Environment and Natural Resources Journal

Volume 23
Issue 5
2025

Effect of Climate Variability on Chili Pepper (*Capsicum frutescens* L.) Cultivation in Indonesia

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ARTICLE INFO

Received: 17 Apr 2025
Received in revised: 20 Jun 2025
Accepted: 24 Jun 2025
Published online: 22 Jul 2025
DOI: 10.32526/ennrj/23/20250097

Keywords:
ENSO/ Chili productivity/ Climate factors/ Rainfall variability/ Seasonal variability/ Statistical analysis

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ABSTRACT

Significant shifts in climate patterns, particularly in rainfall and frequency of rainy days, are factors contributing to high variability in cultivation of agricultural products such as chili peppers. Therefore, this study investigated the impact of seasonal climate variability on chili pepper (*Capsicum frutescens* L.) production in Sleman Regency, of Central Java, Indonesia. Statistical methods including analysis of variance (ANOVA), principal component analysis (PCA), and Pearson correlation were used to examine the influence of various climate and seasonal factors such as rainfall, air temperature, humidity, rainy days, dry season onset, and duration on chili productivity. The results showed that total rainfall and frequency of rainy days significantly affected chili productivity, with correlation coefficients of +0.579 and +0.492 ($p<0.05$), and ANOVA confirming a strong relationship ($F=260.75$, $p<0.001$). This showed that rainfall distribution and frequency were critical factors influencing yield variability. Statistical analyses correlated with climate variability index calculations further confirmed significant climate changes in the region. Based on the results, both total rainfall and seasonal distribution were critical factors influencing chili pod productivity, emphasizing the importance of agricultural planning and adaptation strategies under changing climate conditions. The novelty of this study was in local-scale seasonal analysis, which used a climate variability index to detect extreme variability. When combined with multivariate statistical triangulation (correlation, PCA, and ANOVA), it offered robust evidence for region-specific adaptation strategies for chili farmers. The results showed the importance of including climate indicators in agricultural policy planning. Moreover, further studies were recommended to explore spatial climate trends across broader regions.

HIGHLIGHTS

- Climate data from 2010-2023 is analyzed for chili productivity trends.
- Rainfall and rainy days show a strong correlation with productivity.
- PCA identifies rainfall as the dominant factor influencing chili yield.
- ANOVA confirms rainfall's significant effect on yield variability.
- Study offers local adaptation insights for climate-sensitive crops.

1. INTRODUCTION

Indonesia is recognized as one of the world's most agriculture-dominated nations, where the sector serves as a cornerstone of the national economy (Hajad et al., 2023). The abundant natural resources, tropical climate, year-round sunshine, sufficient water availability, and fertile soils provide highly favorable conditions for agricultural development (Malihah,

Citation: Nugroho BDA, Ardhitama A, Sartohadi J, Qadafi M, Siswoko BD, Adilah AHA. Effect of climate variability on chili pepper (*Capsicum frutescens* L.) Cultivation in Indonesia. Environ. Nat. Resour. J. 2025;23(5):459-468. (https://doi.org/10.32526/ennrj/23/20250097)

2022). A significant portion of the population depends on this sector, where the majority is engaged in farming activities, making farmers significant contributors to national food production and rural livelihoods (Arvianti et al., 2019; Khotimah and Purnomo, 2018). Fertile soils are among key assets in Indonesia, advancing the agricultural sector (Pewista and Harini, 2013; Rondhi et al., 2018).

The availability of natural resources offers substantial opportunities for cultivating various food and horticultural crops (Setiyanto and Pasaribu, 2021). Among these crops, chili pepper (*Capsicum frutescens* L.) is a high-value commodity (Pertami et al., 2022). In addition to the economic importance, chili plays an essential role in Indonesian cuisine by contributing the distinctive spiciness and nutritional value (Siebert et al., 2022; Aprilia et al., 2023). However, the volatility of chili prices and supply often triggers public as well as governmental concerns, directly influencing national inflation and food security (Zelviyani, 2022).

