**Source: Research data (2022)**

Furthermore, the authors analyzed the recorded tea production under the above factors (rainfall, temperature and fertilizers). Therefore, as illustrated in Figure 5, it was noticed that the production of tea recorded the fluctuating production. For example, in 2010, the production increased from 8,383.41 Kg/Ha to 9,161.36 Kg/Ha in 2011. The two following year MFC has seen a decrease in production from 7,474.21Kg/Ha of 2012 and 7,419.39Kg/Ha of 2013. In 2014, the production increased considerably to 9,498.28Kg/Ha and to 9,554.08Kg/Ha in 2015. The same Figure 5 showed that in 2016, the tea production decreased to 8,607.44Kg/Ha before increasing slightly from 9,209.42Kg/Ha in 2017 to 9,785.97Kg/Ha. A small decrease in production was observed from 9,283.27Kg/Ha in 2019 to 9,046.90Kg/Ha in 2020. In 2021 the production increased considerably to reach 10,131.40Kg/Ha.

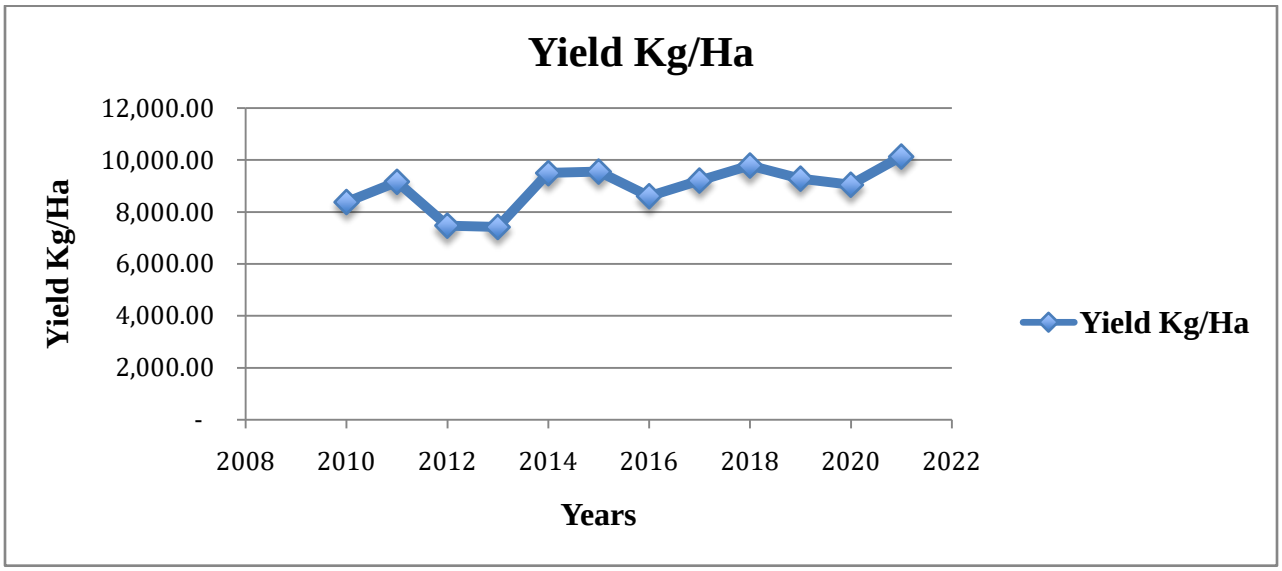


**Figure 5: Variations of tea production**

**Source: Research data (2022)**

The generated and combined Pearson correlation analysis between variations on rainfall and temperature and fertilizer application with tea production at Mulindi Factory Company was indicated in Table 2. The analysis shows a statistically significant (positive) relationship between rainfall variation and tea production with the correlation r1= 0.990. The same Table 2 showed a statistically significant (positive) relationship between temperature and tea prediction with the correlation $r_2$=0.993. In addition, the analysis generated a statistically significant (positive) relationship between fertilizer application and tea production with the correlation r3= 0.593.

