that small length of lactation increase milk production, with the mean of 1.121 and the standard deviation of 0.41418 ; it is explained that the milk production increase with the length of lactation. Respondents corresponding to 81.45% strongly disagreed, 16.53 % disagreed , 1.20 % were neutral 0.40% agreed and 0.40% strongly agreed that long length of lactation decreases milk production, with the mean of 1.2177 and the standard deviation of 0.51787. This assertion is related to reality given that normally the long length of lactation increases milk production. Generally, the length of lactation is 10 months considering the modern cattle farming.

Number of lactation per day

Respondents corresponding to 76.20 % strongly disagreed, 21.77 disagree, 1.20 were neutral and 0.80% agreed that the low number of lactation per day increases milk production, with the mean of 1.2661 and the standard deviation of 0.51862. This assertion related to the reality that the low number of lactation per day decreases milk production. The number of respondents corresponding to 75.4 % strongly disagreed, 22.58 disagreed and 2.01% were neutral that the high number of lactation per day decreases the milk production, with the mean of 1.2661 and standard deviation of 0.4864. The reality is that the high number of lactation per day increases the milk production.

Weather conditions and milk production

The majority of respondents which equal to 77.82% strongly agreed, 19.75% agreed and 2.41 % were neutral that heat stress reduces milk production with strong agreement, with the mean of 4.754 and standard deviation 0.48456; it is a good assertion given that generally heat stress is a major fator that reduces milk production in dairy cows.

3.4. Received milk variability in MCCs

The table 2 shows that the received milk quantity (in Liters) at MCCs level was affected by variations, with mean of 117374.077 and standard deviation of 52985.9417 at Murundi MMC, 4768.058 of mean and standard deviation 4350.2116 at Gahini MCC, 19162.409 of mean and standard deviation 10434.8630 at Ndego MCC , 9129.972 of mean and standard deviation 5525.3404 at Mukarange MCC , and 11332.981 of mean standard deviation at Mwiri MCC.

Table 2: Received Milk variability in MCCs (L)

MCC	Minimum	Maximum	Mean	Std. Deviation
Murundi	35257.0	210134.0	117374.077	52985.9417
Gahini	1282.0	21154.5	4768.058	4350.2116
Ndego	2325.0	51989.0	19162.409	10434.8630
Mukarange	3214.5	21226.0	9129.972	5525.3404
Mwiri	2391.0	22600.	11332.981	5310.6592

Source: Received milk data analysis

According to the table 11, monthly milk data, Murundi MCC received more milk 117374.077L and Gahini MCC receive less milk 4768.058L while at each MCC the received milk sensibly varies.

Relationship between received milk and climate variability indicators:

This relationship concern Received milk as dependent variable while temperature and rainfall are considered as independents variable. To explain this relationship, we used statistical correlation model which giving us different values that allow to verify the relationship presence.

ISSN 2350-1049

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)
Vol. 10, Issue 2, pp: (1-10), Month: April - June 2023, Available at: www.paperpublications.org

Table 3: Correlation between received milk and climate variability indicators at Murundi MCC

		Milk	Rainfall	Mean Temperature(^{0}C)
Milk	Pearson Correlation	1	.388	.044
	Sig. (2-tailed)		.050	.831
	N	26	26	26
Rainfall	Pearson Correlation	.388	1	-.270
	Sig. (2-tailed)	.050		.183
	N	26	26	26
Mean Temperature(^{0}C)	Pearson Correlation	.044	-.270	1
	Sig. (2-tailed)	.831	.183	
	N	26	26	26

Source: Meteo Rwanda data and MCC milk data analysis

Considering that the correlation is significant at the 0.01 level (2-tailed), the correlation between received milk and temperature is positive medium correlation equal to .044 and the supplied milk increase with increasing of the temperature. Received milk and average temperature haven't statistically significant linear relationship (p> 0.01). The correlation between supplied milk and rainfall is .388 which is positively medium correlation. Received milk and rainfall haven't statistically significant linear relationship (r=0.388, p >0.01).This relationship is positively moderate. At this Murundi MCC, the received milk variation was due to others factors which are not rainfall and temperature.