The rising demand for chili production has driven both land expansion and production intensification, including through large-scale agricultural initiatives such as “food estates.” National development strategies for chili focus on four objectives, namely ensuring year-round availability, stabilizing market prices, reducing imports, and boosting exports (Swastika et al., 2017). Despite these efforts, chili pepper is highly sensitive to environmental and climate factors, particularly temperature, humidity, and precipitation. Moreover, optimal growth occurs at temperatures between 24-28°C and humidity levels of 78-88%, with a weekly water requirement of approximately 2.5 to 3.5 cm (Yahwe and Isnawaty, 2016).

The sensitivity to environmental factors makes chili pepper vulnerable to climate variability and extreme weather events, leading to flower drop, crop failure, as well as high pest and disease outbreaks (Ayu et al., 2021). Climate change disrupts traditional agricultural practices by altering planting schedules, sowing periods, and overall yield as well as quality (Hidayati and Suryanto, 2015). For chili and other vegetable crops, intense rainfall causes direct damage, fostering fungal and bacterial diseases such as anthracnose, potentially reducing yields by approximately 50% (Emilia, 2020; Ardhitama et al., 2025).

Although previous studies have identified key climate factors influencing agricultural productivity, the specific seasonal impacts on chili yield remain underexplored (Herlina and Prasetyorini, 2020). Due to the varying climate changes, generalizations regarding temperature and humidity effects are insufficient without localized analysis. Therefore, this study aimed to investigate the impact of seasonal climate variability on chili pepper (*Capsicum frutescens* L.) production in Sleman Regency, Central Java, Indonesia. The experiment was conducted in Sleman Regency, Central Java, designated as a national chili production center under Decree No. 472/Kpts/RC.040/6/2018.

Despite the strategic role, there is limited understanding of how seasonal climate variability affects chili productivity in this region. Although several studies have explored the effect of rainfall on crop productivity, there is still limited quantitative analysis of seasonal climate variability using statistical indices and combined statistical validation at the local level in high-value horticultural crops like chili. Few studies have also focused on strategic agricultural regions like Sleman Regency, where climate risks are compounded by orographic and monsoonal influences.

The novelty of this study is in the focus on seasonal shifts, the application of climate variability indices, and the use of multivariate statistical analysis (PCA, ANOVA, and Pearson correlation) to validate the influence of several factors on productivity. The results are expected to offer practical adaptation strategies for local farmers. Additionally, this study explores the influence of seasonal rainfall and frequency of rainy days on chili production, providing locally relevant adaptation recommendations to enhance agricultural resilience under climate change.

2. METHODOLOGY

This study was conducted in Sleman Regency, Yogyakarta, located at coordinates 110°18'47" to 110°29'50" E and 7°34'13" to 7°49'57" S from August to December 2023, using secondary data collected between 2010-2023. Climate data (rainfall, rainy days, and temperature) were obtained from the BMKG Climatology Station, while chili productivity data were from the Sleman Agriculture Department. A statistical method was applied to analyze the influence of weather and climate variability on chili productivity.

Sleman Regency is located on the southern slope of Mount Merapi in the Yogyakarta Special Region, Java Island. This region is characterized by undulating to mountainous terrain, which contributes to the unique rainfall pattern through orographic influences. Figure 1 shows the administrative boundaries and key topographic features relevant to the spatial variability of climate.