**Table 2: Summary of correlation between independent and dependent variables**

| | | Rainfall | Temperature | Fertilizer |
|---|---|---|---|---|
| Tea production | Pearson Correlation | .990 | .993 | . 593 |
| | Sig. (2-tailed) | .041 | .043 | .029 |
| | N | 3 | 3 | 3 |

*. Correlation is significant at the 0.05 level (2-tailed).

**Source: Primary data, 2022**

## 4. Discussion

Global warming has a direct effect on crops, food chains and production cycles in terms of marked changes on growth and yield processes. The reports of the intergovernmental Panel on Climate change (IPCC) indicate that the rise in temperature since 1980 led to reduction in yields of staple crops offsetting gains even from improved farm practices, which has several implications for agriculture, crop yields and patterns in the long run (IPCC, 2001). In Rwanda, changing climate started to manifest its impact on agricultural production many years ago. For example, in 2015, the dry season started early than expected, and this greatly led to reduction of agricultural production mainly in the Eastern province (Lamek. N., 2018).

For this study, it was noticed that both 2014 and 2020 years recorded high rainfall of 105.5 and 126.2 mm, respectively. For the temperature variation, the record was quite stabilized and/or constant compared to the rainfall. With regard to fertilizers, since 2010 to 20921, the record kept on increasing in terms of application. The tea production revealed a growing trend from 8,383.41 Kg/Ha in 2010 to 10,131.40Kg/Ha in 2021.

Recent studies (FAO, 2014; Dutta & R, 2014 & Lamek et al., 2018) on the impact of climate variability confirmed the fact that under climate change, the agricultural production will likely decrease or be damaged. This results from the fact that tea production depends on the local weather but also other factors like soil properties, fertilizer application, types of tea varieties, etc., might contribute to its production variation. This agree with the current research, as shown in Figures 2,3 and 4, rainfall, temperature and fertilizers varied over time and the tea production

recorded varying production over years. This expresses that rainfall, temperature or fertilizer affected the production by either increasing or decreasing its production.

In addition, as previously reported, climate variability affects agricultural production in Sub-Saharan Africa because the sector accounts near 96% of rain-fed agriculture compared to overall production (FAO, 2014). This expresses that rainfall and temperature variability greatly affects these countries' agriculture since the sector is rain-fed. This is due to the reason that irrigation is not developed in these areas (FAO, 2017). This also confirms with the results of this study in Table 2 where the Pearson Correlation between rainfall and temperature variations generate a positive relationship with coffee production compared to that of fertilizer and tea production (Table 4.4).

Hence, the results of this study confirm the fact that climate variability is impacting on tea production at some extent and that potential impacts on human, environmental and economic systems require a cost that can, to some extent, be avoided by taking appropriate actions to adapt to the changes in temperature and rainfall.



## 5. Conclusion

The study employed secondary data on rainfall, temperature variations, fertilizers application along with tea production recorded between 2010 and 2021 at Mulindi Factory Company in the Northern Rwanda. The Microsoft Excel and SPSS software enabled the researcher to analyze the collected data. The results indicate that both 2014 and 2020 years recorded high rainfall of 105.5 and 126.2 mm, respectively. For the temperature variation, the record was quite stabilized and/or constant compared to the rainfall. With regard to fertilizers, since 2010 to 2021, the record kept on increasing in terms of application. The tea production also revealed a growing trend from 8,383.41 Kg/Ha in 2010 to 10,131.40Kg/Ha in 2021. For the relationship between rainfall and temperature variations with tea production, a statistically significant (positive) relationship ($r1=0.990$) and ($r_2=0.993$) was estimated, respectively. This confirmed that p*recipitation and temperature variability significantly impact tea production*. Policy maker can base on the findings of this study to implement climate resilient agriculture.

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