Table 4: Correlation between received milk and climate variability indicators at Gahini MCC

Received Milk (L)	Pearson Correlation	1	-.126	-.064
	Sig. (2-tailed)		.337	.628
	N	60	60	60
Rainfall (mm)	Pearson Correlation	-.126	1	-.358**
	Sig. (2-tailed)	.337		.005
	N	60	60	60
Average Temperature(°C)	Pearson Correlation	-.064	-.358**	1
	Sig. (2-tailed)	.628	.005	
	N	60	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Meteo Rwanda data and MCC milk data analysis

The correlation between supplied milk and rainfall is negatively low correlation equal to -.126.

Received milk and rainfall haven't statistically significant linear relationship (p =.337> 0.01).

The correlation between supplied milk and temperature is -.064, positively high correlation.

Received milk and average temperature haven't statistically significant linear relationship (p=.628 > 0.01). The variation of received milk at Gahini MCC, was due to other factors was due to others factors not rainfall and temperature.

Table 5: Correlation between received milk and climate variability indicators at Ndego MCC

		Received Milk (L)	Rainfall	Mean Temperature(^{0}C)
ReceivedMilkL	Pearson Correlation	1	.111	-.152
	Sig. (2-tailed)		.473	.325
	N	44	44	44
Rainfall	Pearson Correlation	.111	1	-.410**
	Sig. (2-tailed)	.473		.006
	N	44	44	44
Mean Temperature0C	Pearson Correlation	-.152	-.410**	1
	Sig. (2-tailed)	.325	.006	
	N	44	44	44
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: Meteo Rwanda data and MCC milk data analysis

The correlation between supplied milk at MCC and rainfall is 0.111, positively low correlation.

Received milk and rainfall haven't statistically significant linear relationship (p = 0.473>0.01)

The correlation between supplied milk and temperature -0.152, negatively low correlation.

Received milk and average temperature haven't statistically significant linear relationship (p= 0.325 > 0.01). The received milk variation was due to others factors, not rainfall and temperature.

Table 6: Correlation between received milk and climate variability indicators at Mukarange MCC

		Receivedmilk	Mean temperature ^{0}C	Ranfall (mm)
Received milk	Pearson Correlation	1	-.627**	.112
	Sig. (2-tailed)		.000	.515
	N	36	36	36
Mean temperature ^{0}C	Pearson Correlation	-.627**	1	-.253
	Sig. (2-tailed)	.000		.136
	N	36	36	36
Ranfall(mm)	Pearson Correlation	.112	-.253	1
	Sig. (2-tailed)	.515	.136	
	N	36	36	36
**. Correlation is significant at the 0.01 level (2-tailed).				

The correlation between supplied milk and rainfall is equal to .112, positively low correlation.

Received milk and rainfall haven't statistically significant linear relationship (0.515>0.01)

The correlation between supplied milk and temperature is -.627, negatively high correlation.

Received milk and average temperature have statistically significant linear relationship

(p = .000< 0.01). The variation of received milk is due to others factors, considering rainfall, but it is due to the temperature variation as shown by used correlation model.

Table 7: Correlation between received milk and climate variability indicators at Mwiri MCC

		Received milk L	Rainfall mm	Mean tempearture0C
Received milk L	Pearson Correlation	1	-.217	.114
	Sig. (2-tailed)		.276	.570
	N	27	27	27
Rainfall mm	Pearson Correlation	-.217	1	-.669**
	Sig. (2-tailed)	.276		.000
	N	27	27	27
Averagetempearture0C	Pearson Correlation	.114	-.669**	1
	Sig. (2-tailed)	.570	.000	
	N	27	27	27
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: Meteo Rwanda data and MCC milk data analysis

The correlation between supplied milk at MCC and rainfall is -.217, negatively moderate correlation. Received milk and rainfall haven't statistically significant linear relationship (p= .276>0.01) The correlation between supplied milk to the MCC and temperature is 0.114, positively low correlation. Received milk and average temperature haven't statistically significant linear relationship (p= .570 > 0.01). For this MCC, the variation of received milk is due to others factors, not rainfall and temperature.