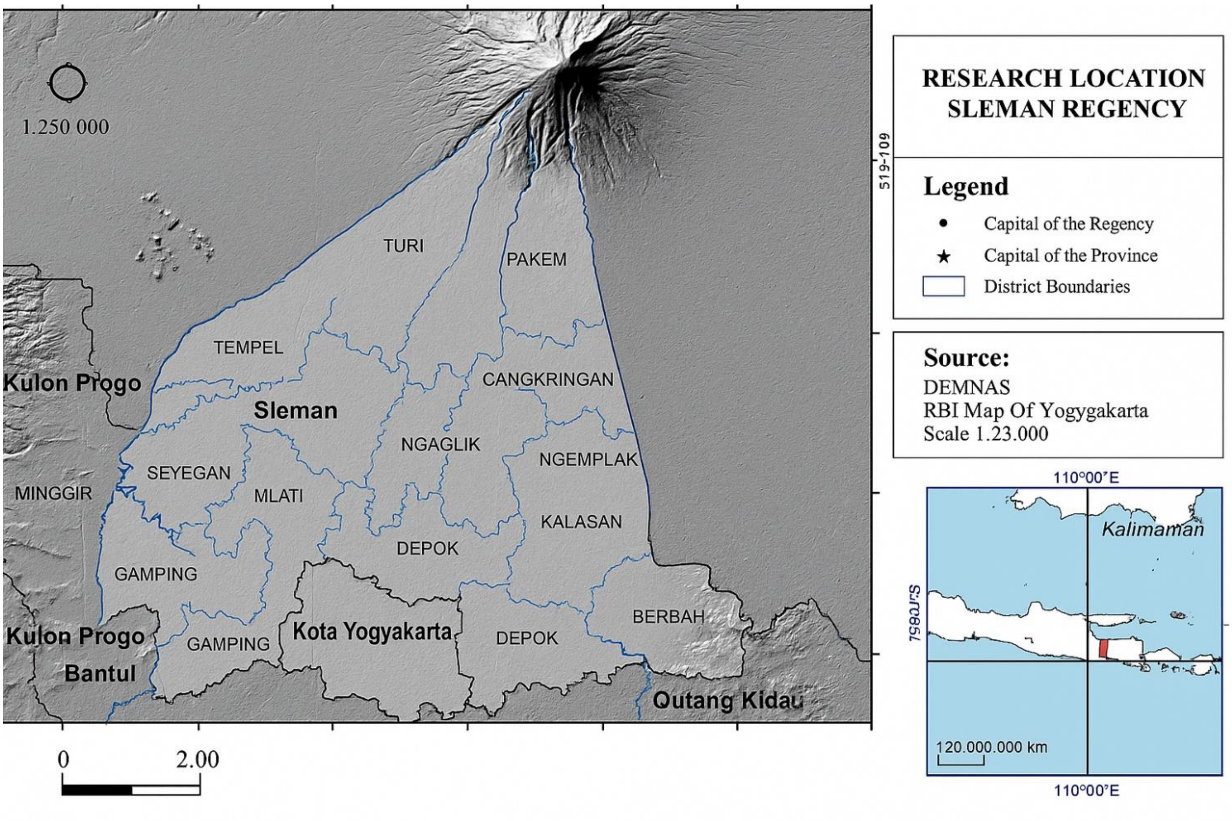

Figure 1. Map of study location

Secondary data were collected from the Sleman Geophysics Station under the BMKG Climatology Station of the Special Region of Yogyakarta. The data obtained covered rainfall, rainy days, humidity, temperature, onset and shift of dry season, dry season rainfall characteristics, and dry season duration for the 2010-2023 period. Data on chili pepper productivity and harvested region for the same period were obtained from the Sleman Department of Agriculture, Food, and Fisheries. The analysis focused on evaluating the influence of climate factors on chili productivity in Sleman Regency from 2010 to 2023. The onset and retreat of the wet and dry seasons were determined using BMKG's rainfall-based thresholds, where the start of the rainy season was defined by a sequence of five consecutive days with rainfall ≥50 mm. Seasonal duration was calculated based on monthly rainfall distribution. These definitions were consistently applied to ensure objectivity and transparency in seasonal classification across years. The stages of data processing in this study comprised, analysis of climate change variability, which included calculating climate data as follows:

$$\text{Variability} = (90p - 10p) / 50p \qquad (1)$$

Climate change variability is found by taking away the rainfall amount at the 90th percentile from the 10th percentile value, and then this number is divided by the value obtained at 50th percentile. (Eldridge and Beecham, 2017). The values of climate factors in region are essential indicators of variability coefficient, as shown in Table 1.

Table 1. Climate variability coefficient

Variability coefficient	Category
0-0.50	Low
0.50-0.75	Low to moderate
0.75-1.00	Moderate
1.00-1.25	Moderate to high
1.25-1.50	High
1.50-2.00	Very high
>2.00	Extreme

Source: Eldridge and Beecham (2017)

Conducting chili productivity analysis from 2010 to 2023 in Sleman Regency using the following calculations:

Productivity = (Production (Kw))/(Harvested area) (2)

In order to see how climate affects chili productivity, this study checked the connection between rainfall, temperature, rainy days, when the dry season starts and ends, and some farming activities like harvested area. The objective was to find out how much these weather parts matter for chili production.

Before performing the actual analysis, the data from 2010 to 2023 was looked at to ensure availability and followed a normal pattern. If any data was missing, methods like filling in gaps with straight lines or using average values from seasons were used to fix it for everything to be consistent over the 14 years. The ways to study the data were picked based on usual practices in climate and farming practices. Pearson correlation was used to tell whether there was a strong or weak connection between each climate factor and how much chili was produced. To check more things at the same time and facilitate easy understanding, PCA was used to point out the most important factors. ANOVA helped to check if differences in rainfall or rainy days really made a difference in how much chili was grown.

All the analysis was done in RStudio using known packages like stats, car, FactoMineR, and factoextra. PCA was useful in picking out which weather things had the most effect on changes in productivity. This methodological framework reflects current advances in data-driven climate-agriculture studies, offering valuable insights by integrating multiple statistical methods for robust interpretation. The results have the potential to contribute novel understanding to the field, particularly in the context of climate variability impacts on horticultural production in tropical regions.

Climate data on rainfall, temperature, and rainy days were obtained from the Gamping Climatology Station, which served as the primary reference for Sleman Regency. However, this study used meteorological data from a single climatological station, which might not fully capture the microclimatic heterogeneity across this region. The limitation could affect the generalizability of the results and was acknowledged in the interpretation of the results.

This study applies a triangulated statistical method combining correlation, PCA, and ANOVA, each serving complementary purposes. Pearson correlation identifies the strength and direction of bivariate relationships between individual climate factors and productivity. PCA is used to reduce dimensionality and detect the most influential factors among multiple correlated indicators. ANOVA is applied to test whether differences in productivity across climate categories (high vs. low rainfall years) are statistically significant. These tools enable a comprehensive and layered interpretation of how seasonal climate variability affects chili productivity at local level.

3. RESULTS AND DISCUSSION

3.1 Analysis of chili productivity in Sleman Regency

The productivity of chili pepper in Sleman Regency from 2010 to November 2023, measured in quintals per hectare (q/ha), shows considerable fluctuation, as presented in Figure 2. The time-series analysis shows an unstable trend, with productivity ranging between 22 and 37 q/ha over the 14-year period. Based on the results, the highest yield was recorded in 2010, while the lowest occurred in 2022 and 2023, showing the influence of environmental and climate factors.

The fluctuation in chili production in Sleman Regency seem to be much because of changes in climate. One big reason for this is how the El Niño-Southern Oscillation (ENSO) affects the rain. During years with El Niño, like 2015, 2019, and 2023, it rained significantly less, and chili yields also dropped. On the other hand, in La Niña years such as 2011, 2020, and 2022, there was more rain, which had mixed results, sometimes helping and affecting crops. This shows that large climate system like ENSO affects local rain patterns and can really change how much chili is grown in the region.

Recent studies indicate that Sleman Regency has been increasingly affected by climate disturbances associated with El Niño and La Niña events (Siswanto et al., 2022). During El Niño years 2015, 2019, and 2023 chili productivity declined markedly, reaching 25 q/ha in 2015, decreasing further to 22 q/ha in both 2019 and 2023. The drop in chili production matches with dry conditions and hotter weather that usually come with El Niño, which makes water harder to get and slows down photosynthesis, limiting much yield (Aditya et al., 2021). But in La Niña years like 2011, 2020, and 2022, productivity was also affected, rising substantially in 2020. Even though La Niña represents more rain and cooler air that can help plants grow better at first, too much rain is not good for productivity. It can flood the soil and bring more root problems, which makes the crops less healthy. A good example is the Triple Dip La

Niña from 2020 to 2022, which showed how longer periods of this kind of weather can be risky (Anggraini et al., 2022). This shows that climate factors do not always work the same way and can have complicated effects on farming.