4. CONCLUSION AND RECOMMENDATION

Based to analysis of results and its discussion, this conclusion concerns the climate indicators evaluation, received milk variation and relationship between considered climate variations indicators and received milk at MCC level; the rainfall and temperature at all 5 MCCs were submitted to the variation from 2011 to 2021, this climate variability is sensible and popular to respondents. Respondents confirm the difficulties to keep well their cattle due to the drought in their localities. The data analysis completes the respondent assertions by showing that temperature and rainfall recognized variations in each of MCC located in Kayonza District. The quantity of milk received at each MCC was varied, Murundi MCC received more milk quantity 117374.077L and Gahini MCC received less milk quantity 4768.058L. There are correlation between supplied milk and climate variability factors, but different degree of correlation, the value of -.6627 is the more value of high correlation (negative) while the value of 0.044 is the more low correlation (positive). In more of cases, there is not significant linear relationship between received milk at the MCCs and considered climate variability indicators (temperature and rainfall). However, we only noted significant relationship between received milk and temperature at Mukarange MCC. The variation of received milk can be due to other factors, those others factors which can influence received milk can be, MCC mismanagement, milk value chain monitoring and milk supply regulation, and Livestock intensification program.

REFERENCES

[1] Mauger, Bauman ,Nennich nd Salathé . (2015). Impacts of Climate Change on Milk Production in the United States. *The Professional Geographer 67(1)*.

[2] Abiodum,Ogundeji, Hemila, Weldemichael and Willen. (2021). Influence of heat stress on milk production and its financial implications in semi-arid area of South Africa. *Heliyon* .

[3] Bapasha, Chinimaya,Balakrishna and David . (2021). Impact of climate change on milk production and milk composition . *DOI*, Vol9 (10).

[4] Gauly et al. (2013). Future consequences and challenges for dairy cow production systems arising from climate change in Central Europe-a review . *Animal vol 7*, 843-859.

[5] Habiyaremye,Ouma, Mtimed and Obare. (2021). A review of the evolution of dairy Policies and regulations in Rwanda and its implications on imputs and services delivery . *Front.vet.sci.*

[6] Hakizimana. (2018). *Investigating Drought frequency in the Eastern region of Rwanda during the last two decades.* University of Rwanda .

[7] Harmela. (2017). Economic Impact of climate change on milk production : A case area in the Free State.

[8] IPCC. (2018). *Global worming of 1.5 0c.*

[9] Kirui. (2014). Assessment of the influence of climate change on smallholder dairy productivity in Kosirai , Kenya and Namayumbain Uganda. *University of Nairobi,Department of Meteorology* .

[10] Magita and Sangeda. (2017). Effects of climate stress to pastoral communities in Tanzania: A case of Mvomero District. *Sokoine University of Agriculture.Morogoro Tanzania*.

[11] Mauger , Bauman , Nennichand Salathe. (2014). Impact of climate change on milk production in the United States . *Professional Geographer Volume 67* .

[12] Mauger, Bauman, Nennich and Salathe. (2015). Impact of climate change on milk production in the United States. pp. 121-131.

[13] Mazimpaka. (2017). Characterization of cattle production systems in Nyagatare District of Eastern Province of Rwanda . *School of Animal Sciences and veterinary Medecine , Nyagatare , Rwanda* .

[14] Ministry of Agriculture and Animal Resources - Rwanda. (2021). *Annual report* .

[15] MInistry of Agriculture and Animal Resources -Rwanda. (2013). *Natioanal Dairy strategy* .

[16] Mirindi. (2018). *Assessment of the past and future meteological drought characteristics in the Eastern Province of Rwanda under a changing climate* . Nairobi : University of Nairobi .

[17] Montcho, Padonou,Montacho, Mutua and Sinsin. (2022). Perception and adaptation strategies of dairy farmers to wards climate variability and changes in West Africa .

[18] Ngare,Koech,Manguriu,Gichuki and Karanja. (2016). The trend of climate variability Effect on Dairy Farming in Masaba North , Nyamira Country Kenya. *Journal of Environment and Earth Science* .

[19] USAID. (2019). *Climate Risk Profile : Rwanda Fact Sheet* .

[20] World Bank . (2015). *Climate - Smart Agriculture in Rwanda.* Washington D C.