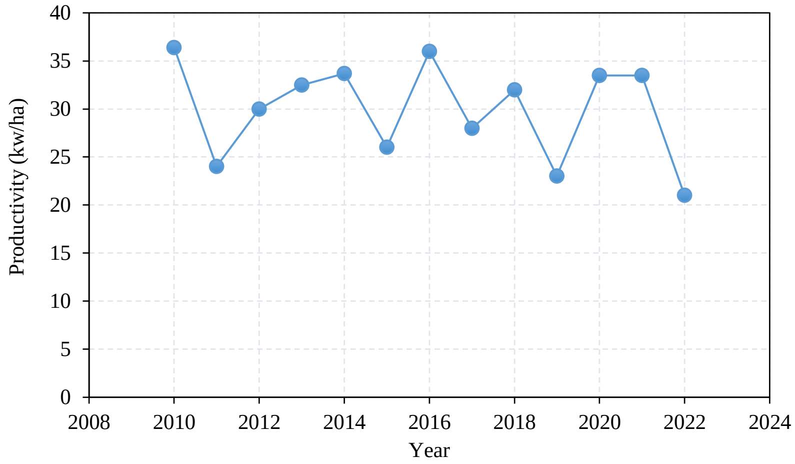

Figure 2. Calculation of chili pod productivity in Sleman Regency 2010-2023

3.2 Climate variability analysis

At the Gamping Geophysical Station, calculations were conducted for each climate factor, namely rainfall, air temperature, air humidity, and rainy days. The analysis was conducted to examine the response to climate factors that occurred between 2010 and 2023. From the calculation results in Table 2, climate variability values indicate that factors experiencing changes over the 14-year period are rainfall as well as the frequency of rainy days. Rainfall and rainy days have average variability values of 1.84 and 1.18, respectively. Based on the Climate Variability Index (CVI), rainfall showed very high variability, while frequency of rainy days had medium to high variability. In comparison, air temperature and relative humidity showed low inter-annual changes, with CVI values below 0.05, indicating minimal fluctuations during this study.

Table 2. Calculated value of climate variability

Year	Rainfall	Temperature	Relative humidity	Number of rainfall days
2010	1.30	0.03	0.05	0.45
2011	1.63	0.10	0.25	1.15
2012	1.29	0.05	0.54	1.14
2013	2.32	0.06	0.09	1.10
2014	2.37	0.07	0.12	1.28
2015	1.68	0.08	0.13	1.04
2016	0.92	0.04	0.04	0.51
2017	2.71	0.05	0.07	1.28
2018	2.46	0.10	0.06	1.39
2019	2.66	0.11	0.12	1.39
2020	1.86	0.04	0.10	1.24
2021	1.44	0.03	0.07	1.64
2022	1.15	0.04	0,07	0.97
2023	2.03	0.06	0.09	1.92
rata-rata	1.84	0.06	0.13	1.18

Source: Data Processed 2023

Rainfall intensity, distribution, and frequency of rainy days in Sleman Regency have been increasingly influenced by climate change, showing high variability compared to other equatorial regions such as West Kalimantan (Firdauzi and Suarma, 2023). Compared to Sleman, which is in the southern monsoonal zone of Java with strong orographic effects, West Kalimantan is situated near the equator with flatter terrain and more uniform rainfall patterns. Although rainfall in equatorial climate tends to be more evenly distributed throughout the year, making seasonal shifts less pronounced, Sleman shows greater fluctuation in rainfall distribution. This is due to the geographical position and topographic complexity, which amplify the sensitivity of rainfall to seasonal and climate changes. In equatorial zones, like West Kalimantan, rainfall variability is generally classified as medium, with stations showing minor fluctuations in specific months (Aditya et al., 2021). These regions typically experience two rainy seasons and a brief dry season, driven by the sun's apparent biannual passage across the equator, causing relatively small temperature and seasonal amplitude (Liebmann et al., 2014). In Sleman Regency, the changes between the wet and dry times are becoming more bigger, showing that the normal equator rain system is not happening like before (Azizah and Zaki, 2025; Sundararaj et al., 2024).

Table 3 is showing the information on the monthly data like rain, air temperature, humidity, number of rainy days, when the dry season starts, and how long the dry season. The data are obtained from 2010 until 2023. The rainfall is changing significantly, from very small (18.2 mm) to very high (567.3 mm), which is representing big variations every season and year. Rainy days are also very different, with numbers between 3 and 27 days in a month. Meanwhile, temperature and humidity are not changing much, with standard numbers being just 1.1°C and 4.3%. The dry season mostly starts at the end of May and can last from 2 months to 6 months. This kind of data numbers is used for helping to look at how much the climate is changing and the effect on farming and crop growing.

Table 3. Summary statistics of climate and seasonal factors in Sleman Regency (2010-2023)

Factors	Mean	Min	Max	Standard deviation	Unit	Notes
Rainfall (monthly total)	215.8	18.2	567.8	110.4	mm/month	Higher values in Nov-Mar (wet season)
Rainy days (monthly count)	14.1	3	27	5.6	days/month	Strong El Niño years had lowest values
Temperature (monthly mean)	27.4	24.3	30.9	1.1	°C	Relatively stable throughout the year
Relative Humidity	83.5	70	94	4.3	%	Higher during La Niña periods
Dry season Onset (average)	3rd week of May	April	June	-	-	Defined per BMKG onset criteria (5 consecutive dry days)
Dry season duration	4.2	2	6	1.2	months	Shorter in La Niña, longer in El Niño years

When comparing, Sleman Regency is considered to be tropical monsoon and also has orographic rain, which is the reason why the rainfall is more changing. The wet season has not many rainy days but many dry ones, which shows the rain is not spread properly. This is similar to what was found by Eldridge and Beecham (2017), who stated that places with mountains and high lands usually get more changing rain than regions near the sea. Since Sleman is on the side of Mount Merapi, the rain is affected by the mountain, where going up in height makes more rain problems happen.

Rainfall changes are very much affected by year-to-year climate factors like El Niño and La Niña, the Indian Ocean Dipole (IOD), and temperature in the sea near south Java (Izumo et al., 2020; Jun-Ichi et al., 2012; Pothapakula et al., 2020). These reasons make rain patterns more complicated, showing that the region is more prone to bad climate and needs special plans to help farming be better prepared.

3.3 Analysis of correlation coefficient values for climate and seasonal factors

The results of the correlation coefficient calculations relating productivity with climate and seasonal factors were computed individually. Table 4 shows the calculation results, indicating that the influential factors were rainy days and rainfall, with correlation coefficient values of +0.579 and +0.492, respectively. Among the 8 climate factors, only 2 showed Pearson correlation coefficients that were significant, with values exceeding 0.5. This showed a fairly strong relationship between chili productivity as well as climate and seasonal factors.

Table 4. Pearson correlation between climate and seasonal factors on chili productivity

	Rainfall	Temperature	RH	Number rainfall days	Start season	Shift	Season characteristics	Duration
Productivity	**0.579***[*]	-0.049	0,045	**0.492**[**]	0.083	0.083	0.218	-0.326

Note: [*,**] = p value<0.05 was taken to be significant. Source: Data Processed, 2023

Pearson correlation coefficient was calculated at a significance level of 0.05 to analyze the relationship between climate variability and chili productivity. Table 4 shows that the most influential factors were rainy days and rainfall, with correlation coefficients of +0.579 and +0.492, respectively. This showed a positive and fairly strong linear relationship between these climate factors and chili productivity. Generally, rainfall plays a key role in providing the necessary water for chili plant growth, which significantly impacts productivity, particularly in regions like Sleman Regency. Seasonal variability, particularly in rainfall intensity and temporal distribution, also affects chili productivity (Firdauzi and Suarma, 2023).

Excessive rainfall can negatively impact chili, due to high sensitivity to waterlogging. Chili requires specific water conditions to thrive, and prolonged rainfall can disrupt this balance, affecting plant growth. Therefore, chili growers often plant at seasonal transitions to avoid waterlogged conditions capable of hindering root respiration and overall plant health (Jinagool and Arom, 2023). In addition to rainfall, the onset and duration of dry season also influence productivity. This study found a weak correlation (0.218) between the dry season's characteristics and productivity. There was also a slightly stronger inverse correlation (0.326) between the length of the dry season and productivity. However, the onset and advance of the dry season did not significantly impact chili productivity.

A study in Malang Regency showed a different pattern, where the relationship between productivity as well as rainfall and temperature was weaker, with air humidity being the most influential factor on chili productivity (Ridho and Suminarti, 2020). In contrast to Malang Regency, with lower annual rainfall variation due to coastal proximity and differing agroclimatic zoning, Sleman Regency shows more pronounced dry season extremes. This suggests that temperature and humidity consistently affect different regions. For instance, excessive humidity from heavy rainfall can delay pollination, thereby promoting fungal growth, pests, and diseases, which negatively impact chili productivity (Ferdiyanto and Sujono, 2018). In one study about corn growing in Malang Regency, the air temperature was found to be the biggest thing that affected productivity. Rainfall did not have much effect because the amount of rain every month was already enough for the corn to get water (Herlina and Prasetyorini, 2020). This is showing that different crops need climate factors, because of variations across regions.

Table 5 summarizes the key statistical results showing that rainfall and rainy days consistently become the dominant factors influencing chili productivity in Sleman Regency. The correlation coefficients (r=0.579 and 0.492, respectively; p<0.05) indicate a moderate to strong positive relationship. These results are further supported by PCA analysis, where both factors contribute significantly to the variance in productivity. Additionally, ANOVA confirmed significant differences in productivity across different levels of these factors (F=260.75, p<0.001).

The results from three methods, correlation, PCA, and ANOVA, all showed that rainfall and rainy days are very important for chili productivity. Using these methods helped make the understanding more sure and matched with other studies in tropical places where rainfall was mostly the main factor stopping crops from growing well (Guido et al., 2020; Eldridge and Beecham, 2017). Although the correlation coefficients fall within a moderate range (r=0.579 and 0.492), their statistical significance (p<0.05) and consistent confirmation across multivariate analyses support their validity. More importantly, these results emphasize that, among various fluctuating factors, rainfall both in total volume and temporal distribution remains the most actionable and policy-relevant parameter for climate-sensitive crops such as chili.

There is a need to contextualize these findings in light of spatial variations reported in the literature. Some studies, particularly those conducted in more hydrologically stable or lowland regions, have found that rainfall does not significantly influence productivity. These differences show variations in agroecological regions, farming systems, and rainfall sufficiency thresholds. In comparison, Sleman

Regency experiences high seasonal rainfall variability due to orographic and monsoonal dynamics, making rainfall a far more critical determinant of crop outcomes. Therefore, this study shows the importance of conducting localized climate-productivity assessments focusing on regional conditions.

Table 5. Summary of statistical results on climate factors influencing chili productivity in Sleman Regency (2010-2023)

Method	Factors	Key result	Significance
Pearson correlation	Rainfall, Rainy Days	R=0.579, 0.492	$p<0.05$
PCA	Rainfall, Rainy Days	Dominant components	Cumulative variance < 80%
ANOVA	Rainfall, Rainy Days	F=260.75	$p<0.001$

In line with this study, rainfall and rainy days are dominant predictors, although other agronomic factors such as fertilizer application, pest outbreaks, irrigation management, seed variety, and market access also contribute significantly to productivity. These non-climate factors are not included due to data availability constraints, and their exclusion limits the comprehensiveness of the analysis. Therefore, future studies should consider integrating both climate and non-climate factors in a multivariate framework to develop a more holistic understanding of the determinants of chili productivity.

3.4 PCA analyses between climate variability and productivity

The PCA results for rainfall and rainy days in Figure 3 show that the total variance value is under 80%, which means it is important. By using PCA on the data about chili productivity and climate, the main part of the analysis was found to affect chili farming the most. These results provided more details about how much each climate and season factor added to the changes in chili productivity. Rainfall and rainy days were the biggest components that had the most effect on the change in chili pod productivity values.

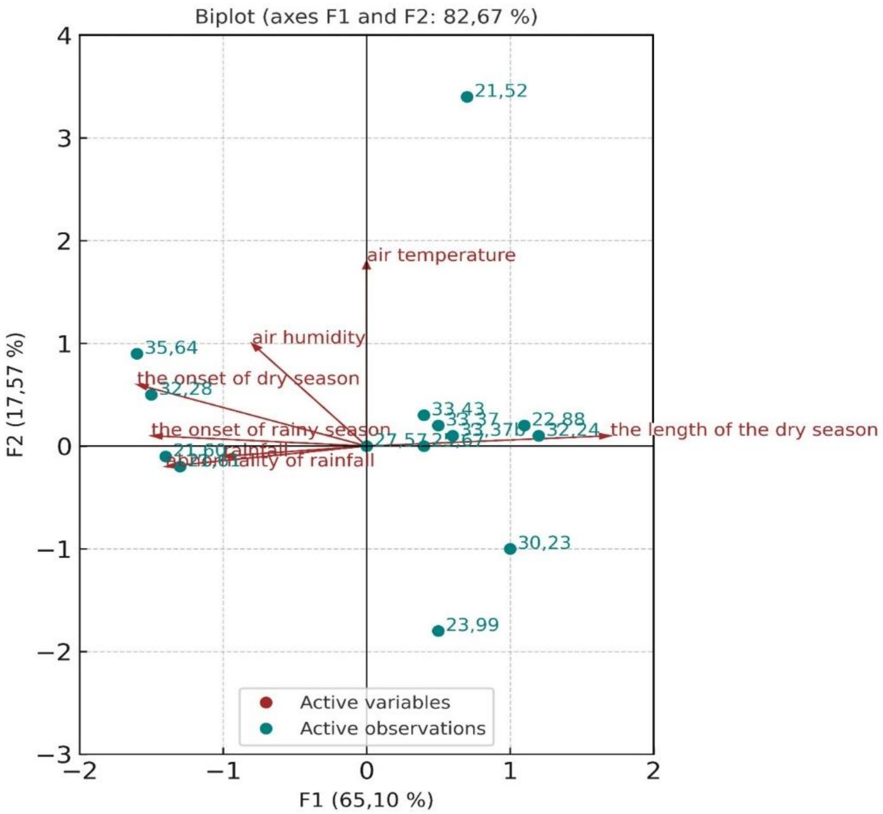

Figure 3. Principal component analysis results

The PCA results in Figure 3 showed that rainfall and rainy days were the main factors causing changes in productivity, with the total variance being less than 80%. To find which factors were most important, the analysis looked at three things, namely scree plot line, how much was explained in total, and eigenvalue. Because rainfall data is very important for how crops grow, knowing how rain occurs in each area is needed to help with making choices in farming (Guido et al., 2020). In some places, rain may not have a big effect on farming productivity (Aditya et al., 2021).

3.5 ANOVA analysis

ANOVA analysis of climate and seasonal factors as the main components influencing chili commodity (Table 4). After PCA results identified rainfall and rainy days as influential, ANOVA analysis was performed to observe the relationship between rainfall, rainy days, and chili productivity. The results showed that factors related to rainy days and rainfall significantly affected chili productivity. With a p-value<0.05, production was significantly impacted by the significant differences between the two factors, as shown in Table 6.

Table 6. Results of ANOVA analysis of the relationship between climate factors and productivity

Source of variation	SS	df	MS	F	p-value	F crit
Between groups	42228656	2	21114328	260.7484	2.6828E-23	3.238096
Within groups	3158059	39	80975.86			
Total	45386715	41				

Note: p-value<0.05 was taken to be significant. Source: Data Processed, 2023

4. CONCLUSION

In conclusion, this study showed that chili productivity in Sleman Regency was significantly influenced by climate factors, particularly rainfall and rainy days. The correlation analysis showed a positive relationship between these factors and chili productivity, with coefficients of +0.579 for rainy days and +0.492 for rainfall, indicating a moderately strong association. PCA further confirmed that rainfall and rainy days were the most influential factors contributing to productivity variability, accounting for a substantial proportion of the overall variance. Furthermore, ANOVA analysis supported these results, showing the significant role of seasonal and climate factors in determining chili productivity. This study also showed that changes in climate variability, particularly in rainfall patterns, had become more pronounced in recent years, further emphasizing the impact of climate change on agricultural productivity. Moreover, future studies should focus on integrating non-climate variability such as agronomic practices and socio-economic factors to build a more comprehensive resilience model. The investigations should be carried out by exploring spatial climate patterns and incorporating additional factors to provide a more comprehensive understanding of the factors affecting crop productivity in Sleman Regency.

ACKNOWLEDGEMENTS

This study is supported by the Research Center for Land Resources Management, Universitas Gadjah Mada.

AUTHOR CONTRIBUTIONS

Conceptualization, B.D.A.N and A.H.A.A.; Methodology, B.D.A.N.; Software, B.D.A.N.; Validation, B.D.A.N and J.S.; Formal Analysis, B.D.A.N and A.H.A.A.; Investigation, B.D.A.N.; Resources, M.Q.; Data Curation, B.D.A.N.; Writing-Original Draft Preparation, B.D.A.N.; Writing-Review and Editing, A.H.A.A and J.S.; Visualization, B.D.A.N.; Supervision, J.S and B.D.S.; Project Administration, B.D.A.N.; Funding Acquisition, A.H.

DECLARATION OF CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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